# Department of Post Graduate Studies in Chemistry

**FIRST SEMESTER**
**CH 101 -ANALYTICAL CHEMISTRY I**
Fundamentals of Chemical Analysis

(48 HOURS)

**UNIT – I**

**Statistical Treatment of Analytical Data and Sampling:** Limitations of analytical methods. Classification of errors – systematic errors – sources, effects and their reduction. Random errors – sources and distribution. Accuracy and precision. Measures of central tendency and variability. Reliability of results – confidence interval.

Comparison of results – Student's t-test, comparing the two means and standard deviations-F test, t-test and paired t-test. Rejection of a result – Q-test. Number of replicate determinations. Control charts. Correlation and regression- correlation coefficient, linear regression, errors in slope and intercept, error in the estimate of concentration. Detection limits.

Sampling and sample handling – representative sample, sample storage, sample pretreatment and sample preparation. Hazards in sampling.

Quality in analytical laboratories – quality control and quality assurance, accreditation system.

[16 Hours]

**UNIT – II**

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

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

**Applications of acid-base titrations:** Determination of nitrogen, sulphur, ammonium salts, nitrates and nitrites, carbonates and bicarbonates, and organic functional groups like carboxylic acid, sulphonic acid, amine, ester, hydroxyl, carbonyl groups, air pollutants like $SO_2$.

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

[16 Hours]

**UNIT – II**

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

**Complexometric titrations:** Complex formation reactions, stability of complexes, stepwise formation constants, chelating agents, EDTA – acidic properties, complexes with metal ions, equilibrium calculations involving EDTA, conditional formation constants, derivation of EDTA

titration curves –effect of other complexing agents, factors affecting the shape of titration curves-completeness of reaction, indicators for EDTA titrations- theory of common indicators.

Titration methods employing EDTA -direct, back and displacement titrations, indirect determinations, titration of mixtures, selectivity, masking and demasking agents, typical applications of EDTA titrations-hardness of water, magnesium and aluminium in antacids, magnesium, manganese and Zinc in a mixture, – titration of chloride with $Hg^{2+}$ and cyanide with $Ag^{+}$.

[16 Hours]

**REFERENCES.**


1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D Christian, 5th edition, 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A Day and A.L. Underwood, 6th edition, 1993prentice Hall, Inc. New Delhi.
4. Vogel's Text book of Quantitative Chemical Analysis, J. Mendham, R.C Denney, J.D Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003 Pearson education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principals, John H. Kennedy, 2nd edition, Saunders College Publishing California, 1990.

## FIRST SEMESTER

## CH 102 -INORGANIC CHEMISTRY I

Modern Concepts of Inorganic Chemistry

(48 HOURS)

### UNIT – I

**Ionic Bond:** Properties of ionic substances, structures of crystal lattices (NaCl, CsCl, ZnS, Wurtzite and rutile) Lattice energy, Born-Haber cycle, uses of Born-Haber type calculations, Born-Lande equation, Ionic radii, factors affecting the radii of ions, radius ratio effects, covalent character in ionic bonds, hydration energy and solubility of ionic compounds.

**Covalent Bond:** M.O. Treatment for homonuclear and heteronuclear diatomic molecules. M.O. treatment involving delocalized π-bonding ($CO_3^{2-}$, $NO_3^-$, $NO_2$, $CO_2$ and $N_3^-$). Weak interactions in covalent substances. VSEPR model for explaining structure of molecules including fluxional molecules, short comings of the VSEPR model.

[16 Hours]

### UNIT – II

**Modern concepts of acids and bases:** Lux - Flood and Usanovich concepts, solvent system and leveling effect. Hard – Soft Acids and Bases Classification and Theoretical backgrounds.

**Non – aqueous solvents:** Classification of solvents, properties of solvents (dielectric constant; donor and acceptor properties) protic solvents (anhydrous $H_2SO_4$, HF and glacial acetic acid), aprotic solvents (liquid $SO_2$, and $N_2O_4$). Solutions of metals in liquid ammonia, hydrated electron. Complex hydrides of boron and aluminium, halogens in positive oxidation states, astatine, psuedo halogens.

[16 Hours]

### UNIT – III

Correlation of general properties of d-block elements with those of 4f and 5f elements.

**Lanthanide series:** Introduction, electronic structure, oxidation states, lanthanide contraction, abundance and extraction, lanthanides as shift reagents.

**Separation of lanthanides:** Solvent extraction and ion – exchange.

Chemical properties of compounds of lanthanides in II, III, and IV oxidation states. Magnetic properties, colour and spectra.

**Actinides:** Electronic structure and position in the periodic table, oxidation states, occurrence and synthesis of the elements. Spectral and magnetic properties of compounds of actinides in comparison with those of lanthanides and d-block elements.

**Uranium:** Isotope separation / enrichment, Chemical properties, hydrides, oxides and halides. Chemistry of trans – uranium elements.

[16 Hours]

**REFERENCES**


1. Inorganic Chemistry (4th edition): J.E Huheey, E.A Keiter and R.L. Keiter (1993); Harper Collins.
2. Introduction to modern inorganic chemistry (4thedition): K.M. Mackay and R.A Mackay (1989): Blackie.
3. Advanced inorganic Chemistry (5th edition): F.A Cotton and G.Wilkinson (1990): Wiley.
4. Concise Inorganic Chemistry (5th edition): J.D. Lee (2000); Blackwell Science.
5. Concepts and Models if Inorganic Chemistry (3rd edition) B.E.Dougglas, D.H. Mc Daniel and Alexander. (2001): Wiley.
6. Chemistry of the Elements: Greenwood and Earnshaw. (1986): Pergamon Press.
7. Inorganic Chemistry (3rd edition): Shriver, Atkins and Langford (1999); Oxford University Press.

## FIRST SEMESTER

## CH 103 -ORGANIC CHEMISTRY I

Stereochemistry and Organic Reaction Mechanism

(48 HOURS)

### UNIT – I

**Stereochemistry:** Stereoisomerism, projection formulae (Fischer, Newman, sawhorse, flying wedge), enantiomers, diastereomers, racemic mixtures and their resolutions, configurational notations of simple molecules, DL and RS.

**Optical isomerism:** Conditions for optical isomerism: isomerism due to chiral centers and molecular dissymmetry, allenes and biphenyls.

**Geometrical isomerism:** Isomerism due to C=C, C=N and N=N. EZ conventions. Determination of configuration by physical and chemical methods.

**Structure and reactivity:** Acids and Bases, Structural effects on acidity and basicity, hydrogen bonding, resonance, inductive and hyperconjugation effects.

**Reaction intermediates:** Formation, structure, stability, detection and reactions of carbocations (classical and non-classical), carbanions, free-radicals, carbenes, nitrenes, nitrile oxides, nitrile imines and nitrile ylides.

[16 Hours]

### UNIT – II

**Reaction Mechanism I**

Classification of reactions, meaning and importance of reaction mechanism.

**Determination of reaction mechanism by kinetic and non-kinetic methods:**

**Kinetic method:** Mechanistic implications from rate laws, the transition state theory, ambiguities in interpreting kinetic data, solvent effect, ionic effect, isotopic effect, substituent effect, steric effect, linear free energy relationships – Hammett equation and Taft treatment.

**Non-kinetic methods:** Energy profile diagram, identification of products, testing possible intermediates, trapping of intermediates, cross over experiments, isotopic labeling, stereochemical studies, limitations of reactions.

**Substitution reactions:**

**Mechanism of nucleophilic substitution reactions –** Kinetics, mechanism and stereo chemical factor affecting the rate of SN1, SN2, SRNi, SNi, SN1', SN2', SNi' reactions, Neighbouring group participation.

**Mechanism of electrophilic substitution reactions –** Kinetics, mechanism and stereochemical factor affecting the rate of SE1 & SE2

**Elimination reactions:** Mechanism and stereochemistry of eliminations- E1, E2, E1cb mechanism, *cis* – elimination, Hoffmann and Saytzeff eliminations, competition between elimination and substitution, Chugaev reaction.

[16 Hours]

### UNIT – III

**Reaction Mechanism II**

**Mechanism of Addition reactions:** Addition to C-C multiple bonds involving electrophiles, nucleophiles and free radicals. Markownikoff's rule and anti-Markownikoff's rule, Hydroboration and its application.

**Typical additions to carbonyl compounds:** Addition of hydride, water, alcohol, thioalcohol, bisulphite, HCN, Grignard reagents and amino compounds.

**Mechanism of reactions of carboxylic acids and their derivatives:** Mechanism of ester hydrolysis formation, formation and hydrolysis of amides, decarboxylation mechanisms.
**Aromatic electrophilic substitution:** Mechanism of nitration, halogenation, sulphonation, Friedel-Crafts alkylation and acylation, Mannich reaction, chloromethylation, Vilsmeier – Haack reaction,
**Aromatic nucleophilic substitution:** SN1, SN2 and benzyne mechanism, Bucherer reaction.

[16 Hours]

**REFERENCES.**


1. E.L.Eliel and S.H. Wilen, Stereochemistry of Organic Compounds, JhonWilley and Sons, New York. 1994.
2. Introduction to stereo chemistry- K.Mislow.
3. Stereo chemistry and mechanism through solved problems – P.S. Kalsi.
4. D. Nasipuri, Stereo chemistry of Organic Compounds, 2nd edition, Wiley Eastern Limited, New Delhi, 1987.
5. H.Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mac Grow hill, New York, 1987.
6. Organic Chemistry – Morrison & Boyd.
7. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.
8. Basic principles of Organic Chemistry – Robert & Casereo.
9. N.S. Issacs, Reactive intermediates in Organic Chemistry, John Willey abd Sons, New York. 1974.
10. R.K. Bansal, Organic Reaction Mechanism, Wiley Eastern Limited, New Delhi, 1993.
11. J. March, Advanced Organic Chemistry Wintermediates in Organic Chemistry Wirley Interscience, 194.
12. E.S. Gould, Mechanism Mechanism and Structure in Organic Chemistry, Halt, Rinhart and Winston, New York,964.
13. A guide book to mechanism in Organic Chemistry – Petersykes.
14. F.A Carey and Sundberg, Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York, 1990.
15. S.K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd, 1998.

**FIRST SEMESTER**
**CH 104 -PHYSICAL CHEMISTRY I**
Quantum and Electrochemistry

(48 HOURS)

## UNIT – I

Wave-particle duality, deBroglie equation. Heisenberg Uncertainty principle, concept of operators (operator-operand), algebra of operators, commutative and non-commutative operators, linear operator, Laplacian operator, Hamiltonian operator, eigen value, eigen function, class Q function, Hermitian operator, turn over rule, atomic units. Wave equation for stretched strings, Schrodinger wave equation for particles, postulates of quantum mechanics. Application of Schrodinger equation to a free particle and to a particle trapped in a potential field (one dimension and three dimensions). Degeneracy, wave equation for H atom, separation and solution of R, Ø and θ equations. Application of Schrodinger equation to rigid and harmonic oscillator.

[16 Hours]

## UNIT – II

Approximate methods – Necessity of approximate methods, perturbation method, the theory of perturbation method – first order and second order correction, application to He – atom (first order correction only) – calculation of first ionization potential and binding energy. Variation theorem-statement and proof. Application of variation theorem to a particle in one dimensional box, linear oscillator, H and He – atoms, SCF method for many electron atom. Slater Orbitals – Effective nuclear charge (ENC), expressions for slater orbitals for 1s, 2s, 3s, 2p and 3d electrons (no derivation). Slater's rules for calculation of ENC -Slater's orbitals for He, carbon and nitrogen. Theories of valence – introduction, linear and non-linear variation functions, secular equations, coulombic, exchange, normalization and overlap integrals, secular determinants.

[16 Hours]

## UNIT – III

Debye-Huckel theory of strong electrolytes, Debye Huckel – Onsager equation, Debye - Huckel limiting equation for activity coefficients, modifications and verifications.

Electrical double layer and its thermodynamics.

A brief survey of Helmholtz - Perrin, Gouy - Champman and Stern electrical double layer, EMF cells Liquid Junction Potential and its determination. Transport Number: Determination of transport number by Hittorf method and e.m.f method. True and apparent transport numbers. Abnormal transport numbers, effect of temperature and concentration on transport number.

Energetics of cell reactions, effect of temperature, pressure and concentration on energetics of cell reactions (calculation of $\Delta G$, $\Delta H$ and $\Delta S$).

Electrochemical energy sources – Batteries, classification, characteristics, primary, secondary and Fuel cells.

[16 Hours]

**REFERENCES**


1) Quantum Chemistry - A. K. Chandra, Second Edition, Tata McGraw Hill Publishing Co. Ltd., (1983).
2) Quantum Chemistry – Eyring, Walter and Kimball, John Wiley and Sons, Inc., New York.
3) Quantum Chemistry – I.N. Levine, Pearson Education, New Delhi, (2000).
4) Theoretical Chemistry – S. Glasstone, East West Press,New Delhi,(1973).
5) Quantum Chemistry- R.J.Prasad, New Age International Publishers (1996).
6) Valence Theory – Tedder, Murel and Kettle.
7) Quantum Chemistry- D.A. McQuarrie.
8) Theoretical Inorganic Chemistry – Day and Selbin.
9) Elements of Physical Chemistry – Lewis and Glasstone.
10) Physical Chemistry by P.W. Atkins, ELBS,4$^{th}$ Edition,Oxford University Press (1990).
11) Introduction to electrochemistry by S. Glasstone.
12) Modern Electrochemistry Vol I and II by J.O.M. Bockr's and A.K.N. Reddy,Plenum Press, New York (1970).
13) Chemical and Electrochemical energy systems – R.NarayanandB. Vishwanathan,Universities Press (India) (1998).
14) Electrochemistry – Principles and applications by E.G. Potter.
15) Electrochemistry by Reiger, Prince Hall (1987).

## FIRST SEMESTER

## CH 105 -SYMMETRY ANDCOMPUTER APPLICATIONS

(48 HOURS)

### UNIT – I

**Symmetry elements and symmetry operations:** rotation axis, rules for orientation of molecules, plane of symmetry, rotation-reflection axis, center of symmetry and identity element of symmetry. Correlation of Schoenflies and Hermann- Maugin Symbols for symmetry elements. Products of symmetry operations. General relations among symmetry elements and symmetry operations.

**Group theory:** Concept of a group, definition of a point group, procedure for classification of molecules into point groups. Schoenflies and Hermann - Maugin symbols for point groups. Properties and definitions of group theory. Multiplication tables for the symmetry operations of simple molecules. International (Hermann - Mauguin) notations, subgroups. Matrix notation for the symmetry elements and for geometric transformations. Class of a group and similarity transformation.

[16 HOURS]

### UNIT – II

**Representation of groups:** Reducible and irreducible representations. The great orthogonality theorem and its consequences. Character tables (Cs, Ci, C2, C2V,C2h and C3V). Labelling of irreducible representations. Group theory and hybrid orbitals to form bonds.

**Applications of group theory:** Applications of group theory to crystal field theory. Bonding in octahedral and tetrahedral complexes. Symmetry and dipole moments, symmetry and optical activity.

**Molecular vibrations:** Introduction, symmetry of normal vibrations, determining the symmetry types of normal modes, selection rules for fundamental vibration transitions.

Representation of vibrational modes in non-linear molecules. Group theory and linear molecules (integration method). Vibrations in polyatomic molecules.

[16 HOURS]

### UNIT – III

**Computers:** Introduction to computers and computing: Basic Structure and functioning of computers with a PC as an illustrative example. I/O devices, Memory, Secondary Storage, Computer Languages, Operating Systems, Introduction to Windows, Introduction to Algorithms and Flow -charts.

**Basic:** Element, principles of Basic Programming, GW Basic and Visual Basic, Chemistry and Basic Programming.

**Fortran:** Principles of Fortran programming, chemistry and Fortran programming. A very brief account of C-programming and chemistry applications.

Computer programming in C: C Fundamental, the characters set, identifiers and key words, data types – constants and variables, declarations, expressions and operators. Data input and output. Control statements, functions and arrays.

**Application of C-language in Chemistry:** Development of small computer codes for solving simple formulae in chemistry such as Van der waals' Equation, pH titration, kinetics of radioactive decay, evaluation of lattice energy and ionic radii from experimental data, linear and simultaneous equations to solve secular equations within the Huckel Theory.

**Application of Computers in Chemistry:** (including practical demonstration), programming examples (using basic, Fortran, spreadsheet and 'C') to handle the following numerical methods in chemistry -least squarefit, solution of simultaneous equation, polynomial equation, graphic kinetics (Montecarlo simulations of kinetics), potentiometric titrations and end point location. Fitting curves and plotting functions. Simulation studies, elements of molecular modeling.

[16 HOURS]

**REFERENCES**


1) Symmetry in Chemistry – H. Jaffe and M.Orchin,John Wiles, New York(1965).
2) Symmetry in Molecules- J.M.Hollas, Chapman and Hall Ltd., London (1972).
3) Chemical Applications of Group Theory- F.A. Cotton, Wiley Eastern Ltd., nd edition,New Delhi (1971).
4) Group theory and Symmetry in Chemistry- G. Raj,A. Bhagi and V. Jain, Krishna Prakashan Media (P) Ltd., Meerut (1998).
5) The Determination of Molecular Structure – P.J. Wheatley,Oxford University Press,Oxford (1969).
6) R. Hunt and J.Shell: Computer and Common Sense (Prince Hall).
7) V. Raja Raman and T. Radhakrishna: An introduction to Digital Computer Design (Prince Hall).
8) A.C. Norris: Computational Chemistry.
9) J.P.Killngbeck and Adam Hilger:Microcomputer Quantum Mechanics.
10) E. Balaguruswamy: Programming in 'ANSI C", Second Ed. (Tata Mc Graw Hill).
11) Theory and Problems of Computing with Basic,B.G.Gotfried, Mc.Graw Hill, New York.
12) Quantitative Analysis,R.A. Day and A.L. Underwood,6$^{th}$ edition,Prince Hall, Inc. 1999.
13) Computer Programming in Fortran IV,V. Rajaraman – Prince Hall, India.
14) Fortran IV for computers, P.N. Arora and H. Singh,S. Chand and Co., New Delhi.
15) C Programming Principles and Practices,M.T. Gardy,Mc Graw Hill.
16) Illustrated C Programming, J.E. Bean, B.P.B. Publications, Delhi.

**FIRST SEMESTER PRACTICALS**
**CH -106 ANALYTICAL CHEMISTRY PRACTICAL I**

**[64 HOURS]**

## PART – I

**Acid – base titrations.**

1. Determination of carbonate and bicarbonate in a mixture by pH-metric titration and comparison with visual acid- base titration.
2. Determination of total acidity of vinegar and wines by acid – base titration.
3. Determination of aniline by non – aqueous acid – base titrations.
4. Determination of replaceable hydrogen and relative molecular mass of a week organic acid by titration with NaOH.
5. Determination of total alkalinity of soda ash by visual and pH-metric titrations.
6. Analysis of sulphathiazole tablets by non-aqueous titration with tetrabutylammonium hydroxide.
7. Determination of saponification value of edible oils.

**Precipitation titrations.**

8. Determination of percentage of chloride in a sample by precipitation titration – Mohrs, Volhard and Fajans methods.
9. Determination of sulphate in ground water by titration with $BaC1_2$ using an adsorption indicator.
10. Determination of saccharin in tablets by precipitation titration.

**Complexometric titrations.**

11. Determination of total hardness of water by complexation titration using EDTA.
12. Determination of calcium in milk powder by EDTA titration.
13. Determination of calcium in calcium gluconate / calcium carbonate tablets or injections by EDTA titration.
14. Determination of chloride content of an industrial effluent by conductometric titration with silver nitrate.
15. Analysis of an industrial effluent for sulphate by conductometric titration with $BaC1_2$.

**REFERENCES.**


1. Vogel's Qualitative inorganic analysis – Svelha.
2. Macro and Semimicro inorganic qualitative analysis – A.I. Vogel.
3. Semimicro Qualitative Analysis -F.J. Welcher and R.B. Halin.
4. Semimicro Qualitative Analysis – Ramanujam.

**FIRST SEMESTER PRACTICALS**
**CH -107 INORGANIC CHEMISTRY PRACTICAL I**

[64 HOURS]

1. **Analysis of Ores:**
    1. Hematite
        1. Insoluble (gravimetrically)
        2. Iron titrimetrically using cerium (IV) solution.
    2. Dolomite.
        1. Insoluble (gravimetrically)
        2. Calcium and magnesium using EDTA
    3. Pyrolusite.
        1. Insoluble (gravimetrically)
        2. Manganese dioxide titrimetrically using permanganate.
2. **Micro – volumetric estimation of calcium using EDTA.**
3. **Analysis of alloys:**
    a) Solder – lead and tin using EDTA
    b) Copper – nickel alloy
        (i) Copper volumetrically using $KIO_3$
        (ii) Nickel gravimetrically using DMG.
4. **Quantitative analysis of mixtures:**
    a) Chloride and iodide
        (i) Iodide volumetrically using $KIO_3$
        (ii) Total halide gravimetrically.
    b) Calcium and lead – using EDTA
5. **Spectrophotometric determination of :**
    a) Iron using thiocyanate / 1, 10 – phenonthroline
    b) Chromium using diphenyl carbazide.
    c) nickel Using dimethylglyoxime
    d) Titanium using hydrogen peroxide.
6. **Circular paper chromatography – separation of : (Demonstration)**
    a) Iron and nickel,
    b) Copper and nickel.

**REFERENCES**


1. A text book of Quantitative Inorganic Analysis – A.I. Vogel. III edition.
2. Vogel's text book of Quantitative Chemical Analysis – J. Basset, R.C. Denney.
3. G.H. Jeffery and J. Mendham. Spectrophotometric determination of elements.

## FIRST SEMESTER PRACTICALS
## CH -108 INORGANIC CHEMISTRY – PRACTICAL I

[64 HOURS]

**Organic Preparations:** Preparations involving oxidation, reduction, dehydration, decarboxylation, halogenation, nitration, sulfonation, diazotization, cyclization, condensation, addition reactions.

1. Preparation of p-bromoaniline from acetanilide.
2. Preparation of p-nitroacetanilide from acetanilide.
3. Preparation of n-butyl bromide from n-butanol.
4. Preparation of o- iodobenzoic acid from anthranilic acid.
5. Preparation of aniline from nitrobenzene.
6. Preparation of osazone derivative.
7. Preparation of penta – O – acetyl – D – glucose from glucose.
8. Preparation of 3 – methyl – 1 – phenyl – pyrazolone.
9. Preparation of cis and trans cinnamic acids.
10. Preparation of phenoxy acetic acid.
11. Preparation of hippuric acid from glycine.
12. Preparation of m-nitrobenoic acid from methyl benzonate.
13. Preparation of aspirin.
14. Oxidation of toluene by $KMnO_4$
15. Preparation of adipic acid from cyclohexanol.

**REFERENCES.**


1. A Text book of Practical Organic chemistry – A.I. Vogel Vol. I
2. Practical Organic chemistry – Mann & Saunders.
3. Manual of Organic chemistry – Dey and Seetharaman.
4. An introduction to practical organic chemistry – Robert, Vingrover etc.
5. J.N Guthru and R. Kapoor, Advance experimental chemistry. S. Chand company, New Delhi, 1991.
6. R. K. Bansal, Laboratory Manual of Organic chemistry, New PGE ingternational (P) ltd. London, 3rd edition, 1996.
7. N. K. Visno, Practical Organic Chemistry, New PGE International (P) Ltd. London, 3rd edition, 1996.

**FIRST SEMESTER PRACTICALS**
**CH -109 PHYSICAL CHEMISTRY – PRACTICAL I**

[64 HOURS]

1. Study of kinetics of hydrolysis of an ester using $HCl/H_2SO_4$ at two different temperatures, determination of rate constants and energy of activation.
2. Study of kinetics of reaction between $K_2S_2O_8$ and KI, first order, determination of rate constants at two different temperatures and Ea.
3. Study of kinetics of reaction between $K_2S_2O_8$ and KI, second order, determination ef rate constant and Ea.
4. Conductometric titration of a mixture HCI and $CH_3COOH$ against of NaOH.
5. Potentiometric titration of KI Vs $KMnO_4$ solution.
6. Determination of dissociation constant of a weak acid by Potentiometric method.
7. Potentiometric titration of $AgNO_3$ vs KCI.
8. To obtain the absorption spectra of colored complexes, verification of Beer's law and estimation of metal ions in solution using a spectrophotometer.
9. Spectrophotometric titration of $FeSO_4$ against $KMnO_4$.
10. Determination of heat of solution of benzoic acid / salicylic acid by variable temperature method (graphical method).
11. Thermometric titration of an acid with a base.
12. Determination of molecular weight of a compound using Bekmann's cryoscopic method using benzene or / and water as solvent.
13. Potentiometric titrations of
    (a) Fe(II) Vs Ce(IV)
    (b) Fe(II) Vs V(V).
14. Conductometry – to determine the degree of hydrolysis and hydrolysis constant of aniline hydrochloride.
15. Determination of the molecular weight of a polymer materiel by viscosity measurements (polyvinyl alcohol / polystyrene / cellulose acetate / methyl acrylate).

**REFERENCES**


1. Practical Physical chemistry – A.J. Findlay.
2. Experimental Physical Chemistry – F. Daniels et al.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico – Chemical experiments – J. Rose.
7. Practical Physical Chemistry. - S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry – D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994)

**SECOND SEMESTER**
**CH 201-ANALYTICAL CHEMISTRY-II**

## AUTOMATED, ELECTROANALYTICAL AND THERMAL METHODS OF ANALYSIS

**(48 Hours)**

### UNIT-I

**Automated systems:** An Overview, definition, distinction between automatic and automated systems, advantages and disadvantages by automation, types of automated techniques. Non-discrete techniques, segmented flow methods and basic equipment, special techniques and devices, theoretical considerations and problems, applications. Single/channel and multi channel auto analysers, BUN analysers, automatic glucose analyser and ammonia in water analyser, COD analyser, CFA in industry. Non-segmented flow methods.

Flow injection analysis, principles, types of dispersion, factors affecting dispersion, applications of small, medium and large dispersions, stopped flow methods, flow injection titrations. Discrete methods: Centrifugal fast scan analyser, automatic multipurpose analysers, automatic elemental analyser, automatic analyser based on multilayer film-principles, film structure, instrumentation applications.

Comparison of discrete and non-discrete methods. Advantages of flow injection measurements over continuous flow measurements.

**[16 Hours]**

### UNIT-II

**Redox titrations:** Balancing redox reactions, calculation of the equilibrium constant of the reaction, titration curves, visual end point detection. Redox indicators- theory, working and choice. Applications of redox titrations. Sample prearation - prereduction and preoxidation.

**Electroanalytical methods:** Introduction to electro analytical methods.

**Potentiometry:** Fundamentals of potentiometry. Indictor and ion-selective electrodes. Membrane electrodes. Glass electrode for pH measurement, glass electrodes for cations other than protons. Liquid membrane electrodes, solid state ion selective detectors and biochemical electrodes. Potentiometric end point detection. Applications of potentiometry. Direct potentiometric measurements-determination of pH and fluoride.

**Electrogravimetric analysis:** Theory, apparatus, cell process, deposition and separation, electrolytic separation of metals, applications.

**Voltammetry and Polarography:** Theory of classical polarography, polarographic measurements, polarograms, polarographic currents. Current and concentration relationship. Factors influencing diffusion currents, half-wave potential, oxygen interference, advantages and limitations.

**Modified voltammetric methods**, pulse polarography, fast linear-seep polarography, first order polarographic techniques. Organic polarography.

**Cyclic voltammetry:** Principles and applications.
**Stripping analysis:** Stripping voltammetry-basic principles, electrodes used for stripping analysis, apparatus for stripping analysis, applications, determination of lead in water voltammetry with micro electrodes.

**[16 Hours]**

## UNIT III

**Thermal methods of analysis:** Introduction, thermogravimetric analysis (TGA) –types of thermogravimetric analysis, principle. Factors affecting the results-heating rate, furnace atmosphere, crucible geometry. Isothermal gravimetric analysis. Instrumentation –balance furnace, instrument control/data handling. Application- purity and thermal stability, evaluation of correct drying temperature, analysis of complex mixture and determination and kinetic parameters of thermal degradation.

**Differential thermal analysis (DTA):** Theory-variables affecting the DTA curves. Difference between TGA and DTA. General principles. Instrumentation. Applications-analysis of the physical mixtures and thermal behaviour study. Determination of the melting point, boiling point and decomposition point.

**Differential scanning calorimetry (DSC):** Basic principles. Differences between DTA and DSC. Instrumentation-power compensated DSC. Heat flux DSC. Applications- studies of thermal transitions and isothermal crystallization. Pharmaceutical industry for testing the purity of the samples.

**[16 Hours]**

**REFERENCES**


1. Fundamental Analytical Chemistry, D.A. Skoog, D.M. West, Hollar and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G. D. Christian, 5th ed., 2001 John Wiley and Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 presence Hall, Inc. New Delhi.
4. Vogel's Text book of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D Barners and M.J.K. Thomas, 6th edition, Third Indian Reprint. 2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, Callifornia, 1990.

**SECOND SEMESTER**
**CH 202-INORGANIC CHEMISTRY-II**
**Coordination Chemistry**

**(48 Hours)**

**UNIT-I**

**Preparation of coordination compounds:** Introduction, preparative methods- simple addition reactions, substitution reactions, oxidation-reduction reactions, thermal dissociation reactions, reactions of coordinated ligands, trans effect, other methods.

Geometries of metal complexes of higher coordination numbers (2-12).

**Stability of coordination compounds:** Introduction, Stepwise and overall stability constants of coordination compounds, factors influencing the stability of metal complexes with reference to the nature of metal ion and ligand, the Irving-William series, chelate effect.

Theoretical aspects of the determination of stability constants of the coordination compounds by spectrophotometric, pH metric and polarographic methods.

**Crystal Field Theory:** Salient features of CFT, d-orbital splitting in octahedral, tetrahedral, square planar and tetragonal complexes, measurement of 10Dq. Spectrochemical series, short comings of CFT.

**[16 HOURS]**

**UNIT-II**

Experimental evidences for covalence and adjusted CFT. MOT applied to octahedral, tetrahedral and square planar complexes without and with pi-bonding. M.O. energy level diagrams for octahedral complexes with sigma-ligands having pi-systems. Jahn-Teller effect.

**Electronic absorption spectra of transition metal complexes:** Introduction, selection rules, electronic –dipole transitions, magnetic-dipole transitions, term symbol for $d^n$ ions. Effects of spin orbit coupling, energy level diagrams, Orgel and Tanabe-Sugano diagrams, charge-transfer transitions.

**Magnetic properties of transition metal complexes:** Introduction, magnetic susceptibility and its measurements, spin cross over systems, ferromagnetism and antiferromagnetism.

**[16 Hours]**

**UNIT-III**

**Reaction kinetics of coordination compounds:** Introduction, electron transfer reactions: Outer sphere reactions, the Marcus theory, ligand-bridged inner sphere reactions doubly-bridged inner-sphere transfer, one electron and two electrons transfers, non-complementary reactions. Ligand exchange via electron exchange.
Mechanisms of ligand substitution reactions-general considerations, substitution reactions of square planar and octahedral complexes. Base catalyzed hydrolysis of cobalt (III) ammine complexes.
**Metal-metal bonding:** Evidences and factors favouring of M-M bonding, bi, tri, tetra, penta and hexa nuclear metal clusters.
**Thermodynamic and related aspects of ligand fields:** Hydration**,**
ligation and lattice energies.

**[16 Hours]**

**REFERENCES**


1. Advanced inorganic chemistry, ($5^{th}$ edition)- F.A. Cotton and G. Wilkinson: John Wiley and sons 1988.
2. Inorganic chemistry ($3^{rd}$ edition)-J.E. Huheey: Harper and Row, N.Y. 1983
3. Modern aspects of Inorganic chemistry ($4^{th}$ edition)-H.J., Emeleus and A.G. Sharpe: UBS 1989.
4. Coordination chemistry-S.F.A. Kettle, (1969)-Thomas Nelson and Sons Ltd., London.
5. Physical Inorganic Chemistry-A Coordination Chemistry Approach- S.F.A. Kettle, Spektrum, Oxford, 1996.

## SECOND SEMESTER
## CH 203-Synthetic Organic Chemistry and Photochemistry

**(48 Hours)**

### UNIT-I

**Reductions:** Catalytic hydrogenations (homogeneous and heterogeneous): catalysis, solvents, equipment and reduction of functional groups, catalytic hydrogen transfer reactions, Wilkinson's catalyst. Bakers yeast, $LiAlH_4$, $NaBH_4$, dissolving metal reactions (Birch reduction) diborane Meerwein-Pondorf- Varley reduction Wolf-Kishner Reduction, Clemensen reduction.

**Oxidations:** Oxidation with chromium and manganese compounds ($CrO_3$, $K_2Cr_2O_7$, PCC, PDC, Sarret reagent, Jones reagent, $MnO_2$, $KMnO_4$), oxygen (singlet and triplet), ozone, peroxides and peracids, lead tetra acetate, periodic acid, $OsO_4$, $SeO_2$, NBS, Chloramine-T, Sommlet oxidation, Oppenauer oxidation.

**[16 Hours]**

### UNIT-II

**Reagents in Organic synthesis:** use of following reagents in organic synthesis and functional group transformations: Gilmann reagent, dicyclohexyl carbodiimide, DDQ, trimethylsilyl halides, diazomethane, LDA, 1,3-Dithiane (reactivity and umpolung) Woodward and Prevost hydroxylation, Peterson reaction.

**Molecular rearrangements:** Introduction.

**Carbon-to Carbon migrations:** Pinacol-pinacolone, Wagner-Meerwein, Benzidine, Demjanov, Benzillic acid, Favorskii, Fries, Cope, Claisen rearrangement, von Richter reaction.

**Carbon to nitrogen migrations:** Hofmann, Curties, Lossen, Schmidt and Beckmann rearrangements.

**Miscellaneous rearrangement:** Stevens, Sommlet-Hauser, Wittig, Smiles, Neber and Bayer-Villeger rearrangement.

**[16 Hours]**

### UNIT-III

**Photochemistry and concerted reactions:** Introduction, light absorption and electronic transitions, Jablonski diagram, intersystem crossing, energy transfer, sensitizers, quenchers

Photochemistry of olefins, conjugated dienes, aromatic compounds, ketones, enones, photooxidations, photoreductions Norrish type I and II reactions, Paterno-Buchi reaction, Barton reaction, Di-pi-methane rearrangements

**Pericyclic reactions:Electrocyclic reactions:** Stereochemistry, Symmetry and Woodward-Hofmann rules for electro cyclic reactions, FMO theory of electrocyclic reactions, correlation diagram for cyclobutadine and cyclohexadiene systems.

**Cycloaddition reactions:** [2+2] [3+2] and [4+2] cycloadditions, analysis by FMO and correlation diagram method.

**Sigmatropic reactions:** Classification, stereochemistry and mechanisms.

**[16 Hours]**

**REFERENCES**


1. H. Pine, Hendickson, Cram and Hammond, Organic Chemistry, Mac Grow Hill, New York, 1987.
2. Organic Chemistry-Morrison & Boyd
3. I. Finar, Organic Chemistry, ELBS Longmann, Vol I &II, 1984.
4. J. March, Advanced Organic Chemistry, Willey Interscience, 1994.
5. E.S. Gould, Mechanism and Structure in Organic Chemistry, Halt, Rinhart &Winston, Nee York, 1964.
6. F. A. Carey and Sundberg, Advanced Organic Chemistry-Part A and B, 3rd edition, Plenum Press, New York, 1990.
7. Comprehensive Organic Synthesis- B. M. Trost and I. Fleming series, Pergamon Press, New York, 1991.
8. A Guide book to mechanism in Organic Chemistry- Peterskye
9. S. K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd., 1998.
10. Photochemistry-Calvert & Pitts, Willey, New York, (1966).
11. Advances in Photochemistry- Rahatgi Mukherjee.
12. Principles and applications of Photochemistry – RP Wayne, Elsevier, New York, (1970).
13. Photochemistry, Paul Suppan, RSC, London, (1944).
14. Dupey and Chapmann Molecular reactions and Photochemistry, Prenctic Hall-International, Tokyo, 1972.
15. Introduction to Physical organic chemistry – Kosower
16. Molecular orbital calculations- J. D. Roberts
17. N. J. Turro, Modern molecular Photochemistry, The Benzamann Cummings publishing Co. Ltd, Menlo Park, 1978.
18. K. Yates, Huckel's Molecular Orbital Theory, Academic Press, New York, 1978.
19. T. L. Gilchrist & R. C. Storr, Organic reaction and orbital symmetry, Cambridge University Press, Londdon. 1979.
20. D. C. Neckers, Mechanistic Organic Photochemistry, Reinhaold, New York, 1967.

**SECOND SEMESTER**
**CH 204-PHYSICAL CHEMISTRY-II**
**Thermodynamic and Statistical Mechanics**

**(48 Hours)**

**UNIT-I**

**Concepts of entropy and free energy:** Entropy as measure of unavailable energy. Entropy change during spontaneous process. Helmholtz and Gibbs free energies. Thermodynamic criteria of equilibrium and spontaneity. Variation of free energy with temperature and pressure. Maxwell's relations, Von't Hoff's reaction isotherm and isochore, Gibbs-Helmholtz equation. Determination of free energy changes. Nernst heat theorem and third law of thermodynamics-calculation of absolute entropies and residual entropy.

**Partial molar Properties:** Partial molar volumes and their determination by intercept method and from density measurements. Chemical potential and its significance. Variation of chemical potential with temperature and pressure. Formulation of the Gibbs Duhem equation. Thermodynamic derivation of the law of mass action mass action. Derivation of Duhem-Margules equation.

**[16 Hours]**

**UNIT-II**

**Fugacity:** Determination of fugacity of gases. Variation of fugacity with temperature and pressure. Activity and activity coefficients. Variation of activity with temperature and pressure. Determination of activity coefficients by vapour pressure, depression in freezing point, solubility measurements and by electrical methods.

**Thermodynamics of dilute solutions:** Raoult's law, Henry's law. Ideal and non-ideal solutions. Discussion and derivation of the laws of osmotic pressure, cryoscopy and ebullioscopy. Determination of molecular weights. Thermodynamic treatment using the concept of chemical potentials. Heat capacity of solids, Einstein and Debye heat capacity equations, Debye-characteristic temperature and its significance.

**Phase Rule Studies:** Thermodynamic derivation of phase rule, application of phase rule to the two component systems, simple eutectic type, compound formation with congruent melting point and incongruent melting points, systems involving the formation of a continuous series of solid solutions. Application of phase rule to three component systems. Systems of three liquids and systems of two salts and a liquid.

**[16 Hours]**

**UNIT-III**

**Statistical mechanics:** Introduction, thermodynamic probability relation between entropy and thermodynamic probability, principle of equipartition of energy, Maxwell-Boltzmann distribution equation, partition function, translational rotational and vibrational partition functions, evaluation of molecular entropies, entropy of monatomic gas (Sackur-Tetrode equation). Evaluation of internal energy, enthalpy, Helmholtz and Gibbs free energies, equilibrium constant, partition functions of atoms and diatomic molecules.

Distribution equations – Bose-Einstein and Fermi-Dirac distribution equations. Free energy function and its use in evaluating the equilibrium constant, entropy of water and hydrogen.

**[16 Hours]**

**REFERENCES**


1. Themodynamics for chemists by S. Glasstone. Affiliated East-West press, New Delhi, (1965)
2. Chemical Thermodynamics by I. M. Koltz, W.A Benzamin Inc. NewYork, Amsterdam, (1964).
3. Basic Physical Chemistry by W.J. Moore, Prentice Hall of India Pvt. Ltd., New Delhi (1986).
4. Text book of Physical Chemistry by Samuel Glasstone, MacMillan Indian Lts., (II edition), (1974).
5. Theoretical chemistry by S. Glasstone.
6. Statistical themodynamics by B.C. Meclelland, Chapman and Hall, London (1973).
7. Elementary Statistical themodynamics by N. D. Smith, plenum Press, NY (1982).
8. Elements of classical and statistical thermodynamics by L.K Nash, Addison-Westley (1970).
9. Statistical themodynamics by I. M. Klotz.
10. Introduction to Statistical themodynamics by M. Dole, Prantice-Hull, (1962).

## SECOND SEMESTER

## CH 205-SPECTROSCOPY-I

**(48 Hours)**

### UNIT-I

**Microwave spectroscopy:** classification of the molecules based on rotation-Linear, symmetric, spherical and asymmetric top molecules (HCl, HCN, $H_2O$, $BCl_3$, $CH_4$ and $CH_2$=CH-Cl). Pure rotation Spectra of diatomic molecules-Rigid rotor model, energy levels, rotational quantum number and the selection rule. Effect of non rigid rotation. Determination of moment of inertia and bond length of diatomic molecules using rotational spectra. Effect of isotopic substitution on rotation spectra. Relative intensities of spectral lines.

Rotational spectra of polyatomic molecules ($BCl_3$, OCS and $CH_3F$). Moment of inertia expression for linear and nonlinear molecules. Experimental techniques – Microwave spectrometer. Applications-Principles of determination of bond length and Moment of inertia from Rotational spectra. Stark effect in rotation spectra and determination of dipole moments.

**Raman spectroscopy:** Introduction, Raman and Rayleigh scattering, stokes and anti stokes lines, polarization of Raman lines, depolarization factor, polarizability ellipsoid. Theories of Raman spectra –classical and quantum theory. Rotation, vibration and rotation-vibration Raman spectra. Comparison of Raman and IR spectra, rule of mutual exclusion principle. Advantages of Raman spectra. Molecular data bond length and vibration determined by Raman spectroscopy.

**[16 Hours]**

### UNIT-II

**Vibrational spectroscopy:** Vibration of diatomic molecules, the energy curves for simple harmonic oscillator- vibration spectra. Effects of anharmonic oscillation- the diatomic vibrating rotator – vibration rotation spectra of carbon monoxide. Expressions for fundamental and overtone frequencies.

Vibration of polyatomic molecules- The number of degrees of freedom of vibration and their symmetry – overtones and combination frequencies – Influence of rotation on the spectra. Parallel and perpendicular vibrations ($CO_2$ and $H_2O$). Fundamental, overtone, combination and difference bands. Fermi resonance. Force constant , its determination and significance. The theory of infrared absorption and theoretical group frequency. Intensity of absorption band and types of absorptions. Correlation chart. Important spectral regions- Hydrogen stretching region, triple bond region, double bond region and ‘fingerprint region’. Application: Structure of small molecules: $XY_2$- linear or bent, $XY_3$: planer or pyramidal. Coordination chemistry (aqua, amino, nitrite, thiocyanate) - change in symmetry on coordination (nitrate, carbonate and sulphate complexes)- Organometallic compounds- geometrical isomers and Jahn-teller Effect. Organic compounds- Structure determination and the characteristic group frequencies. Factors affecting the group frequency- physical state, vibrational coupling, electrical effect, hydrogen bonding, steric effect and ring strain. Interpretation of IR spectra for qualitative identification of polymers

**[16 Hours]**

## UNIT-III

**UV-VIS Spectroscopy (Outer shell electronic spectroscopy):** Quantitative aspects of absorption – Beer's law. Terminology associated with absorption measurements. Limitations of the law: Real, Chemical, instrumental and personal. Theory of molecular absorption. Vibration-rotation fine structure of electronic spectra. Types of absorption bands: $n\rightarrow\pi^*$, $\pi\rightarrow\pi^*$, $n\rightarrow\sigma^*$, $\sigma\rightarrow\sigma^*$, C-T and ligand field. Empherical rules for predicting the wave length of maximum absorption: Olefins, conjugated dienes, cyclic trienes and polyenes –α, β-unsaturated aldehydes and ketones, benzene and substituted benzene rings. Basic components of instrumentation, single and double beam deigns. Applications: Qualitative and quantitative analysis of binary mixtures, measurement of dissociation constants of acids and bases, determination of molecular weight, photometric titrations, Determination of stoichiometry and stability of the complexes and kinetic studies.

**[16 Hours]**

## REFERENCES


1. Symmetry in molecules, -J. M Hollas, Chapman &Hall Ltd., London, (1972).
2. Chemical Applications of group theory, - F. A. cotton, Willey Eastern Ltd., 2nd edition, new Delhi, (1971).
3. Group theory and Symmetry in Chemistry, G- raj, a Bhagi and V. Jain, Krishna Prakashan Media (P) Ltd., Meerut, (1998).
4. Fundamentals of molecular spectrioscopy by C.N Banwell and E.M. Mc Cash-4th edition, tata Mc. Graw Hill, New delhi, 1998.
5. Introduction to molecular spectroscopy by G. M. Barrow, Mc Graw Hill, New york (International student edition) (1972).
6. Therretical chemistry by S. Glasstone, affliated East-West press Pvt. Ltd., New Delhi, (1973).
7. Spectroscopy Vol I and II by B. P. Straughan and S. Walker, John wiley and sons Inc, New York. (1976).
8. Vibrational spectroscopy, Theory and Applications, by D. N. Sathyanarayana, New Age International Publications, new Delhi, (1996).
9. Instrumental methods of analysis by H.H Willard, L.L. Merritt and J.A Dean, 7th edition, (1988).
10. Physical methods inorganic chemistry by R.S Drago, Affliated East-West Press Pvt. Ltd. (student edition) (1978).
11. Principles of instrumental Anallysis by D A. Skoog, F J. Holler and T.A. Nieman. Fifth edition, Saunders college Publishing, Philadelphia.
12. Spectroscopy of organic compounds, P. S. kalsi, new age international publishers, new Delhi.

**SECOND SEMESTER PRACTICALS**

CH-206 ANALYTICAL CHEMISTRY PRACTICAL II

**[64 Hours]**

1. Determination of iron in pharmaceuticals by visual and potentiometric titration using cerium (IV) sulphate.
2. Determination of iron in razor blade by visual and potentiometric titration using sodium metavanadate.
3. Potentiometric determination of the equivalent weight and Ka for a pure unknown weak acid.
4. Potentiometric titrations of copper with EDTA.
5. Determination of calcium in limestone by redox titrations.
6. Determination of copper in an ore/an alloy by iodometric redox titration.
7. Determination of antimony in stibnite by titration with iodine.
8. Analysis of commercial hypochlorite or peroxide solution by iodometric titration.
9. Periodate determination of ethylene glycol (Malprade reaction).
10. Determination of silver in an alloy by Volhard method.
11. Determination of vitamin C in citrus fruit juice by iodimetric titration.
12. Determination of ascorbic acid in vitamin C tablet by titrations with $KBrO_3$.
13. Electrolytic determination of copper in an ore/an alloy.
14. Analysis of waste waters for DO and COD by redox titrimetry
15. Polarographic determination of copper and zinc in brass.

**REFERENCES**


1. Vogel's Qualitative Inorganic Analysis- Svelha.
2. Macro and semimicro inorganic qualitative analysis – A.I Vogel.
3. Semimicro Qualitative Analysis –F.J. Welcher and R. B. Halin.
4. Semimicro Qualitative Analysis – Ramanujam.
5. Vogel's Quantitative Inorganic Analysis – Svelha.

## SECOND SEMESTER PRACTICALS

CH-207 INORGANIC CHEMISTRY PRACTICAL II

**[64 Hours]**

Semimicro qualitative analysis of mixtures containing TWO anions and TWO cations and ONE of the following less common cations.
W, Mo, Ce, Th, Ti, Zr, V, U and Li.

## REFERENCES


1. Vogel's Qualitative Inorganic Analysis- Svelha.
2. Macro and semimicro inorganic qualitative analysis – A.I Vogel.
3. Semimicro Qualitative Analysis –F.J. Welcher and R. B. Halin.
4. Semimicro Qualitative Analysis – Ramanujam.

## SECOND SEMESTER PRACTICALS

CH-208 ORGANIC CHEMISTRY PRACTICAL II

**[64 Hours]**

### PART-I

**Qualitative analysis**: Separation of binary mixtures, identification of functional group and preparation of suitable derivatives (8 DIFFERENT MIXTURES).

### PART-II

1. Isolation of piperine from pepper
2. Isolation of caffeine from tea
3. Isolation of cysteine from heir
4. Isolation of hesperidiene from orange peal
5. Isolation of azaleic acid from castor oil
6. Isolation and spectroscopic characterization of Lycopene
7. Isolation of lipids from egg yolks
8. Extraction of nicotine from tobacco leaves

### REFERENCES


1. A text book of practical organic chemistry – AI Vogel Vol I
2. Practical organic chemistry –Mann &Saunders
3. Manual of organic chemistry – Dey and Seetharaman
4. An introduction to practical organic chemistry – Robert, Vingrove etc.
5. Semimicro qualitative organic analysis by Cheronis, Entrikin and holdnet
6. J.N. Guthru & R. Kapoor, Advanced experimental chemistry, S. Chand Company, new Delhi, 1991.
7. R. K. Bansal, laboratory Manual of Organic chemistry, New PGE International (P) Ltd. London, 3rd edition, 1996.
8. N. K. Visno, Practical organic chemistry, New PGE International (P) Ltd. London, 3rd edition, 1996.

**SECOND SEMESTER PRACTICALS**

CH-209 PHYSICAL CHEMISTRY PRACTICAL II

**[64 Hours]**

1. Analysis of a binary mixture by measurement of refractive index.
2. Determination of degree of association of benzoic acid in benzene by distribution method.
3. Binary analysis of two miscible liquids by viscometric method.
4. To study the salt effects on kinetics of reaction between $K_2S_2O_8$ and KI
5. Study of kinetics of reaction between chloramine-T and Indigocarmine by spectrophotometrically and determination of rate constant.
6. Determination of energy of activation for the bromide- bromate reaction.
7. Conductometric titration of sodium sulphate against barium chloride
8. Determintion of equivalent conductance at infinite dilution of a strong electrolyte and verification of Onsager equation.
9. Determintion of dissociation constant of a weak electrolyte by conductivity method.
10. Potentiometric titration of a mixture of halides (KCl+ KI and KCl+ KBr+ KI) against $AgNO_3$
11. pH titration of ( a) ($CH_3COOH$ + HCl) Vs NaOH b) $CuSo_4$ Vs NaOH and c) ($CH_3COOH$ + NaOH) and Determintion of Ka
12. Determination of redox potential and estimation of $Fe^{2+}$ ions by potentiometric method.
13. Determination of partial molar volume of (a) NaCl- $H_2O$ and b) $C_2H_5OH$- $H_2O$ systems.
14. Conductometric titration of formic acid/ oxalic acid against NaOH and $NH_4OH$.
15. Conductometric titration of orthophosphoric acid against NaOH.

References


11. Practical Physical chemistry – A.J. Findlay.
12. Experimental Physical Chemistry – F. Daniels et al.
13. Selected Experiments in Physical Chemistry – Latham.
14. Experiments in Physical Chemistry – James and Prichard.
15. Experiments in Physical Chemistry – Shoemaker.
16. Advanced Physico – Chemical experiments – J. Rose.
17. Practical Physical Chemistry. - S.R. Palit.
18. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
19. Experiments in Physical Chemistry – Palmer.
20. Experiments in Chemistry – D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994)

**THIRD SEMESTER**
**CH 301 – ANALYTICAL CHEMESTRY-III**
**Advanced Separation Technique [48 HOURS]**

**UNIT-I**

**Solvent extraction:** definition, types, principle and efficiency of extraction, sequence of extraction process, factor affecting extraction-pH, oxidation state, modifiers, synergistic, masking and salting out agent, techniques- batch and continuous extraction, application.

**Fundamentals of chromatography:** general description, definition, terms and parameter used in chromatography, classification of chromatographic methods, criteria for selection of stationary phase, and mobile phase, nature of adsorbents, factor influencing the adsorbent, nature and type of mobile phases and stationary phases.

**Elution chromatography:** Theories- plate theory, rate theory, brad broadening-eddy diffusion, longitudinal diffusion and resistance to mass transfer, column efficiency-plate theory and rate theory approach, Van Deemter's equation, and its modern version, optimization column performance, interrelationships- capacity factor, selectivity factor, column resolution, distribution constant and applications of conventional column chromatography, advantages and limitations.

**[16 HOURS]**

**UNIT-II**

**Paper chromatography (PC):** definitions, theory and principle, technique; one, two dimensional and circular PC, mechanism of separation, structure of cellulose and types of paper, methodology-preparation of sample, choice of solvent, location of spot and measurement of RF value, factors affecting RF values, advantages and applications.

**Thin- layer chromatography (TLC):** definitions, mechanism, efficiency of TL plates, methodology-selection of stationary phase, and mobile phase, preparation of plates, spotting, development, identification and detection, reproducibility of RF values, comparison of TLC with high performance thin- layer chromatography, Paper chromatography, and column chromatography. Qualitative and quantitative analysis.

**Gas chromatography (GC):** principle, comparison of GSC and GLC, instrumentation column packed and tubular, study of detector- thermal conductivity, flame ionization, electron capture and mass spectrometry, factors affecting separation, applications.

**High pressure liquid chromatography (HPLC):** apparatus, pump, column packing, characteristics of liquid chromatographic detector-UV, IR, refractometer and fluorescence detector, advantages and applications.

**Ion-exchange chromatography (IEC):** definitions, requirement of ion-exchange resin, synthesis and type of ion exchange resin, principle, basic features of ion exchange reactions, resin properties-ion- exchange capacity, resin selectivity factors affecting the selectivity, applications of IEC in preparative, purification and recovery processes.

**Exclusion chromatography:** theory and principle in size Exclusion chromatography, experimental techniques for gel-filtration chromatography (GFC) and gel-permeation chromatography (GPC), materials for packing – factors governing column efficiency, methodology, applications.

**[16 HOURS]**

## UNIT-III

**Affinity chromatography:** definitions, separation mechanism, matrices, matrix activation role of spacer arms and applications.

**Ultracentrifugation:** principle, sedimentation constant, sedimentation equilibrium, sedimentation velocity, methodology, and applications.

**Capillary electrophoresis:** overview, types, basis for electrophoretic separations, migration rates and plate heights, electroosmetic flow, instrumentation, capillary zone electrophoresis, capillary gel electrophoresis, capillary isoelectrophoresis, capillary isoelectric focusing.

**Capillary electrochromatography:** packed column electrochromatography, micellar electrokinetic capillary chromatography and applications.

**Supercritical fluid chromatography:** properties of supercritical fluid, instrumentation and operating variables, comparison of supercritical to other type of chromatography and applications.

**Supercritical fluid extraction:** advantages of supercritical fluid extraction, instrumentation, supercritical fluid choice, off-line and on-line extractions, typical applications supercritical fluid extraction.

**[16 HOURS]**

**REFERENCES:**

1] Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2] Analytical Chemistry, G. D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
3] Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.
4] Vogel text book of Quantitative chemical Analysis, J. Mendham, R.C. Denny , J D. Barnes and MJK Thomas, 6th edition, Third Indian reprint 2003 Pearson Education Pvt. Ltd., New Delhi.
5].Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.

**THIRD SEMESTER**
**CH 302 – INORGANIC CHEMISTRY III**
**Organometallic chemistry [48 HOURS]**

## UNIT-I

**Organometallic chemistry:** Introduction, 16 and 18 electron rule, classification of organometallic compounds by bond type, nomenclature.
**Chemistry of organometallic compounds:** synthesis and reactions of organozinc and organolithium reagents (n-BuLi, PhLi).
**Metal Carbonyls Complexes**: Preparation, Structure, chemical bonding in metal carbonyls, physical evidence related to M-CO bonding. Preparation of anionic metal carbonyl complexes and substituted metal carbonyl complexes.
**Metal nitrosyls**: Preparation, linear and bent nitrosyls.
**Cyclopentadienyl Metal Complexes:** Preparation, structures of Cyclopentadienyl Metal Complexes. M.O diagram for ferrocene. Reactions and aromaticity of ferrocene.

**[16 HOURS]**

## UNIT-II

**Metal –arene Complexes:** methods of preparation of arene complexes, reactions of metal –arene complexes Structure, chemical bonding in metal-arene complexes.
**Heterocyclic Sandwich compounds**: preparation and properties.
**Olefin-transition metal complexes**: methods of preparation, structure and bonding metal olefin complexes.
**Conjugated diolefins and related metal complexes**. preparation, structure and bonding.
**Acetylene and acetylene derived metal complexes**: preparation, structure and bonding in acetylene complexes. Reactions of coordinated acetylene.
**Pi-allylic metal complexes**: preparation complexes containing allylic ligands, Structure and bonding.

**[16 HOURS]**

## UNIT-III

**Homogeneous catalysis**: Introduction , properties of catalysis, types of reactions in homogeneous catalysis, hydrogenation of olefins, isomerization of olefins, oxo-process, Wacker process, Monsanto acetic acid process, Monsanto L-Dopa synthesis, water gas shift reaction, carbonylation, template synthesis, alkene hydrosilation.
**Heterogeneous Catalysis**: Introduction, Fischer-Tropsch reaction, Ziegler-Natta catalysis.
**Biological applications and Environmental aspects of organometallic compounds: b** Introduction, organometallics in medicine, agriculture and in horticulture, and environmental aspects of organometallic compounds

**[16 HOURS]**

**REFERENCES:**


1. Inorganic Chemistry- F. A. Cotton and G .Wilkinson ($2^{nd}$ edition)
2. Inorganic chemistry Principles and Structures- J. Huheey.
3. Organometalli Chemistry- R. C. Mehrothra and A. Singh
4. Fundamental Transition metal Organometallic Chemistry- Charles M. Lukehart.
5. Inorganic Chemistry-Purcell and Kotz
6. Advanced Organic Chemistry- J,. March, Wiley Interscience, 1994.
7. Comprehensive organic synthesis- Trost Series, Pergamon Press, New York, Vol.1, 1991
8. Principles of organic synthesis- R. Norman and J.M.Coxon, 21nd Edition, Replika Press Pvt. Ltd., India, 2005.

**THIRD SEMESTER**

**CH 303 –ORGANIC CHEMISTRY III**

**Chemistry of natural products**

**[48 HOURS]**

## UNIT-I

**Steroids:** Introduction, Structure and synthesis of cholesterol. Ergosterol and its irradiation products. Biological importance of bile acids, estrone, progesterone, testosterone, androsterone and carticosterone.

Biosynthesis of cholesterol.

**Alkaloids**: Introduction, classification. Isolation and general methods of structural elucidation. Biological importance of alkaloids. Structure and synthesis of qunine, morphine, reserpine and lysergic acid.

Biosynthesis of alkaloids (nicotine and morphine)

**[16 HOURS]**

## UNIT-II

**Terpenoids:** Introduction, classification and general methods of structural elucidation. Biological importance of terpenoids. Chemistry of pinene, camphor, caryophyllene, santonin and squalene.

**Porphyrins**: Introduction, structure and synthesis of haemin. Vitamin $B_{12}$ structure and as coenzyme in molecular rearrangement reactions: Chlorophyll: structure and biological importance.

**Anthocyanins:** Introduction, general nature of anthocyanin. Occurrence, structure and synthesis of anthocyanidins, Flavones and isoflavones.

**Pheromones:** introduction, classification, source and their use in pest control. Synthesis of disparlure, grandisol, brevicomin and bomykol.

**[16 HOURS]**

## UNIT-III

**Lipids:** nomenclature, classification, purification, structure and synthesis of lipids, phospholipids, sphingolipids. Biological importance of lipids: Lecithin, sphingolipids, oils and fats**.**

**Prostaglandins:** Introduction, classification and biological importance. Constitution of PGE1. Synthesis of PGE & F series.

**Enzymes**: Introduction, nomenclature, classification with examples and their functions.

**Carbohydrates**: Introduction, Ring size determination of monosaccharides, configuration and conformations of monosaccharides, anomeric effect, Hudson's rules, epimerization and mutarotation. Synthesis, industrial and biological importance of glycosides, amino sugars, sucrose, maltose and lactose.

**[16 HOURS]**

**REFERENCES:**


1. I. L finar, Organic chemistry, ELBS Longman, Vol I & II, 11984.
2. Harper's Biochemistry, Ed. R. Harper, 22nd edition, prentice Hal Press, New York, 1990.
3. Encyclopedia of Chemicl technology- Kirck-Othmer series.
4. Harper's review Biochemistry- P.W. Martin, P. A. Mayer and V. W Rodfwell, 15th edition, Maurzen Asian Edition, California, 1981.
5. Introduction to the chemistry of fats and fatty acids- F. D. Gunstone.
6. Carbohydrates-Chemistry and Biochemistry- Pigmann and Hartmon
7. An Introduction to carbohydrate chemistry- Guthri and Honeymon.
8. E. shroder, Peptides Vol-I and II, Academic Press New York, 1966.
9. Gowarikar, Etal, Polymer Science, Wiley Eastern, New Delhi, 1990
10. Introduction to alkaloids, G. W Swan.
11. The alkaloids, K. W. Bently.
12. Steroids. L Fieser and M Fieser.
13. Steroids, Shoppe
14. Introduction to the chemistry of fats and faty acids, F.D Gunstone.

**THIRD SEMESTER**
**CH 304–PHYSICAL CHEMISTRY III**
**Chemical Kinetics**

**[48 HOURS]**

**UNIT-I**

**Kinetics of complex reactions:** parallel, consecutive and reversible reactions. Determination of order of reaction. Arrhenius equation, energy of activation and its experimental determination. Simple collision theory-mechanism of bimolecular reaction. Lindemann's theory, Hinshelwood's theory for unimolecular reaction.

Activated complex theory of reaction rate, classical thermodynamic treatment, partition function, statistical thermodynamic treatment. Kinetics of reactions in solution-Salt effects, effect of dielectric constant (single sphere and double sphere mode), effects of pressure, volume and entropy change on reaction rate. Cage effect with an example. Kinetics of heterogeneous reactions-Langmuir's theory, unimolecular and biomolecular surface reactions.

**[16 HOURS]**

**UNIT-II**

**Fast reactions:** Study of kinetics by flow techniques, equation for constant time, stopped flow and continuous flow methods. Relaxation method, equation for relaxation time, temperature jump and pressure and pressure jump methods, flash photolysis, pulse radiolysis and shock tube method. Potential energy surface, theoretical calculation of energy of activation**.**

**Chain reactions:** Rice-Herzfeld mechanism for the thermal decomposition of acetaldehyde, kinetics of explosive reactions, explosion limits ($H_2$ and $O_2$ reaction) Kinetics of autocatalytic and oscillatory chemical reactions, oscillatory chemical reaction of oxidation of malic acid by bromate ion catalyzed by Ce (III). Catalyzed and unanalyzed reaction: Ru (III) catalyzed oxidation reaction of primary amines by chloramine-T in HCl medium**.**

**[16 HOURS]**

**UNIT-II**

**Kinetic methods of analysis:** Analytical uses of reaction rates relative, basis of reaction rate methods, rate laws-first and second order reactions relative rates of reactions, analytical utility of first or pseudo first order reactions, determination of reaction rates, types of kinetic methods-differential methods, integral methods, multicomponent analysis-neglect of reaction of slow-reacting component, logarithmic extrapolation method, reaction rate method, applications-catalyzed reactions, measurement methods for catalyzed reactions, micro determination of inorganic species like iodine, selenium, cobalt and mercury in complex materials, determination of organic species, non catalytic reactions. Applications of enzyme- catalyzed reactions for the analysis of substrates-stiochiometric and rate methods, determination of urea, uric acid, blood glucose galactose and blood alcohol, determination of enzymes-LDH, GOT and GPT.

**REFERENCES:**


1. Chemical Kinetics by K. J Laidler
2. Chemical Kinetics- Moore and Pearson
3. Kinetics and Mechanism of Chemical Transformation by J. Rajaram and J. C. Kuriacose.
4. Chemical Kinetics – S. K Jain
5. Chemical Kinetics- Benson
6. Elements of Physical Chemistry – Lewis and Glasstone
7. Physical Chemitry by P . W Atkins, ELBS, 4$^{th}$ Edition, Oxford University Press (1990)
8. Kinetics in Analytical Chemistry- H. B. Mark and G. A Rechnitz. Interscience Publishers. John Willey and Sons, New York.

**THIRD SEMESTER**
**CH 305–SPECTROSCOPY II**

**[48 HOURS]**

**UNIT-I**

**Nuclear Magnetic Resonance Spectroscopy:** General introduction. Theory of magnetic resonance-magnetic properties of nuclei, spin number and allowed transitions-classical description and Fourier transform NMR. Population of nuclear magnetic energy levels-relaxation process-factors affecting line width. Magnetic shielding–chemical shift- standards employed –sheilding mechanism- chemical shift correlations. Spin-spin interaction-coupling constants and factor influencing the coupling constant- splitting patterns- first order rules for predicting the band multiplets. Proton decoupling- Broad band decoupling- Off resonance decoupling, pulse decoupling and nuclear Overhauser enhancement. Simplification of complex spectra- increased field strength, spin decoupling or double resonance and contact shift reagent. Studies of nuclei other than protons $^{13}C$, $^{19}F$, $^{14}N$ and $^{31}P$. Applications-identification, analysis of binary mixtures-applications of NMR structural diagnosis – conformational analysis- keto-enol tautomerism and determination of reaction velocities- H-bonding. Structural determination using $^{13}C$ NMR-application of NMR to other nuclei. Two dimensional NMR. Magnetic resonance Imaging.

**[16 HOURS]**

**UNIT-II**

**Mass Spectrometry:** Principles, instrumentation different methods of ionization. EI, CI, FD and FAB, ion separators- single focusing separator with magnetic diffraction, double focusing analyser, time-of-flight separator and quadrupole analyser. Mass spectra- Molecular ion- base peak- meta-stable peak. General rules for fragmentation patterns. Nitrogen rule Hydrogen transfer rearrangement and McLafferty rearrangement. Mass spectral fragmentation of organic and inorganic compounds. Examples of mass spectral fragmentation of organic and inorganic compounds with respect to their structural determination. Applications: Identification of pure compounds, molecular weight determination, molecular formula from isotopic ratio, structural information from fragmentation patterns, evaluations of thermodynamic data, heats of sublimation and species in the vapor over high melting solids, appearance potential and ionization potential.

**[16 HOURS]**

**UNIT-III**

**Electron Spin Resonance Spectroscopy:** Basic principles- intensity-width-position and multiple structure. General rules for the interpretation of the spectra. Zero field splitting and Kramer's degeneracy rule. Factors affecting the magnitude of 'g' value. Double resonance-ENDOR and ELDOR. Applications-study of free radicals-structure determination- biological study-coordination compound and analytical applications.

**Mossbauer spectroscopy:** Theoretical basis. Interpretation of Mossbauer spectra- isomer shift-Quadrupole splitting and magnetic hyperfine structure, time and temperature effects. Instrumentation. Applications-structure deducetion-$I_2Br_2Cl_4$, $Fe_3(CO)_{12}$

**NQR Spectroscopy**: Energies of the Quadrupole transitions, effect of magnetic filed on the spectra, relationship between electric field gradient and molecular structure. Applications- interpretation of $e^2Qq$ data. Structural information from NQR spectra.

**[16 HOURS]**

**REFERENCES:**

1] Spectroscopy by B P Stranghan and S Walker, John Wiley and Sons, Inc., New York, Vol. I and 2 , 1976

2] Organic spectroscopy by Willaa Kemp, ELBS Society, MacMillan, 1987.

3] Application of absorption spectroscopy of organic compounds by JohnR. Dyer, Prentice-Hall of

India Pvt. Ltd., New Delhi.1974.
4] Organic spectroscopy by V.R. Dhani, Tata McGrow-Hill Publishing company Ltd., New Delhi, 1995.
5] Spectometric identification of organic compounds, 4th edition, Robert M, Silverstein, G. Clayton Bassler and Terence C. Morrill, John Wiley and Sons Inc., New York, Vol.1, 1981
6] Interpretation of carbon-13 NMR specta, F. W.Wehrli and T. Wirthln, Heyden, London, 1976.
7].Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
8] Instrumental method of analysis, Hobart H, Willard, Lynne L, Merritt, Jr., John A. dean and franmk A Settle, Jr., 6th edition, CBS Publishers and Distributors, Delhi, 1986.
9] Physical methods for chemists by R.S. Drago, Sunders College publishing, New York.
10] Quantitative Analysis, R. A Day and A./L Underwqood, 6th edition, prentice Hall, Inc., 1999.
11] Principles of instrumental Analysis, D.A.Skoog, F.J Holler and T.A. Nieman, 5th edition, Thomson Asis Pvt. Ltd. Singapore,1998.

**THIRD SEMESTER PRACTICALS**
**CH 306– ANALYTICAL CHEMISTRY PRACTICAL III**

**[64 HOURS]**

1. Determination of iron as the 8-hydroxyquinolate by solvent extraction method.
2. Determination of total cation concentration of tap water by ion-exchange chromatography.
3. Anion-exchange chromatographic separation of Zinc and Magnesium followed by EDTA titration of the metals.
4. . Anion-exchange chromatographic separation of chloride and bromide in a mixture.
5. Determination of magnesium in milk and magnesium tablets by ion-exchange chromatography.
6. Spectrophotometric determination of pH of an unknown buffer using a dye (bromocresol green)
7. Determination of iron in mustard seeds and phosphorus in peas bu spectrophotometry
8. Separation of metal ions by paper chromatography and their identification
9. Thin-layer chromatographic separation of nitroanilines on fluorescent sheets.
10. Spectrophotometric determination of iron in natural water by thiocyanate/orthophenanthroline method.
11. Spectrophotometric determination of molecular weight of a compound.
12. Determination of nitrite-nitrogen by spectrophotometry using NEDA as chromogenic agent.
13. Spectrophotometric determination of creatinine in urine.
14. Gas chromatographic determination of ethanol in beverages.
15. Colorimetric analysis of procaine by diazotization and coupling reaction.

**REFERENCES:**


1. Vogel's Qualitative Inorganic analysis- Svelha.
2. Macro and semimicro inorganic qualitative analysis- A. I Vogel.
3. Semimicro Qualitrative Analysis- F. J Welcher and R. B Halin.
4. Semimicro Qualitative Analysis- Ramanjam

**THIRD SEMESTER PRACTICALS**
**CH 307– INORGANIC CHEMISTRY PRACTICAL III**
**[64 HOURS]**

I. Analysis of alloys:

1. Stainless steel

a) Nickel gravimetrically using dimethyl glyoxime

b) Chromium titrimetrically by persulphate oxidation

c) iron titrimetrically using cerium sulphate

d) chromium and Manganese ( Simultaneous Spectrophotometric method)

2. Ferromanganese: Manganese using EDTA.
3. Molybdenum and Tungsten steels; gravimetric
4. Woods alloy

a) tin (gravimetric)

b) bismuth

c) lead | titrimetrically using EDTA

d) Cadmium

II. Quantitative analysis of the constituents in mixtures containing the following cations.

a. Cu(II) + Fe(II)

Copper gravimetric as CUSCN

Iron- titrimetric using Cerium (IV) solution.

b. Cu(II) + Ni(II)- gravimetric using salicylaldoxime.

c. Cr(III) + Fe(III)- Using EDTA (Kinetic Masking)

III. Semi-micrograviметric estimation of aluminium

IV. Electrogravimetric Estimation of

a. Copper
b. Nickel
c. Copper- nickel alloy

V. Flame photometric determination of

a. Sodium
b. Potassium
c. Calcium
d. Lithium
e. Sodium + Potassium

VI. Polarographic determination of

a. cadmium

b. Zinc

c. Cadmium + Zinc

VII Spectrophotometric determination of the pKa Value of an indicator

VIII Potentiometric determination of cobalt.

IX. Solvent extraction and Spectrophotometric determination of:

a. Uranium or molybdenum

b. Nickel

**REFERENCES:**


1.Advanced physico- chemical experiments- J. Rose
2.Instrumental analysis omanual- Modern Experiments for Laboratory – G. G. Guilbault and L. G Hargis.
3.A Text Book of quanntitaive Inorganic Analysis- 5th edidtion- A. I. Vogel.
4.Experimental norganic chemistry- G. Palmer
5.Inorganic synthesis- O. Glemser.
6.Experimental Inorganic/Physical chemistry- Mounir A. Malati.
7.Spectrophotometric determination of elements- A. Marczenko.

## THIRD SEMESTER PRACTICALS
## CH 308 –ORGANIC CHEMISTRY PRACTICAL III

**[64 HOURS]**

### Part-I

**Quantitative Analysis:**

1. Determination of OH group by acylation.
2. Determination of $NH_2$ by acylation.
3. Determination of nitro group.
4. Estimation of sugars by Fehling's Method
5. Determination of equivalent weight of a carboxylic acid.
6. Estimation of uric acid
7. Estimation of cholesterol.

### Part-II

**Qualitative Analysis:** Separation of binary mixtures, identification of functional groups and preparation of suitable solid derivatives.

**REFERENCES:**


1. Manual of organic chemistry – Dey and Seetharaman
2. Natural products chemistry by Raphel Ikhan
3. Modern experimental organic chemistry by John H. miller and E. F. Neugil p289.
4. An introduction to practical organic chemistry – Robert, Vingrove etc
5. A text book fo practical organic chemistry – A. I. Vogel Vol I
6. Practical organic Chemistry – Mann and Saunders
7. An introduction to practical organic chemistry- Robert, Vingrove etc
8. Semimicro qualitative analysis by Cheronis, Entrikin and Hodnet.
9. R. K. Bansal. Laboratory Manual of Organic Chemistry, New PAG International (P) Ltd. London, 3rd edition, 1966
10. N. K. Visno, Practical Organic chemistry, New PAGE International (P) (P) Ltd. London, 3rd edition, 1966
11. Quantitative Analysis By A I Vogel
12. Practical organic Chemistry, Mann and Saunders
13. Practical Organic chemistry manual.

**THIRD SEMESTER PRACTICALS**
**CH 309– PHYSICAL CHEMISTRTY PRACTICAL III**

**[64 HOURS]**

1. Kinetics of reaction between sodium formate and iodine, determination of energy of activation and thermodynamic parameters ($\Delta H, \Delta S, \Delta G$).
2. To study the kinetics of saponification of ethyl acetate by conductivity method, determination of order of reaction w.r.t. [$OH^-$].
3. To study the kinetics of reaction between acetone and iodine- determination of order of reaction w.r.t, iodine and $H_2SO_4$.
4. Conductometric titration of thorium nitrate with potassium tartarate.
5. Determination of mean ionic activity coefficient of a weak electrolyte by conductometric measurements.
6. To study the acid catalyzed kinetics of oxidation of glycine by chloramines T (CAT)- determination of order of reaction w.r.t [CAT], [Glycine] and effect of [$H^+$].
7. To study the kinetics of auto catalytic reaction between $KMnO_4$ and $C_2H_2O_4$.
8. Kinetics of decomposition of benzene diazonium chloride, determination of energy of activation and thermodynamic parameters.
9. To study the kinetics of solvolysis of t-butyl halide by conductivity method.
10. Potentiometric titration of $Pb(NO_3)_2$ Vs EDTA.
11. Preparation of Ag/AgCl electrode and to determine the activity of 0.2M HCl.
12. Determination of ionic product of water and study the effect of temperature.
13. Determination of transport number by e.m.f method.
14. To determine the eutectic point of a two component system (Naphthalele-m-dinitrobenzene, Naphthalene-biphenyl system).
15. Study of phase diagram of a three component system (Eg: acetic acid-chloroform-water and benzene-alcohol-water system).

**REFERENCES:**


1. Practical Physical chemistry – A. J. Findlay
2. Experimental Physical chemistry-F. Daniels et al.
3. Selected experiments in Physical chemistry-Latham
4. Experiments in Physical chemistry – James and Prichard
5. Experiments in Physical chemistry- Shoemaker
6. Advanced Physico-Chemical Experiments- J. Rose
7. Practical Physical chemistry- S. R. Palit.
8. Experiments in Physical chemistry- Yadav, Geol Publishing House.
9. Experiments in Physical chemistry-Palmer.
10. Experiments in chemistry- D.V Jahagirdar, Himalaya Publishing House, Bombay, (1994).

**FOURTH SEMESTER**

**CH 401-ANALYTICAL CHEMISTRY IV**

Optical Methods and Water Analysis

**[48 HOURS]**

**UNIT-I**

**Atomic absorption spectrometry**: Introduction, principles, elementary theory instrumentation flames, the nebuliser-burner system, graphite furnace technique, cold vapour technique and hydride generation. Monochromators. Detectors. Interferences- spectral interferences, ionization interferences and physical interferences. Use of organic solvents. Quantitative techniques-calibration curve procedure and the standard addition technique. Applications, selected determinations-magnesium and calcium in tap water, vanadium in lubricating oil, trace elements in contaminated soil, tin in canned fruit juice.

**Atomic emission spectrometry**. Emission spectra. Emission spectroscopy with thermal excitation-flame emission spectroscopy (flame photometry)-principles, instrumentation, interferences, applications. Emission spectroscopy with plasma and arc sources. Plasma emission spectroscopy-direct current plasma (DCP), inductively coupled plasma (ICP), crossed-flow nebuliser. ICP instrumentation - simultaneous multi element spectrometer, sequential instruments. Evaluation ICPAES. Relative detectabilities of atomic absorption and flame emission spectrometry.

**Molecular luminescence spectrometry:** Introduction, Fluorometry- principles of fluorescence, distinction between fluorescence and phosphorescence. Factors affecting fluorescence - molecular structure, pH, oxygen quenching - chemical reaction, temperature and solvent effects. Relation between fluorescent intensity and concentration. Excitation spectra vs emission spectra. Fluorescence instrumentation - fluorometers and spectrofluorometers. Applications - sensivity and selectivity, organic analysis, inorganic analysis, biochemical and biomedical analysis, pharmaceutical analysis and agricultural analysis. Typical applications include: quinine tonic water, codeine and morphine in a mixture, boron in steel, aluminum in alloy. Thiamine (Vitamin$B_1$) and riboflavin (Vitamin $B_2$) in foods.

**[16 Hours]**

**UNIT-II**

**Water pollution and analysis**: Water resources, origin of waste water, types of water pollutants of their sources and effects, chemical analysis for water pollution control -objectives of analysis, parameters of analysis, sample collection and preservation.

Environmental and public health significance and measurement of colour, turbidity, total solids, acidity, alkalinity, hardness chloride, residual chlorine, chlorine demand, sulphate, fluoride, phosphates and different forms of nitrogen in natural and waste/polluted waters, heavy metal pollution-public health significance of Pb, Cd, Cr, Hg, As, Cu, Zn, and Mn, general survey of the instrumental techniques for the analysis of heavy metals in aquatic systems, organic loadings-significance and measurement of DO, BOD, COD, TOD, and TOC, phenols, pesticides, surfactants and tannin and lignin as water pollutants and their determination.

**[16 Hours]**

**UNIT III**

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

**Primary treatment**: Sedimentation, equalization, neutralization.

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

**Tertiary treatment**: Evaporation, ion-exchange, adsorption, electrodialysis, electrolytic recovery

and reverse osmosis.

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

Waste water disposal and reuse. Industrial waste water and its treatment.

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

**[16 Hours]**

**REFERENCES:**


1. Chemistry of environmental engineering, Chair H. Sawyer and Perry L. M Canty, McGraw Hill Book, Co., New York 1975.
2. The air Pollution Hand Book, Richard Mabey, Penguin, 1978.
3. The pollution hand Book, Richard Mabey, Penguin 1978.
4. Soil Chemical analysis, M. L. Jackson, Prentice Hall of India pvt. Ltd. New Delhi, 1973.
5. Experiments in Environmental chemistry, F. D. Vowler, and D. W. Counel, Pergamon press, Oxford 1980.
6. Manual soil Laboratory Testing- vol I, K. H. Head, Pentech Press, London 1980.
7. A text Book of Environmental chemistry and pollution control. S. S. Dara, S. Chand and Co, Ltd. New Delhi 2004.
8. Air pollution Vol II Edn. By A. C Stern, Academic press New York 1968.
9. Instrumental methods for automatic air monitoring systems in Air Pollution Control, Part-III Edn by W. Stranss, John-Wiley and sons, New York, 1978.
10. Analysis of air pollutants, P. O. Warner, John Wiley and sons, New York, 1976.
11. The Chemical analysis Air Pollutants, Interscience, New York, 1960.
12. The Analysis of Air Pollutants, W. Liethe, Ann Arbor Science Pub Inc. Michigan 1970.
13. Environmental chemistry A. K De.

**FOURTH SEMESTER**
**CH 402-INORGANIC CHEMISTRY IV**
**Bioinorganic Chemistry**

**[48 HOURS]**

**UNIT-I**

**Bioenergetics:** Energy in biology, energy transfer, standard free energy, entropy, the energy of ATP, kinetic stability of ATP. High energy compounds, mitochondrial flow of electrons from NADH to $O_2$.

**Bioinorganic Chemistry of phosphorus**: Phosphates and Bioenergetics. Phosphorylation, oxidative Phosphorylation,- substrate level Phosphorylation, respiratory chair Phosphorylation, mechanism of oxidative Phosphorylation.

**Bioinorganic aspects of sodium and Potassium**: Sources, absorption, distribution and functions. The transport mechanism, $Na^+$, $K^+$ transporting $ATP^{ase}$ (The $Na^+/K^+$ pump)

Macrocyclic crown ether compounds, cryptands, spherands and ionophores.

**Bioinorganic chemistry of calcium and Magnesium**. Binding, transport and accumulation of $Ca^{2+}$, calcium and muscle contraction, calcium in blood cloting mechanism. Chlorophyll and its role in photosynthesis.

**Chemistry of Vitamin $B_{12}$ and model compounds**. Structure of Vitamin $B_{12}$, Derivatives of $B_{12}$, Biochemical functions of $B_{12}$ model compounds.

**Biochemical aspects of Molybdenum**. Aspects of molybdenum chemistry, Molybdenum containing enzymes - xanthine oxidase, aldehyde oxidase, sulphite oxidase, nitrogenase and nitrate reductase. Nitrogen fixation.

**[16 Hours]**

**UNIT-II**

**Role of metal ions on the catalytic mechanism of enzyme**. Ligand bridge complex, metal bridge complex and enzyme bridge complex.

**Dioxygen metal complexes in biological system**. Reactions of molecular oxygen, activation of dioxygen molecule in transition metal dioxygen complexes.

**Oxygen carrying proteins**: Introduction to porphyrin system, substituent effects on porphyrin rings, hemoglobin and myoglobin, model compounds for oxygen carriers (cobalt, iridium, iron and nickel). Hemerythrin and hemocyanin.

**Transport and Storage of Iron**; Ferretin, transferrin, phosvitin, and gastroferrin.

**Iron transport in microbes**: Siderophores, *in vitro* microbial transport of iron.

**Electron transport Proteins**: Iron-Sulphur proteins (rubredoxins and ferredoxins) and cytochromes including cytochrome P450.

**Iron and Copper containing redox enzymes**: Catalase and peroxidase. Superoxide dismutase.

**Zinc Containing enzymes**: Alcohol dehydrogenase, carboxy peptidase A.

**[16 Hours]**

**UNIT-III**

**Therapeutic uses of some metals and ligands**.

**Metal complexes as drugs and therapeutic agents**: Introduction, antimicrobial agents, antiviral agents, antiarthritis agents and anticancer agents.

**Treatment of toxicity due to inorganics**: Mechanism of

(i) Antidote complexes with poison, rendering it inert (heavy metals, iron, copper and thallium)
(ii) Antidote accelerated metabolic conversion of poison to non-toxic product (cyanide).
(iii) Antidote cometes with poison for essential receptors (carbon monoxide, morphine and morphine like narcotics).

**[16 Hours]**

**REFERENCES:**


1. Biochemistry – A. L. Lehninger
2. Biochemistry- L. Stryer
3. Bioinorganic Chemistry- R. W. Hay
4. The Inorganic chemistry of Biological Processes – 2nd edition, M. N. Hughes.
5. Bioinorganic Chemistry- M. Satake and Y. Mido.
6. Bioinorganic Chemistry- G. R. Chatwal and Ajaykumar Bhagi.
7. Biological aspects of Inorganic chemistry- A. W. Addison, W. R. Cullen, D Dolphin and B. R. James
8. Principles of drug action: The basis o pharmacology, 2nd edition- A. Goldstein, A. Aronow and S. M. Kalman.
9. Advanced Inorganic Chemistry- II- Gurdeep Raj.

**FOURTH SEMESTER**
**CH 403-ORGANIC CHEMISTRY IV**
**Bioorganic Chemistry and Chemistry of Drugs.**

**[48 HOURS]**

**UNIT-I**

**Amino acids**: General structure, physiological properties.

**Peptides: P**eptide bond, structure, determination: C- & N-terminal residue determination, peptide synthesis, Merrifield's solid phase synthesis, selective cleavage of polypeptide bonds (Chemical and enzymatic)

**Proteins:** Classification, Isolation and purification: primary, secondary, tertiary and quartenary structure determination, denaturate and renaturing of proteins, biological application of oxytocin and insulin.

**Nucleic acids**: structure and synthesis of nucleosides and nucleotides, structure of RNA and DNA, Crick-Watson model, role of nucleic acids in the biosynthesis of proteins.

**[16 HOURS]**

**UNIT-II**

**Vitamins:** Introduction, constitution and synthesis of thiamine, riboflavin, pyridoxine, biotin, ascorbic acid, vitamin A, E and K groups**.** Biosynthesis of Vitamin C

**Coenzymes:**

1. Thiamine pyrophosphate (TPP) in oxidative and non-oxidative decarboxylation of α-keto acids and formation of ketols.
2. Pyridoxal phosphate - trasmination, decarboxylation, dealdolization and elimination reactions of amino acids.
3. Tetrahydrofolic acid - in one carbon transfer reactions at all oxidation levels except that of $CO_2$
4. Nicotinamide dinucleotides and flavin coenzymes - in biological oxidation –reduction reactions**.**

**[16 HOURS]**

**UNIT-III**

**Synthetic drugs**: Introduction, chemotherapy, pharamacodynamics, metabolites and antimetabolites, agonists and antagonists

A general study of the following class of drugs

1. Sulpha drugs : sulphonamides, sulphamethoxazole
2. Antipyretics: Aspirin, paracetamol, phenacitin, navolgin
3. Antimalerials: Quinine, chloroquine
4. Hypnotics, analgesics and sedatives: phenobarbital, chlorodiazopoxide, meprobamate
5. Antihistamines: chlorphenaramine
6. Stimulants: caffeine
7. Antineoplastic: 5-flurouracil and chlorambucil
8. Antibiotics: introduction, structure and synthesis of streptomycin, chloromycetin and tetracyclines.

**[16 HOURS]**

**REFERENCES:**


1. Introduction to alkaloids - G. A. Swan
2. The alkaloids - K.W. Bently.
3. Steroids - L. Fiescher and M. Fiescher
4. Steroids- Shoppe
5. Essentials of physiological chemistry- Anderson, John Wiley and Sons, New York, 1953.

6. K. Albert, L. Lehninger, D. L. Nelson, M. M. Cox, Principles of Biochemistry, CBZ publishers, Ist edition, New Delhi, 1993.
7. I. L Finar, Organic Chemistry, ELBS Longmann, Vol. I and II, 1984.
8. Organic Chemistry – Morrison and Boyd.
9. Harper's Biochemistry, Ed. R. Harper, 22nd edition, Prentic Hall press, New York, 1990
10. Encyclopedia of chemical technology – Kirck - Othmer series.
11. Harper's review of Biochemistry – P. W Martin, P. A. Mayer and V. W Rodfwell, 15th edition, Maurzen Asian Edition, California, 1981.
12. Burger's Medicinal Chemistry and drug discovery, Ed. Manfred, E. Wulf, Vol. I-IV, John Wiley and Sons, 1995.
13. Pharmaceutical Chemistry By G R Chatwal et al, Himalaya Publishing house, New Delhi.

**FOURTH SEMESTER**
**CH 404-PHYSICAL CHEMISTRY IV**
**Photochemistry and Solid State chemistry.**

**[48 HOURS]**

**UNIT-I**

**Photochemistry:** Introduction to photochemistry, quantum yield and its determination, factors affecting quantum yield, experimental technique in photochemistry, Actinometry- Uranyloxalate and potassium ferrioxalate actinometers, acetone and diethylketone actinometers.

Term symbols and significance. Photosensitization: by mercury, dissociation of $H_2$, sensitized isomerization. Photodimerization of anthracene, photochemical kinetics of: Decomposition of HI, $CH_3CHO$; formation of HCl, HBr and $COCl_2$; Chlorination of $ZnO/TiO_2$ in the photo degradation of dyes (IC), pesticides (DDT) and in industrial effluents. Effect of photodegradation on COD value.

Direct spectroscopic identification of primary processes, use of free radical traps in the determination of primary photodecomposition modes. Photophysical properties: Fluorescence, characteristics of fluorescence, resonance fluorescence, sensitized fluorescence, quenching of fluorescence, phosphorescence, characteristics, chemiluminescence - theory and applications.

**[16 HOURS]**

**UNIT-II**

**Photochemistry and concerted reactions:** Introduction, light absorption and electronic transitions, Jablonski diagram, inter system crossing, energy transfer, sensitizers, quenchers.

Photochemistry of olefins, conjugated dienes, aromatic compounds, ketones, enones, photooxidations, photoreductions, Norrish type I and II reactions, Paterno-Buchi reaction, Barton reaction, Di-pi-rearrangements.

**Pericyclic reactions:**

**Electrocyclic reactions:** stereochemistry, symmetry and Woodward-Hofmann rules for electrocyclic reactions, FMO theory of electrocyclic reactions, correlation diagram for cyclobutadiene and cyclohexadiene systems.

**Cycloaddition reactions.** [2+2], [3+2] and [4+2] cycloadditions, analysis by FMO and correlation diagram method.

**Sigmatropic reactions**: Classification, stereochemistry and mechanisms.

**[16 HOURS]**

**UNIT-III**

Fundamentals of X-ray crystallography, law of interfacial angles, laws of symmetry, Miller indices, crystal systems, Bravais lattice, X-ray diffraction, Bragg equation, Bragg X-ray spectrometer, Experimental methods - powder and rotating crystal methods, indexing of powder and rotating crystal photographs.

Atomic scattering factor, structure, Fourier synthesis and electron density diagrams.

Electron diffraction of gases. Experimental technique, Scattering -Intensity curves, Wierl equation (no derivation), Radial distribution method, Determination of bond lengths and bond angles.

**[16 HOURS]**

**REFERENCES:**


1. Advances in Photochemistry - Rohatgi Mukherjee.
2. Principles and applications of Photochemistry - R.P. Wayne, Elsevier, New York., 1970.
3. Dupey and Chapmann, Molecular reactions and photochemistry, Prentice Hall - International, Tokyo, 1972.
4. N. J. Turro, Modern molecular photochemistry, The Benzamin Cummings Publishing Co. Ltd. Menlo Park, 1978.
5. Introduction to X-ray crystallography- Azaroff
6. X-ray crystallography – Buerger, M.J. John Wiley and sons.

## FOURTH SEMESTER PRACTICALS
## CH 406– ANALYTICAL CHEMISTRY PRACTICAL IV

**[64 HOURS]**

1. Analysis of ground water sample for sulphate by titrimetry (EDTA) and turbidimetry.
2. Flame emission spectrometric determination of sodium and potassium in river/lake water.
3. Spectrophotometric determination of lead in waste water using solvent extraction procedure.
4. Analysis of waste water for phosphate by Molybdenum blue method
5. Analysis of brackish water for chloride content by spectrophotometry (mercuric thiocyanate method).
6. Analysis of waste water for total acidity and alkalinity by conductometric titration and comparison with visual methods.
7. Determination of fluoride in drinking water / ground water by spectrophotometry (alizarin red lake method)
8. Analysis of soil sample for organic carbon by titrimetry and spectrophotometry ($K_2C_2O_7$ method)
9. Analysis of urine for reducing sugars by titrimetry and spectrophotometry
10. Analysis of blood for cholesterol by spectrophotometry
11. Analysis of blood for urea and uric acid by titrimetry and spectrophotometry.
12. Assay of protein content of wheat flour by Kjeldahl method.
13. Determination of Vitamin A in Vanaspathi.
14. Assay of Aspirin / Caffeine/ Phenacetin by UV spectrometry.
15. Determination of sodium, potassium and calcium in mineral water by atomic emission spectrometry.

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1. Analytical Chemistry, G. D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
2. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.
3. Vogel's text book of Quantitative chemical Analysis, J. Mendham, R.C. Denny, J D. Barnes and MJK Thomas, 6th edition, Third Indian reprint 2003 Pearson Education Pvt. Ltd., New Delhi.
4. Practical Clinical biochemistry methods and interpretations, R. Chawla, J. P. Bothers Medical Publishers (P) Ltd., 1995
5. Laboratory manual of biochemistry, J Jayaraman, New Age international Publishers, New Delhi, 1981.
6. Practical Clinical biochemistry- Harold Varley and Arnold. Hein Mann, 4th edn.
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8. Experiments on Water pollution, D. I Williams and D. Anglesia, Wayland Publishers Ltd, England, 1978.
9. Experiments on Land pollution, D. I Williams and D. Anglesia, Wayland Publishers Ltd, England, 1978.
10. Experiments in Environmental Chemistry, P. D. Vowler, and D. W. Counel, Pergamon press Ltd., Oxford 1980.
11. Manual of soil Laboratory testing- Vol I, K H Head, Pentech Press, London1980.
12. Practical Clinical biochemistry methods and interpretations, R. Chawla, J. P. Bothers Medical Publishers (P) Ltd., 1995
13. Laboratory manual in biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.
14. Practical Clinical biochemistry- Harold Varley and Arnold. Hein Mann, 4th edition.
15. Environmental Science: Laboratory Manual. Maurice A. Strabbe, The C.V. Mosbey Co. Saint. Loucs, 1972.

## FOURTH SEMESTER PRACTICALS
## CH 407– INORGANIC CHEMISTRY PRACTICAL IV

**[64 HOURS]**

1. Preparation of any Four of the following complexes and determination of the purity of the prepared sample and structural study of the prepared complexes using physical methods such as magnetic susceptibility measurements, absorption spectra etc.
   a) Chloropentaammine Cobalt (III) Chloride
   b) nitropentaammine Cobalt (III) Chloride
   c) nitritopentaammine Cobalt (III) Chloride
   d) Hexamine Cobalt (III) Chloride
   e) mercury tetrathiocyanato cobaltate (II)
   f) Hexemine nickel (II) chloride
   g) tris –(thiourea) copper (I) sulphate
   h) Potassium tris (Oxalato) ferrate (III)
2. Determination of ionisable chloride by ion exchange method.
3. Stabilization of an unstable oxidation state by complexation: Preparation of Manganese (III) acetyl acetonate
4. Preparation of EDTA complex of Mn (III).
5. Determination of the composition of a complex of iron-phenanthroline by
   a) Mole -ratio method
   b) Job's method
   c) Slope ratio method
6. Determination of the stability constant of a complex
   a) Turner-Aderson method (iron-T iron or iron-phenanthroline complex)
   b) Bjerrum's method (copper sulphosalicylic acid)
   c) Kinetic method ($KI_3$ complex)
7. Preparation and kinetics of the acid hydrolysis of potassium trisoxalato cobaltate (III) trihydrate
8. Preparation and photolysis of potassium trisoxalatoferrate(III).
9. Preparation and screening of copper complex for its fungicidal and bactericidal activity.
10 Demonstration Experiments
   a) Recording and interpretation of IR and NMR spectra of complexes
   b) Interpretation of a simple x-ray powder photograph
   c) TGA of calcium Oxalate monohydrate
   d) DTA studies of copper sulphate penta hydrate
   c) Spectrochemical series- evaluation of Dq value.

**REFERENCES:**


1.A Text Book of quantitative Inorganic Analysis- $5^{th}$ edition- A. I. Vogel.
2.Experimental inorganic chemistry- G. Palmer
3.Inorganic synthesis- O. Glemser.
4.Experimental Inorganic/Physical chemistry- Mounir A. Malati.
5.Instrumental analysis manual- Modern experiments for Laboratory- G G. Guilbault and L.G. Hargis

## FOURTH SEMESTER PRACTICALS
## CH 408 – ORGANIC CHEMISTRY PRACTICAL IV

**[64 HOURS]**

### Part-I

**Separation Techniques:**

1. Fractional crystallization: Separation of mixture of Naphthalele and biphenyl.
2. Fractional distillation: Separation of mixture of benzene and toluene.
3. Thin layer chromatography: Separation of plant pigments
4. Column chromatography: Separation of mixture of o and p- nitroanilines.
5. Paper chromatography: Separation of amino acids.

### Part-II

**Multistep synthesis:**

1. Esterification: Preparation of Benzoccaine from p-nitro toluene.
2. Diazotization: (Sandmayers reaction): preparation of p-chlorobenzoic acid from p-toluidine.
3. Molecular rearrangements:
    i. Preparation of o-chlorobenzoic acid from phthalic anhydride
    ii. Preparation of benzillic acid from benzaldehyde
    iii. Preparation of o-hydroxy benzophenone via Fries rearrangement.
    iv. Preparation of benzanilide from benzophenone oxime.
4. Grignards reaction: Preparation of triphenyl carbinol
5. Preparation of Luminol from Phthalic anhydride
6. Preparation of paraacetamol

## FOURTH SEMESTER PRACTICALS
## CH 409– PHYSICAL CHEMISTRY PRACTICAL IV

**[64 HOURS]**

1. Kinetics of decomposition of diacetone alcohol by sodium hydroxide - determination of energy of activation and thermodynamic parameters.
2. Spectrophotometric kinetics of oxidation of indigocarmine by chloramines-T (CAT)
   a) Determination of order of the reaction w.r.t. (CAT).
   b) Effect of pH and determination of order of the reaction w.r.t. ($H^+$).
   c) Effect of dielectric constant of the medium on the rate of reaction.
3. Kinetic studies on Ru(III) - catalyzed reaction between primary amine and CAT
   a) Determination of order of the reaction w.r.t. (amine)
   b) Determination of order of the reaction w.r.t. [Ru(III)]
   c) Determination of order of the reaction w.r.t. ($H^+$).
   d) Effect of dielectric constant of the medium using (methanol).
   f) Determination of Ea and thermodynamic parameters.
4. Kinetics of saponification of ethyl acetate by conductivity method and study the effect of dielectric constant of the medium (Using methanol).
5. Study of photolysis of uranyl oxalate:
   a) Determination of intensity of light source
   b) Study of Photocatalysis of oxalic acid
6. Photolysis of CAT solution - determination of quantum yield and study of kinetics of photodecomposition.
7. Potentiometric determination solubility of sparingly soluble salt (AgCl or $AgBrO_3$): Study of salt effect on solubility and determination of activity coefficient.
8. Differential Potentiometric titration of mixture of weak acids (HCOOH, $CH_3COOH$. $ClCH_2COOH$ Vs NaOH).
9. Determination of pK value of an indicator (Methyl orange / bromophenol blue /phenolphthalein etc,.).
10. Determination of composition and stability constant of uranyl (V) sulphosalicylate complex by limiting logarithmic method.
11. Determination of half wave potential of metal ions in a mixture ($Cd^{2+}$, $Zn^{2+}$, $Mn^{2+}$, $Pb^{2+}$, $Cu^{2+}$).
12. Estimation of metal ion in solution by polarographic method.

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1. Practical Physical chemistry – A. J. Findlay
2. Experimental Physical chemistry- F. Daniels et al.
3. Selected experiments in Physical chemistry – Latham
4. Experiments in Physical chemistry – James and Prichard
5. Experiments in Physical chemistry- Shoemaker
6. Advanced Physico-Chemical Experiments- J. Rose
7. Practical Physical chemistry- S. R. Palit.
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