

SOLAPUR UNIVERSITY, SOLAPUR



NAAC Accredited-2015
'B' Grade (CGPA 2.62)

Name of the Faculty: Science

Syllabus: Chemistry

Name of the Course: B. Sc. II(Sem-III&IV)

CBCS

With effect from June- 2017

Solapur University, Solapur
B.Sc. Part-II
Chemistry
Choice Based Credit System (CBCS)
In force from June-2017

General Structure :

There will be two theory papers of 70 marks for each semester. Their titles & marks distribution are as under.

N. B.

- i. Figures shown in bracket indicate the total number of contact hours required for the respective topics
- ii. The question paper should cover the entire syllabus. Marks allotted questions should be in proportion to the number of contact hours allotted to respective topics.
- iii. All topics should be dealt with S.I units.
- iv. Use of scientific calculator is allowed.
- v. Industrial tour is prescribed.

Semester-III

Paper-V : Organic Chemistry 100 marks (70 + 30 marks)

Paper-VI : Inorganic Chemistry 100 marks (70 + 30 marks)

Semester-IV

Paper-VII : Physical Chemistry 100 marks (70 + 30 marks)

Paper-VIII : Analytical & Industrial Inorganic Chemistry 100 marks (70 + 30 marks)

Practical Course : Practical Examination will be held at the end of the year - 200 marks

A) Distribution of marks :

- a) Physical : 45 marks (35 marks physical experiment + 5 marks oral + 5 marks Journal)
- b) Inorganic : 50 marks
 - I (25 marks gravimetric analysis + 15 marks preparation + 5 marks oral + 5 marks Journal)
 - II (25 marks for semimicro qualitative analysis + 15 marks volumetric estimation + 5 marks oral + 5 marks Journal).
- c) Organic : 45 marks (20 marks for organic qualitative Analysis + 15 marks estimation/preparation + 5 marks oral + 5 marks Journal)

B) Duration of Examination – Two days, 6 hrs. per day

Equivalent Subject for Old Syllabus

Sr. No.	Name of the Old Paper	Name of the New Paper
1)	Paper: III Organic Chemistry	Paper: V Organic Chemistry
2)	Paper: IV Inorganic Chemistry	Paper: VI Inorganic Chemistry
3)	Paper: V Physical Chemistry	Paper: VII Physical Chemistry
4)	Paper: VI Analytical and Industrial Inorganic Chemistry	Paper: VIII Analytical and Industrial Inorganic Chemistry

Semester-III
Paper-V: Organic Chemistry

Total Credits: 3
(45 Contact hrs.)

UNIT-I Credits: 1.6 Contact Hrs: 24

1. Spectroscopic Methods (8)

Ultra-Violet (UV) absorption:

Introduction to Spectroscopy, Beer – Lambert law (mathematical derivation not expected), Types of electronic transitions, Terms used in UV spectroscopy: Chromophore, Auxochrome, Bathochromic Hypsochromic, Hypochromic and Hyperchromic shifts, Effect of conjugation on position of UV and visible bands. Calculation of λ_{max} by Woodward-Fieser rules for conjugated dienes and enones. Applications of UV spectroscopy – Determination of structure and stereochemistry (cis and trans) spectral problems based on UV. (Spectroscopic charts will not be supplied)

2. Stereochemistry (8)

2.1. Geometrical isomerism: Introduction, Geometrical isomerism in aldoximes and ketoximes, configuration of ketoximes-Beckmann transformation (Mechanism & Proof are not expected) configuration of aldoximes.

2.2. Conformational Isomerism: Introduction, conformation of ethane and n-butane and their representation by using Saw-Horse, Fischer (dotted Wedge line) and Newmann's projection formulae.

2.3. Conformational analysis of ethane and n-butane with the help of energy profile diagrams.

2.4. Nomenclature – D & L, R & S, E & Z systems

3. Alcohols and Phenols (8)

3.1. Alcohols : Introduction

i. Dihydric alcohols : Nomenclature, Methods of formation of ethylene glycol from ethylene, ethylene dibromide and ethylene oxide, physical properties & chemical reactions of ethylene glycol – acidic nature, reaction with hydrogen halide, oxidation – lead acetate, HIO_4 and nitric acid, Uses of ethylene glycol. Pinacol formation, Pinacol-Pinacolone rearrangement and its mechanism.

ii. Trihydric alcohols: Nomenclature, Methods of formation of glycerol – from fats and oils physical properties. Chemical reactions of glycerol – reaction with electropositive metals, reaction with hydrogen halide HCl and HI Reaction with conc. nitric acid in presence of conc. sulphuric acid. Reactions with potassium hydrogen sulphate, esterification, oxidation. Uses of glycerol.

3.2. Phenols : Introduction, Reactions of phenol (carbolic acid) :

i. Acylation and Fries rearrangement

ii. Ether formation and claisen rearrangement

iii. Gattermann Synthesis

iv. Carboxylation – Kolbe's reaction

v. Reimer – Tiemann reaction and its mechanism.

4. Aldehydes and Ketones

(5)

Introduction, Nomenclature, structure and reactivity of the carboxyl group. Mechanism of nucleophilic additions to carbonyl group. Study of following reactions with mechanism and applications 1) Aldol condensation (base catalysed), 2) Perkin reaction, 3) Cannizzaro's reaction, 4) Knoevenagel reaction 5) benzoin condensation..

5. Ethers and Epoxides

(5)

5.1. Ethers : Introduction, Nomenclature, Methods of formation of anisole by Williamson's synthesis and from diazomethane, chemical reactions of anisole with HI, Gravimetric estimation of $-OCH_3$ group by Ziesel's method (Related problems are expected based on % of $-OCH_3$ and number of $-OCH_3$ groups).

5.2. Epoxides : Introduction, Nomenclature, commercial method of preparation of ethylene oxide. Acid and base catalysed ring opening of ethylene oxide, reactions of Grignard and organolithium reagents with ethylene oxide.

6. Carboxylic acids

(7)

6.1. Monocarboxylic acids : Introduction. Methods of formation of Halo acids, di- and trichloroacetic acid by HVZ reaction, substitution reactions of monochloroacetic acid by nucleophiles CN^- , OH^- , I^- , and NH_3 .

6.2. Hydroxy acids : A. Malic acid and B. Citric acid, Methods of formation of malic acid from maleic acid and from α -bromo succinic acid. Reactions of malic acid – action of heat, oxidation reaction and reaction with HI, uses of malic acid. Methods of formation of citric acid from glycerol. Reactions of citric acid: Acetylation with acetic anhydride reduction by HI, Action of heat at $422^\circ K$. Uses of citric acid.

6.3. Unsaturated acids : Methods of formation A. Acrylic acid from acrolein and by dehydration of β -hydroxy propionic acid. Reactions of acrylic acid – Addition of H_2O , reduction by Na / C_2H_5OH . Uses of acrylic acid. Methods of formation B. Cinnamic acid from benzaldehyde using diethyl malonate and by using acetic anhydride and sodium acetate. Reactions of cinnamic acid – bromination, oxidation. Uses of cinnamic acid.

6.4. Dicarboxylic acids : Succinic and phthalic acids. Methods of formation of succinic acid from ethylene bromide, maleic acid. Reactions of succinic acid – action of heat, action of $NaHCO_3$, C_2H_5OH in presence of acid. Uses of succinic acid. Methods of formation of phthalic acid from o-xylene and naphthalene Reactions of phthalic acid – action of heat, reaction with sodalime, NH_3 . Uses of phthalic acid.

7. Diazonium Salts

(4)

7.1 Diazonium salts : Introduction, benzene diazonium chloride – preparation, chemical properties.

- i. Formation of iodo benzene
- ii. Sandmeyer's reaction
- iii. Formation of benzene
- iv. Formation of phenylhydrazine
- v. Azo coupling – synthesis of methyl orange and congo red.

Reference Books :

Latest editions of following reference books.

1. Organic Chemistry. Volume 1 – The fundamental principles by I.L. Finar.
2. Organic Chemistry. Volume 2 – Stereochemistry and the chemistry of natural. Products by I.L. Finar, Low-priced Edn. ELBS – Longman
3. Organic Chemistry. Volume I, II, III by S.M. Mukharjee, S.P. Singh and R.P. Kapoor. Wiley Eastern Limited.
4. Advanced Organic Chemistry by, B.S. Bahl, Arun Bahl. S.Chand & Company, Ltd.
5. Organic Chemistry by Morrison – Boyd.
6. A Text Book of Organic Chemistry by K.S. Tiwari. S.N. Meharotra. N.K. Vishnoi. Vikas Publication, Meerut.
7. Spectroscopic methods in Organic Chemistry by Williams and Fleming. Mc-Graw Hill.
8. Stereochemistry of Organic Compounds by E.L. Eliel. Orient Longman.
9. Stereochemistry of Organic Compounds by P.S. Kalsi. New Age International Ltd.
10. A Guide Book to Mechanism in Organic Chemistry by Peter Sykes.
11. Advanced Organic Chemistry, structure, reactions and mechanism by Jerry March. Mc Graw Hill Kogakusha, Ltd.
12. Spectroscopy of Organic Compounds by P.S. Kalsi.
13. Absorption spectroscopy of Organic molecules by V.M. Parikh.
14. College Organic Chemistry Part I & II by G.R. Chatwal.
15. Stereochemistry by Nasi Puri.
16. Organic synthesis by Smith.

Semester-III
Paper-VI- Inorganic Chemistry

Total Credits : 3
(45 Contact hrs.)

UNIT-I Credits: 1.53 Contact Hrs: 23

1. Co-ordination Chemistry : **(16)**

- 1.1 Definition and formation of co-ordinate covalent bond in $\text{BF}_3 \cdot \text{NH}_3$ and in $[\text{NH}_4]^+$.
- 1.2 Distinction between double salt and complex salt,
- 1.3 Werner's theory :
 - A. Postulates of theory,
 - B. Applications of theory:
Theory applied to cobalt amine viz;
a] $\text{CoCl}_3 \cdot 6\text{NH}_3$ b] $\text{CoCl}_3 \cdot 5\text{NH}_3$, c] $\text{CoCl}_3 \cdot 4\text{NH}_3$, d] $\text{CoCl}_3 \cdot 3\text{NH}_3$
 - C. Limitations
- 1.4 Description of terms –
 - a] ligand, b] co-ordination number,
 - c] co-ordination sphere, d] effective atomic number,
 - e] Geometrical isomerism and optical isomerism in co-ordination compounds for CN = 4 and CN = 6.
- 1.5 IUPAC nomenclature of co-ordination compounds,
- 1.6 Valence bond theory of transition metal complexes.
 - A. Introduction
 - B. Postulates of VBT/ basic concepts of VBT
 - C. Role of transition metal in the formation of complex
 - D. Stepwise process of formation of complex : Salient features
 - E. Applications : High spin and low spin complexes w.r.t. CN = 4 and CN = 6.
 - F. Limitations of Valence bond theory.

2. Chelation **(07)**

- 2.1 A brief introduction w.r.t. ligand, chelating agent, chelation and metal chelate.
- 2.2 Structural requirements of chelate formation.
- 2.3 Difference between metal chelate and metal complex.
- 2.4 Classification of chelating agents (with specific illustrations of bidentate chelating agent).
- 2.5 Applications of chelation w.r.t. chelating agents : EDTA and DMG.

UNIT-II Credits: 1.47 Contact Hrs: 22

3. Acids and Bases **(07)**

- 3.1 Lewis Concept : A. Definition, B. classification, C. merits and D. demerits.
- 3.2 Hard and soft acids and bases (HSAB) :
 - A. Classification of acids and bases as hard and soft,
 - B. Pearson's HSAB concept,
 - C. Acid-Base strength and hardness-softness,
 - D. Applications and limitations of HSAB principle.

4. Study of d-block elements **(15)**

- 5.1. Introduction,
- 5.2. Position of d-block elements in periodic table,
- 5.3. Names & electronic configuration of 1st, 2nd & 3rd three transition series.
- 5.4. General Characteristics of 3 d-block elements w.r.t. –
 - a) oxidation state b) colour c) Magnetic behavior (spin only formula)
 - d) catalytic properties and e) tendency to form complexes.

- 5.5. Comparison of 1st transition series with 2nd & 3rd transition series w.r.t. –
- a) electronic configuration
 - b) reactivity
 - c) stability of oxidation state
 - d) magnetic behavior and
 - e) stability of complexes (Brief account only)

Reference Books :

1. Concise Inorganic Chemistry by J.D. Lee ELBS 4th & 5th Edn.
2. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and P.L. Gaus Wiley.
3. Concepts and Models of Inorganic Chemistry by B. Douglas, D.Mc. Daniel and J. Alexander, John Wiley.
4. Advanced Inorganic Chemistry by Satyaprakash, Tuli, Basu (S. Chand and Co.)
5. Inorganic Chemistry by Puri and Sharma (S. Chand & Co.)
6. Inorganic Chemistry by Agrawal.
7. Inorganic Chemistry by D.E. Shriver, P.W. Atkins and C.H. Longford, Oxford.
8. Selected topics in Inorganic Chemistry : Madan, Malik Tuli, S. Chand & Company.
9. Vogel's Text Book of Quantitative Inorganic Analysis–Bassett, Denny, Jeffery Mendham.
10. Basic concepts of Analytical Chemistry by S.M. Khopkar.

Semester-IV
Paper-VII- Physical Chemistry

Total Credits : 3
(45 Contact hrs.)

UNIT-I Credits: 1.87 Contact Hrs: 28

1. Electrochemistry : (18)

- 1.1. Introduction, conduction of electricity, Types of conductors : electronic and electrolytic.
- 1.2. Explanation of terms : Conductance, Specific resistance, specific conductance, Equivalent conductance, Molecular conductance.
- 1.3. Variation of specific and equivalent conductance with concentration, Equivalent conductance at infinite dilution. (Mention Onsager equation, $\lambda_v = \lambda_\infty - b\sqrt{c}$ from graph)
- 1.4. Migration of ions, Hittorf's rule, Transport number, Determination of transport number by moving boundary method, factors influencing transport number: Nature of electrolyte, concentration, temperature, complex formation and Degree of hydration.
- 1.5. Kohlrausch law, Applications of Kohlrausch law :
 - i. Determination of relationship between ionic conductance, ionic mobility and transport number.
 - ii. Determination of equivalent conductance at infinite dilution of weak electrolytes.
 - iii. Determination of degree of dissociation of weak electrolyte.
 - iv. Determination of ionic product of water.
 - v. Determination of solubility of sparingly soluble salts.
- 1.6. Numerical problems.

2. Thermodynamics (10)

- 2.1. Introduction, concept of entropy, Entropy as a state function: Definition, mathematical expression, unit, physical significance of entropy.
- 2.2. Entropy changes for reversible and irreversible processes in isolated systems.
- 2.3. Entropy changes for an ideal gas as a function of V and T and as a function of P and T.
- 2.4. Entropy change in mixing of gases.
- 2.5. Entropy change in physical transformations :
 - i. Fusion of a solid.
 - ii. Vaporization of a liquid.
 - iii. Transition from one crystalline form to another.
- 2.6. Third law of thermodynamics, Absolute entropy and Evaluation of absolute entropy, use of absolute entropies: Determination of entropy changes in chemical reactions.
- 2.7. Numerical problems.

UNIT-II Credits: 1.13 Contact Hrs: 17

3. The Solid State (10)

- 3.1. Introduction, space lattice, lattice sites, lattice planes, Unit Cell.
- 3.2. Laws of crystallography :
 - i. Law of constancy of interfacial angles.
 - ii. Law of rational indices
 - iii. Law of crystal symmetry.
- 3.3. Weiss indices and Miller indices.

- 3.4. Cubic lattice and types of cubic lattice, planes or faces of a simple cubic system, spacings of lattice planes.
- 3.5. Diffraction of X-rays, Derivation of Bragg's equation.
- 3.6. Determination of crystal structure of NaCl and KCl on the basis of Bragg's equation.
- 3.7. Numerical problems.

4. Distribution Law

(07)

- 4.1. Introduction
- 4.2. Nernst distribution law, its limitations and modification with respect to association and dissociation of solute in one of the solvents
- 4.3. Applications of distribution law in
 - i. Process of extraction (derivation expect)
 - ii. Determination of solubility
 - iii. Distribution indicators
 - iv. Determination of molecular weight
- 4.4. Numerical problems expected

List of Reference Books :

- 1) Elements of Physical Chemistry : S. Glasstone and D. Lewis (D.Van Nostrand Co. Inc)
- 2) Physical Chemistry : W.J. Moore (Orient Longman)
- 3) Principles of Physical Chemistry : Maron & Prutton (Oxford IVth Edn.)
- 4) Chemistry Principle & Applications : P.W. Atkins, M.J. Clugsto, M.J. Fiazer, R.A.Y. Jone (Longman)
- 5) Physical Chemistry : G.M. Barrow (Tata Mc-Graw Hill)
- 6) Essentials of Physical Chemistry : B.S. Bahl & G.D. Tuli (S. Chand)
- 7) Physical Chemistry: Daniels – Alberty.
- 8) Principles of Physical Chemistry : Puri – Sharma (S. Nagin)
- 9) Basic Chemical Thermodynamics : V.V. Rao.
- 10) Physical Chemistry Through problems : Dogra and Dogra (Wiley Eastern Ltd.,)
- 11) Physical Chemistry: S. Glasstone.
- 12) Text book of Physical Chemistry – S. Glasstone (2nd Edn. Mac Millan)
- 13) Elements of Physical Chemistry – P. Atkins & J. Paula (Oxford IVth Edn.)
- 14) Principles of Physical Chemistry : B. R. Puri, L. R. Sharma and M. S. Pathania
- 15) Electrochemistry : S. Glasstone

Semester-IV
Paper- VIII- Analytical & Industrial Inorganic Chemistry

Total Credits : 3
(45 Contact hrs.)

UNIT-I Credits: 1.33 Contact Hrs: 20

1. Volumetric Analysis : (10)

1.1 Introduction, Terminology :- Titrant; Titrand, standard solution; Titration Indicator; Equivalence point; End point. Primary standard, Secondary standard. Strength of solution, volumetric analysis & their types.

1.2 Acid Base Titration

i) Introduction

ii) Theory of Acid-Base indicator :

A) Colour change Interval

B) Theories-Ostwald's theory & Quinoid theory,

iii) Neutralization curve and choice of indicator for following titrations :

A) Strong acid and Strong Base

B) Strong Acid and Weak Base

C) Weak Acid and Strong Base

1.3 Complexometric titration :

A) General account,

B) Types of EDTA Titrations,

C) Metallochromic Indicator w.r.t. Eriochrome Black-T

2. Gravimetric Analysis: (10)

2.1. Introduction, Terminology :-Gravimetric analysis, Saturation, Super-saturation, Sol, Gel, Coagulation or Flocculation, Coagulation or Flocculation value, Peptisation, Precipitation, Precipitate, Precipitant, Solubility, Aging or digestion, Ignition,

2.2. General steps involved in gravimetry

2.3. Precipitation – A) Physical nature of Precipitate: Gelatinous, Curdy and Crystalline.

B) Conditions of Precipitation

2.4. Process of precipitation – A) Nucleation B) Crystal growth C) Digestion

2.5. Co-precipitation and Post precipitation and their difference.

2.6. Role of Organic precipitants in gravimetric analysis,

2.7. Study of organic precipitants viz. A) DMG, B) Aluminon, C) 8- Hydroxy quinoline.

2.8. Advantages and disadvantages of organic precipitants.

UNIT-II Credits: 1.67 Contact Hrs: 25

3. Industrial heavy Chemicals (07)

3.1. Introduction

3.2. Physicochemical Principles & manufacture of following heavy chemicals:

i) Ammonia by Haber process

ii) Sulphuric acid by contact process.

4. Metallurgy

(08)

4.1. Introduction: Terminology:- Metallurgy, Mineral, Ore, Gangue, Flux, Slag.

4.2. Occurrence of metals: Types of ores

4.3. Steps involved in metallurgical processes:

A) Concentration of ores-

I. Physical methods:

a) Gravity separation method, b) Magnetic separation method, c) Froth flotation process.

II. Chemical Methods:

a) Calcination b) Roasting

B) Reduction- i) Chemical methods of reduction

ii) Electrolytic reduction method for e.g. Aluminium and copper

5. Iron and Steel

(10)

5.1 Occurrence of Iron

5.2 Extraction of Iron: Blast furnace

5.3 Types of Iron

5.4 Steel-

A) Definition

B) Types of Steel

C) Manufacture of Steel: a) Bessemer process b) L. D. process

D) Heat treatment on Steel

List of Reference Books :

1. Concise Inorganic Chemistry by J.D. Lee ELBS 4th & 5th Edn.
2. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and P.L. Gaus Wiley.
3. Advanced Inorganic Chemistry by Satyaprakash, Tuli, Basu (S. Chand and Co.)
4. Inorganic Chemistry by Puri and Sharma (S. Chand & Co.)
5. Inorganic Chemistry by G.S. Manku Tata Mc. Graw Hill.
6. Inorganic Chemistry by Agrawal.
7. Industrial Chemistry by B.K. Sharma.
8. Inorganic Chemistry by D.E. Shriver, P.W. Atkins and C.H. Longford, Oxford.
9. Text book of Quantitative Inorganic Analysis by A.I. Vogel.
10. Vogel's Text Book of Quantative Inorganic Analysis – Bassett, Denny, Jeffery Mendham.
11. Basic concepts of Analytical Chemistry by S.M. Khopkar.

Laboratory Course (Practicals) Chemistry

University practical Examination : 140 marks

Internal practical Examination : 60 marks

Total 200 Marks = Credits : 4

B.Sc.II-Chemistry practical Examination-pattern

Mark Distribution

* University Examination : (Two Day Exam)	Expt	Journal	Oral	Total
Q.1: Physical Chemistry Experiment	35	5	5	45
Q.2 : Inorganic Chemistry Experiment	40	5	5	50
Q.3 : Organic Chemistry Experiment	35	5	5	45

* Internal Examination :

Practical paper has 60 marks for Internal Examination.

There will be **three** practicals of 20 marks each.

1. Physical Chemistry Expt : 20 marks

2. Inorganic Chemistry Expt : 20 marks

3. Organic Chemistry Expt : 20 marks

Note : i) Use of Electronic / Single pan balance / Digital balance is allowed.

ii) Use of scientific calculator is allowed.

iii) Use S.I. Units wherever possible.

Laboratory Course Physical Chemistry

A) Instrumental

1. Viscosity : To determine the percentage composition of a given liquid mixture by viscosity method. (Density data be given)
2. Refractometry : To determine the specific and molar refractions of benzene, tolyene and xylene by Abbe's refractometer and hence determine the refraction of $-\text{CH}_2$ group. (Densities should be determined by the students.)
3. Polarimetry : To determine the specific rotation and find unknown concentration of sugar solution.
4. Conductometry : (any two)
 - i. To determine degree of dissociation and dissociation constant of acetic acid at various dilutions and to verify Ostwald's dilution law conductometrically.
 - ii. To determine the normality of the given strong acid by titrating it against strong alkali conductometrically.
 - iii. To determine the equivalent conductance at infinite dilution of strong electrolyte at five different dilutions conductometrically. (e.g. any one from KCl, NaCl, KNO_3 and HCl) and verify Onsager equation.

B) Non-Instrumental

1. Chemical Kinetics (ANY THREE)

- i. To study the hydrolysis of methyl acetate in presence of HCl and H_2SO_4 and to determine the relative strength of acids.
- ii. To study the effect of acid strength (0.5M and 0.25M HCl) on hydrolysis of an ester.
- iii. To study the reaction between $\text{K}_2\text{S}_2\text{O}_8$ and KI (unequal concentration)
- iv. To study the reaction between KBrO_3 and KI (equal concentrations)

2. Partition coefficient

To determine partition coefficient of benzoic acid between water and benzene

Reference Books :

1. Experimental Physical Chemistry by A. Findlay Longman.
2. Experiments in Physical Chemistry by R.C. Das & B. Behra. Tata Mc Graw Hill.
3. Advanced Experimental Chemistry Vol. I Physical by J.N. Gurtu and R. Kapoor S. Chand & Co.
4. Experiments in Physical Chemistry by J.C. Ghosh, Bharati Bhavan.
5. Practical book of Physical Chemistry – by Nadkarni Kothari Lawande. Bombay Popular Prakashan.
6. Systematic Experimental Physical Chemistry – by S.W. Rajbhoj, Chondhekar. Anjali Publication.
7. Practical Physical Chemistry – by B.D. Khosala & V.C. Garg R. Chand & Sons.
8. Experiments in Chemistry by D.V. Jagirdar.

Practical Course Inorganic Chemistry

1. Gravimetric Analysis :

- i. Gravimetric estimation of Fe as Fe_2O_3 from a solution containing ferrous ammonium sulphate and free sulphuric acid.
- ii. Gravimetric estimation of Ba as BaSO_4 from a solution containing barium chloride and free hydrochloric acid.

2. Titrimetric Analysis : Calibration of burette, pipette and volumetric flask.

- i. Fertilizer analysis : To determine the percentage of nitrogen present in a given sample of nitrogenous fertilizer.
- ii. Quality control – To determine percentage purity of soda ash in the given sample.
- iii. Analysis of commercial vinegar – To determine the percentage of acetic acid in a given commercial sample of vinegar.
- iv. To prepare standard solution of calcium chloride from calcium carbonate and determine the total hardness of given water sample.

3. Inorganic Preparations :

- i. Ferrous Ammonium Sulphate (Mohr's salt)
- ii. Tetrammine Copper (II) sulphate

4. Semi-micro Qualitative Analysis :

Cations : Cu^{++} , Al^{+++} , Fe^{+++} , Mn^{++} , Zn^{++} , Ni^{++} , Ba^{++} , Ca^{++} , Mg^{++} , NH_4^+ , K^+

Anions : Cl^- , Br^- , I^- , SO_4^{2-} , NO_3^- , CO_3^{2-} At least **SIX** mixtures to be completed.

Reference Books :

1. Quantative Inorganic Chemistry – A.I. Vogel.
2. Practical Chemistry – Physical – Inorganic – Organic and Vice-voce by Balwant Rai Satija. Allied Publishers Pvt. Ltd.
3. Inorganic Qualitative Analysis – A.I. Vogel.
4. Basic Concepts in Analytical Chemistry – S.M. Khopkar.
5. Vogel's Text Book of Quantative Inorganic Analysis – Bassett, Denny, Jeffery Mendham.

Laboratory Course Organic Chemistry

A) Organic Qualitative Analysis :

Identification of at least **Eight organic compounds** with reactions including two from acids, two from phenols, two from bases and two from neutrals.

- **Acids** : succinic acid, phthalic acid, salicylic acid, aspirin
- **Phenols** : α -naphthol, o-nitrophenol, p-nitrophenol
- **Bases** : o-, m-, and p-nitroanilines N, N-dimethylaniline
- **Neutral** : urea, acetanilide, carbontetrachloride, bromobenzene, methylacetate, nitrobenzene, naphthalene, anthracene, acetophenone, ethylmethyl ketone.

Note : A systematic study of an organic compound involves the following operations which should be taught in details with reactions in the determination of elements and functional group.

- 1) Preliminary tests and physical examination
- 2) Determination of type
- 3) Determination of physical constant
- 4) Detection of elements
- 5) Determination of functional group
- 6) A search into the literature
- 7) Special test if any
- 8) Summary
- 9) Result.

B) Organic Quantitative Analysis :

i. Estimations (Any Two)

1. Estimation of ester
2. Estimation of acetone
3. Estimation of ibuprofen from ibuprofen tablet

ii. Organic Preparations (Any Three)

1. Preparation of phthalimide from phthalic anhydride.
2. Preparation of p-bromoacetanilide from acetanilide.
3. Preparation of m-dinitrobenzene from nitrobenzene using NaNO_2 and conc. H_2SO_4 .
4. Preparation of acetanilide from aniline using acetic acid and anhydrous zinc chloride.
5. Preparation of p-nitroethylbenzoate from p-nitrobenzoic acid

Reference Books :

1. Practical Organic Chemistry by A.I. Vogel.
2. Hand book of Organic qualitative analysis by H.T. Clarke.
3. A laboratory Hand Book of Organic qualitative analysis and separation by V.S. Kulkarni. Dastane Ramchandra & Co.
4. Practical Organic Chemistry by F.G. Mann and B.C. Saunders. Low – priced Text Book. ELBS. Longman.
5. Experiments in General Chemistry by C.N.R. Rao. Affiliated East-West Press Pvt. Ltd. Delhi.
6. Advanced Practical Organic Chemistry by N.K. Vishnoi. Vikas Publishing House Private Limited.
7. Comprehensive Practical Organic Chemistry Qualitative Analysis by V.K. Ahluwalia, Sunita Dhingra. University Press. Distributor-Orient Longman Ltd.
8. Practical Chemistry – Physical – Inorganic – Organic and Viva – voce by Balwant Rai Satija. Allied Publishers Private Limited.
9. Experimental organic chemistry by J. R. Norris, published by Sarup and sons, Delhi
10. Advanced practical chemistry by J. Singh, L. D. S. Yadav, R. K. P. singh, I. R. Siddiqui et.al, Pragati prakashan.
