Devrukh Shikshan Prasarak Mandal's

Nya. Tatyasaheb Athalye Arts, Ved. S.R. Sapre Commerce and Vid. Dadasaheb Pitre Science College

(Autonomous)

Devrukh, Dist: Ratnagiri- 415 804, Maharashtra

Syllabus

Programme:- S. Y. B. Sc.

Course- Chemistry

w.e.f. Academic Year 2020-21

Choice Based Credit System S.Y.B.Sc. Chemistry Syllabus
To be implemented from the Academic year 2020-21

Name of Programme- S.Y.B.Sc.
Name of Course- Chemistry

For the subject of chemistry there shall be three papers for 45 lectures each comprising of three units of 15 L each.

Semester-III

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
3. Paper III Basics of Analytical Chemistry

Semester-IV

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
3. Paper III Basics of Analytical Chemistry

Choice Based Credit System
S. Y. B. Sc.
Chemistry Syllabus
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Course Content

Semester III

Course Code	Unit	Topics	Credits	L/Week
USCHT31	I	Chemical Thermodynamics-II, Electrochemistry	2	1
	II	Chemical Bonding		1
	III	Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides		1
USCHT32	I	Chemical Kinetics-II, Solutions	2	1
	II	Selected topics on p block elements		1
	III	Carbonyl Compounds		1
USCHT33	I	Introduction to Analytical Chemistry and Statistical Treatment of analytical data-I	2	1
	II	Classical Methods of Analysis.		1
	III	Instrumental Methods-I		1
USCHP31	Chemistry Practicals I		1	3
USCHP32	Chemistry Practicals II		1	3
USCHP33	Chemistry Practicals III		1	3

Semester IV

Course Code	Unit	Topics	Credits	L/Week
USCHT41	I	Electrochemistry-II, Phase Equilibria	2	1
	II	Comparative Chemistry of the transition metals & Coordination Chemistry		1
	III	Carboxylic acids and their derivatives, Sulphonic acids		1
USCHT42	I	Solid state, Catalysis	2	1
	II	Ions in aqueous medium & Uses and Environmental Chemistry of volatile Oxides and oxo-acids		1
	III	Amines, Diazonium salts, Heterocyclic compounds		1
USCHT43	I	Separation Techniques in Analytical Chemistry	2	1
	II	Instrumental Methods-II		1
	III	Statistical Treatment of analytical data --II		1
USCHP41	Chemistry Practicals I		1	3
USCHP42	Chemistry Practicals II		1	3
USCHP43	Chemistry Practicals III		1	3

Chemistry Paper-I
Syllabus

Semester III

Unit I: Physical Chemistry

Chemical Thermodynamics-II (8L)

Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's free energy with Pressure and Temperature. Gibbs-Helmholtz equation, Van't Hoff reaction isotherm and Van't Hoff reaction isochore. (Numericals expected). Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation.Concept of Fugacity and Activity.

Electrochemistry (7L)

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts, ionic product of water. (Numericals expected). Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.

Unit-II: Inorganic Chemistry

Chemical Bonding

Non-Directional Bonding (4L)

Ionic Bond: Conditions for the Formation of Ionic Bond.Types of Ionic Crystals
Radius Ratio Rules Lattice Energy, Borne-Lande Equation Kapustinski Equation
Born-Haber Cycle and its Application

Directional Bonding: Orbital Approach (6L)

Covalent Bonding, The Valence Bond Theory- Introduction and basic tenets.
Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system. Corrections applied to the system of two hydrogen atoms- Formation of H_2.Homonuclear diatomic molecules from He_2 to Ne_2.
Resonance and the concept of Formal Charge; Rules for Resonance or Canonical structures.
Bonding in Polyatomic Species: The role of Hybridization. And types of hybrid orbitals-sp, sp^2, sp^3, sp^3d, sp^2d^2 and sp^2d sp^3d^2.
Equivalent and Non-Equivalent hybrid orbitals
Contribution of a given atomic orbital to the hybrid orbitals (with reference to sp^3 hybridization as in CH_4, NH_3 and H_2O and series like NH_3, PH_3, AsH_3, BiH_3)

Molecular Orbital Theory (5L)

Comparing Atomic Orbitals and Molecular Orbitals.
Linear combination of atomic orbitals. to give molecular orbitals LCAO- MO approach for diatomic homonuclear molecules).
Wave mechanical treatment for molecular orbitals (H_2^+ and H_2)
Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2,O_2^+ O_2^-,O_2^{2-}(Problems and numerical problems expected wherever possible)

Unit III: Organic Chemistry

Reactions and reactivity of halogenated hydrocarbons (4L)

Alkyl halides: Nucleophilic substitution reactions: S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions- nature of substrate, solvent, nucleophilic reagent and leaving group.

Aryl halides: Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (S_NAr) addition-elimination mechanism and benzyne mechanism.

Organomagnesium and organolithium compounds (3L)

Nomenclature, nature, type and reactivity of carbon-metal bond. Preparation using alkyl / aryl halide. Structure, stability and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO_2, cyanides and epoxides.

Alcohols, phenols and epoxides (8L)

Alcohols: Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols

Phenols: Preparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols.

Epoxides: Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides.

Semester IV

Unit I: Physical Chemistry

Electrochemistry-II (8L)

Electrochemical conventions, Reversible and irreversible cells.

Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected). Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected) Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

pH determination using hydrogen electrode and quinhydrone electrode. (Numericals expected)

Phase Equilibria (7L)

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation.

Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (Numericals expected)

Phase diagrams of one-component systems (Water and Sulphur).

Two component systems involving eutectics, congruent and incongruent melting points (lead-silver system).

Unit-II: Inorganic Chemistry

Comparative Chemistry of the transition metals (9L)

Position in the periodic table; Natural occurrence principal ores and minerals;
Significance of special stability of d^0, d^5 and d^{10} leading to variable oxidation states; Unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium, and chromium.)
Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry, and ability for charge transfer).
Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons; equation for spin only and spin-orbital magnetism in terms of Bohr magnetons (No derivation of relevant equations expected); Reasons for quenching of orbital moments.
Chemistry of Titanium and vanadium: properties of Oxides and chlorides; use in titrimetric analysis
Qualitative tests for transition metal ions: General considerations in devising tests (with reference to Chromium, Manganese, iron, Cobalt Nickel and Copper)

Coordination Chemistry: (6L)

Introduction to Chemistry of Coordination Compounds
Historical perspectives: Early ideas on coordination compounds, Basic terms and nomenclature.
Types of ligands, Isomerism: General Types with special reference to stereoisomerism of coordination compounds (C.N.=6), Evidence for the formation of coordination compounds,
Theories of coordination compounds
Werner's Theory of coordination compounds, Effective atomic number rule. Eighteen electron Rule
Nature of the Metal-Ligand Bond:
Valence Bond Theory; Hybridization of the central metal orbitals-sp^3, sd^3/d^3s sp^3d^2/d^2sp^3, sp^2d,
Inner and outer orbital complexes (suitable examples of Mn(II) Fe(II),Fe(III),Co(II)/Co(III),Ni(II), Cu(II) Zn(II) complexes with ligands like aqua, ammonia CN^- and halides may be used), Limitations of V.B.T, Application of coordination compounds.

Unit III: Organic Chemistry
Carboxylic Acids and their Derivatives (11L)
Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids.

Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles.
Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard-Zelinsky reaction, Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity.
Mechanism of nucleophilic acyl substitution and acid-catalyzed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution.

Sulphonic acids (4L)
Nomenclature, preparation of aromatic sulphonic acids by sulphonation of benzene (with mechanism), toluene and naphthalene, Reactions: Acidity of arene sulfonic acid, Comparative acidity of carboxylic acid and sulfonic acids. Salt formation, desulphonation. Reaction with alcohol, phosphorous pentachloride, IPSO substitution.

S.Y.B.Sc. Syllabus Chemistry Paper-II

Semester III

Unit I: Physical Chemistry

1.1 Chemical Kinetics-II (7L)

1.1.1 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected), Thermal chain reactions: H. and Br. reaction. (only steps involved, no kinetic expression expected).
1.1.2 Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (Ea). (Numericals expected).
1.1.3 Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories (Qualitative treatment only)
1.1.4 Concept of entropy: Introduction, Definition, Mathematical expression, Physical significance of entropy

1.2 Solutions (8 L)

1.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature- composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes.
1.2.2 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water, Triethanolamine – Water and Nicotine – Water systems
1.2.3 Nernst distribution law and its applications, solvent extraction.
1.2.4 Immiscibility of liquids- Principle of steam distillation (Self Learning)

Unit II: Inorganic Chemistry

Selected Topics on p-Block Elements (15L)

2.1 Chemistry of Boron compounds
2.1.1 Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications.
2.1.2 Preparation of simple boranes like diborane and tetraborane.
2.1.3 Structure and bonding in diborane and tetraborane (2e-3c bonds)
2.1.4 Synthesis of Borax.

2.2 Chemistry of Silicon and Germanium
2.2.1 Silicon compounds: Occurrence, Structure and inertness of SiO_2
2.2.2 Preparation of structure of $SiCl_4$
2.2.3 Occurrence and extraction of Germanium
2.2.4 Preparation of extra pure Silicon and Germanium

2.3 Chemistry of Nitrogen family
2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen.
2.3.2 Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4.

Unit III: Organic Chemistry

Carbonyl Compounds (15L)

3.1 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds. Structure, reactivity of aldehydes and ketones and methods of preparation; Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, Gattermann – Koch formylation and Friedel Craft acylation of arenes
3.2 General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions.
3.3 Reactions of aldehydes and ketones with NaHSO3, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, LiAlH4 and NaBH4.
3.4 Keto-enol tautomerism: Mechanism of acid and base catalyzed enolization, stabilized enols
3.5 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt and Cannizzaro reaction.
3.6 Active methylene compounds: Acetylacetone, ethyl acetoacetate, diethyl malonate. Reactions of Active methylene compounds (alkylation, conversion to ketone, mono- and dicarboxylic acid)

Semester IV

Unit I: Physical Chemistry

1.1 Solid State (7L)

1.1.1 Recapitulation of laws of crystallography and types of crystals
1.1.2 Characteristics of simple cubic, face centered cubic and body centered cubic systems, interplanar distance in cubic lattice (only expression for ratio of interplanar distances are expected)
1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected)

1.2 Catalysis: (8 L)

1.2.1 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation 1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH.
1.2.3 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation)
1.2.4 Effect of particle size and efficiency of nanoparticles as catalyst.

Unit II: Inorganic Chemistry

Ions in Aqueous Medium (15L)

2.1. Acidity of Cations and Basicity of Anions i. Hydration of Cations; Hydrolysis of Cations, predicting degree of hydrolysis of Cations-effect of Charge and Radius. ii. Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical Presentation
iii. Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples iv. Hydration of Anions; Effect of Charge and Radius; Hydration of anions concept, diagram classification on the basis of basicity.
2.2. Uses and Environmental Chemistry of volatile Oxides and oxo-acids
i. Physical properties of concentrated oxo-acids like sulfuric, Nitric and Phosphoric acid
ii. Uses and environments aspects of these acids

Unit III: Organic Chemistry

Nitrogen Containing Compounds and Heterocyclic Compounds (15L)

3.1 Amines (4L)
3.1.1 Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines;
3.1.2. Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation, chemical reduction using Fe-HCI, Sn-HCl, Zn-acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination
3.1.3. Reactions: Salt Formation, N-acylation, N-alkylation, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation.

3.2 Diazonium Salts (3L)
Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by -H, -OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine and hydroazobenzene

3.3 Heterocyclic Compounds (8L)
3.3.1. Classification, nomenclature, electronic structure of 5-membered and 6-membered rings containing one heteroatom; Aromaticity of heterocyclic compounds
3.3.2. Synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis),
3.3.3. Reactivity of furan, pyrrole and thiophene towards electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine towards nucleophilic substitution on the basis of electron distribution.
3.3.4. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Ring opening.
3.3.5. Acidity and basicity of Nitrogen containing heterocycles:
Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine (with and without catalyst), reduction and action of sodamide (Chichibabin reaction).

S.Y.B.Sc. Syllabus Chemistry Paper-III

Semester III

Unit I: Introduction to Analytical Chemistry and Statistical Treatment of analytical data-I

1.1. Role of Analytical Chemistry (9L)

1.1.1. Language of analytical chemistry: important terms and their significance in Analytical Chemistry.

1.1.2. Purpose of Chemical Analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and micro analysis)

1.1.3. Classical and Non-Classical Methods of Analysis; their types and importance.

1.2. Results of Analysis. (6L)

1.2.1. Errors in Analysis and their types

1.2.2. Precision and Accuracy in Analysis

1.2.3. Minimization of Determinate Errors

[Numerical problems wherever possible, expected]

Unit II: Classical Methods of Analysis (15L)

2.1. Volumetric Analysis (5L)

2.1.1 Introduction to volumetry

2.1.2. Titrimetry - Terms involved in Titrimetric analysis.

2.1.3. The Conditions suitable for titrimetry

2.1.4. Tools of Titrimetry: Graduated glasswares and Calibration

2.1.5. Standard solutions (Primary and Secondary standards in Titrimetry) and calculations in Titrimetry.

2.2. Neutralisation Titrations (4L)

2.2.1. Concept of pH and its importance in Neutralisation Titrations

2.2.2. End point and Equivalence point of Neutralisation titrations

2.2.3. Determination of End point by using

i. Indicators involving colour change

ii. Change in potential, (by potentiometry)

iii. Change in conductance (by conductometry)

2.2.4. Construction of titration curve (on the basis of change in pH) of a titration of

i. Strong acid-weak base

ii. Strong base-weak acid

2.3. Gravimetric analysis (6L)

2.3.1. General Introduction to Gravimetry.

2.3.2. Types of Gravimetric Methods

2.3.3. Precipitation Gravimetry:

i. Steps involved in precipitation gravimetry analysis

ii. Conditions for precipitation

iii. Completion of precipitation,

iv. Role of Digestion, Filtration, Washing, Drying Ignition of precipitate.
v. Applications of Gravimetric Analysis: Determination of sulphur in organic compounds; Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime; Determination of Aluminum by converting it into its oxide.

Unit III: Instrumental Methods-I (15L)

3. Basic Concepts in Instrumental methods

3.1. Relation between the Analyte, Stimulus and measurement of change in the observable property.

3.2. Block Diagram of an Analytical instrument.

3.3. Types of Analytical Instrumental methods based on

i. Optical interactions (eg. Spectrometry: UV-visible, Polarimetry)
ii. Electrochemical interactions (eg. Potentiometry, Conductometry,)
iii. Thermal interactions (eg. Thermogravimetry)

3.4. Spectrometry

3.4.1. Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy

3.4.2. Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorptivity

3.4.3. Statement of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer -Lambert's Law, Validity of Beer-Lambert's Law, Deviations from Beer-Lambert's Law ((Real deviations, Instrumental deviations and Chemical deviations)

(Numerical problems based on Beer-Lambert's Law)

3.4.4. Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers

3.4.5. Block Diagrams for Single beam Colorimeter, and Spectrophotometer (Principles, Construction and working-Details of Components expected i.e., Source, Sample holder, Filters / Monochromators, Detectors such as Photomultiplier tube)

3.4.6. Applications of UV-Visible Spectrophotometry: Quantitative analysis by Calibration curve method

Semester IV

Unit –I -Methods of separation (15L)

1. Separation Techniques in Analytical Chemistry

1.1. An Introduction to Analytical Separations and its importance in analysis.

1.2. Estimation of an analyte without effecting separation.

1.3. Types of separation methods

1.3.1. Based on Solubility (Precipitation, Filtration Crystallization)

1.3.2. Based on Gravity- Centrifugation

1.3.3. Based on Volatility-Distillation

1.3.4. Based on Electrical effects -Electrophoresis

1.3.5. Based on retention capacity of a Stationary Phase -Chromatography

1.3.6. Based on distribution in two immiscible phases-Solvent Extraction

1.3.7. Based on capacity to exchange with a resin - Ion Exchange chromatography;

1.4. Chromatography:

1.4.1. Introduction to Chromatography

1.4.2. Classification of chromatographic methods based on stationary and mobile phase

1.4.3. Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations.

1.4.4. Thin layer Chromatography: Principle, theory (Solute-Solvent interaction), technique and Applications in determining the purity of a given solute; following progress of a given reaction.

Unit –II - Instrumental Methods-II (15L)

2. Instruments based on the electrochemical properties of the analyte

2.1. Potentiometry (8L)

2.1.1. Principle

2.1.2. Construction and working

2.1.3. Role of Reference and indicator electrodes

2.1.4. Applications

2.2. pH-metry (7L)

2.2.1. Principle

2.2.2. Types of pH meters.

2.2.3. Principle, Construction, Working and Care of Combined Glass electrode

2.2.4. Applications in Titrimetry (Acid-Base titrations), biological and environmental analysis.

Unit-III: Chemical Calculations and Sampling Techniques (15L)

3.1. Chemical Calculations (Numericals and word problems are expected) **(7L)**

3.1.1. Introduction to various concentration units

3.2.2. Inter conversion of various concentration units. (Conversion of concentration from one unit to another unit with examples)

3.1.3. Percent composition of elements in chemical compounds

3.2. Sampling Techniques (8L)

3.2.1. Importance and Terms involved in Sampling

3.2.2. Types of Sampling

3.2.3. Purpose, significance and difficulties encountered in sampling

3.2.4 Sampling of solids: Sample size – bulk ratio, size to weight ratio, multistage and sequential sampling, size reduction methods, sampling of compact solids, equipment's and methods of sampling of compact solids, sampling of particulate solids, methods and equipment's used for sampling of particulate solids.

3.2.5. Sampling of liquids: Homogeneous and heterogeneous, Static and flowing liquids.

3.2.6. Sampling of gases: Ambient and stack sampling: Apparatus and methods for sampling of gases.

3.2.7 Collection, preservation and dissolution of the sample

Reference Books:

Unit I:

1. Barrow, G.M. Physical Chemistry Tata McGraw- Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., New York (1985).
6. K.L. Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., New Delhi (2001)

Unit II:

1. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
2. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
3. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar

Unit III:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek barton ,W. David Ollis.
8. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
9. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
10. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005

Additional References:

1. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
2. R. Gopalan, Universities Press India Pvt. Ltd. Inorganic Chemistry for Undergraduates.
3. Chemistry of Transition Elements Pg.- 608–679 .
4. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359-648.
4. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) page 325-446.
5. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
6. CNR Rao edited, University General Chemistry, 513-578.
7. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,
8. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
9. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
10. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
11. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
12. Bruce H. Mahan, University Chemistry, Narosa publishing house.
13. R. Gopalan, Universities Press India Pvt. Ltd. Inorganic Chemistry for Undergraduates.
14. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS
15. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999)
16. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
17. CNR Rao edited, University General Chemistry
18. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity
19. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry
20. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
21. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
22. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry

Semester III
Chemistry Practicals

Unit I: Physical Chemistry

1. To verify Ostwald's dilution law for weak acid conductometrically.
2. To determine dissociation constant of weak acid conductometrically.
3. To determine the critical solution temperature (CST) of Phenol - Water System.
4. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate.
5. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants
6. To determine solubility of sparingly soluble salts (any two) conductometrically.

Unit II: Inorganic Chemistry

1. Identification of cations in a given mixture and Analytically separating them [From a mixture containing not more than two of the following: Pb(II), Ba(II), Ca(II), Sr (II), Cu(II), Cd(II), Mg(II), Zn(II), Fe(II), Fe(III), Ni(II), Co(II) Al(III), Cr(III)]
2. Crystallization of potassium iodate and to estimate its purity before and after the separation.
3. Estimation of total hardness
4. Investigation of the reaction between Copper sulfate and Sodium Hydroxide (Standard EDTA solution to be provided to the learner).

Unit III: Organic Chemistry

Short organic preparation and their purification: Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product.

Preparation of:

1. Cyclohexanone oxime from Cyclohexanone.
2. Glucosazone from dextrose or Fructose
3. Tribromoaniline from Aniline.
4. β-Naphthylbenzoate
5. m-Dinitrobenzene from Nitrobenzene
6. Phthalic anhydride from Phthalic acid by sublimation
7. Acetanilide from Aniline
8. p-Bromoacetanilide from Acetanilide
9. Iodoform from Acetone

(Any Eight preparations)

Paper III: Basics in Analytical Chemistry

1. Tools of Analytical Chemistry I:

a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating funnels.

b) Weighing tools such as two pan balance and monopan balance, digital balances.

c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace,

d) Drying Devices: Hot Air Oven, Microwave Oven, Desiccators, Vacuum desiccators

e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes

(The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) and principle, construction and uses of items (b) to (e) in his journal.

2. Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error.

(The learner is expected to know the role of the various reagents/chemicals used. In the estimation, various steps involved. They should write the complete and Balanced chemical reaction for the formation of the $Ni(DMG)_2$ complex.

3. Colorimetric Determination of Copper Ions in given Solution by using calibration curve method and calculation of % error.

(The learner is expected to learn the relation between concentration and Absorbance to draw a calibration curve, use the slope of the calibration curve and compare it with the calculated slope. They are also expected to state the error estimate of their results).

4. Determination of buffer capacity of acid buffer and basic buffer.

(The learner is expected to learn the use pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity)

5. Estimation of Aspirin from APC Tablets.

6. Gravimetric estimation of barium ions using K_2CrO_4 as precipitant calculation of % error.

(The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation; Using counterpoise method Whatman No.42 for filtration. In such a case no incineration or use of silica crucible is required.

They are also expected to state the error estimate of their results)

Semester IV
Chemistry Practicals

Unit I: Physical Chemistry

1. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically.

2. To determine the amount of HCl in the given sample potentiometrically.

3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of acid hydrolysis of methyl acetate.

4. Review Report / Industrial visit report / Assignment

Unit II: Inorganic Chemistry

1. Inorganic preparation – Nickel dimethyl glyoxime using microscale method.
2. Complex cation – *Tris* (ethylene diamine) nickel (II) thiosulphate.
3. Complex anion – Sodium Hexanitrocobaltate (III) The aim of this experiment is to understand the preparation of a soluble cation (sodium)and a large anion Hexanitrocobaltate (III) and its use to precipitate a large cation (potassium)
4. Inorganic salt – Calcium or magnesium oxalate using PFHS technique

Unit III: Organic Chemistry

Qualitative Analysis of bi-functional organic compounds on the basis of

1. **Preliminary examination**
2. **Solubility profile**
3. **Detection of elements C, H, (O), N, S, X.**
4. **Detection of functional groups**
5. **Determination of physical constants (M.P./B.P.)**

Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysis to be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides.

Students are expected to write balanced chemical reactions wherever necessary. (Minimum 6 compounds to be analyzed)

Paper III (Basics in analytical Chemistry)

1.Tools of Analytical Chemistry-II

a. Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus.
b. Development chamber for chromatography
c. Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance.)
d. Conductivity cell (with respect to care and maintenance.)
e. Combined Glass electrode (with respect to care and maintenance.)
f. Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell

(The learner should draw diagrams and write-ups providing uses of the items mentioned in (a and b) and Principle, Construction care and Uses of items (c) to (f) in his journal.)

2.**Paper chromatography:** Separation of cations like Fe(III), Ni(II) and Cu(II) in a sample.

3.Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. (Solutes could be as their aqueous solutions and the organic solvent ethyl acetate) Suggested solute for the distribution study: Fe(III) in aqueous solutions.

(The learner is expected to learn the technique of solvent extraction by using separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency)

4.Conductometric titration: Estimation of given acid by conductometric titration with strong base and calculation of % error.

(The learner is expected to learn the handling of the conduct ometer and the conductivity cell, determination of end point by plotting a graph. They are also expected to state the error estimate of their results).

5.Estimation of Fe(II) in the given solution by titrating against $K_2Cr_2O_7$potentiometrically and calculation of % error.

(The learner is expected to learn the handling of the potentiometer, use of Platinum electrode and reference electrode like SCE. They will learn to determine end point by plotting a graph. They are also expected to state the error estimate of their results).

6.Gravimetric estimation of Sulphate as $BaSO_4$ and calculation of % error.

(The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.)

Reference Books for Practicals:

Unit I:

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)

Unit II:

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)

Unit III:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organi chemistry, 5th Ed., Pearson (2012)
4. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996