SOPHIA COLLEGE (AUTONOMOUS)

Affiliated To
University of Mumbai

Programme: Science, Chemistry (Major)

S.Y.B.Sc.

Syllabus for the Academic Year 2024-2025

As per the National Education Policy 2020

Programme Outline: SYB Sc Chemistry (SEMESTER III)

Course Code	Title of the paper	Unit	Topic	Credits	HRs/Week
Paper I DSCI SCHE233MJ	Basics of Physical and Analytical Chemistry -I	I	1.1 Chemical Thermodynamics – II 1.2 Electrochemistry – I	3	3
		II	2.1 Chemical Kinetics-II 2.2 Catalysis		
		III	3.1 Introduction to Analytical Chemistry		
Paper II DSC II SCHE234MJ	Basics of Organic and Inorganic Chemistry -I	I	1.1 Non directional bonding 1.2 Directional bonding 1.3 Molecular Orbital Theory 1.4 Acid- Base Theory	3	3
		II	2.1Alkanes (5L) 2.2 Alkenes and alkynes- Introduction (5L) 2.3 Alkenes and Alkynes Reactions		
		III	2.1 Alkyl Halides 2.2 Alcohols 2.3 Ethers and Epoxides		
Practicals Semester III					
SCHE233MJP And SCHE234MJP	Basics of Physical and Analytical Chemistry -I Practical & Basics of Organic and Inorganic Chemistry -I Practical	-	-	1	4

Programme Outline: SYB Sc Chemistry (SEMESTER IV)

Course Code	Title of the paper	Unit	Topic	Credits	Hrs/Week
Paper I DSC I SCHE245MJ	Basics of Physical and Analytical Chemistry -II	I	1.1 Solutions 1.2 Electrochemistry – II 1.3 Solid State	3	3
		II	2.1 Phase Equilibria 2.2 Applied Electrochemistry		
		III	3.1 Titrimetric methods 3.2 Instrumental methods 3.3 Spectroscopic methods of analysis		
Paper II DSC II SCHE246MJ	Basics of Organic and Inorganic Chemistry -II	I	1.1 Chemistry of transition metals 1.2 Coordination Chemistry 1.3 Chemistry of Silicon and Germanium	3	3
		II	2.1 Aliphatic Carbonyl Compounds 2.2 Aliphatic Carboxylic Acid & their Derivatives 2.3 Aliphatic Amines 2.4 Aromatic compounds Nomenclature Reactions		
		III	3.2 Haloarenes 3.3 Phenols 3.4Aromatic Carboxylic acids Sulfonic acids 3.5Aromatic Carbonyl compounds 3.6 Aromatic amines		
Practicals Semester IV					
SCHE245MJP and SCHE246MJP	Basics of Physical and Analytical Chemistry -II Practical & Basics of Organic and Inorganic Chemistry -II Practical	-	-	1	4

Preamble

Chemistry - a vibrant and ever growing science that encompasses every aspect of our lives. The fascinating study of matter and its applications is vital in areas like drug designing, material science, nanotechnology and most importantly, 'green chemistry', areas that are beneficial to both humanity and the environment. Bachelor's degree in Chemistry is the culmination of in-depth knowledge of Inorganic, Organic and Physical chemistry, Analytical chemistry and specialized courses such as Pharmaceutical Chemistry, spectroscopy, Nanoscience, Forensic Science, Cosmeticology, Food chemistry, Dairy Chemistry, Environmental chemistry and so on.

The learning objectives are designed to provide a focused outcome based syllabus with an agenda to structure the teaching learning experiences in a more student centric manner. This programme helps learners in building a solid foundation for higher studies in Chemistry. The hands-on experience the students gain in Practical enable them to apply theoretical knowledge acquired to solve problems in everyday life, think critically and innovatively. The syllabus is designed so that the student starts from the basic concepts of chemistry and will gradually move towards the advanced level. They are given opportunities to improve their creativity, scientific writing and communication skills through assignments and other co-curricular activities in all the semesters. The credit courses on "Positive Health in Women" and "Innovation in Natural dyeing and Entrepreneurship Skills" offered by the department further enhances their life skills and helps them evolve as entrepreneurs.

Students completing this programme will be equipped with knowledge of the concepts of Chemistry, interpret data and present their findings to both the scientific community and laymen. Completion of this programme will also enable the learners to join teaching professions, conducting research in Industry and Government run research labs

PROGRAMME OBJECTIVES	
PO1	The students are expected to understand the basic concepts in chemistry and be aware of the recent development in the subject area.
PO2	To inculcate critical thinking and scientific attitude in the students.
PO3	The students should be able to apply the theoretical knowledge and practical skills acquired to solve the real world problems and environmental issues.

PROGRAMME SPECIFIC OBJECTIVES	
PSO1	**Core competency:** The chemistry graduates are expected to gain theoretical and practical knowledge of the basic concepts in chemistry.
PSO2	**Skill development:** They would acquire necessary skills and training to pursue higher studies in the field of chemistry and to be an entrepreneur.

PSO3	**Responsible citizens:** The students will get trained to adopt and practice sustainable techniques for their personal growth and to address societal and environmental problems.

Syllabus for Approval

Serial No.	Heading	Particulars
1	Title of course	SYBSc Chemistry
2	Passing marks	40%
3	Ordinance/Regulation (if any)	
4	No. of Semesters	Two
5	Level	UG
6	Pattern	Semester
7	To be implemented from Academic year	2024-25

Date:

BOS Chairperson
Dr. Prabha G. Shetty Parbat

Convener
Dr. Harichandra

SEMESTER 3
DSC I

NAME OF THE COURSE	**Basics of Physical and Analytical Chemistry - I**	
CLASS	SY BSc	
COURSE CODE	SCHE233MJ	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

The learner will

CO 1.	Understand and enumerate the concept of entropy, free energy functions, its variation with temperature and pressure, partial molal properties and emanate the significance of Van't Hoff Reaction Isotherm & Isochore.
CO 2.	Understand different classes of chemical reactions with respect to kinetics
CO 3.	Know about catalysis, properties and types of catalyst, reactions with nanoparticles as catalyst and to derive the Michaelis-Menten equation.
CO 4.	Get acquainted with the language of analytical chemistry and its importance

COURSE LEARNING OUTCOMES:

The learner will be able to

CLO 1.	Explain and relate the different thermodynamic parameters such as entropy, helmholtz free energy, gibbs free energy changes and its significance
CLO 2.	To identify and classify chemical reactions with respect to kinetics identify techniques for fast reactions, the effect of temperature on rate and theories of reaction rate
CLO 3.	Illustrate mechanism of reactions and explain the importance of catalysis

CLO 4.	Identify and classify the sources of error, calculate accuracy and precision of a method from the given data, and apply significant figures rules accurately.

BASICS OF PHYSICAL AND ANALYTICAL CHEMISTRY- I

SEMESTER 3

DSCI

SCHE233MJ

	UNIT I	
1.1	**Chemical Thermodynamics – II (8L)**	
	1.1.1	Recapitulation: Second law of thermodynamics
	1.1.2	Free Energy Functions: Helmholtz Free Energy, Gibbs Free Energy, Variation of Gibbs Free Energy with pressure and temperature, Gibbs - Helmholtz Equation. (Numericals expected)
	1.1.3	Thermodynamics of open systems: Partial molal properties, Chemical potential and its variation with pressure and temperature, Gibbs- Duhem equation.
	1.1.4	Van't Hoff Reaction Isotherm and Van't Hoff Reaction Isochore. (Numericals expected)
1.2	**Electrochemistry – I (7L)**	
	1.2.1	Electrochemical Cells: Galvanic cells, Electrochemical conventions, Reversible and Irreversible cells.
	1.2.2	Types of electrodes, Standard electrode potential, Electrochemical series, Nernst Equations: Derivation and its applications. (Numericals expected).
	1.2.3	Calomel electrode, Glass electrode and Salt bridge – Principle, construction and working.
	1.2.4	pH determination using Glass electrode and Quinhydrone electrode (Numericals expected)
	UNIT II	
	Chemical Kinetics-II (8)	
2.1	2.1.1	Collision theory of reaction rates application of collision theory to (1) Bimolecular reaction and (2) Unimolecular reaction (Lindermann theory, derivation expected). Merits and drawbacks of collision theory.
	2.1.2	Activated Complex Theory of Bimolecular Reactions. (Qualitative treatment only).
	2.1.3	Comparison of collision theory and activated complex theory.
	2.1.4	Classification of chemical reactions and study of kinetics by stop flow method.
2.2		**Catalysis (7L)**
	2.2.1	Concept of catalysis and characteristic features of catalyst.
	2.2.2	Homogeneous and heterogeneous catalysis, catalytic activity and selectivity, promoters, inhibitors, catalyst poisoning and deactivation.
	2.2.3	Mechanism and Kinetics of Acid and Base catalyzed reactions, Effect of pH on the rate of reaction.
	2.2.4	Mechanism and Kinetics of Enzyme Catalyzed Reaction. (Michaelis-Menten's Equation).

	Unit III	
		Inttroduction to Analytical Chemistry (15 L)
	3.1	Language of Analytical Chemistry: (Important terms and their significance in Analytical Chemistry): Analysis, determination, measurement, techniques, methods, procedures, protocols, sensitivity, selectivity, robustness, ruggedness and scale of operation.
	3.2	Classical and non-classical methods of analysis: Their types and importance. Errors: Errors in analysis and its classification, Minimization of errors. Normal distribution curve.
	3.3	Precision and accuracy: Methods for their expression:- Absolute error, relative error, mean, mode, median, range, deviation, relative average deviation, standard deviation, relative standard deviation, variance and coefficient of variance (Numericals expected)
	3.4	Significant figures and computation: Significant figures, Significance of zero in the computation of analytical data, Rules of computation.
	3.5	Calibration of glasswares: Calibration of burette, pipette and standard flask.

SEMESTER 4

NAME OF THE COURSE	**Basics of Physical and Analytical Chemistry - I**	
CLASS	SY BSc	
COURSE CODE	SCHE245MJ	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand and extrapolate phase rule, phase diagrams and its application.
CO 2.	understand and extrapolate Raoult's law, deviation of Raoult's law, composition curves, Azeotropes and methods of separating them
CO 3.	To understand and restate the laws of crystallography, symmetry elements, Bravais lattice types, theory and prevention of corrosion

CO 4.	To introduce the importance of classical and instrumental methods of analysis.

COURSE LEARNING OUTCOMES:

The learner will be able to

CLO 1.	Explain Raoult's law its deviation and applications to different systems And use of x-rays in crystal structure determination.
CLO 2.	Explain the different physical parameters for liquids and solutions
CLO 3.	Explain over voltage, decomposition potential and explain the theory of corrosion and suggest corrosion prevention methods
CLO 4.	Explain the principle, working and applications of UV-VIS spectrophotometer.

BASICS OF PHYSICAL AND ANALYTICAL CHEMISTRY- I
SEMESTER 4
DSC-I
SCHE245MJ

	UNIT I	
1.1	**Solutions (5 L)**	
	1.1.1 1.1.2 1.1..3	Viscosity: Introduction, method of determination (Numerical expected) Thermodynamics of Ideal solution: Raoult's Law (Numericals expected), Deviations fromRaoult's Law Immiscibility of Liquids: Principle and method of Steam Distillation. (Numericals expected)
1.2	**Electrochemistry – II (5 L)**	
	1.2.1 1.2.2 1.2.3	Conductivity, Equivalent and Molar Conductivity (Numericals expected) and their variation with dilution of weak and strong electrolytes, Debye- Huckel Onsager Equation (no derivation) and its verification. Kohlrausch Law of Independent Migration of ions and its application: Determination of Ionization constant of a weak electrolyte, Solubility of a sparingly soluble salt and ionic product of water (Numericals expected) Transference Number and Its Experimental Determination using Moving Boundary Method (Numericals expected)
1.3	**Solid State (5L)**	
	1.3.1 1.3.2 1.3.3	Laws of Crystallography. Symmetry elements, Unit cells, Bravais Lattice types, Weiss and Miller Indices. Use of X-rays in crystal structure determination, X-ray Diffraction method, Bragg's equation (Numericals expected),
	UNIT II	

2.1	**Phase Equilibria (7L)**	
	2.1.1	Phases, Components and Degrees of Freedom of a System, Criteria of Phase Equilibrium, Gibbs Phase Rule: Thermodynamic derivation and its application.
	2.1.2	Phase diagram of one component system: Water and Sulphur.
	2.1.3	Phase diagram of two component system involving Eutectics: Lead- Silver system.
	2.1.4	Clapeyron Equation and Clausius-Clapeyron Equation: Derivation and its importance in phase equilibrium. (Numericals expected)
2.2	**Applied Electrochemistry (8L)**	
	2.2.1	Polarization and its elimination.
	2.2.2	Decomposition potential: Experimental determination and factors.
	2.2.3	Overvoltage: Experimental determination and Taffel's equation.
	2.2.4	Corrosion: Introduction, types of corrosion, Electrochemical theory of corrosion (no derivation)
	2.2.5	Importance of protection of metals from corrosion, methods of protection viz. coating, electroplating, cathodic protection, anodizing, sacrificial coating
	UNIT III	
	Quantitative Methods of Chemical Analysis	
3.1	**Titrimetric methods (3L)**	
	3.1.1	Terms involved in titrimetric methods of analysis, conditions suitable for titrimetry
	3.1.2	Types of titrimetry: Neutralization, Redox (iodometry, iodimetry), Precipitation, and Complexometric titrations
3.2	**Instrumental Methods (4L)**	
	3.2.1	Basic concepts in Instrumental methods : Relation between the analyte, stimulus and measurement of change in the observable property.
	3.2.2	Types of Analytical Instrumental methods (only principle) based on: (i) Optical Interaction: UV- Visible Spectroscopy, Polarimetry (ii) Electrochemical interactions: Potentiometry, pH metry and Conductometry (iii) Thermal interactions: Thermogravimetry
3.3	**Spectroscopic methods of analysis (8L)**	
	3.3.1	EMR, absorption and emission spectroscopy, absorbance, transmittance and wavelength of maximum absorption.
	3.3.2	Beer-Lambert law and its deviation (no derivation) Numericals expected.
	3.3.3	Instrumentation for absorption spectroscopy: Colorimeters and spectrophotometers, Block diagram of single and double beam colorimeter and spectrophotometer, Principle, construction and working. Applications of UV-Vis spectroscopy: (i) Qualitative analysis (ii) Quantitative analysis by calibration curve method.

- Physical Chemistry by G.M. Barrow. Tata McGraw-Hill (2007)

- Physical Chemistry by G.W. Castellan. Narosa 4th Edition (2004)
- General Chemistry by Kotz J.C., Treichel P.M. & Townsend. Cengage Learning India Pvt. Ltd., New Delhi (2009)
- University Chemistry by B.H. Mahan. Narosa 3rd Edition (1998)
- General Chemistry by R.H. Petrucci. Macmillan Publishing Co., New York 5th Edition (1985)
- A textbook of Physical Chemistry by K.L. Kapoor. Macmillan Publishing Co., New Delhi 3rd Edition (2001)
- Analytical Chemistry by G. L. David Krupadanam, D.Vijaya Prasad and others. University Press.
- Modern Analytical Chemistry by David Harvey. Mc Graw-Hill International Edition.
- Fundamental of Analytical Chemistry by Skoog, West, Holler and Crouch. Indian Edition
- Analytical Chemistry by D. Kealey and P.J. Haines.
- Quality Assurance in Analytical Chemistry by Elizabeth Prichard and Vicki Barwick. John Wiley and Sons, Ltd.
- Analytical Chemistry by Open Learning series (ACOL)-Wiley India Edition.

SEMESTER 3

NAME OF THE COURSE	**Basics of Inorganic and Organic Chemistry - I**	
CLASS	SY BSc	
COURSE CODE	SCHE234MJ	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand the bonding fundamentals for both ionic and covalent compounds, including electronegativities, bond distances and bond energies

	using MO diagrams and thermodynamic data. To predict geometries of simple molecules
CO 2.	To understand methods of preparation, reactions and applications of hydrocarbons, stability of cycloalkanes
CO 3.	To understand the regioselectivity involved in select reactions
CO 4.	To learn and apply mechanism of selected reactions

COURSE LEARNING OUTCOMES:

The learner will be able to

CLO 1.	differentiate between ionic and covalent compounds, and explain their properties using different theories, predict and understand geometries of different covalent compounds
CLO 2.	Write various preparative methods and predict the mechanisms of hydrocarbon and predict the stability of cycloalkanes
CLO 3.	Predict the product for given reactions and identify and arrange the given compounds as per acidity and basicity.
CLO 4.	predict and write the mechanism of a reaction under given conditions

BASICS OF INORGANIC AND ORGANIC CHEMISTRY- I
SEMESTER 3
DSC II
SCHE234MJ

	UNIT I	
1.1	**Non-Directional Bonding (3L)**	
	1.1.1 1.1.2 1.1.3	Ionic Bond: Introduction, conditions for the formation of an ionic bond. Ionic crystals: definitions-crystal lattice, lattice points, unit cell, lattice parameters, types of ionic crystals Lattice Energy: Born-Lande equation, Kapustinski equation, Born-Haber Cycle and its application (Numericals expected)
1.2	**Directional bonding (5L)**	
	1.2.1 1.2.2 1.2.3 1.2.4 1.2.5	Covalent Bonding: Valence Bond Theory- introduction and basic tenets Formation of H_2 :Interaction between two hydrogen atoms and the potential energy diagram of the resultant system, corrections applied to the system of two hydrogen atoms Hybridization and types of hybrid orbitals- *sp*, sp^2,sp^3,sp^3d, sp^3d^2 Equivalent and Non-Equivalent hybrid orbital Limitations of VBT

1.3	**Molecular Orbital Theory(4L)**	
	1.3.1.	Introduction to MOT, definitions- bonding, anti-bonding and non-bonding molecular orbitals
	1.3.2.	LCAO- MO approach to homonuclear diatomic molecules H_2 to Ne_2 (calculation of bond order and magnetic property)
	1.3.3	Bond Order and magnetic property of species of O_2 : $O2^+$,$O2^{2-}$
	1.3.4	LCAO- MO approach to heteronuclear diatomic molecules- HCl, NO, CO(calculation of bond order and magnetic property)
1.4	**Acid- Base Theory (3L)**	
	1.4.1	Arrhenius, Lowry- Bronsted, Lewis, Usanovich concept, Solvent – Solute concept of acids and bases
	1.4.2	Concept of Ka and pKa to understand acid strength(numericals expected)
	1.4.3	Hard and Soft acids and bases. Applications of HSAB

	UNIT II (Suitable Name Reactions will be mentioned wherever applicable)	
2.1	**Alkanes (5L)**	
	2.1.1	Introduction to Alkanes and Cycloalkanes. The Chemistry of Petroleum Refining, Shapes of Alkanes Conformational Analysis of Butane. The Relative Stabilities of Cycloalkanes: Ring Strain. Conformations of Cyclohexane: The Chair and the Boat
	2.1.2	Physical Properties of Alkanes and Cycloalkanes, Synthesis of Alkanes and Cycloalkanes- Hydrogenation of Alkenes and Alkynes. Chemical Reactivity of Alkanes
	2.1.3	Applications: The Chemistry of Pheromones, Muscle Action, Nanoscale Motors and Molecular Switches.
2.2	**Alkenes and alkynes- Introduction (5L)**	
	2.2.1	Relative Stabilities of Alkenes, Cycloalkenes Synthesis of Alkenes via Elimination Reactions, (mechanism) - Dehydrohalogenation of Alkyl Halides, Acid-Catalyzed Dehydration of Alcohols, Carbocation Stability, and Molecular Rearrangements
	2.2.2	The Acidity of Terminal Alkynes, Synthesis of Alkynes by Elimination Reactions, Replacement of the Acetylenic Hydrogen Atom of Terminal Alkynes Alkylation of Alkynide Anions and Reactivity
	2.2.3	The Chemistry of Hydrogenation in the Food Industry The Function of the Catalyst, Hydrogenation of Alkynes
2.3	**Alkenes and Alkynes Reactions** 5L	
	2.3.1	Addition Reactions of Alkenes. Electrophilic Addition of Hydrogen Halides to Alkenes: Mechanism and
	2.3.2	Markovnikov's Rule Stereochemistry of the Ionic Addition to an Alkene Addition of Sulfuric Acid to Alkenes Addition of Water to Alkenes: Acid-Catalyzed Hydration.

	2.3.3	Alcohols from Alkenes through Oxymercuration–Demercuration: Markovnikov Addition Alcohols from Alkenes through Hydroboration–Oxidation: Anti-Markovnikov Syn Hydration Hydroboration: Synthesis of Alkylboranes, Oxidation and Hydrolysis of Alkyl Boranes, Oxidative Cleavage of Alkenes. Addition of Hydrogen Halides to Alkynes Electrophilic Addition of Bromine and Chlorine to Alkynes.

	UNIT III (Suitable Name Reactions will be mentioned wherever applicable)	
3.1	**Alkyl Halides 7L**	
	3.1.1	Organic Halides, Nucleophilic Substitution Reactions, Nucleophiles Leaving Groups, Kinetics of a Nucleophilic Substitution Reaction. An S_N2 Reaction, (Mechanism and Free-Energy Diagrams)
	3.1.2	The Reaction of tert-Butyl Chloride with Hydroxide Ion: An S_N1 Reaction (Mechanism) Carbocations,Stereochemistry of S_N1 Reactions Factors Affecting the Rates of S_N1 and S_N2 Reactions. Wurtz reaction, Wurtz-Fittig reaction.
	3.1.3	The Chemistry of Biological Methylation.
3.2	**Alcohols 3L**	
	3.2.1	Preparation: hydration, Oxymercuration-Demercuration and hydroboration of alkenes, reduction of aldehydes and ketones and using Grignard reagent. Properties: Hydrogen bonding- types and effect on different properties.
	3.2.2	Reactions of alcohols: Alcohols as acids, conversion of alcohols into mesylates and tosylates and alkyl halides. The Chemistry of Alkyl Phosphates.
3.3	**Ethers and Epoxides 5L**	
	3.3.1	Preparation : Dehydration of alcohols (mechanism), Willamson synthesis (mechanism).
	3.3.2	Reactions : Acid catalyzed cleavage reaction with HX (mechanism). The Chemistry of environmentally friendly alkene oxidation methods Crown Ethers
	3.3.3	The Chemistry of Transport Antibiotics and Crown Ethers Preparation: Oxidation of olefins, Reaction of per acids with olefins, from vicinal halohydrins.
	3.3.4	Reactions: Reactivity, Ring opening reactions by nucleophiles (i) In acid conditions: hydrolysis, reaction with – HX, alcohol, HCN (ii) In neutral or basic conditions:Reaction with ammonia, amines, metal cyanides, and alkoxides.

BASICS OF INORGANIC AND ORGANIC CHEMISTRY- I

SEMESTER 4

NAME OF THE COURSE	**Basics of Inorganic and Organic Chemistry - I**	
CLASS	SY BSc	
COURSE CODE	SCHE246MJ	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To gain understanding of transition metal ions and their properties and build knowledge on coordination complexes and their application in bioinorganic chemistry
CO 2.	Will learn the mechanisms of select reaction and predict the product formed
CO 3.	Learn aromatic compounds with respect to nomenclature physical properties, preparations, reactions and mechanism of selected reactions
CO 4.	Learn functional group interconversions.

COURSE LEARNING OUTCOMES:

The learner will be able to

CLO 1.	identify and list different transition metal ions and their properties and understand bonding in coordination complexes, naming of coordination compounds and explain their magnetic properties
CLO 2.	predict the product for given reactions and identify and arrange the given compounds as per acidity and basicity.
CLO 3.	interconvert functional groups using sulphonic acid derivatives
CLO 4.	write the name/draw structure of a given aromatic organic compound

	UNIT I	
1.1	**Chemistry of transition metals (7L)**	
	1.1.1	Position in the periodic table, natural occurrence, principal ores and minerals of elements of the first transition series.
	1.1.2	Oxidation states,origin of colour of transition metals and their compounds: d-d transitions and charge transfer
	1.1.3	Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons; equation for spin only and spin-orbital magnetism terms of Bohr magnetons (No derivation of relevant equations expected); Reasons for quenching of orbital moment of electrons
	1.1.4	Uses of transition elements
1.2	**Coordination Chemistry (6L)**	
	1.2.1	Introduction: Basic terms, types of ligands, nomenclature of co-ordination compounds, isomerism and its types
	1.2.2	Werner's theory of coordination, effective atomic number rule,sixteen and eighteen electron rule
	1.2.3	Nature of the Metal-Ligand Bond:Valence Bond Theory: hybridisation -sp^3, dsp^2, sp^3d^2,d^2sp^3 (Inner and outer orbital complexes of Mn(II), Fe(II),Fe(III),Co(II),Co(III),Ni(II), Cu(II), Zn(II) with ligands like aqua, ammonia,cyanide and halides)
	1.2.4	Limitations of V.B.T with respect to co-ordination compounds.
	1.2.5	Uses of coordination compounds: medicinal, biological, industrial and as laboratory reagents
1.3	**Chemistry of Silicon and Germanium (2L)**	
	1.3.1 1.3.2 1.3.3	Silicon & Germanium: Occurrence and extraction Preparation of pure Silicon and Germanium Uses of Silicon and germanium

	UNIT II (Suitable Name Reactions will be mentioned wherever applicable)
2.1	**Aliphatic Carbonyl Compounds: (4L)**

	2.1.1	Structure and reactivity of aldehydes and ketones.
	2.1.2	Preparation: Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, from esters using Grignard reagent.
	2.1.3	Reactions of aldehydes and ketones: General mechanism of nucleophilic addition and acid catalyzed nucleophilic addition. Reactions with $NaHSO_3$, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$.
	2.1.4	Keto-enol tautomerism, Mechanism of acid and base catalyzed enolization.
2.2	**Aliphatic Carboxylic Acids and their Derivatives: (6L)**	
	2.2.1	Structure and physical properties: acidity of carboxylic acids, effects of substituents on acid strength of aliphatic carboxylic acids.
	2.2.2	Preparation of carboxylic acids: oxidation of alcohols, carbonation of Grignard reagent and hydrolysis of nitriles.
	2.2.3	Reactions: Mechanism of nucleophilic acyl substitution and acid-catalyzed nucleophilic acyl substitution. Relative reactivity of Acyl compounds. Interconversion of acid derivatives by nucleophilic acyl substitution. 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.
2.3	**Aliphatic Amines : (5L)**	
	2.3.1	Basicity and effect of substituents on basicity of amines.
	2.3.2	Preparation: Chemical reduction using Fe-HCl, Sn-HCl, Zn-acetic acid, reduction of nitriles, alkylation of ammonia, reductive amination, Hofmann degradation reaction.
	2.3.3	Reactions: Salt formation, N-alkylation, Hofmann elimination reaction, reaction with nitrous acid, carbylamine reaction.
2.4	**Aromatic Compounds (2L)**	
	2.4.1	Nomenclature of Benzene, Naphthalene and anthracene contain different functional groups.
	2.4.2	Reactions of aromatic compounds- Electrophilic substitution (mechanism expected) and Nucleophilic substitution.

	UNIT III (Suitable Name Reactions will be mentioned wherever applicable)	
3.1	**Haloarenes: (4L)**	
	3.1.1	Preparation of Haloarenes:– Halogenation of benzene and substituted benzenes with molecular halogens (mechanism).
	3.1.2	Reactions of haloarenes: Lack of reactivity of aryl halides under S_Nl and S_N2 reactions. General mechanism (addition – elimination) of aromatic nucleophilic substitutions on the reaction – hydrolysis and amination of haloarenes. Benzyne intermediate mechanism (elimination – addition) of aromatic nucleophilic substitution reaction (cine substitution)
	3.1.3	The Chemistry of Aryl Halides: Their Uses and Environmental Concerns

3.2	**Phenols: (2L)**	
	3.2.1	Preparation of phenols: from (i) halobenzenes, (ii) aromatic sulfonic acids (benzene and naphthalene sulfonic acids) (iii) isopropyl benzene by hydroperoxide method.
	3.2.2	Reaction of phenols: Acidity of phenols – effect of substituents on acidity of phenols. Salt formation, Etherification – direct reaction with alcohol, Williamson Synthesis, O-acylation, Halogenation, Nitration, Fries rearrangement of aryl carboxylates, Claisen rearrangement of allyloxy arenes.
	3.2.3	Applications of phenols.
3.3.	**Aromatic Carboxylic acids and their derivatives and sulfonic acids (4L)**	
	3.3.1	Preparation of mono-carboxylic acids: Preparation by side chain oxidation of alkyl benzenes, reaction of Grignard reagents with solid carbon dioxide, hydrolysis of aryl nitriles, Kolbe-Schmitt reaction (mechanism)
	3.3.2	Reactions of aromatic carboxylic acids: Acidity, Effect of substituent on the acidity of benzoic acid, Acid catalyzed esterification, Reduction and decarboxylation.
	3.3.3	Preparation of aromatic sulfonic acids: Commonly used sulfonating agents. Sulfonation of benzene (with mechanism), monosubstituted benzene and naphthalene.
	3.3.4	Reactions: Acidity of arene sulfonic acids, comparative acidity of carboxylic acids and sulfonic acids, salt formation, desulfonation, IPSO substitution, -SO_3H as solubilizing and blocking group, preparation of sulfonate ester.
	3.3.5	Uses of p-TSA, sulfonated polystyrene
3.4	**Aromatic Carbonyl Compounds (3L)**	
	3.4.1	Preparation of aromatic aldehydes : Preparation using CO (Gattermann-Koch reaction) HCN (Gattermann reaction) DMF/$POCl_3$, (Vilsmerier – Haack reaction) Reimer-Tiemann reaction (mechanism) Rosenmund reaction.
	3.4.2	Preparation of aromatic ketones: Friedel-Crafts acylation using acid chloride and acid anhydride
	3.4.3	General reaction: Reactions with -Ammonia and amines, hydroxylamine, phenylhydrazine, hydrogen cyanide, sodium bisulphate.Reactions with mechanism :Knoevengel reaction, Claisen-Schmidt reaction, Benzoin reaction, Cannizzaro reaction
3.5	**Aromatic Amines (2L)**	

	3.5.1 3.5.2	Reactions of aryl diazonium salts-Sandmeyer, Gattermann and Gomberg reactions, Replacement of diazo group by -H, -OH, -CN, -I, -F, reaction. Azo-coupling reaction with phenols/naphthols and aromatic amines. Reduction of diazonium salt to aryl hydrazine. Formation of azo-and hydrazobenzene

References-Theory

REFERENCE–Theory

- Concise inorganic chemistry, J D Lee, Blackwell Science Ltd, fifth edition.
- Principles of structure and reactivity, James Huheey, Addison Wesley publishing company, fourth edition
- Environmental Chemistry, A K De,New Age publication, sixth edition
- Fundamental concepts of environmental chemistry, G.S. Sodhi, Narosa, second edition
- Graham Solomons, T.W., FryhleC.b.&Dnyder, S.A *Organic Chemistry* John Wiley & Sons 7th Edition.
- Mc Murry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition 2013.
- Sykes, P. *A Guide to Mechanism in Organic Chemistry*, 6th Ed. Orient Longman, New Delhi (1988)
- Paula Y. B., *Organic Chemistry*, 3rd Ed. Pearson Education, Inc.
- Morrison, R.T. Boyd & R.N. Bhattacharjee, S.K., *Organic Chemistry,* 7th Ed. Pearson Education Inc.
- Organic Chemistry by Jonathan, Clayden,Greeves Warren
- Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning
- India Edition, 2013

PRACTICAL
DSC I and DSC II
SEMESTER 3
SCHE233MJP and SCHE234MJP

DSC I
COURSE OBJECTIVES:

CO 1.	To prove various laws and equations using different instrumental methods.
CO 2.	use potentiometry for analysis of various compounds and to construct an electrochemical cell

COURSE LEARNING OUTCOMES:

The learner will be able to

CLO 1.	analyze various compounds by using classical and instrumental methods of analysis
CLO 2.	able to prove or verify laws/equations through simple experiments and calculate rate and order of the reaction for known chemical systems

DSC II
COURSE OBJECTIVES:

CO 1.	Qualitatively analyze the given mono functional organic compounds using microtechniques.
CO 2.	to determine the amount of analyte present in a given solution complexometrically, iodometrically and gravimetrically.

COURSE LEARNING OUTCOMES:

The learner will be able to

CLO 1.	To prepare, recrystallise and identify the organic compound synthesized with the help of physical constant
CLO 2.	report the amount of ions present by doing gravimetric analysis, iodometric and complexation reaction

PRACTICAL
DSC I and DSC II
SEMESTER 3
SCHE233MJP and SCHE234MJP

Exp. No	**DSC I** **SCHE233MJP**

1.	To interpret the order of the reaction graphically for the given experimental data and calculate the specific reaction rate.
2.	To investigate the reaction between $K_2S_2O_8$ and KI with equal concentration of reactants.
3.	To determine the rate constant for the alkaline hydrolysis of ethyl acetate conductometrically
4.	To titrate a strong acid against a strong base conductometrically
5.	To estimate copper in a given solution iodometrically.
6.	To determine the standard EMF and the standard free energy of the Daniel cell potentiometrically.
7.	To conduct a pH titration of a weak acid against a strong base and to find out its dissociation constant.
	DSC II **SCHE234MJP**
1.	To estimate the amount of zinc ions in solution complexometrically.
2.	To determine the amount of magnesium ions in the given solution complexometrically
3.	Organic preparation & recrystallisation of the following a) Bromination of phenols/amines b) Nitro Derivative of aromatic hydrocarbons **(Sem IV)** c) Hydrolysis of esters

PRACTICAL
DSC I and DSC II
SEMESTER 4

DSC I

COURSE OBJECTIVES:

CO 1.	To understand applications of various instrumental methods to various systems, to evaluate simulated data
CO 2.	To understand and perform experiments based on optical methods

COURSE LEARNING OUTCOMES:

The learner will be able to

CLO 1.	Generate data to find out rate and order of reaction
CLO 2.	analyze commercial samples by optical methods at very low concentration

DSC II

COURSE OBJECTIVES:

CO 1.	Qualitatively analyze the given mono functional organic compounds using microtechniques.
CO 2.	analysis of given organic compounds based on functional group specific reactions

COURSE LEARNING OUTCOMES:

The learner will be able to

CLO 1.	identify the given monofunctional organic compounds
CLO 2.	estimate the amount of organic compound present in the given sample using suitable method

PRACTICAL
DSC I and DSC II
SEMESTER 4
SCHE245MJP and SCHE246MJP

Exp.No	DSC I SCHE245MJP
1.	To statistically evaluate the given analytical data for its accuracy and precision.
2.	To determine the amount of HCl in the given sample potentiometrically using Quinhydrone electrode.
3.	To determine the amount of Fe (III) in the given solution by titrating against $K_2Cr_2O_7$
4.	To determine the concentration of Cu (II) in the given solution by colorimetry.
	DSC II

	SCHE246MJP
1.	To determine the percentage of optically active substance in a given solution (glucose/sucrose) by polarimetry.
2.	To determine the amount of nickel ions (as nickel DMG) in the given solution gravimetrically.
3.	To determine the amount of barium ions (as barium chromate) in the given solution gravimetrically
4.	To determine the hardness of water.
5.	To determine the dissolved oxygen in the given sample.
6.	To determine the percentage of composition of calcium oxide/magnesium oxide in the given dolomite sample complexometrically.
7.	Systematic Qualitative analysis of organic compounds with mono functional groups (acids, phenols, alcohols/ketone, amides, nitro, amines, esters, hydrocarbons) minimum 8 compounds
8.	Organic Estimations: a. Estimations equivalent weight of acid b. Estimation of acetamide

References- Practicals

- Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg & A. Gulati. R. Chanda and Co., New Delhi (2011)
- Experiments in Physical Chemistry by C.W. Garland, J.W. Nibler& D.P. Shoemaker. McGraw-Hill New York 8th Edition (2003)
- Experimental Physical Chemistry by Halpern A.M. & G.C. McBane. W.H. Freeman and Co., New York (2003)
- Experimental Physical Chemistry by V.D. Athawale and P. Mathur. New Age International, New Delhi (2001)
- Practical Physical Chemistry by Vishwanathan B. and RaghavanP.S.. Viva Books (2017)
- Systematic experimental physical chemistry by Rajbhoj S.W. and Chondhekar T.K. Anjali Publication (2013)
- Physical Chemistry – A Lab Manual by Sinha S.K. Narosa Publication (2014)

- Vogel's Textbook of Quantitative Chemical Analysis. Pearson Publication
- Vogel, A.I., Tatchell, A.R.,Furnis B.S. Hanaford, A.J..J &Smith P.W.G, *Textbook of Practical Organic Chemisry*, Prentice-Hall, 5th Edition, 1996.
- Ahluwalia, V.K. &Aggrawal, R. *Comprehensive Practical Organic Chemistry*, University Press
- Vogel's qualitative inorganic analysis, G. Svehla, Orient Longman, sixth edition
- Semi-micro qualitative analysis, Velcher and Hahn, East West Press
- A textbook of quantitative inorganic analysis, Athur I. Vogel, Longman, 3rd edition
- A. I. Vogel's *Quantitative Chemical Analysis,* Mendham,Pearson ,*6th Edition*

ASSESSMENT DETAILS:

I. Internal Assessment (IA): 50 marks

- 2 activities of 25 marks each
- An additional 25 mark activity will be held ONLY for those who missed any one or both of the 2 activities, due to valid reasons.

II. Semester End Examination (SEE): 50 marks

- All units of the syllabus will be covered in SEE and will be given equal weightage.
- An additional SEE will be held for those who are absent, due to valid reasons, for the main/regular SEE.

There is a single head of passing ; a student must get 40 marks out of 100 marks to clear the course but under the condition that the learner has attended IA activities and SEE. A student who fails will have to give an ATKT exam of 100 marks.

III. Practical Examination

- A 50 marks practical examination will be conducted at the end of the semester.
- Practical is a separate head of passing. The learner will have to get 20 out of 50 to pass the examination.