SEMESTER-III

Program: B.Sc. (Sem-III)	**Type:** Theory
Subject: DSC-5-Inorganic Chemistry-II	
Credit: 04 (T) + 02 (P)	**Total learning hours:** 60

Course description:

This course provides an overview of some important topics in inorganic chemistry.

This course includes knowledge in the areas of some basic topics like oxidation, reduction, metallurgy etc.

Course comprises of information about various theories of bonding, coordination compounds and organometallic compounds as well as basics of oxidation-reduction and acids and bases.

Student learning outcome:

Upon completion of this course, students will:

- Have systematic understanding of modern concepts of chemical bonding
- Have a deep knowledge regarding p-block elements
- Have information regarding principles of metallurgy
- Be able to understand various theories related to coordination compounds
- Be able to carry out nomenclature of coordination compounds
- Get exposure to concept of oxidation and reduction and various acid-base concepts

Unit-1 Chemical Bonding-II **(10 Hrs)**

1.1 VSEPR theory
1.2 Atomic orbital theory of covalent bond
1.3 Hybridisation with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements, equivalent and non-equivalent hybrid orbitals
1.4 Molecular orbital theory
1.5 Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, F_2, CO, NO, and their ions (CO^+ , NO^+ , NO^-)

Unit-2 Chemistry of p-block Elements **(07 Hrs)**

2.1 Chemical reactivity and group trend of elements
2.2 Catenation and allotropy
2.3 Hydrides and halides (synthesis, properties and structure)
2.4 Application of redox potential diagrams with reference to N, P, S, Cl, Br and I
2.5 Interhalogens, Psuedohalogens and polyhalides
2.6 Complex formation tendency of *p* block elements

Unit-3 General Principle Of Metallurgy **(06 Hrs)**

3.1 Chief modes of occurrence of metals based on standard electrode potentials
3.2 Ellingham diagrams: Salient features. Selection of reducing agents using Ellingham's Diagrams
3.3 Electrolytic reduction, Hydrometallurgy
3.4 Methods of purification of metals: Electrolytic Kroll process, Parting process, van

Arkel-de Boer process and Mond's process, Zone refining

3.5 Extraction of the following metals:
Nickel from sulphide ore
Thorium from Monazite sand
Uranium from Pitch blende
Plutonium from Nuclear waste

Unit-4 Co-ordination Chemistry-I **(11Hrs)**

4.1 Coordinate bonding: double and complex salts
4.2 Ligands and their classification, Ambidentate ligands, Chelate
4.3 EAN rule, Valence bond theory postulates, limitations
4.4 Werner's theory
4.5 IUPAC nomenclature of coordination complexes (up to two metal centres)
4.6 Isomerism in coordination compounds

Unit-5 Organometallic Compounds-I **(12 Hrs)**

5.1 Definition and classification of organometallic compounds on the basis of bond type
5.2 Concept of hapticity of organic ligands
5.3 Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series
5.4 General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3rd series
5.5 Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co, Ni using VBT
5.6 Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls

Unit-6 Acid-base Chemistry **(05 Hrs)**

6.1 Brönsted-Lowry concept of acid-base reactions
6.2 Levelling solvents
6.3 Lewis acid-base concept
6.4 Lux-Flood concept and solvent system concept
6.5 Concept of Hard and Soft Acids and Bases (HSAB) and its application

Unit-7 Oxidation Reduction Reactions **(05 Hrs)**

7.1 Use of redox potential data
7.2 Analysis of redox cycle
7.3 Redox potentials in water
7.4 Frost, Latimer, Pourbaix diagram

Unit-8 Silicates **(04 Hrs)**

8.1 Structure of SiO_4
8.2 Classification of silicates based on the structure
8.3 Zeolites: their structure and applications

Reference Books:

1. Advanced Inorganic Chemistry, Satya Prakash Tuli, Basu & Madan 6th Edn , 2009, S. Chand Publishing
2. Calculation of Analytical Chemistry, Hamilton, Simpson &Ellis 7th Edn.,1969, Pearson
3. Theoretical Inorganic Chemistry, Day, M.C. and Selbin, J. , 2009, East-West Press
4. Concise Inorganic Chemistry, Lee J. D., Wiley India, 5th Edn., 2017, Wiley
5. Inorganic Chemistry – Principles of structure and reactivity, Huheey J. E., Keiter E. A. and Keiter R. L., 1997, Pearson
6. Principles of Inorganic Chemistry, Puri, Sharma, Kalia 33rd Edn., 2020, Vishal Publishing Co.
7. Basic Inorganic Chemistry, Cotton and Wilkinson, 1995, Wiley

Program: B.Sc. (Sem-III)	**Type:** Theory
Subject: DSC-6-Organic Chemistry-II	
Credit: 04 (T) + 02 (P)	**Total learning hours:** 60
Course description:	
This course provides a systematic study of Chemistry of functional groups. It includes study about the different organic compounds having different functional groups. Topics involved nomenclature, preparation, properties and uses of organic compounds.	
Student learning outcome:	
Students will be able:	
• To Identify functional groups. • To Explain organic reactions and their mechanisms. • To Use nomenclature of different organic compounds. • To know about physical and chemical properties of different compounds • To know about applications of different organic compounds.	

Organic Chemistry-2: Chemistry of Functional Groups

UNIT- 1 Heterocyclic Compounds **(07Hrs)**

- **1.1 I**ntroduction
- **1.2** Classification
- **1.3** Five membered: Furan, Furfural, Pyrrole, Thiophene
- **1.4** Six Membered: Pyridine and its derivatives
- **1.5** Condensed: Indole, Quinoline, Isoquinoline

UNIT- 2 Alcohols and Ethers **(07Hrs)**

Alcohols

- **2.1** Introduction & Nomenclature
- **2.2** Physical Properties
- **2.3** Preparation
- **2.4** Reactions
- **2.5** Alcohols as acids and bases

Ethers

- **2.6** Introduction & Nomenclature
- **2.7** Preparation
- **2.8** Physical Properties
- **2.9** Reactions
- **2.10** Cyclic ethers

UNIT- 3 Phenols and Aromatic Ethers **(07Hrs)**

- **3.1** Introduction & Nomenclature
- **3.2** Method of Preparation
- **3.3** Physical Properties

3.4 Chemical Reactions (Rearrangement & Substitution)
3.5 Acidity of phenols

UNIT- 4 Aldehydes and Ketones **(07Hrs)**

4.1 Introduction
4.2 Nomenclature
4.3 Method of Preparation
4.4 Physical Properties
4.5 Chemical Reactions
4.6 Formaldehyde, Acetaldehyde
4.7 Acetone, Methyl Ethyl Ketone
4.8 Aromatic Aldehydes: Benzaldehyde, Cinnamaldehyde
4.9 Aromatic Ketones: Acetophenone, Benzophenone

UNIT- 5 Carboxylic acids and its derivatives **(08Hrs)**

5.1 Introduction & Nomenclature
5.2 Physical Properties
5.3 Preparation
5.4 Chemical Reactions
5.5 Acidity of carboxylic acids
5.6 Effect of substituents on acidity
5.7 Dicarboxylic acids
5.8 Acid chlorides, Acid anhydrides, Amides, Imides, Esters

UNIT- 6 Amines and Aryldiazonium Salts **(08Hrs)**

Amines

6.1 Introduction
6.2 Nomenclature
6.3 Method of preparation, Physical and Chemical Properties of- 1) Primary amine
2) Secondary amine
3) Tertiary amine
6.4 Basicity of amines
6.5 Methylamine, Dimethylamine, Trimethylamine, Quaternary ammonium salts

Aryldiazonium Salts

6.6 Introduction
6.7 Nomenclature
6.8 Preparation
6.9 Physical Properties
6.10 Chemical Properties

UNIT- 7 Organic Nitrogen and Nitro Compound **(08Hrs)**

Organic Nitrogen Compounds

7.1 Nitiles-Introduction, Nomenclature, Method of preparation, physical & chemical Properties
7.2 Acrylonitriles
7.3 Isonitriles- Introduction, Nomenclature, Method of preparation, physical & chemical properties
7.4 Alkyl nitrites: Ethyl Nitrite
7.5 Nitroalkanes- Introduction, Nomenclature, Method of preparation, physical & chemical Properties

7.6 Diazoalkane: Diazomethane

Aromatic Nitro Compounds

7.7 Introduction, Nomenclature, Method of preparation, physical & chemical Properties

7.8 Nitrobenzene, TNT

UNIT- 8 Thiols, Thioethers and Aromatic Sulphonic Acids (08Hrs)

Thiols

8.1 Introduction

8.2 Nomenclature

8.3 General Method of preparation

8.4 Physical & Chemical Properties

Thioethers

8.5 Introduction

8.6 Nomenclature

8.7 General Method of preparation

8.8 Physical & Chemical Properties

Aromatic Sulphonic Acids

8.9 Introduction

8.10 Nomenclature

8.11 General Method of preparation

8.12 Physical Properties

8.13 Chemical Reactions: 1) Reactions of –OH of SO_3H group
2) Reactions in which –SO_3H is replaced
3) Reactions of Benzene ring

8.14 Benzenesulphonic acid, Benzenesulphonyl Chloride, Toluenesulphonic acid, Saccharin, Chloramine –T, Sulphanilic acid, Sulphanilamide

Reference Books:

1. A Textbook of Organic Chemistry, 22nd Edition, Arun Bahl/B S Bahl, By S.Chand

2. Textbook of OrganicChemistry, P.L.Soni and H.M.Chawala,By Sultan Chand & Sons

3. Organic Chemistry, Seventh Edition, R.T.Morrison, R.N.Boyd, S.K.BhattacharjeeBy Pearson

4. Textbook of Organic Chemistry, By V.K.Ahluwalia, Ane Books Pvt. Ltd.

5. Organic Chemistry, Volume-1, Sixth Edition, By I.L.Finar, By Pearson

Program: B.Sc. (Sem-III)	**Type:** Theory
Subject: SEC-1- Basics of Analytical Chemistry	
Credit: 04 (T) + 02(P)	**Total learning hours:** 60
Course description: This Course Paper proposes to teach about: Sample collection from different sources, preservation techniques, Preparation of standard solutions, principle, reaction mechanism, analysis procedure and applications of volumetric titrations, solvent extractions, gravimetric methods and statistical analysis of the result data.	
Student learning outcome: After completing this course, the students will be able to learn: Types and objectives of sampling techniques, preservation and pre concentration of collected samples, preparation of primary and secondary standards and their standardization methods, buffer solution and buffer capacity, indicators, principle, reaction mechanism, procedure of analysis methods and applications of acid-base titrations, precipitation titrations, complexometric titrations, redox titrations, solvent extractions, gravimetric methods and statistical analysis of the result data.	

Unit 1: Sampling Techniques **(08Hrs)**

- **1.1** Objectives of Sampling
- **1.2** Types of Sampling
- **1.3** Sample Collection: Air, Water, Solids, Soil
- **1.4** Preservation Techniques of Samples
- **1.5** Preconcentration Techniques

Unit 2: Standard Solutions **(08Hrs)**

- **2.1** Primary Standards
- **2.2** Secondary Standards
- **2.3** Standardization of H_2SO_4
- **2.4** Standardization of NaOH
- **2.5** Standardization of $KMnO_4$
- **2.6** Standardization of I_2
- **2.7** Standardization of $Na_2S_2O_3$
- **2.8** Standardization of FAS

Unit 3: Volumetric Titrations-I **(08Hrs)**

- **3.1** Acid-Base: Neutralization Titrations
  - **3.1.1** Types and actions of buffer solution and buffer capacity
  - **3.1.2** Principle
  - **3.1.3** Reaction Mechanism
  - **3.1.**4 Procedure of Analysis Method
  - **3.1.5** Indicators
  - **3.1.6** Applications

Unit 4:Volumetric Titrations-II **(08Hrs)**

- **4.1** Precipitation Titrations
  - **4.1.1** Principle
  - **4.1.2** Reaction Mechanism
  - **4.1.3** Procedure of Analysis Method

4.1.4 Indicators
4.1.5 Applications

Unit 5: Volumetric Titrations-III **(08Hrs)**

5.1 Complexometric Titrations
5.1.1 EDTA and the complexones
5.1.2 Principle
5.1.3 Reaction Mechanism
5.1.4 Procedure of Analysis Method
5.1.5 Applications
5.1.6 Advantages

Unit 6:Volumetric Titrations-IV **(08Hrs)**

6.1 Redox Titrations
6.1.1 Principle
6.1.2 Factors influencing solubility of the precipitate
6**.1.3** Reaction Mechanism
6.1.4 Procedure of Analysis Method
6.1.5 Indicators
6.1.6 Applications

Unit 7: Solvent Extraction & Gravimetric Methods **(08Hrs)**

7.1. Principle and Rules
7.2 Reaction Mechanism
7.3 Classification of extraction methods
7.3.1 Chelation
7.3.2 Solvation
7.3.3 Ion pair formation
7.3.4 Solid phase extraction
7.4 Organic reagents in gravimetric analysis
7.5 Electrogravimetry
7.6 Applications

Unit 8: Statistical Analysis **(04Hrs)**

8.1 Errors in chemical analysis
8.2 Classification of errors
8.3 Determining and improving the accuracy of methods
8.4 Statistical analysis
8.5 Presentation of data
8.6 Confidence limit
8.7 Criteria for rejection of results: Q Test
8.8 Standard t Test
8.9 Standard deviation
8.10 Coefficient of variation
8.11 Linear regression
8.12 Least square fitting

Reference Books:

1. Chemistry for Environmental Engineering and Science, C. N. Sawyer and P. L. Mc Carty, G.F. Parkin, 5th Edition, 21st Reprint, 2015, McGraw Hill Education (India) Private Limited.

2. Quantitative Analysis, R.A Day, A.L Underwood, 6th Edition, 1991, Prentice-Hall.

3. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, 9th Edition, Reprint 2014, Cengage Learning.

4. Quantitative Analysis, R.A Day, A.L Underwood, 6th Edition, 1991, Prentice-Hall.

5. Basic Concepts of Analytical Chemistry, S.M. Khopkar, 3rd Edition, 2008, New Age International Publishers.

Program: B.Sc. (Sem-III)	**Type:** Theory
Subject: DSE-3-Medicinal Chemistry	
Credit: 02	**Total learning hours:** 30
Course description: This course is about Pharmaceutical chemistry which includes different types of drugs ex. General & local anesthetic, sedatives & hypnotic, analgesics & antipyretics, diuretics & antihypertensives and anticonvulsants & anti histaminics.	
Student learning outcome: Student will learn following : • Drug Receptors & Absorption • Drug Discovery, Design & Development • General & Local anesthetic • Sedatives & Hypnotics • Analgesics & Antipyretics • Diuretics & Anti-hypertensives • Anticonvulsants and Anti-histaminics	

Unit – 1: Introduction to Pharmaceutical Chemistry (02 Hrs)

- **1.1** Important Aspects of Pharmaceutical Chemistry
- **1.2** Importance of Chemistry in Pharmacy
- **1.3** Sources & Uses of Natural Drug Products
- **1.4** Biological, Geographical

Unit – 2: Drug Receptors & Absorption (05 Hrs)

- **2.1** Theories of Drug Action
- **2.2** Surface Active Agents
- **2.3** Metabolic Antagonism
- **2.4** Mechanism of Drug Action
- **2.5** Absorption of Drugs
- **2.6** Factors affecting Absorption

Unit – 3: Drug Discovery, Design & Development (05 Hrs)

- **3.1** Introduction
- **3.2** Molecular Modelling
- **3.3** Structure Activity Relationship
- **3.4** QSAR
- **3.5** Molecular Docking
- **3.6** Molecular Dynamics

Unit – 4: General & Local Anaesthetic (03 Hrs)

- **4.1** Classification Synthesis of Nitrus Oxide, Halothen, Thiopental Sodium & Chloroform
- **4.2** Classification of Local Anesthetic
- **4.3** Synthesis of procaine Hydrochloride, Benzocaine, Lignocaine Hydrochloride

Unit – 5: Sedatives & Hypnotics (05 Hrs)

- **5.1** Classification
- **5.2** SAR of Barbituric Acid Derivatives

5.3 Synthesis of Barbital, Allobarbital, HexoBarbital
5.4 SAR of Benzodiazepines
5.5 Synthesis of Diazepam, Alprazolam &Zolpidem
5.6 Synthesis of Phenobarbital & Phenytoin Sodium

Unit – 6: Analgesics & Antipyretics (02 Hrs)

6.1 Classification of Antipyretics & Analgesics
6.2 SAR of Morphine Analogue Salicylic Acid, Aryl Alkanoic Acid Derivatives
6.3 Synthesis of Aspirin & Paracetamol

Unit – 7: Diuretics & Anti-hypertensives (03 Hrs)

7.1 Classification of Diuretics
7.2 SAR, Synthesis & Uses of Hydrochlorthiazide, Hydroflumethiazide, Ethacrynic Acid, Furosemide, acetazolimide
7.3 Classification of Anti-hypertensives
7.4 SAR & Synthesis of Captopril, Propranolol Hydrochloride

Unit – 8: Anticonvulsants and Anti-histaminic (05 Hrs)

8.1 Introduction
8.2 Classification of Anticonvulsant
8.3 Synthesis of Phenobarbital & Phenytoin Sodium
8.4 Classification of Anti-histaminics
8.5 SAR of Ethanolamine Derivatives
8.6 Synthesis of Diphenhydramine Hydrochloride, Promethazine Hydrochloride

Reference Books:

1. Organic Chemistry, Seventh Edition, R.T.Morrison, R.N.Boyd, S.K.Bhattacharjee By Pearson
2. Textbook of Organic Chemistry, By V.K.Ahluwalia, Ane Books Pvt. Ltd.
3. Organic Chemistry, Volume-1, Sixth Edition, By I.L.Finar, By Pearson
4. Introduction to Medicinal Chemistry, G.L. Patrick, 2013, Oxford University Press, UK.
5. Medicinal and Pharmaceutical Chemistry, Hakishan, V.K. Kapoor, 2017 Vallabh Prakashan
6. Principles of Medicinal Chemistry, William O. Foye, Thomas L., Lemke , David A. William, 2019, Walters Kluver
7. Medicinal Chemistry, A. Kar, 2018, New Age International Publishers
8. Pharmaceutical Chemistry, Chatwal, 2018, Himalaya Publishing
9. Essentials of Medical Pharmacology, Tripathi, 2018, Jaypee Brothers Medical Publishers
10. Medicinal Chemistry, Sriram & Yogeswari, 2010, Pearson
11. Wilson & Gisvold's Text Book of Organic & Medicinal Chemistry, 2010, Wolters Kluwer India Pvt. Ltd.

Program: B.Sc. (Sem-III)	**Type:** Theory
Subject: DSE-3: Textile & Dye Chemistry	
Credit: 02	**Total learning hours:** 30
Course description: This course is about textile and dye chemistry which includes different types of dyes, dyeing process and its basic operations.	
Student learning outcome At the end of the course students will be able to: 1. Apply basics and illustrate the modifications in pre-treatment operation 2. Describe the developments in various dyes and dyeing process 3. Distinguish the various dye class and their application to different fibres types. 4. Learn Basic operation in Dyeing process & Methods of dyeing Recent developments in dyeing techniques	

Unit-1 Introduction to Dye Chemistry **(05Hrs)**

- **1.1** Dye-Definition
- **1.2** Requirement of an ideal dyes (colour, solubility, linearity, co-planarity, fastness, substantively, economic viability)
- **1.3** Explanation of nomenclature or abbreviation of commercial dyes with at least one example
- **1.4** Classification of fibers and chemical structure of cellulose like Cotton, Jute etc.
- **1.5** Chemical structure of manmade fibers-Rayon, polyamide, polyester & polyacrilonitrile.
- **1.6** Classification of Dyes
- **1.7** Intermolecular forces related to dyeing, dye-fiber bonds, adsorption at surfaces
- **1.8** Mechanism of Direct, reactive, acid, disperse and other dyes on specific fibers

Unit-2 Dyeing Process **(04Hrs)**

- **2.1** Influence of fibre structure on dyeing
- **2.2** Effect of processes on fibre properties before dyeing and during dyeing
- **2.3** Solubility parameter and cohesive energy density interaction between dyes and polymers
- **2.4** Dye sorption, diffusion and rate of dyeing

Unit-3 Thermodynamics of Dyeing **(04Hrs)**

- **3.1** Thermodynamics of dyeing
- **3.2** Concept of free energy
- **3.3** Surface chemistry
- **3.4** Kinetics of dyeing

Unit-4 Operation in Dyeing process **(04Hrs)**

- **4.1** Basic operation in Dyeing process
  - **4.1.1** Preparation of the fibres
  - **4.1.2** Preparation of the dyebath

4.1.3 Application of the dye
4.1.4 Finishing

4.2 Methods of dyeing
4.2.1 Direct Dyeing
4.2.2 Vat Dyeing
4.2.3 Mordant Dyeing
4.2.4 Disperse Dyeing
4.2.5 Formation of dye on fibres
4.2.6 Dyeing of the wool with acid dyes
4.2.7 Dyeing with reactive dyes

Unit-5 Colour and Constitution of Dyes (04Hrs)

5.1 Study of Bathochromic, Hypsochromic, Hypochromic and hyperchromic effect with examples

5.2 Colour and chemical constitution
5.2.1 Definition of colour, colour and wavelength of radiation
5.2.2 Colour absorbed and colour visualized with respect to wavelength region.
5.2.3 Relation between colour and chemical constitution
5.2.4 Armstrong theory and US limitation
5.2.5 Witt's theory
5.2.6 Action of Light on dyes and dyed fibers

Unit-6 Recent Developments in Dyeing Techniques (03Hrs)

6.1 Introduction
6.2 Ultrasonic assisted dyeing
6.3 Microwave dyeing

Unit-7 Natural Dyes (03Hrs)

7.1 Medicinal properties of Natural Dyes
7.2 Basics of Natural Dyeing
7.3 Methods of Extraction of Natural dyes
7.4 Standardization of Natural dyes
7.5 Continuous dyeing and its adaptation for Natural dyeing

Unit-8 Health and Environmental Hazard of Synthetic Dyes & Remediation (03Hrs)

8.1 Processes
8.2 Impact of the textile and leather dye industry on the Environment with special emphasis on water pollution
8.3 Health Hazards: Toxicity of dyes with respect to food colours

Reference Books:

1. Chemistry of Synthetic Dyes and Pigments, Lubs H. A., Robert E, 1977, Krieger Publishing Company
2. Chemistry of Synthetic Dyes – Vol I, Venkataraman, K., 1952, Academic Press
3. Chemistry of Synthetic Dyes – Vol III, Venkataraman, K., 1952, Academic Press
4. Colour and Chemical Constitution of Organic Dyes, Griffiths J., 1976, Academic Press,
5. Color Chemistry –Synthesis, Properties and Applications of Dyes and Pigments, Zollinger H., 2nd ed., 1991,Weinheim – VCH,
6. Textiles, 10th edition, Kadolph, Sara J., edn., 2007, Pearson/Prentice-Hall, 2007, ISBN 0-13- 118769-4.
7. Synthetic organic chemistry, O.P. Agrawal, 2014, Krishan Prakashan
8. The chemistry of synthetic dyes and pigments, H. A. Lubes, 1955, New York:Reinhold Publishing
9. An introduction to synthetic dyes, D. W. Ranghekar & P. P. Singh, 1980, Himalaya Pub.
10. Chemistry of dyes & Principles of dyeing Vol II, V. A. Shehai, 1983, Sevak Publications
11. Chemistry of synthetic dyes, I. G. Vashi,
12. Chemistry of dyes and pigments, K. M. Shah, 2013, Edu. Tech Publishing
13. Synthetic dyes, G. R. Chatwal, 2009, Himalaya Publishing House

Chemistry Lab-Semester-III

1. Preparation and Standardization of Standard Solutions:
   Sodium hydroxide, Potassium Permanganate, Iodine, Sodium thiosulphate.
2. Determination of Chloride by precipitation titration in water sample.
3. Determination of Free Residual Chlorine by iodometric titration in water sample.
4. Determination of COD of water sample by redox titration.
5. Determination of Zn^{+2}, Cu^{+2}, Ni^{+2}, Hardness (Ca^{+2}, Mg^{+2}) by complexometric titration.
6. Qualitative inorganic analysis: **(Minimum seven)**
   Analysis of simple salt containing one anion and cation from the following
   Anions: Carbonate, Sulphate, Chloride, Bromide, Nitrate, Borate, Phosphate.
   Cations: Lead, Copper, Iron, Aluminium, Zinc, Manganese, Nickel, Calcium, Strontium, Barium, Potassium and Ammonium.

Reference Books:

1. Standard Methods for Examination of Water & Wastewater – Andrew D. Eaton, Lenore S. Clesceri, Eugene W. Rice, Arnold Greenberg, 23rd Edition, 2017, published by APHA, AWWA, WEF.
2. Official Methods of Analysis – Dr. William Harwitz, Dr. George W Latimer, 18th Edition, 2005, published by Association of Officiating Analytical Chemists (AOAC).
3. Vogel's Qualitative Inorganic Analysis