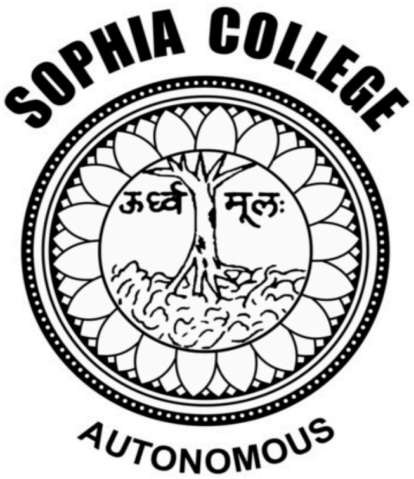

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

Affiliated to the University of Mumbai

Programme: Sciences

Chemistry (Major)

Syllabus for the Academic Year 2024-2025

based on the National Education Policy 2020

SOPHIA COLLEGE (AUTONOMOUS)

DEPARTMENT OF CHEMISTRY

COURSE DETAILS FOR MAJOR:

	SEMESTER 3		SEMESTER 4
TITLE	Basics of Physical and Analytical Chemistry -I		Basics of Physical and Analytical Chemistry -II
	Basics of Organic and Inorganic Chemistry -I		Basics of Organic and Inorganic Chemistry -II
TYPE OF COURSE - DSC	**Major**		**Major**
CREDITS	**4**		**4**

SOPHIA COLLEGE (AUTONOMOUS)

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.

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Sciences **CHEMISTRY MAJOR**	**Semester – 3**
Course Title: Basics of Physical and Analytical Chemistry -I	**Course Code: SCHE233MJ**

COURSE OBJECTIVES:

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.
2. Understand different classes of chemical reactions with respect to kinetics
3. Know about catalysis, properties and types of catalyst, reactions with nanoparticles as catalyst and to derive the Michaelis-Menten equation.
4. Get acquainted with the language of analytical chemistry and its importance

COURSE OUTCOMES:

The learner will be able to :

1. Explain and relate the different thermodynamic parameters such as entropy, helmholtz free energy, gibbs free energy changes and its significance
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
3. Illustrate mechanism of reactions and explain the importance of catalysis
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.

Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT 1 1.1 Chemical Thermodynamics – II	1.1.1	Recapitulation: Second law of thermodynamics Free Energy Functions: Helmholtz Free Energy, Gibbs Free Energy,	15 hours
	1.1.2	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)	
UNIT 1 1.2 Electrochemistry (1 Credit)	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 2 2.1 Chemical Kinetics-II	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.	

UNIT 2 2.2 Catalysis (1 Credit)	2.2.1	Concept of catalysis and characteristic features of catalyst.	15 hours
	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 3 Introduction to Analytical Chemistry (1 Credit)	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.	15 hours
	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.	

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Sciences **CHEMISTRY MAJOR**	**Semester – 3**
Course Title: Basics of Inorganic and Organic Chemistry-I	**Course Code: SCHE234MJ**

COURSE OBJECTIVES:

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
2. To understand methods of preparation, reactions and applications of hydrocarbons, stability of cycloalkanes
3. To understand the regioselectivity involved in select reactions
4. To learn and apply mechanism of selected reactions

COURSE OUTCOMES:

The learner will be able to :

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

Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT 1 1.1 Non-Directional Bonding	1.1.1	Ionic Bond: Introduction, conditions for the formation of an ionic bond.	15 hours
	1.1.2	Ionic crystals: definitions-crystal lattice, lattice points, unit cell, lattice parameters, types of ionic crystals	
	1.1.3	Lattice Energy: Born-Lande equation, Kapustinski equation, Born-Haber Cycle and its application (Numericals expected)	
UNIT 1 1.2 Directional bonding	1.2.1	Covalent Bonding: Valence Bond Theory- introduction and basic tenets	
	1.2.2	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	
	1.2.3	Hybridization and types of hybrid orbitals- *sp*, sp^2,sp^3,sp^3d, sp^3d^2	
	1.2.4	Equivalent and Non-Equivalent hybrid orbital	
	1.2.5	Limitations of VB	
UNIT 1 1.3 Molecular Orbital Theory	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 : O_2^+,O_2^{2-}	
	1.3.4	LCAO- MO approach to heteronuclear diatomic molecules- HCl, NO, CO(calculation of bond order and magnetic property).	
UNIT 1	1.4.1	Arrhenius, Lowry- Bronsted, Lewis, Usanovich concept, Solvent – Solute concept of acids and bases	

1.4 Acid- Base Theory (1 Credit)	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 2 2.1 Alkanes	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	15 hours
	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.	
UNIT 2 2.2 Alkenes and alkynes- Introduction	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	
UNIT 2 2.3 Alkenes and Alkynes Reactions (1 Credit)	2.3.1	Addition Reactions of Alkenes. Electrophilic Addition of Hydrogen Halides to Alkenes: Mechanism and 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.	

	2.3.2	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.	
	2.3.3	Addition of Hydrogen Halides to Alkynes Electrophilic Addition of Bromine and Chlorine to Alkynes.	
UNIT 3 3.1Alkyl Halides	3.1.2	Organic Halides, Nucleophilic Substitution Reactions, Nucleophiles Leaving Groups, Kinetics of a Nucleophilic Substitution Reaction. An S_N2 Reaction, (Mechanism and Free-Energy Diagrams)	15 hours
	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.	
UNIT 3 3.2 Alcohols	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.	
UNIT 3 3.3 Ethers and Epoxides	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	

(1 Credit)	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.	

PRACTICAL **Course Title: BASICS OF PHYSICAL AND ANALYTICAL CHEMISTRY- I**		**Course Code: SCHE233MJP**	
COURSE OUTCOMES: The learner will be able to : 1. analyze various compounds by using classical and instrumental methods of analysis 2. able to prove or verify laws/equations through simple experiments and calculate rate and order of the reaction for known chemical systems			
Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	

	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	30 hours
	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.	

PRACTICAL **Course Title: Basics of Inorganic and Organic Chemistry - I**		**Course Code: SCHE234MJP**	
COURSE OUTCOMES: The learner will be able to : 1. To prepare, recrystallise and identify the organic compound synthesized with the help of physical constant 2. report the amount of ions present by doing gravimetric analysis, iodometric and complexation reaction			
Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	

	1	To estimate the amount of zinc ions in solution complexometrically.	30 hours
	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	

ASSESSMENT DETAILS:

I. Internal Assessment (IA): 50 marks

II. Semester End Examination (SEE): 50 marks

References

1. Physical Chemistry by G.M. Barrow. Tata McGraw-Hill (2007)
2. Physical Chemistry by G.W. Castellan. Narosa 4th Edition (2004)
3. General Chemistry by Kotz J.C., Treichel P.M. & Townsend. Cengage Learning India Pvt. Ltd., New Delhi (2009)
4. University Chemistry by B.H. Mahan. Narosa 3rd Edition (1998)
5. General Chemistry by R.H. Petrucci. Macmillan Publishing Co., New York 5th Edition (1985)
6. A textbook of Physical Chemistry by K.L. Kapoor. Macmillan Publishing Co., New Delhi 3rd Edition (2001)
7. Analytical Chemistry by G. L. David Krupadanam, D.Vijaya Prasad and others. University Press.
8. Modern Analytical Chemistry by David Harvey. Mc Graw-Hill International Edition.
9. Fundamental of Analytical Chemistry by Skoog, West, Holler and Crouch. Indian Edition
10. Analytical Chemistry by D. Kealey and P.J. Haines.
11. Quality Assurance in Analytical Chemistry by Elizabeth Prichard and Vicki Barwick. John Wiley and Sons, Ltd.
12. Analytical Chemistry by Open Learning series (ACOL)-Wiley India Edition.
13. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg & A. Gulati. R. Chanda and Co., New Delhi (2011)

14. Experiments in Physical Chemistry by C.W. Garland, J.W. Nibler& D.P. Shoemaker. McGraw-Hill New York 8th Edition (2003)
15. Experimental Physical Chemistry by Halpern A.M. & G.C. McBane. W.H. Freeman and Co., New York (2003)
16. Experimental Physical Chemistry by V.D. Athawale and P. Mathur. New Age International, New Delhi (2001)
17. Practical Physical Chemistry by Vishwanathan B. and RaghavanP.S.. Viva Books (2017)
18. Systematic experimental physical chemistry by Rajbhoj S.W. and Chondhekar T.K. Anjali Publication (2013)
19. Physical Chemistry – A Lab Manual by Sinha S.K. Narosa Publication (2014)
20. Vogel's Textbook of Quantitative Chemical Analysis. Pearson Publication
21. 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.
22. Ahluwalia, V.K. &Aggrawal, R. *Comprehensive Practical Organic Chemistry*, University Press
23. Vogel's qualitative inorganic analysis, G. Svehla, Orient Longman, sixth edition
24. Semi-micro qualitative analysis, Velcher and Hahn, East West Press
25. A textbook of quantitative inorganic analysis, Athur I. Vogel, Longman, 3rd edition
26. A. I. Vogel's *Quantitative Chemical Analysis,* Mendham,Pearson ,*6th Edition*

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Sciences **CHEMISTRY MAJOR**	**Semester – 4**
Course Title: Basics of Physical and Analytical Chemistry -II	**Course Code:** SCHE245MJ

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

The learner will be able to :

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

Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT 1 1.1 Solutions	1.1.1	Viscosity: Introduction, method of determination (Numerical expected)	15 hours
	1.1.2	Thermodynamics of Ideal solution: Raoult's Law (Numericals expected), Deviations fromRaoult's Law	
	1.1.3	Immiscibility of Liquids: Principle and method of Steam Distillation. (Numericals expected)	
UNIT 1 1.2 Electrochemistry – II	1.2.1	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.	
	1.2.2	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)	
	1.2.3	Transference Number and Its Experimental Determination using Moving Boundary Method (Numericals expected)	
UNIT 1 1.3 Solid State (1 Credit)	1.3.1	Laws of Crystallography. Symmetry elements, Unit cells, Bravais Lattice types, Weiss and Miller Indices.	
	1.3.2	Use of X-rays in crystal structure determination,	
	1.3.3	X-ray Diffraction method, Bragg's equation (Numericals expected),	
	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.	

UNIT 2 2.1 Phase Equilibria (1 Credit)	2.1.3	Phase diagram of two component system involving Eutectics: Lead- Silver system.	15 hours
	2.1.4	Clapeyron Equation and Clausius-Clapeyron Equation: Derivation and its importance in phase equilibrium. (Numericals expected)d reactions, Effect of pH on the rate of reaction.	
UNIT 2 2.2 Applied Electrochemistry (1 Credit)	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 3 3.1 Titrimetric methods	3.1.1	Terms involved in titrimetric methods of analysis, conditions suitable for titrimetry	15 hours
	3.1.2	Types of titrimetry: Neutralization, Redox (iodometry, iodimetry), Precipitation, and Complexometric titrations	
UNIT 3 3.2 Instrumental Methods	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	

UNIT 3 Spectroscopic methods of analysis	3.3.1	EMR, absorption and emission spectroscopy, absorbance, transmittance and wavelength of maximum absorption. Beer-Lambert law and its deviation (no derivation) Numericals expected.	
	3.3.2	Instrumentation for absorption spectroscopy: Colorimeters and spectrophotometers, Block diagram of single and double beam colorimeter and spectrophotometer, Principle, construction and working.	
	3.3.3	Applications of UV-Vis spectroscopy: (i) Qualitative analysis (ii) Quantitative analysis by calibration curve method.	

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Sciences **CHEMISTRY MAJOR**	**Semester – 4**
Course Title: Basics of Inorganic and Organic Chemistry-II	**Course Code: SCHE246MJ**

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

The learner will be able to :

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
2. predict the product for given reactions and identify and arrange the given compounds as per acidity and basicity.
3. interconvert functional groups using sulphonic acid derivatives
4. write the name/draw structure of a given aromatic organic compound

Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT 1 1.1 Chemistry of transition metals	1.1.1	Position in the periodic table, natural occurrence, principal ores and minerals of elements of the first transition series.	15 hours
	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	
UNIT 1 1.2 Coordination Chemistry	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	
UNIT 1 1.3 Chemistry of Silicon and Germanium	1.3.1	Silicon & Germanium: Occurrence and extraction	
	1.3.2	Preparation of pure Silicon and Germanium	
	1.3.3	Uses of Silicon and germanium	
	2.1.1	Structure and reactivity of aldehydes and ketones.	

UNIT 2 2.1 Aliphatic Carbonyl Compounds:	2.1.2	Preparation: Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, from esters using Grignard reagent.	15 hours
	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.	
UNIT 2 2.2 Aliphatic Carboxylic Acids and their Derivatives	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.	
UNIT 2 2.3 Aliphatic Amines	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.	
UNIT 2	2.4.1	Nomenclature of Benzene, Naphthalene and anthracene contain different functional groups.	

2.4 Aromatic Compounds (1 Credit)	2.4.2	Reactions of aromatic compounds- Electrophilic substitution (mechanism expected) and Nucleophilic substitution.	
UNIT 3 3.1Haloarenes	3.1.1	Preparation of Haloarenes:– Halogenation of benzene and substituted benzenes with molecular halogens (mechanism).	15 hours
	3.1.2	Reactions of haloarenes: Lack of reactivity of aryl halides under S_N1 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	
UNIT 3 3.2 Phenols	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.	
	3.3.3	Applications of phenols	
UNIT 3 3.3 Aromatic Carboxylic acids and their derivatives and sulfonic acids (1 Credit)	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: 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.	
	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	
UNIT 3 3.4 Aromatic Carbonyl Compounds	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	
UNIT 3 3.5 Aromatic Amines	3.5.1	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.	
	3.5.2	Reduction of diazonium salt to aryl hydrazine. Formation of azo-and hydrazobenzene	

SOPHIA COLLEGE (AUTONOMOUS)

PRACTICAL **Course Title: BASICS OF PHYSICAL AND ANALYTICAL CHEMISTRY- II**		**Course Code: SCHE245MJP**	
COURSE OUTCOMES: The learner will be able to : 1. Generate data to find out rate and order of reaction 2. analyze commercial samples by optical methods at very low concentration			
Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	

	1	To statistically evaluate the given analytical data for its accuracy and precision.	30 hours
	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	

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PRACTICAL **Course Title: Basics of Inorganic and Organic Chemistry - II**	**Course Code: SCHE246MJP**

COURSE OUTCOMES:
The learner will be able to :
1. identify the given monofunctional organic compounds
2. estimate the amount of organic compound present in the given sample using suitable method

Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	

	1	To determine the percentage of optically active substance in a given solution (glucose/sucrose) by polarimetry.	30 hours
	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	

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.

References

1. Physical Chemistry by G.M. Barrow. Tata McGraw-Hill (2007)
2. Physical Chemistry by G.W. Castellan. Narosa 4th Edition (2004)
3. General Chemistry by Kotz J.C., Treichel P.M. & Townsend. Cengage Learning India Pvt. Ltd., New Delhi (2009)
4. University Chemistry by B.H. Mahan. Narosa 3rd Edition (1998)
5. General Chemistry by R.H. Petrucci. Macmillan Publishing Co., New York 5th Edition (1985)
6. A textbook of Physical Chemistry by K.L. Kapoor. Macmillan Publishing Co., New Delhi 3rd Edition (2001)
7. Analytical Chemistry by G. L. David Krupadanam, D.Vijaya Prasad and others. University Press.
8. Modern Analytical Chemistry by David Harvey. Mc Graw-Hill International Edition.
9. Fundamental of Analytical Chemistry by Skoog, West, Holler and Crouch. Indian Edition
10. Analytical Chemistry by D. Kealey and P.J. Haines.
11. Quality Assurance in Analytical Chemistry by Elizabeth Prichard and Vicki Barwick. John Wiley and Sons, Ltd.
12. Analytical Chemistry by Open Learning series (ACOL)-Wiley India Edition.
13. Concise inorganic chemistry, J D Lee, Blackwell Science Ltd, fifth edition.
14. Principles of structure and reactivity, James Huheey, Addison Wesley publishing company, fourth edition
15. Environmental Chemistry, A K De,New Age publication, sixth edition
16. Fundamental concepts of environmental chemistry, G.S. Sodhi, Narosa, second edition
17. Graham Solomons, T.W., FryhleC.b.&Dnyder, S.A *Organic Chemistry* John Wiley & Sons 7th Edition.
18. Mc Murry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition 2013.
19. Sykes, P. *A Guide to Mechanism in Organic Chemistry*, 6th Ed. Orient Longman, New Delhi (1988)
20. Paula Y. B., *Organic Chemistry*, 3rd Ed. Pearson Education, Inc.
21. Morrison, R.T. Boyd & R.N. Bhattacharjee, S.K., *Organic Chemistry,* 7th Ed. Pearson Education Inc.
22. Organic Chemistry by Jonathan, Clayden,Greeves Warren
23. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning
24. India Edition, 2013
25. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg & A. Gulati. R. Chanda and Co., New Delhi (2011)
26. Experiments in Physical Chemistry by C.W. Garland, J.W. Nibler& D.P. Shoemaker. McGraw-Hill New York 8th Edition (2003)
27. Experimental Physical Chemistry by Halpern A.M. & G.C. McBane. W.H. Freeman and Co., New York (2003)

28. Experimental Physical Chemistry by V.D. Athawale and P. Mathur. New Age International, New Delhi (2001)
29. Practical Physical Chemistry by Vishwanathan B. and RaghavanP.S.. Viva Books (2017)
30. Systematic experimental physical chemistry by Rajbhoj S.W. and Chondhekar T.K. Anjali Publication (2013)
31. Physical Chemistry – A Lab Manual by Sinha S.K. Narosa Publication (2014)
32. Vogel's Textbook of Quantitative Chemical Analysis. Pearson Publication
33. 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.
34. Ahluwalia, V.K. &Aggrawal, R. *Comprehensive Practical Organic Chemistry*, University Press
35. Vogel's qualitative inorganic analysis, G. Svehla, Orient Longman, sixth edition
36. Semi-micro qualitative analysis, Velcher and Hahn, East West Press
37. A textbook of quantitative inorganic analysis, Athur I. Vogel, Longman, 3rd edition
38. A. I. Vogel's *Quantitative Chemical Analysis,* Mendham,Pearson ,*6th Edition*

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