Department of Chemistry

The major program specific outcome of B.Sc. Chemistry course are:

1. The learner will understand the fundamental aspects of the various core areas of Chemistry.
2. The learner will be proficient in analyzing the various observations and chemical phenomena presented to him during the course.
3. The learner will be capable of solving problems in the various units of this course.
4. The learner will have an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry.
5. Acquire various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling.
6. The learner will be capable of analyzing and interpreting results of the experiments he conducts or performs.
7. The learner will be capable of acquiring or pursuing a source of livelihood like jobs in chemical industry.
8. The interest to pursue higher levels of learning in chemistry will be instilled.

Learning outcome of Subject of Chemistry

Class/ SEM/ Paper/ Units	**Syllabus**	**Objectives**	**Learning outcomes**
F.Y.BSc.			
SEM I			
Paper I			
Unit I	Chemical Thermodynamics: Thermodynamic terms: System, surrounding, boundaries, open, closed and isolated system, intensive and extensive properties, state functions and path functions, zero th law of thermodynamics. First law of thermodynamics: concept of heat (q), work (w), internal energy (U), statement of first law, enthalpy, relation between heat capacities, sign conventions, calculations of heat (q), work (w), internal energy (U), and enthalpy (H) (Numericals expected) Thermochemistry: Heats of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equation (Numericals expected).	1) To develop a clear idea about. The various form of energy and how one form of energy may be transfer in to another. 2) To develop the clarity of concept of system surround and boundaries. 3) To able to realize the importance of laws of thermodynamics. 4) Learn to understand the concept of heat in	The learner will be able to 1) Define various terms, definitions and state functions in Thermodynamics. 2) Explain and defined heat energy works and their relationship between them. 3) State various sign conventions when work is done by or on a system. 4) Define heat capacity at constant volume and constant pressure and its uses. 5) Define enthalpy of standard states.

	Chemical Calculations: Expressing concentration of solutions: Normality, molality, molarity, formality, mole fractions, weight ratio, volume ratio, weight to volume ratio, ppm, ppb, millimoles, milliequivalents (Numericals expected)	various reactions and the relationship between enthalpy, temperature and heat capacity based on Kirchhoff's law. 5) Define and learn to calculate various concentration terms. 6) Learn to interconvert the concentration unit.	Calculate change in enthalpy and heat capacity through Kirchhoff's law. 6) States various definitions and formulae of concentration terms and calculate the equivalent weight, normality, molarity formality, mole fraction of the solutions. 7) Understand to write concentration of solution in weight percent or weight/volume percent and express the concentration of solution in ppm ppb.
Unit II	Atomic structure: (Qualitative treatment only; it is expected that the learner knows the mathematical statements and understands their physical significance after completing this topic. No derivations of the mathematical equations required) a) Historical perspectives of the atomic structure; Rutherford's Atomic Model, Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Structure of hydrogen atom. b) Hydrogenic atoms: 1. Simple principles of quantum mechanics; 2. Atomic orbitals i) Hydrogenic energy levels ii) Shells, subshells and orbitals iii) Electron spin iv) Radial shapes of orbitals v) Radial distribution function vi) Angular shapes of orbitals. 3. Many Electron Atoms i) Penetration and shielding ii) Effective nuclear charge 4. Aufbau principle. Periodic Table and periodicity : Long form of Periodic Table; Classification for elements as main group, transition and inner transition elements; Periodicity in the following properties: Atomic and ionic size; electron gain enthalpy; ionization enthalpy, effective nuclear charge (Slater's rule); electronegativity; Pauling, Mulliken and Alred Rochow electronegativities. (Numerical problems	1)To understand the structure of atom through the various model propose for the same 2) To understand the various concepts involved in the prescribed atomic model. 3) To understand Hydrogenic atom and the relevant properties like energy level shapes of orbital. 4) To understand the position of element and their classification in the long form of the periodic table. 5) To understand periodic trends of atomic and ionic size, electron gain enthalpy, enthalpy	The student will be able to 1. Appreciate the historical perspectives of atomic structure. 2. Comprehend periodic table by knowing arrangement in 18 group and 7 periods and explain the periodic trends. 3. Find electronegativity by Pauling's method, Mullikan method and Alfrede Rochow method. 4. Correlate atomic number, atomic mass and properties of atom based on these concepts. 5. Understand the difference between the electromagnetic and matter wave

	expected, wherever applicable.)	of ionization. 6) To understand the electronegativity and its various scales.	
Unit III	Basics of Organic Chemistry Classification and Nomenclature of Organic Compounds: Review of basic rules of IUPAC nomenclature. Nomenclature of mono and bi-functional aliphatic compounds on the basis of priority order of the following classes of compounds: alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines; including their cyclic analogues. Bonding and Structure of organic compounds: Hybridization: sp^3, sp^2, sp hybridization of carbon and nitrogen; sp3 and sp2 hybridizations of oxygen in Organic compounds (alcohol, ether, aldehyde, ketone, carboxylic acid, ester, cyanide, amine and amide) Overlap of atomic orbitals: Overlaps of atomic orbitals to form sigma and pi bonds, shapes of organic molecules. Shapes of molecules; Influence of hybridization on bond properties (as applicable to ethane, ethene, ethyne). Fundamentals of organic reaction mechanism: Electronic Effects: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strengths. Bond fission: Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types (primary, secondary, tertiary, allyl and benzyl), shape and their relative stability of reactive intermediates: Carbocations, Carbanions and Free radicals. Introduction to types of organic reactions: Addition, Elimination and Substitution reaction. (With one example of each)	1) To introduced the IUPAC nomenclature of the organic compounds to undergraduate student. 2) To understand the correlation between nomenclature and structure of mono functional and bifunctional organic compounds. 3)To introduce concept of hybridization and its significance 4) To explain the correlation between the nature of overlaps of bonding orbital and the shape of organic molecules. 5. To expose to the concept of reaction mechanisms and various terminologies. 6. Help to understand types of reactive species.	1) The undergraduate student will understand the different aspects of IUPAC nomenclature of organic compounds. 2) The learners will able to draw the structure of organic compound s from their IUPAC names and vice-versa. 3) The students will able to explain the concept of hybridization. 4) The learner will able to highlight the significant outcome of hybridization. 5) The student will able to predict the shape of organic molecule on the basis of hybridization. 6. The student will be able to identify the different mechanisms in reactions.
Paper II			
Unit I	Chemical Kinetics: Rate of reaction, rate constant, measurement of	1) Understand the process of	The learner will be able to

	reaction rates, order and molecularity of reaction, integrated rate equation of first and second order reactions (with equal initial concentration of reactants) (Numericals expected) Determination of order of reaction by (a) Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method (Numericals expected) Liquid State: Surface tension: Introduction, methods of determination of surface tension by drop number method (Numericals expected) Viscosity: Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer (Numericals expected) Refractive index: Introduction, molar refraction and polarizability, determination of refractive index by Abbe's refractometer (Numericals expected) Liquid crystals: Introduction, classification and structure of thermotropic phases (Nematic, smectic and cholesteric phases), applications of liquid crystals.	chemical change. 2) Learn the essential of chemical kinetics and the factors affecting it. 3) To understand the nature of liquid state. 4) To define and distinguished between various properties of liquid state 5) To understand the nature of liquid crystals and their applications.	1. Calculate conclude about the order of given reaction. 2. From available method and data supplied, student will be able to find order reactions. 3. Define and differentiate between the various properties of matter particularly viscosity, surface tension refractive index polarizability. 4. Understand the concept of liquid crystal, the properties of different phase of liquid crystals and different types of liquid crystals
Unit II	Comparative chemistry of Main Group Elements: Metallic and non-metallic nature, oxidation states, electronegativity, anomalous behaviour of second period elements, allotropy, catenation, diagonal relationship. Comparative chemistry of carbides, nitrides, oxides and hydroxides of group I and group II elements. Some important compounds- $NaHCO_3$, Na_2CO_3, NaCl, NaOH, CaO, $CaCO_3$; oxides of carbon, oxides and oxyacids of sulphur and nitrogen with respect to environmental aspects.	To introduce to the learner 1)The physical and chemical properties of the main group elements and their comparative trends 2)Comparative trends in the properties of binary and other compounds formed by main group elements 3) Reactions of formation of some compounds of main group elements. 4) Various application of compound formed by Group I and Group-II elements.	The learner will be able to 1. Visualize the physical and chemical properties of main group elements, their compounds. 2. Understand reactions of formation of the binary compounds form by main group elements. 3. Understand various properties shown by compounds of group I and Group II 4. Explore various application of the compounds formed by group I and group II elements.

		5) The learner regarding environmental impact of oxide of carbon, nitrogen Sulphur.	
Unit III	Stereochemistry I: Fischer Projection, Newman and Sawhorse Projection formulae (of erythro, threo isomers of tartaric acid and 2,3- dichlorobutane) and their interconversions ; Geometrical isomerism in alkene and cycloalkanes: cis–trans and syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two similar and dissimilar chiral-centres, Distereoisomers, meso structures, racemic mixture and resolution (methods of resolution not expected). Relative and absolute configuration: D/L and R/S designations. Conformation analysis of alkanes (ethane, propane and n-butane); Relative stability with energy diagrams.	To introduce to the learner 1) Three dimensional structure of molecule. 2) Molecule with same molecular formula may exist in different forms. 3) The concept of optical activity.	The learner will be able to 1. Distinguished and draw different molecular projection. 2. Recognized the difference between configuration and conformation. 3. Distinguished among different form of stereoisomerism. 4. Identify optical active and inactive compounds. 5. Assign stereo-descriptors.
SEM II			
Paper I			
Unit I	Gaseous State: Ideal gas laws, kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (qualitative discussion), ideal gases, real gases, compressibility factor, Boyle's temperature (Numericals expected) Deviation from ideal gas laws, reasons for deviation from ideal gas laws, Van der Waals equation of state, Joule-Thomson effect: qualitative discussion and experimentation, inversion temperature. (Numericals expected) Chemical Equilibria and Thermodynamic Parameters: Reversible and irreversible reactions, law of mass action, dynamic equilibria, equilibrium constant, (Kc and Kp), relationship between Kc and Kp, Le Chatelier's principle, factors affecting chemical equilibrium (Numericals expected) Statement of second law of thermodynamics, concepts of entropy and free energy, spontaneity and physical significance of free energy, thermodynamic derivation of equilibrium constant (Numericals expected)	To introduce to the learner 1. Various Gas Laws 2. Various Gas Law equations. 3. Concept of Chemical equilibria and Thermodynamics. 4. Different parameters of Thermodynamics.	The learner will be able to 1. Understand the concept of kinetic theory of gases. 2. Solve numerical problems related to Gas Laws and Thermodynamics. 3. Use the different equilibria constants and distinguish the factors affecting these. 4. Distinguish between spontaneous and non-spontaneous reactions.

Unit II	Concept of Qualitative Analysis: a) Testing of Gaseous Evolutes, Role of Papers impregnated with Reagents in qualitative analysis (with reference to papers impregnated with starch iodide, potassium dichromate, lead acetate, dimethylglyoxime and oxine reagents). b) Precipitation equilibria, effect of common ions, uncommon ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds. (Balanced chemical equations and numerical problems expected.) Acid Base Theories: Arrhenius, Lowry- Bronsted, Lewis, Solvent – Solute concept of acids and bases, Hard and Soft acids and bases. Applications of HSAB Applications of acid base chemistry in: i) Understanding organic reactions like Friedel Craft's (acylation/alkylation) reaction. ii) Volumetric analysis with special reference to calculation of titration curve involving strong acid and strong base.	To make the learner aware of 1. Concept of qualitative analysis. 2. Role of different paper impregnated with reagents. 3. Concept of common ion effect and other related effects. 4. Concept of different Acid-Base theories.	The learner will be able to 1. Extrapolate the concept of qualitative analysis. 2. Use different reagents in qualitative analysis. 3. Understand the role of common ion effect in experiments and use it successfully. 4. Distinguish between acids& bases and do necessary calculations.
Unit III	Chemistry of Aliphatic Hydrocarbons Carbon-Carbon sigma bonds: Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity. Carbon-Carbon pi bonds: Formation of alkenes and alkynes by elimination reactions: Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), Mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2-and 1, 4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination using N-bromosuccinimide and mechanism, e.g. propene, 1-butene, toluene, ethylbenzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.	The learner will be imparted with the knowledge of 1. Different types of bonds. 2. Various Reactions of carbon compounds containing sigma and pi bonds. 3. Different mechanisms which take place in sigma and pi bond compounds.	The learner will be able to 1. Distinguish between sigma and pi bond compounds. 2. Write different reactions of such compounds. 3. Understand the mechanisms of the reactions of aliphatic hydrocarbons.
Paper II			
Unit I	Ionic Equilibria:	The learner will	The learner will be

	Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, dissociation constants of mono-, di- and triprotic acid (exact treatment for monoprotic acid) Buffers: Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected) Molecular Spectroscopy: Electromagnetic radiation, electromagnetic spectrum, Planck's equation, interaction of electromagnetic radiation with matter: Absorption, emission, scattering, flourescence, electronic, vibrational and rotational transitions, Beer-Lambert's law (Numericals expected) Solid State Chemistry: Types of solids, crystal lattice, lattice points, unit cell, space lattice and lattice plane, laws of crystallography: Law of constancy of interfacial angle, law of symmetry and law of rational indices (Numericals expected)	be imparted with the knowledge of 1. Ionic equilibria along with various concepts, pH and constants. 2. Various aspects of buffer and its types. 3. Molecular spectroscopy ased on absorption and emission of electromagnetic radiation. 4. Crystal Lattice and crystallography.	able to 1. Explain different aspects of ionic equilibria. 2. Explain the concept of buffer, dissociation constants. Calculate pH of solution. 3. Understand electromagnetic radiation, its applications. 4. Understand the concept of Crystallography and crystal lattice.
Unit II	Chemical Bond and Reactivity: Types of chemical bond, comparison between ionic and covalent bonds, polarizability (Fajan's Rule), shapes of molecules, Lewis dot structure, Sidgwick Powell Theory, basic VSEPR theory for ABn type molecules with and without lone pair of electrons, isoelectronic principles, applications and limitations of VSEPR theory. Oxidation Reduction Chemistry: a) Reduction potentials b) Redox potentials: half reactions; balancing redox equations. c) Redox stability in water i) Latimer and Frost Diagrams ii) pH dependence of redox potentials. d) Applications of redox chemistry i) Extraction of elements: (example: isolation of copper by auto reduction) ii) Redox reagents in Volumetric analysis: a) I_2; b) $KMnO_4$ iii) Titration curves: i) single electron systems (example Ce(IV) against Fe(II)); and ii) Multi electron systems as in $KMnO_4$ against Fe(II))	The learner will be imparted with the knowledge of 1. Different types of chemical bonds. 2. VSEPR theory. 3. Redox reactions and to balance those. 4. To use redox reagents in titrations.	The learner will be able to 1. Understand different types of chemical bonds and predict the properties of the molecules. 2. VSEPR theory and its limitations. 3. Solve redox equations. 4. Use redox reagents in volumetric reagents.
Unit III	Stereochemistry-II: Cycloalkanes and Conformational Analysis: Types of cycloalkanes and their relative	The learner will be imparted with the knowledge of	The learner will be able to 1. Understand

	stability, Baeyer strain theory, Conformation analysis of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy. Aromatic Hydrocarbons: Aromaticity: Hückel's rule, anti-aromaticity, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft alkylation/acylation with their mechanism. , Hammond's postulate, Directing effects of the groups.	1. Conformational analysis of cyclo alkanes. 2. Aromaticity and different rules involved in it. 3. Electrophilic substitutions along with mechanisms	Conformation, conformational analysis. 2. Distinguish between aromatic and non-aromatic compounds 3. Understand electrophilic substitutions and their mechanisms.
SYBSc			
SEM III			
Paper I			
Unit I	Chemical Thermodynamics-II 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: 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.	The learner will be imparted with the knowledge of 1. Different Free energy functions. 2. Thermodynamic systems. 3. Electrochemistry	The learner will be able to 1. Understand and express various free energy functions. 2. Work on different thermodynamic systems. 3. Understand basics of electrochemistry, conductance and applications. 4. Solve numericals on these topics.
Unit II	Chemical Bonding Non-Directional Bonding Ionic Bond: Conditions for the Formation of Ionic Bond. Types of Ionic Crystals, Radius Ratio Rules,	The learner will be imparted with the knowledge of 1. Non-directional chemical bonds.	The learner will be able to 1. Understand non-directional bonds. 2. Express ionic

	Lattice Energy, Borne-Lande Equation, Kapustinski Equation, Born-Haber Cycle and its Application. Directional Bonding: Orbital Approach. 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 hybridisation as in CH_4, NH_3 and H_2O and series like NH_3, PH_3, AsH_3, BiH_3) Molecular Orbital Theory 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)	2. Types of crystals. 3. Directional bonds. 4. Hybridization. 5. LACO-MO approach	bonds. 3. Understand types of crystals. 4. Distinguish between different types of crystals. 5. Understand directional bond. 6. Use knowledge of covalent bonds. 7. Understand hybridization. 8. Use different types of hybridizations. 9. Use the concept of LACO-MO .
Unit III	Reactions and reactivity of halogenated hydrocarbons: Alkyl halides: Nucleophilic substitution reactions: SN^1, SN^2 and SN^i 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 (SNAr) addition-elimination mechanism and benzyne mechanism. Organomagnesium and organolithium compounds: Nomenclature, nature, type and reactivity of carbon-metal bond.	The learner will be imparted with the knowledge of 1. Different reactions of halogenated hydrocarbons. 2. Different substitution reactions. 3. Aryl halides and their reactions. 4. Organometallic compounds. 5. Properties of	The learner will be able to 1. Understand, express and use different reactions of halogenated hydrocarbons. 2. Understand and use various substitution reactions on halogenated hydrocarbons. 3. Understand properties of aryl halides and their reactivity.

	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: 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.	alcohols, phenols, epoxides.	4. Express Properties of organometallic compounds. 5. Understand, write and use properties of compounds of the classes of alcohols, phenols and epoxides.
Paper II			
Unit I	Chemical Kinetics-II 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). Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (Ea). (Numericals expected). Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories (Qualitative treatment only) Solutions: 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. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial	By the end of semester, student will understand types of complex reaction, thermal chain reaction and theory of reaction rates, effect of temp. on rates. By the end of semester, student will understand, Thermodynamic of ideal and non –ideal solutions, basic rules like Raoult's law Lever Nernst distribution law	By the end of semester, student will understand various chemical reaction and solve problems. By the end of semester, student will able to apply the concept of ideal and non- ideal solution to various systems. Learn the principle of stream distillation and solvent extraction.

	miscibility of liquids with respect to Phenol-Water, Triethanolamine – Water and Nicotine – Water systems. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.	and applications.	
Unit II	Selected topics on p block elements Chemistry of Boron compounds Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications. Preparation of simple boranes like diborane and tetraborane. Structure and bonding in diborane and tetraborane (2e-3c bonds) Synthesis of Borax. Chemistry of Silicon and Germanium Silicon compounds: Occurrence, Structure and inertness of SiO_2. Preparation of structure of $SiCl_4$ Occurrence and extraction of Germanium Preparation of extra pure Silicon and Germanium Chemistry of Nitrogen family Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen. Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4. Synthesis of ammonia by Bosch – Haber process.	By the end of semester, student will understand chemistry of Boron, silicon, germanium and Nitrogen, preparation of various compound and structure and bonding.	By the end of semester, student will able to apply this concept for the pure synthesis of compounds and special process like Bosch-Harber process.
Unit III	Carbonyl Compounds: 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. General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions. Reactions of aldehydes and ketones with $NaHSO_3$, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$. Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt and Cannizzaro reaction. Keto-enol tautomerism: Mechanism of acid and	By the end of semester, student will understand nomenclature, reaction, preparation and properties of various types of aliphatic, alicyclic and aromatic carbonyl compound.	By the end of semester, student will able to write the reaction , mechanism, preparation of various organic carbonyl compounds.

	base catalysed enolization. Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilised enols. Reactions of Acetylacetone and ethyl acetoacetate (alkylation, conversion to ketone, mono- and dicarboxylic acid)		
Paper III			
Unit I	Intorduction to Analytical Chemistry and Statistical Treatment of analytical data-I Role of Analytical Chemistry Language of analytical chemistry: important terms and their significance in Analytical Chemistry. 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) Classical and Non-Classical Methods of Analysis; their types and importance. Significance of Sampling in Analytical Chemistry Terms involved in Sampling Types of Sampling Sampling techniques Results of Analysis. Errors in Analysis and their types Precision and Accuracy in Analysis Corrections for Determinate Errors (Problems including Numericals expected wherever required).	By the end of semester, student will understand important terms and significance of Analytical chemistry. They will be learn about method of analysis, sampling techniques, concept of errors.	Learners should be able to 1. Select a method of analysis. 2. Decide how to identify a sample and prepare it for analysis. 3. Select a procedure for analysis. 4. Identify sources of possible errors in the results obtained.
Unit II	Classical Methods of Analysis Titrimetric Methods Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry. The Conditions suitable for titrimetry. Types of titrimetry – Neutralisation (Acidimetry, alkalimetry), Redox, (Iodometry, Iodimetry,) Precipitation and Complexometric titrations and indicators used in these titrations. Tools of Titrimetry: Graduated glasswares and Callibration Standard solutions (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry. Neutralisation Titrations Concept of pH and its importance in Neutralisation Titrations End point and Equivalence point of	By the end of semester, student will understand types of titration methods, detail of neutralization of titration, concept of gravimetric analysis.	The main objectives of this unit are 1. Introduce classical methods of chemical analysis. 2. Appreciate the various terms and types of titrimetric analysis. 3. Ability to select proper titrimetric method 4. Appreciate the usefulness of the gravimetric method of analysis 5. Identify a suitable

	Neutralisation titrations Determination of End point by using i. Indicators causing colour change ii. Change in potential, (by potentiometry) iii. Change in conductance (by conductometry) 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 Gravimetric analysis General Introduction to Gravimetry. Types of Gravimetric Methods – 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 sulfur in organic compounds; Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime; Determination of Aluminum by converting it to its oxide.		gravimetric method 6. Perform the required calculations involved in the analysis by titrimetry as well as gravimetry.
Unit III	Basic Concepts in Instrumental methods Relation between the Analyte, Stimulus and measurement of change in the observable property. Block Diagram of an Analytical instrument. 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). Spectrometry Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorbtivity 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) Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers Block Diagrams for Single beam and	By the end of semester, student will understand type of analytical instrument base on various properties, concept of interaction of electromagnetic radiation with matter, block diagrams Various instrumentals.	On completing the learning of this unit the learner is expected to 1. Know the various instrumental methods of analysis. 2. Advantages of using instruments to make measurements. 3. The various observable properties of a given analyte and the stimulus best suited for its analysis. 4. Know about a generalized diagram of an analytical instrument. 5. Select a suitable instrumental method for analysis. 6. Appreciate the basic terms in spectrometry. 7. Use the relationship between absorbance (and its variations) and

	Colorimeter, and Spectrophotometer (Principles, Construction and working-Details of Components expected i.e , source ,Sample holder , Filters/Monochromators, Detectors such as Photomultiplier tube) Applications of UV-Visible Spectrophotometry (a) Qualitative analysis such as Identification of functional groups in Organic compounds, Chromophores and Auxochrome,cis and trans isomers (b) Quantitative analysis by Calibration curve method. Photometric Titrations: Principle, Instrumentation, Types of Photometric titration Curves with examples.		concentration of the analyte. 8. Chose a suitable method foe photometric titrations.
SYBSc			
SEM IV			
Paper I			
Unit I	Electrochemistry-II: 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) Calculation of equilibrium constant 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: 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).	By the end of semester, student will understand basic concepts of reversible and irreversible cells, types of electrodes, thermodynamics of cells, calculation of ΔG, ΔH, ΔS. equilibrium constant from cell emf. By the end of semester, student will understand phases, components, degrees of freedom. They will learn to derive basic rules like Gibbs Phase rule, Clapeyron	By the end of semester, student will be able to calculate thermodynamic properties from emf, measurements, solve numerical problems. By the end of semester, student will able to solve numerical problems based on equations and learn to apply phase rule to various system.

		equation and learn about phase diagrams of one and two component system.	
Unit II	Comparative Chemistry of the transition metals. Position in the periodic table; Natural occurrence principal ores and minerals; Significance of special stability of d0, d5 and d10 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 : Introduction to Chemistry of Coordination Compounds i. Historical perspectives: Early ideas on coordination compounds ii. Basic terms and nomenclature. iii. Types of ligands iv. Isomerism: General Types with special reference to stereoisomerism of coordination compounds (C.N=6) v. Evidence for the formation of coordination compounds. Theories of coordination compounds i. Werner's Theory of coordination compounds, ii. Effective atomic number rule. iii. Eighteen electron Rule Nature of the Metal-Ligand Bond: i. Valence Bond Theory; Hybridisation of the central metal orbitals-sp^3, sd^3/d^3s, sp^3d^2/d^2sp^3, sp^2d, ii. Inner and outer orbital complexes of .(suitable examples of Mn(II)	By the end of semester, student will understand stability, properties of transition metals in general and specifically about Titanium and Vanadium. By the end of semester, student will understand chemistry of coordination compounds various theories of coordination compounds and their application.	By the end of semester, student will able to learn the significance of electronic configuration and properties. And understand qualitative tests for analysis of transition metals. By the end of semester, student will able to solve learn basic terms and nomenclature of coordination compounds, nature of M-L bond.

	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) iii. Limitations of V.B.T Application of coordination compounds.		
Unit III	Carboxylic Acids and their Derivatives : 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-catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution. Mechanism of Claisen condensation and Dieckmann condensation. Sulphonic acids: 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.	By the end of semester, student will understand carboxylic acid nomenclature, preparation and properties. By the end of semester, student will understand sulphonic acid nomenclature, preparation and properties.	By the end of semester, student will able to write the reactions carboxylic acids and understands their mechanisms. By the end of semester, student will able to write the reactions Sulphonic acids and understands their mechanisms.
Paper II			
Unit I	Solid State: Recapitulation of laws of crystallography and types of crystals 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) 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)	By the end of semester, student will understand law of crystallography and types of crystals. By the end of semester, student will understand catalysts, the	By the end of semester, student will able to learn the characteristics of various types of crystals and understand the used of X- ray for study of crystal structure. Solve numerical problem. By the end of

	Catalysis: Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH. Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation) Effect of particle size and efficiency of nanoparticles as catalyst.	mechanism of their action and kinetics of their reactions.	semester, student will able to learn the effect of particle size and efficiency of nano size catalyst particles.
Unit II	Ions in aqeous medium Acidity of Cations and Basicity of Anions i. Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations- effect of Charge and Radious. 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 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	By the end of semester, student will understand hydration of cations and anions. Classification of cations and use of Latimer equation. By the end of semester, student will understand properties of oxo acid and their uses.	By the end of semester, student will able to learn to draw diagrams about effect of charge and radius and relationship between pKa acidity and Z^2/ r ratio of metal ions. By the end of semester, student will able to learn the environmental aspects of Oxo acids.
Unit III	Nitrogen containing compounds and heterocyclic compounds: Amines: Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines; 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 , Hofmann bromamide reaction. Reactions- Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM),Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation. Diazonium Salts: Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by -H,-OH. Azo coupling with	By the end of semester, student will understand the nomenclature, classification, synthesis, reactions of nitrogen containing heterocyclic compounds.	By the end of semester, student will able to explain properties of amines, various reactions and properties of diazonium salts. The properties, synthesis and mechanism of reactions of heterocyclic compounds.

	phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine and hydroazobenzene Heterocyclic Compounds: Classification, nomenclature, electronic structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), 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. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Ring opening. Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine (with and without catalyst), reduction and action of sodamide (Chichibabin reaction).		
Paper III			
Unit I	Separation Techniques in Analytical Chemistry An Introduction to Analytical Separations and its importance in analysis. Estimation of an analyte without effecting separation. Types of separation methods Based on Solubilities (Precipitation, Filtration Crystallisation) Based on Gravity- Centrifugation Based on volatility-Distillation ; Based on Electrical effects-Electrophoresis Based on retention capacity of a Stationary Phase -Chromatography; Based on distribution in two immiscible phases-Solvent Extraction; Based on capacity to exchange with a resin-Ion Exchange; Electrophoresis: Principles, Basic Instrumentation, Working and Application in	By the end of semester, students will understand concept of separation methods based on various unit operations. They will learn the theory of solvent extraction and chromatoghaphy, especially paper and thin layer chromatography.	The learner is expected to understand 1. The importance of separation in sample treatment 2. Various methods of separations 3. How to select a method of separation of an analyte from the matrix 4. How a solute gets distributed between two immiscible phases 5. Principle of solvent extraction and various terms

	separation of biomolecules like enzymes and DNA. Solvent extraction Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient. Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH. Single step and multi-step extraction, Percentage extraction for single step and multistep extraction. Separation factor. Batch and continuous extraction Chromatography : Introduction to Chromatography Classification of chromatographic methods based on stationary and mobile phase Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations. Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction		involved therein 6. Effect of various parameters on solvent extraction of a solute 7. Classification of Chromatographic methods 8. Paper and thin layer chromatography and using them in practice.
Unit II	Instruments based on the electrochemical properties of the analytes. Potentiometry: Principle. Role of Reference and indicator electrodes Applications in Neutralisation reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode) Graphical methods for detection of end points pH metry: Principle Types of pH meters. Principle, Construction Working and Care of Combined Glass electrode Applications in Titrimetry (Strtong acid-Strong Base) biological and environmental analysis. Conductometry: Principle Conductivity cell its construction and care Applications in Neutralization Titrimetry with respect to i. Strong Acid-Strong Base ii. Strong Acid-Weak Base iii. Strong Base-weak Acid iv. Weak Acid- Weak Base. Advantages & limitations of conductometric titrations.	By the end of semester, students will understand electrochemistry properties like emf of cell, pH, conductivity, their measurements and their usage in chemical analysis.	On completing this unit the learner is 1. Expected to appreciate the nature of interaction between applied electrical potential and the concentration of the analyte. 2. The nature of chemical reactions that influence potential of a given cell. 3. Familiar with the various types of electrodes or half cells. 4. Appreciate the nature, need and importance of pH 5. Expected to know the applications of the various instrumental methods dealt with in this unit.
Unit III	Nature of Indeterminate Errors: The true and acceptable value of a result of analysis	By the end of semester, students	On completing this unit the learner is expected to

	Measures of central tendency: mean, median. mode, average Measures of dispersion: Absolute deviation, relative deviation, relative average deviation, standard deviation,(s,sigma) variance, coefficient of variation Distribution of random errors: Gaussian distribution curve. Equation and salient features of Gaussian distribution curve Concept of Confidence limits and confidence interval and its computation using (i) Population standard deviation (ii) Student's t test (iii) Range Criteria for rejection of doubtful result (i) 2.5 d rule (ii) 4.0 d rule (iii) Q test Test of Significance (i) Null hypothesis (ii) F-test (variance ratio test) Graphical representation of data and obtaining best fitting straight line (a) For line passing through origin (b) For line not passing through origin [Numerical problems wherever possible, expected]	will understand errors, tackling of error by use of statistics. They will be able to use statistical parameters of central tendency and tests for rejection of data, graphical representation of data.	understand 1. The use of statistical methods in chemical analysis. 2. The nature of indeterminate errors 3. The randomness of such errors and its distribution around a correct or acceptable result 4. Computation of Confidence limits and confidence interval 5. Test for rejection of doubtful result 6. Method to draw best fitting straight line
TYBSc			
SEM V			
Paper I			
Unit I	MOLECULAR SPECTROSCOPY Rotational Spectrum: Introduction to dipole moment, polarization of a bond, bond moment, molecular structure, .Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of internuclear distance and isotopic shift. Vibrational spectrum: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum. Vibrational-Rotational spectrum of diatomic molecule: energy levels, selection rule, nature of spectrum, P and R branch lines. Anharmonic oscillator - energy levels, selection rule, fundamental band, overtones. Application of vibrational-rotational spectrum in determination	By the end of semester, students will understand concept of spectroscopy ie. Study of interaction between electromagnetic radiation from microwave and IR region and molecules.	By the end of semester, they will able to learn the importance of dipole moment and its relation with molecular structure, theory of Raman effect and applications in structure elucidation.

	of force constant and its significance. Infrared spectra of simple molecules like H_2O and CO_2. Raman Spectroscopy : Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion- CO_2 molecule.		
Unit II	CHEMICAL THERMODYNAMICS Colligative properties: Vapour pressure and relative lowering of vapour pressure. Measurement of lowering of vapour pressure - Static and Dynamic method. Solutions of Solid in Liquid: Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of the solution and molar mass of non-volatile solute. Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. Beckmann Method and Rast Method. Osmotic Pressure: Introduction, thermodynamic derivation of Van't Hoff equation, Van't Hoff Factor. Measurement of Osmotic Pressure - Berkeley and Hartley's Method, Reverse Osmosis. CHEMICAL KINETICS Collision theory of reaction rates : Application of collision theory to 1. Unimolecular reaction Lindemann theory and 2. Bimolecular reaction. (derivation expected for both) Classification of reactions as slow, fast and ultra -fast. Study of kinetics of fast reactions by Stop flow method and Flash photolysis (No derivation expected).	By the end of semester, students will understand concept of various properties and their measurements. They will understand how boiling point is elevated and freezing points is depressed. By the end of semester, students will understand concept of reaction rates and effect of collisions the rates.	By the end of semester, they will able to learn to solve numerical problem based on the concepts of osmosis and elevation or depression of boiling point.
Unit III	NUCLEAR CHEMISTRY Introduction: Basic terms-radioactive constants (decay constant, half-life and average life) and units of radioactivity. Detection and Measurement of Radioactivity: Types and characteristics of nuclear radiations, behaviour of ion pairs in electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter. Application of use of radioisotopes as Tracers: chemical reaction mechanism, age determination - dating by C^{14}. Nuclear reactions: nuclear transmutation (one	By the end of semester, students will understand concept of radioactivity, detection and measurements of radioactivity and application of radio iso –topes. They will comprehend the	By the end of semester, they will able to learn the basic terms in nuclear chemistry, nuclear reaction and perform numerical calculation.

	example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy. Fission Process: Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. Multiplication factor and critical size or mass of fissionable material, nuclear power reactor and breeder reactor. Fusion Process : Thermonuclear reactions occurring on stellar bodies and earth.	nuclear reaction like fusion and fission.	
Unit IV	SURFACE CHEMISTRY Adsorption: Physical and Chemical Adsorption, types of adsorption isotherms. Langmuir's adsorption isotherm (Postulates and derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation. COLLOIDAL STATE Introduction to colloids - Emulsions, Gels and Sols Electrical Properties : Origin of charges on colloidal particles, Concept of electrical double layer, zeta potential, Helmholtz and Stern model. Electro-kinetic phenomena - Electrophoresis, Electro-osmosis, Streaming potential, Sedimentation potential; Donnan Membrane Equilibrium. Colloidal electrolytes : Introduction, micelle formation, Surfactants: Classification and applications of surfactants in detergents and food industry.	By the end of semester, students will understand concept of adsorption, types of adsorption and adsorption isotherms. By the end of semester, students will understand concept of emulsions, gels and solution, their electrical properties and electro-kinetic phenomena. They will learn the classification and application of surfactants.	By the end of semester, they will able to learn to derive adsorption isotherms and determination of surface area calculations. By the end of semester, they will able to learn the concept of zeta potential electrophoresis, electroosmosis, micelle formation and how to use these concepts in colloids.
Paper II			
Unit I	Molecular Symmetry and Chemical Bonding Molecular Symmetry Introduction and Importance of Symmetry in Chemistry. Symmetry elements and Symmetry operations. Concept of a Point Group with illustrations using the following point groups :(i)$C_{\infty V}$ (ii) $D_{\infty h}$ (iii) C_{2V} (iv) C_{3v} (v)C_{2h} and (vi)D_{3h} Molecular Orbital Theory for heteronuclear diatomic molecules and polyatomic species Comparision between homonuclear and heteronuclear diatomic molecules. Heteronuclear diatomic molecules like CO, NO	The student will able to understand symmetry and molecular orbital for diatomic and polyatomic molecule.	The student will able to discuss the point group for molecule and also able to construct molecular orbital diagram for heteronuclear and polyatomic molecules.

	and HCl, appreciation of modified MO diagram for CO. Molecular orbital theory for H_3 and H_3^+ (correlation diagram expected). Molecular shape to molecular orbital approach in AB_2 molecules. Application of symmetry concepts for linear and angular species considering σ- bonding only. (Examples like: i) BeH_2, ii) H_2O).		
Unit II	SOLID STATE CHEMISTRY Structures of Solids Explanation of terms viz. crystal lattice, lattice point, unit cell and lattice constants. Closest packing of rigid spheres (hcp,ccp), packing density in simple cubic, bcc and fcc lattices. Relationship between density, radius of unit cell and lattice parameters. Stoichiometric Point defects in solids (discussion on Frenkel and Schottky defects expected). Superconductivity Discovery of superconductivity. Explanation of terms like superconductivity, transition temperature, Meissner effect. Different types of super conductors viz. conventional superconductors, alkali metal fullerides, high temperature super conductors. Brief application of superconductors.	The student will able to understand Structure of solid, stoichiometric point defect in solid, types of superconductor and their applications.	The students will learn the simple cubic, body centered cubic lattice and able to solve numerical based on it. They should learn about superconductivity and their applications.
Unit III	CHEMISTRY OF INNER TRANSITION ELEMENTS Introduction: Position in periodic table and electronic configuration of lanthanides and actinides. Chemistry of Lanthanides with reference to (i) lanthanide contraction and its consequences (ii) Oxidation states (iii) Ability to form complexes (iv) Magnetic and spectral properties Occurrence, extraction and separation of lanthanides by (i) Ion Exchange method and (ii) Solvent extraction method (Principles and technique) Applications of lanthanides	The student will able to understand Position of lanthanides and actinides in the periodic table, lanthanide contraction, magnetic and spectra properties of lanthanides. Occurrence, extraction and separation of lanthanides.	Student will able to write electronic configuration of lanthanide and actinide. Able to understand lanthanide contraction and their effect .should learn separation of lanthanide by ion exchange and solvent extraction method should learn commercial and nuclear application of lanthanides.
Unit IV	SOME SELECTED TOPICS Chemistry of Non-aqueous Solvents. Classification of solvents and importance of	The student will able to understand	Student will able to learn physical and chemical properties

	non-aqueous solvents. Characteristics and study of liquid ammonia, dinitrogen tetra oxide as non-aqueous solvents with respect to: (i) acid-base reactions and (ii) redox reactions. Comparative Chemistry of Group 16 Electronic configurations, trends in physical properties, allotropy. Manufacture of sulphuric acid by Contact process. Comparative Chemistry of Group 17 Electronic configuration , General characteristics, anamolous properties of fluorine, comparative study of acidity of oxyacids of chlorine w.r.t acidity, oxidising properties and structures(on the basis of VSEPR theory) Chemistry of inter-halogens with reference to preparations, properties and structures (on the basis of VSEPR theory).	Chemistry of non-aqueous solvents, comparative chemistry of group system of group-16 and group-17elements.	of solvents, classification of solvents, trends in physical properties of group 16 and 17 elements, allotropy, allotropes of sulphur, synthesis of H2SO4 by contact process, VSEPR theory, able to draw and understand the structure of geometry of oxyacids of chlorine interhalogens.
Paper III			
Unit I	Mechanism of organic reactions The basic terms & concepts: bond fission, reaction intermediates, electrophiles & nucleophiles, ligand, base, electrophilicity vs. acidity & nucleophilicity vs basicity. Neighbouring group participation in nucleophilic substitution reactions: participation of lone pair of electrons, kinetics and stereochemical outcome. Acyl nucleophilic substitution (Tetrahedral mechanism): Acid catalyzed esterification of carboxylic acids (AAC2) and base promoted hydrolysis of esters (BAC2). Pericyclic reactions, classification and nomenclature: Electro cyclic reactions (ring opening and ring closing), cycloaddition, sigma tropic Rearrangement, group transfer reactions, cheletropic reaction (definition and one example of each type) Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates. Photochemistry Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules,	The learner will be imparted with the knowledge of 1. Basic terms and concepts of organic reaction mechanisms. 2. Different types of pericyclic reactions. 3. Fundamentals of photochemistry. 4. Different reaction mechanisms in photochemical reactions.	The learner will be able to 1. Explain fundamentals of reaction mechanisms. 2. Differentiate between sigmatropic reactions. 3. Draw Jablonski diagram and fate of the molecule. 4. Distinguish the different types of cleavages in photochemical reactions.

	photosensitization. Photochemical reactions of olefins: photoisomerization, photochemical rearrangement of 1,4dienes (di- π methane) Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages. Photo reduction (e.g. benzophenone to benzpinacol)		
Unit II	Stereochemistry I: Molecular chirality and elements of symmetry: Mirror plane symmetry, inversion center, roation -reflection (alternating) axis. Chirality of compounds without a stereo genic center: cummulenes and biphenyls. Agrochemicals: General introduction & scope, meaning & examples of insecticides, herbicides, fungicide, rodenticide, pesticides, plant growth regulators. Advantages & disadvantages of agrochemicals Synthesis & application of IAA (Indole Acetic Acid) & Endosulphan, Bio pesticides – Neem oil & Karanj oil. Heterocyclic chemistry: Reactivity of pyridine-N-oxide, quinoline and iso-quionoline. Preparation of pyridine-N-oxide, quinoline (Skraup synthesis) and iso-quinoline (Bischler-Napieralski synthesis). Reactions of pyridine-N-oxide: halogenation, nitration and reaction with NaNH2/liq.NH3, n-BuLi. Reactions of quinoline and isoquinoline; oxidation, reduction, nitration, halogenation and reaction with $NaNH_2$/liq.NH_3, n-BuLi.	The learner will be imparted with the knowledge of 1. Molecular chirality and elements of symmetry in selected molecules. 2. Various types of Agrochemicals. 3. Synthesis and reactions of selected heterocyclic compounds.	The student will be able to 1. Identify the chirality of molecules. 2. Comment on the symmetry of molecules. 3. Identify and use different agrochemicals. 4. Write reactions for synthesis and properties of selected heterocyclics like pyridine-N-oxide quinoline etc.
Unit III	IUPAC: IUPAC Systematic nomenclature of the following classes of compounds (including compounds upto two substituents / functional groups): Bicyclic compounds – spiro, fused and bridged (upto 11 carbon atoms) – saturated and unsaturated compounds. Biphenyls Cummulenes with upto 3 double bonds Quinolines and isoquinolines. Synthesis of organic compounds Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemo selectivity and regioselectivity with examples, calculation of yields. Multicomponent Synthesis: Mannich reaction and Biginelli reaction. Synthesis with examples (no mechanism)	The learner will be imparted with the knowledge of 1. IUPAC nomenclature of bicyclic compounds, cummulenes, quinolones and isoquinolines. 2. Types of synthesis and selectivity. 3. Concept of Green chemistry and uses. 4. Planning of organic synthesis.	The student will be able to 1. Write IUPAC names of bicyclic compounds and heterocyclics. 2. Distinguish between types of reactions and selectivity of reactions. 3. Understand the concept of Green chemistry. 4. Use Green chemistry concept in everyday life. 5. Plan different chemical reactions.

	Green chemistry and synthesis: Introduction: Twelve principles of green chemistry, concept of atom economy and E-factor, calculations and their significance, numerical examples. i) Green reagents: dimethyl carbonate. ii) Green starting materials: D-glucose iii) Green solvents: supercritical CO_2 iv) Green catalysts: Bio catalysts. Planning of organic synthesis i) synthesis of nitroanilines. (o&p) ii) synthesis of halobenzoic acid.(o&p) iii) Alcohols (primary / secondary / tertiary) using Grignard reagents. iv) Alkanes (using organo lithium compounds)		
Unit IV	Spectroscopy I Introduction: Electromagnetic spectrum, units of wavelength and frequency UV – Visible spectroscopy: Basic theory, solvents, nature of UV-Visible spectrum, concept of chromophore, auxochrome, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, chromophore-chromophore and chromophore-auxochrome interactions. Mass spectrometry: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule, rule of 13 for determination of empirical formula and molecular formula. Fragmentation of alkanes and aliphatic carbonyl compounds. Natural Products: Terpenoids: Introduction, Isoprene rule, special isoprene rule and the gem-dialkyl rule. Citral: a) Structural determination of citral. b) Synthesis of citral from methyl heptenone c) Isomerism in citral. (cis and trans form). Alkaloids: Introduction and occurrence. Hofmann's exhaustive methylation and degradation in: simple open chain and N – substituted monocyclic amines. Nicotine: a) Structural determination of nicotine. (Pinner's work included) b) Synthesis of nicotine from nicotinic acid c) Harmful effects of nicotine. Hormones: Introduction, structure of adrenaline (epinephrine), physiological action of adrenaline. Synthesis of adrenaline from a) Catechol b) p-hydroxybenzaldehyde(Ott's synthesis)	The learner will be imparted with the knowledge of 1. Fundamentals of Electromagnetic spectrum. 2. Concept, use and interpretation of UV spectroscopy. 3. Concept, use and interpretation of Mass spectroscopy. 4. Natural products like Terpenoids, alkaloids, hormones.	The student will be able to 1. Understand the principles of electromagnetic spectroscopy. 2. Understand and interpret UV spectroscopy of molecules. 3. Understand and interpret Mass spectroscopy of molecules. 4. Distinguish between different natural products. 5. Understand properties and reactions of natural products.
Paper IV			

Unit I	INTRODUCTION TO QUALITY CONCEPTS, CHEMICAL CALCULATIONS AND SAMPLING: Quality in Analytical Chemistry Concepts of Quality, Quality Control and Quality Assurance Importance of Quality concepts in Industry Chemical Standards and Certified Reference Materials; Importance in chemical analysis Quality of material: Various grades of laboratory reagents Chemical Calculations (Numericals and word problems are expected) Inter conversion of various concentration units. (Conversion of concentration from one unit to another unit with examples) Percent composition of elements in chemical compounds. Sampling Purpose, significance and difficulties encountered in sampling. Sampling of solids: Sample size – bulk ratio, size to weight ratio, multistage and sequential sampling, size reduction methods, sampling of compact solids, equipments and methods of sampling of compact solids, sampling of particulate solids, methods and equipments used for sampling of particulate solids. Sampling of liquids: Homogeneous and heterogeneous, Static and flowing liquids. Sampling of gases: Ambient and stack sampling: Apparatus and methods for sampling of gases. Collection, preservation and dissolution of the sample.	By the end of semester, student will understand the concept of quality, quantity control and quality assurance, their importance in industry. By the end of semester, student will understand the concept of concentration and its different units and their interconversion. By the end of semester, student will understand the concept of purpose and significance of sampling in industry. The will learn different aspect of sampling of solids, liquids, and gases.	By the end of semester, student will able to learn about grades of chemicals & laboratory reagents, certified reference materials and chemical standards. By the end of semester, student will able to solve numerical problems on calculation of concentration. By the end of semester, student will able to learn important terms used in sampling procedures, sampling procedures of various types of samples and information about collection, preservation and usage of sample used in analysis.
Unit II	CLASSICAL METHODS ANALYSIS (TITRIMETRY) Redox Titrations (Numerical and word Problems are expected) Introduction. Construction of the titration curves and calculation of Esystem in aqueous medium in case of: (1) One electron system (2) Multielectron system Theory of redox indicators, Criteria for selection of an indicator Use of diphenyl amine and ferroin as redox indicators Complexometric Titrations: Introduction, construction of titration curve Use of EDTA as titrant and its standardization, absolute and conditional formation constants of metal EDTA complexes, Selectivity of EDTA	By the end of semester, student will understand the concept of redox and complexometric titrations, type of titration, indicators used and enhancing selectivity of reagents.	By the end of semester, student will able to learn theory of indicators, theory of stability constants, examples of titrations and their applications.

	as a titrant. Factors enhancing selectivity with examples. Advantages and limitations of EDTA as a titrant. Types of EDTA titrations. Metallochromic indicators, theory, examples and applications		
Unit III	OPTICAL METHODS Atomic Spectroscopy: lame Emission spectroscopy(ES) and Atomic Absorption Spectroscopy(AAS) Introduction, Energy level diagrams, Atomic spectra, Absorption and Emission Spectra Flame Photometry – Principle, Instrumentation (Flame atomizers, types of Burners, Wavelength selectors, Detectors) Atomic Absorption Spectroscopy – Principle, Instrumentation (Source, Chopper, Flame and Electrothermal Atomiser) Quantification methods of FES and AAS – Calibration curve method, Standard addition method and Internal standard method. Comparison between FES and AAS Applications, Advantages and Limitations Molecular Fluorescence and Phosphorescence Spectroscopy Introduction and Principle Relationship of Fluorescence intensity with concentration Factors affecting Fluorescence and Phosphorescence Instrumentation and applications Comparison of Fluorimetry and Phosphorimetry Comparison with Absorption methods Turbidimetry and Nephelometry Introduction and Principle: Factors affecting scattering of Radiation: Concentration, particle size, wavelength, refractive index. Instrumentation and Applications	By the end of semester, student will understand the concept of flame emission and atomic absorption spectroscopy. They will get the knowledge of basic instrumentation, components, working and methods of quantification used .They will also learn the related techniques fluorimetry, phoshorimetry, nephelometry and turbidimetry with respect to principles instrumentation and applications.	By the end of semester, student will able to learn to apply the theory to actual instrument and its components in detail, applications, advantages and limitations for FES, AAS, Fluorimetry, Phosphorimetry, Nephelometry and Turbidimetry. They will learn a comparative account of all these techniques.
Unit IV	METHODS OF SEPARATION I Solvent Extraction: Factors affecting extraction: Chelation, Ion pair formation and Solvation. Graph of percent extraction versus pH. Concept of [pH]1/2 and its significance (derivation not expected) Craig's counter current extraction: Principle, apparatus and applications Solid phase extraction: Principle, process and applications with special reference to water and industrial effluent analysis. Comparison of solid phase extraction and	By the end of semester, student will understand the concept of chelation, ion pair formation and solvation, concept of counter current extraction, solid phase extraction and their comparison.	By the end of semester, student will able to learn the concept of p^H, solvent extraction and its significance, process and applications of both solvent extraction & solid phase extraction.

	solvent extraction. High Performance Liquid chromatography (HPLC) Introduction and Principle Instrumentation- components with their significance: Solvent Reservoir, Degassing system, Pumps-(reciprocating pumps, screw driven- syringe type pumps, pneumatic pumps, advantages and disadvantages of each pump), Precolumn, Sample injection system, HPLC Columns, Detectors(UV – Visible detector, Refractive index detector) Qualitative and Quantitative Applications of HPLC. High Performance Thin Layer Chromatography (HPTLC) Introduction and Principle Stationary phase, Sample application and mobile phase. Detectors a) Scanning densitometer- Components. Types of densitometer- Single beam and Double beam b) Fluorometric Detector. Advantages, disadvantages and applications Comparison of TLC and HPTLC.	By the end of semester, student will understand the concept of HPLC, its principle and their significance, application of HPLC. By the end of semester, student will understand concept of HPTLC, its principle and instrumentation, detectors used and applications, advantages/ disadvantages.	By the end of semester, student will able to learn to draw diagrams of all components and know their advantages and disadvantages. By the end of semester, student will able to learn to choose correct mobile phase, sample application technique and make a comparison of HPLC & HPTLC.
Paper V			
Unit I	General Introduction to Drugs Definition of a drug, sources of drugs, requirements of an ideal drug, classification of drugs (based on therapeutic action), Nomenclature of drugs: Generic name, Brand name, Systematic name. Definition of the following medicinal terms: Pharmacon, Pharmacology, Pharmacophore, Prodrug, Half – life efficiency, LD_{50}, ED_{50}, GI_{50} Therapeutic Index. Brief idea of the following terms: Receptors, Agonists, Antagonists, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia. Routes of Drug Administration and Dosage Forms Oral and Parenteral routes with advantages and disadvantages. Formulations & combination formulation, Different dosage forms (including Patches & Adhesives, emphasis on sustained release formulations and enteric coated tablets). Pharmacodynamic agents: A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical	The learner will be imparted with the knowledge of 1. Pharmaceutical Drugs. 2. Terminologies in pharmaceutical chemistry. 3. Synthesis, uses and toxicity of CNS drugs.	The students will be able to 1. Understand the concept of pharmaceutical drugs. 2. Explain the different terms used in pharmaceutical chemistry and be helpful to common man. 3. Understand the use and toxic effects of CNS drugs.

	structure, chemical class, therapeutic uses, and side effects. CNS Drugs: Classification based on pharmacological actions: CNS Depressants & CNS Stimulants. Concept of sedation and hypnosis, anaesthesia. Phenytoin (Hydantoin); Trimethadione (Oxazolidinediones) (Synthesis from acetone); Alprazolam (Benzodiazepines); Levetiracetam (Pyrrolidines); Amphetamine (Phenethylamine) (Asymmetric synthesis from phenyl acetic acid); Chlorpromazine (Phenothiazines).		
Unit II	Analgesics, Antipyretics and Anti-inflammatory Drugs. Analgesics and Antipyretics: Morphine (Phenanthrene alkaloids); Tramadol (Cyclohexanols) (Synthesis from salicylic acid); Aspirin (Salicylates); Paracetamol (p-Amino phenols) Anti-inflammatory Drugs: Mechanism of inflammation and various inflammatory conditions. Steroids: Prednisolone, Betamethasone, Sodium Diclofenac, Aceclofenac (N- Aryl anthranilic acids) (Synthesis from 2,6-dichlorodiphenyl amine). Antihistaminic Drugs: Diphenhydramine (Ethanol amines); Cetrizene (Piperazine) (Synthesis from 4Chlorobenzhydryl chloride); Chlorpheniramine maleate (Ethyl amines); Pantoprazole (Benzimidazoles). Cardiovascular drugs: Classification based on pharmacological action. Isosorbide dinitrate (Nitrates); Valsartan (Amino acids) (structure not expected); Atenolol (Aryloxy propanol amines) (Synthesis from 3-Hydroxy phenyl acetamide); Amlodipine (Pyridines); Frusemide /Furosemide (Sulfamoyl benzoic acid); Rosuvastatin (Pyrimidine). Antidiabetic Agents: General idea and types of diabetes; Insulin therapy. Glibenclamide (Sulphonyl ureas); Metformin (Biguanides); Dapagliflozin (Pyranose); Pioglitazone (Thiazolidinediones) (Synthesis from 2-(5ethylpyridin-2-yl) ethanol). Antiparkinsonism Drugs: Idea of Parkinson's disease. Procyclidine hydrochloride (Pyrrolidines); Ethopropazine hydrochloride (Phenothiiazines); Levodopa (Amino acids) (Synthesis from Vanillin). Drugs for Respiratory System: General idea of - Expectorants; Mucolytes; Bronchodilators;	The learner will be imparted with the knowledge of synthesis, uses and toxic effects of 1. Different analgesics, antipyretics, anti-inflammatory drugs. 2. Cardiovascular drugs. 3. Antidiabetic drugs. 4. Anti-parkinsonism drugs. 5. Drugs for respiratory systems.	The students will be able distinguish between the following classes of drugs, their synthesis, uses and toxic effects: 1. Different analgesics, antipyretics, anti-inflammatory drugs. 2. Cardiovascular drugs. 3. Antidiabetic drugs. 4. Anti-parkinsonism drugs. 5. Drugs for respiratory systems.

	Decongestants; Antitussives. Ambroxol (Cyclohexanol) (Synthesis from paracetamol); Salbutamol (Phenyl ethyl amines); Oxymetazoline (Imidazolines); Codeine Phosphate (Opiates).		
Unit III	Introduction to the dye-stuff Industry Dyes: Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability. Definition of fastness and its properties and Mordants with examples. Explanation of nomenclature or abbreviations of commercial dyes with at least one example suffixes – G, O, R, B, K, L, C, S H, 6B, GK, 6GK, Naming of dyes by colour index (two examples) used in dye industries. Natural and Synthetic Dyes Natural Dyes: Definition and limitations of natural dyes. Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll –names of the chief dyeing material/s in each natural dye [structures not expected], Synthetic dyes: Definition of synthetic dyes, primaries and intermediates. Important milestones in the development of synthetic dyes – Emphasis on Name of the Scientist, dyes and the year of the discovery is required. (structure is not expected) Substrates for Dyes : Types of fibres Natural: cellulosic and proteinaceous fibres, examples – wool, silk and cotton structures and names of dyes applied on each of them. Semi – synthetic: definition and examples [structures not expected] Synthetic: Nylon, Polyesters and Polyamides structures and names of dyes applied on each of them. Blended fabrics: definition and examples [structures not expected] Binding forces of dyes on substrate: ionic forces, covalent linkages, hydrogen bonding, Van der-walls forces. Classification of dyes based on applications and dyeing methods: Dyeing methods: Basic Operations involved in dyeing process: i. Preparation of fibres ii. Preparation of dyebath iii. Application of dyes iv. Finishing Dyeing Method of Cotton	The learner will be imparted with the knowledge of 1. Dyes and dye-stuff industry. 2. Different terminologies used in dye-stuff industries. 3. Synthesis of different dyes and dye intermediates. 4. Different types of fibres. 5. Classification of dyes based on applications and dyeing methods. 6. Different dying methods. 7. Concept of Optical brighteners and uses.	The learner will be able to 1. Understand the intricacies of dye and dye-stuff industries. 2. Make use of different terminologies used in dye-stuff industries. 3. Write synthesis of various dyes and dye intermediates. 4. Distinguish between different fires. 5. Classify different dyes on the basis of dying methods. 6. Classify different dyes and identify the groups present in those. 7. Understand what are optical brighteners and their uses.

	Fibres: (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing. Classification of dyes based on applicability on substrates (examples with structures) (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes – Diazo components; Fast yellow G, Fast orange R. Coupling components. Naphthol AS, Naphthol ASG (e) Mordant Dyes-Eriochrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, (i) Reactive Dyes- Cibacron Brilliant Red B, Optical Brighteners: General idea, important characteristics of optical brighteners and their classes [Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthylamide derivatives] general structure of each class.		
Unit IV	Colour and Chemical Constitution of Dyes Absorption of visible light, Colour of wavelength absorbed, Complementary colour. Relation between colour and chemical constitution. (i) Armstrong theory (quinonoid theory) and its limitations. (ii) Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic effect (iii) Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iv) Molecular Orbital Theory. Unit process and Dye Intermediates: A brief idea of Unit Processes Introduction to primaries and intermediates. Unit processes: definition and brief ideas of below unit processes: (a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization: (3 different methods & its importance) (e) Ammonolysis (f) Oxidation NB: Definition, Reagents, Examples of each unit processes mentioned above with reaction conditions (mechanism is not expected). Preparation of the Following Intermediates: Benzene derivatives: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; sulphanilic acid; o-, m-, p-chloronitrobenzenes; o-, m-, p-nitroanilines; o-, m-, p-phenylene diamines; Naphthol ASG Naphthalene Derivative:	The learner will be imparted with the knowledge of 1. Concept of Colour and Chemical Constitution of Dyes. 2. Different theories involved in colour. 3. Unit processes in Dye industry. 4. Methods of preparation of different dye intermediates.	The students will be able to 1. Understand the concept of colour. 2. Identify the chemical constitution of different dyes. 3. Make use of different theories involved in colour and their composition. 4. Find the different unit process and their uses. 5. Write synthesis of different dye intermediates.

	Schaeffer acid; Tobias acid; Naphthionic acid; N.W. acid; cleve-6-acid; H-acid; Naphthol AS Anthracene Derivative: 1-Nitroanthraquinone; 1-Aminoanthraquinone Anthraquinone-2-sulphonic acid; Benzanthrone.		
SEM VI			
Paper I			
Unit I	ELECTROCHEMISTRY Activity and Activity Coefficient: Lewis concept, ionic strength, Mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye-Huckel limiting law (No derivation). Classification of cells: Chemical cells and Concentration cells. Chemical cells with and without transference, Electrode Concentration cells, Electrolyte concentration cells with and without transference (derivations are expected), APPLIED ELECTROCHEMISTRY Polarization: concentration polarization and it's elimination Decomposition Potential and Overvoltage: Introduction, experimental determination of decomposition potential, factors affecting decomposition potential. Tafel's equation for hydrogen overvoltage, experimental determination of over –voltage.	By the end of semester, student will understand the concept of activity and activity coefficient, ionic strength and their calculations. They will learn the classification of electrochemical cells. Concept of polarization, decomposition and overvoltage and their determination.	By the end of semester, student will able to learn the use of activity of electrolytes and solve numerical problem based on it. They will be able to derive express for emf of chemical and concentration cell and solve numerical problems based on it.
Unit II	POLYMERS Basic terms: macromolecule, monomer, repeat unit, degree of polymerization. Classification of polymers: Classification based on source, structure, thermal response and physical properties. Molar masses of polymers: Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity Method of determining molar masses of polymers: Viscosity method using Ostwald Viscometer. (derivation expected) Light Emitting Polymers: Introduction, Characteristics, Method of preparation and applications. Antioxidants and Stabilizers: Antioxidants, Ultraviolet stabilizers, Colourants, Antistatic agents and Curing agents.	By the end of semester, student will understand the concept of polymerization, learn basic term involved, classifications and molecular weight determination of polymers and some applications.	By the end of semester, student will able to define various terms involved in studies of polymers solve numerical problem based on weight determination and learn the methods of preparation of special types of polymers.
Unit III	BASICS OF QUANTUM CHEMISTRY Classical mechanics: Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect.	By the end of semester, student will understand	By the end of semester, student will able to learn the

	Quantum mechanics: Introduction, Planck's theory of quantization, wave particle duality, de –Broglie's equation, Heisenberg's uncertainty principle. Progressive and standing waves- Introduction, boundary conditions, Schrodinger's time independent wave equation (No derivation expected), interpretation and properties of wave function. Quantum mechanics: State function and its significance, Concept of operators - definition, addition, subtraction and multiplication of operators, commutative and non - commutative operators, linear operator, Hamiltonian operator, Eigen function and Eigen value. RENEWABLE ENERGY RESOURCES Renewable energy resources: Introduction. Solar energy: Solar cells, Photovoltaic effect, Differences between conductors, semiconductors, insulators and its band gap, Semiconductors as solar energy converters, Silicon solar cell Hydrogen: Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.	quantum mechanics and various principles involved in it. They will understand concept of operators and state functions. By the end of semester, student will understand the concept of renewable energy and its sources like sun and hydrogen basic principles of their usage and actual usage.	Schrodinger's wave equations. Solve numerical problem on de- Broglie equation, Heisenberg's uncertainty principle and operators. By the end of semester, student will able to learn how the solar energy and hydrogen energy can be put to actuage use by using cells and its advantages.
Unit IV	NMR -NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY Principle : Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in NMR (spin -spin relaxation and spin - lattice relaxation). Instrumentation: NMR Spectrometer ELECTRON SPIN RESONANCE SPECTROSCOPY Principle: fundamental equation, g-value - dimensionless constant or electron g-factor, hyperfine splitting. Instrumentation: ESR spectrometer, ESR spectrum of hydrogen and deuterium.	By the end of semester, student will understand the concept of resonance spectroscopy, g factor for nucleus and electron spectrometer design and working, interpretation of basic spectra.	By the end of semester, student will able to learn various aspects of NMR and ESR spectroscopic techniques and interpretation of actual spectra obtained.
Paper II			
Unit I	Theories of the metal-ligand bond (I) Limitations of Valence Bond Theory. Crystal Field Theory and effect of crystal field on central metal valence orbitals in various geometries from linear to octahedral(from coordination number 2 to coordination number 6) Splitting of d orbitals in octahedral, square	The student will able to understand Valence bond theory and crystal field theory of metal –ligand bond.	Student will able to learn limitations of valence bond theory, crystal field theory, crystal field splitting in octahedral and tetrahedral

	planar and tetrahedral crystal fields. Distortions from the octahedral geometry: (i) effect of ligand field and (ii) Jahn-Teller distortions. Crystal field splitting parameters Δ; its calculation and factors affecting it in octahedral complexes, Spectrochemical series. Crystal field stabilization energy (CFSE), calculation of CFSE for octahedral complexes with d0 to d10 metal ion configurations. Consequences of crystal field splitting on various properties such as ionic radii, hydration energy and enthalpies of formation of metal complexes of the first transition series. Limitations of CFT: Evidences for covalence in metal complexes (i) intensities of d-d transitions, (ii) ESR spectrum of [IrCl6]2- (iii) Nephelauxetic effect.		complex, crystal field stabilization energies (CFSE) for low and high spin complexes, experimental evidences for covalence in metal complexes.
Unit II	.Theories of the metal-ligand bond (II) Molecular orbital Theory for coordination compounds. Identification of the central metal orbitals and their symmetry suitable for formation of σ bonds with ligand orbitals. Construction of ligand group orbitals. Construction of σ-molecular orbitals for an ML_6 complex. Effect of π-bonding on complexes. Examples like $[FeF_6]$-4, $[Fe(CN)_6]^{-4}$, $[FeF_6]^{-3}$, $[Fe(CN)_6]^{-3}$, $[CoF_6]^{-3}$, $[Co(NH_3)_6]^{+}$ Stability of Metal-Complexes Thermodynamic and kinetic perspectives of metal complexes with examples. Stability constants: stepwise and overall stability constants and their interrelationship. Factors affecting thermodynamic stability. Reactivity of metal complexes. Comparison between Inorganic and organic reactions. Types of reactions in metal complexes. Inert and labile complexes: correlation between electronic configurations and lability of complexes. Ligand substitution reactions: Associative and Dissociative mechanisms. Acid hydrolysis, base hydrolysis and anation reactions. Electronic Spectra. 2.4.1Origin of electronic spectra 2.4.2 Types of electronic transitions in coordination compounds: intra- ligand, Charge transfer and	The student will able to understand Molecular orbital theory for co-ordination compounds, stability of metal complexes and reactivity of metal complexes of electronic spectra of complexes.	Student will able to construct molecular orbital diagram for low and high spin octahedral complexes, able to understand thermodynamic and kinetic stability of complexes and factor affecting them, types of reactions in metal complexes. Mechanism for ligand substitution reaction types of electronic transitions, selection rule.LS coupling.

	intra-metal transitions. Selection rules for electronic transitions. Electronic configuration and electronic micro states, Terms and Term symbols for transition metal ions, rules for determination of ground state term. Determination of Terms for p^2 and d^1 electronic configurations.		
Unit III	Organometallic Compounds of main group metal General characteristics of various types of organometallic compounds, viz.ionic, σ-bonded and electron deficient compounds. General synthetic methods of organometallic compounds: (i) Oxidative-addition, (ii)Metal-metal exchange(transmetallation), (iii) Carbanion-halide exchange, (iv) Metal-hydrogen exchange(metallation) and (v) Methyleneinsertion reactions. Some chemical reactions of organometallic compounds: (i) Reactions with oxygen and halogens, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents, (iv) Redistribution reactions and (v) Complex formation reactions. Metallocenes Introduction, Ferrocene: Synthesis, properties, structure and bonding on the basis of VBT. Catalysis Comparison between homogeneous and heterogeneous catalysis Basic steps involved in homogeneous catalysis Mechanism of Wilkinson's catalyst in hydrogenation of alkenes.	The student will able to understand Organometallic compounds of main group elements, metallocenes, and catalysis.	Student will able to learn types, general characteristics of organometallic compounds, example of metallocenes synthesis ,properties of application of ferrocene types of catalysis , basic step involved in homogenous catalysis, hydrogenation of alkenes using wilkinson's catalyst.
Unit IV	SOME SELECTED TOPICS Metallurgy Types of metallurgies, General steps of metallurgy; Concentration of ore, calcinations, roasting,reduction and refining. Metallurgy of copper: occurrence, physicochemical principles, Extraction of copper from pyrites& refining by electrolysis. Chemistry of Group 18 Historical perspectives General characteristics and trends in physical and chemical properties Isolation of noble gases Compounds of Xenon (oxides and fluorides) with respect to preparation and structure (VSEPR)	The student will able to understand metallurgy, chemistry of group 18, introduction to bioinorganic chemistry.	Student will able to understand types of metallurgies, general step of metallurgy, metallurgy of copper, physicochemical principles involved in roasting , smelting and bessemerisation. They should also learn discovery, occurrence and

	Uses of noble gases Introduction to Bioinorganic Chemistry. Essential and non-essential elements in biological systems. Biological importance of metal ions such as Na^{+},K^{+},Fe^{+2}/Fe^{+3} and Cu^{+2}(Role of Na^{+} and K^{+} w.r.t ion pump)		isolation of inert gases, electronic configuration, trends in properties and recent chemistry of noble gases and chemistry of noble gases. Essential and non-essential elements, role of metal ions in biological system.
Paper III			
Unit I	Stereochemistry II Stereoselectivity and stereospecificity: Idea of enantioselectivity and diastereoselectivity Topicity: enantiotopic and diasterotopic atoms, groups and faces. Stereochemistry of – i) Substitution reactions: SNi (reaction of alcohol with thionyl chloride) ii) Elimination reactions: E2–Base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane. iii) Addition reactions to olefins: a) bromination (electrophilic anti addition) b) syn hydroxylation with OsO_4 and $KMnO_4$ c) epoxidation followed by hydrolysis. Amino acids & Proteins α-Amino acids: General Structure, configuration, and classification based on structure and nutrition. Properties: pH dependency of ionic structure, isoelectric point and zwitter ion. Methods of preparations: Strecker synthesis, Gabriel phthalamide synthesis. Polypeptides and Proteins: nature of peptide bond. Nomenclature and representation of polypeptides (di-and tri-peptides) with examples Merrifield solid phase polypeptide synthesis. Protiens: general idea of primary, secondary, tertiary & quaternary structure	The learner will be imparted with the knowledge of 1. Selectivity and topicity. 2. Stereochemistry of different reactions. 3. Basics of amino acids and proteins. 4. Synthesis of α-amino acids. 5. Synthesis of proteins and their structures.	The students will be able to 1. Differentiate the different types of selectivities. 2. Comment on the type of topicity. 3. Understand features of amino acids and proteins. 4. Write and synthesize α-amino acids. 5. Write and synthesize proteins by different methods. 6. Understand different structures of proteins.
Unit II	Molecular Rearrangements Mechanism of the following rearrangements with examples and stereochemistry wherever applicable. Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement.	The learner will be imparted with the knowledge of 1. Mechanism of selected	The students will be able to 1. Understand and represent the mechanisms of

	Migration to the electron deficient nitrogen: Beckmann rearrangement. Migration involving a carbanion: Favorski rearrangement. Name reactions: Michael addition, Wittig reaction. Carbohydrates Introduction: classification, reducing and non-reducing sugars, DL notation Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides) and Haworth formula (furanose and pyranose forms of pentoses and hexoses) Interconversion: open chain and Haworth forms of monosaccharides with 5 and 6 carbons. Chair conformation with stereochemistry of D-glucose, Stability of chair form of D-glucose Stereoisomers of D-glucose: enantiomer, diastereomers, anomers, epimers. Mutarotation in D-glucose with mechanism Chain lengthening & shortening reactions: Modified Kiliani-Fischer synthesis (D-arabinose to D-glucose and D-mannose), Wohl method (D-glucose to D-arabinose) Reactions of D-glucose and D-fructose: (a) Osazone formation (b) reduction: Hi/Ni, $NaBH_4$ (c) oxidation: bromine water, HNO_3, HIO_4 (d) acetylation (e) methylation:(d) and (e) with cyclic pyranose forms Glycosides: general structure	rearrangement reactions. 2. Fundamentals of Carbohydrates. 3. Types of sugar. 4. Different notations. 5. Different structural representations of sugars. 6. Interconversion and altering of chain length in sugars. 7. Selected reactions of sugars.	rearrangement reactions. 2. Understand properties of carbohydrates. 3. Differentiate the types of sugars. 4. Use different notations used in carbohydrates. 5. Represent sugars by different structural representations. 6. Interconvert the one form of sugar to another and use reactions to modify the carbon atom numbers. 7. Write and explain various reactions of sugars.
Unit III	Spectroscopy II IR Spectroscopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region. PMR Spectroscopy: Basic theory of PMR, nature of PMR spectrum, chemical shift (□ unit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) anisotropic effect (with reference to C=C, C≡C, C=O and benzene ring). Spin- spin coupling and coupling constant. Application of deuterium exchange technique. Application of PMR in structure determination. Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to IR and PMR: (1) alkanes (2) alkenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) amines (broad regions characteristic of different groups are expected). Problems of structure elucidation of simple organic compounds using individual or combined use of UV-Vis, IR, Mass and NMR	The learner will be imparted with the knowledge of 1. Basics of IR spectroscopy. 2. Importance of selection rule and fingerprint region. 3. Basics of PMR spectroscopy. 4. Chemical shift. 5. PMR spectroscopy of different class of molecules. 6. Solving problems on spectroscopy involving UV Mass PMR and IR spectroscopy.	The students will be able to 1. Understand the basics of IR and PMR spectroscopy. 2. Understand the need of selection rule and fingerprint region. 3. Realize the importance of Chemical shift. 4. Represent the PMR spectroscopy of various class of molecules. 5. Solve problems based on spectroscopy and use in structure elucidation of unknown molecules.

	spectroscopic technique are expected. (Index of hydrogen deficiency should be the first step in solving the problems). Nucleic Acids: Controlled hydrolysis of nucleic acids. Sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acids (DNA and RNA) including base pairing.		
Unit IV	Polymer: Introduction: terms monomer, polymer, homopolymer, copolymer, thermo plastics and thermosets. Addition polymers: polyethylene, polypropylene, teflon, polystyrene, PVC, Uses. Condensation polymers: polyesters, polyamides, polyurethanes, polycarbonates, phenol formaldehyde resins.Uses Stereochemistry of polymers: Tacticity, mechanism of stereochemical control of polymerization using Ziegler Natta catalysts. Natural and synthetic rubbers: Polymerisation of isoprene: 1,2 and 1,4 addition (cis and trans), Styrene butadiene copolymer. Additives to polymers: Plasticisers, stabilizers and fillers. Biodegradable polymers: Classification and uses. polylactic acid structure, properties and use for packaging and medical purposes. (Note : Identification of monomer in a given polymer & structure of polymer for a given monomer is expected. condition for polymerization is not expected) Catalysts and Reagents: Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism). Catalysts: Catalysts for hydrogenation: a. Raney Nickel b. Pt and PtO2 (C=C, CN, NO2, aromatic ring) c. Pd/C : C=C, COCl→CHO (Rosenmund) d. Lindlar catalyst: alkynes Reagents: a. $LiAlH_4$ (reduction of CO, COOR, CN,NO_2) b. $NaBH_4$ (reduction of CO) c. SeO_2 (Oxidation of CH_2 alpha to CO) d. mCPBA (epoxidation of C=C) e. NBS (allylic and benzylic bromination)	The learner will be imparted with the knowledge of 1. Polymers and types of polymers. 2. Addition polymers. 3. Condensation polymers. 4. Ziegler Natta catalysts. 5. Additives to polymers. 6. Biodegradable polymers. 7. Different catalysts. 8. Reducing agents and oxidizing agents. Their uses.	The students will be able to 1. Understand basics of polymers and different types. 2. Distinguish between addition and condensation polymers. 3. Use of Ziegler Natta catalysts. 4. Use different additives to polymers and their significance. 5. Understand the significance and use of biodegradable polymers. 6. Use of different catalysts. 7. Understand the use of reducing and oxidizing agents in reactions.
Paper IV			

Unit I	ELECTRO ANALYTICAL TECHNIQUES Polarography (Numerical and word problems are expected) Difference between potentiometry and voltammetry, Polarizable and non-polarizable electrodes. Basic principle of polarography H shaped polarographic cell, DME (construction, working, advantages and limitations) DC polarogram: Terms involved - Residual current, Diffusion current, Limiting current, Half-Wave Potential Role and selection of supporting electrolyte, Interference of oxygen and its removal, polarographic Maxima and Maxima Suppressors Qualitative aspects of Polarography: Half wave potential E1/2, Factors affecting E1/2 Quantitative aspects of polarography: Ilkovic equations: various terms involved in it (No derivation) Quantification 1) Wave height – Concentration plots (working plots/calibration) 2) Internal standard (pilot ion) method 3) Standard addition method. Applications advantages and limitations. Amperometric Titrations. Principle, Rotating Platinum Electrode(Construction, advantages and limitations) Titration curves with example. Advantages and limitations.	The student will be imparted with the knowledge of 1. Polarography, Polarizable electrodes, basic principles and terms involved in Polarography. 2. The role of supporting electrolytes, maxima suppressor. They will learn quantitative aspects of Polarography and its applications. 3. Amperometric titrations. 4. Construction and uses of rotating platinum electrode and comparison with DME, advantages, limitations and applications of amperometric titrations.	The students will be able to 1. Draw Polarograms and show various distinctive parts of it. 2. Express Ilkovic equation and its uses. 3. Use quantitative methods for analysis. 4. Understand the nuance of Amperometric titrations. 4. Draw various curves with specific examples.
Unit II	METHODS SEPARATION II Gas Chromatography (Numerical and word problems are expected) Introduction, Principle, Theory and terms involved Instrumentation: Block diagram and components, types of columns, stationary phases in GSC and GLC, Detectors: TCD, FID, ECD. Qualitative, Quantitative analysis and applications. Comparison between GSC and GLC. Ion Exchange Chromatography: Introduction, Principle. Types of Ion Exchangers , Ideal properties of resin Ion Exchange equilibria and mechanism, selectivity coefficient and separation factor Factors affecting separation of ions. Ion exchange capacity and its determination for cation and anion exchangers.	The student will be imparted with the knowledge of 1. Gas chromatography basic principles, theory and instrumentation. 2. Block diagram of a GC and its different components. 3. Qualitative and quantitative analysis. 4. Ion exchange chromatography, 5. Properties of resin, 6. Types of	The students will be able to 1. Draw diagrams of various components of GC. 2. Distinguish between GSC and GLC. 3. Understand the mechanism of ion exchange. 4. Selectivity enhancement of capacity of resin.

	Applications of Ion Exchange Chromatography with reference to Preparation of demineralised water, Separation of amino acids	exchangers. 7. Factors affecting separation. 8. Specific applications of ion exchange.	
Unit III	FOOD AND COSMETICS ANALYSIS Introduction to food chemistry Food processing and preservation: Introduction, need, chemical methods, action of chemicals (sulphur dioxide, boric acid, sodium benzoate, acetic acid, sodium chloride and sugar) and pH control Physical methods (Pasteurization and Irradiation) Determination of boric acid by titrimetry and sodium benzoate by HPLC. Study and analysis of food products and detection of adulterants 1) Milk: Composition & nutrients, types of milk (fat free, organic and lactose milk) Analysis of milk for lactose by Lane Eynon's Method 2) Honey: Composition, Analysis of reducing sugars in honey by Coles Ferricyanide method 3) Tea: Composition, types (green tea and mixed tea) Analysis of Tannin by Lowenthal's method 4) Coffee: Constituents and composition, Role of Chicory. Analysis of caffeine by Bailey Andrew method. Cosmetics: Introduction and sensory properties. Study of cosmetic products – 1) Face powder: Composition. Estimation of calcium and magnesium by complexometric titration 2) Lipstick: Constituents. Ash analysis for water soluble salts: borates, carbonates and zinc oxide 3) Deodorants and Antiperspirants: Constituents, properties. Estimation of zinc by gravimetry	The student will be imparted with the knowledge of 1. Food processing and preservation. 2. Action of various chemicals in food preservation 3. Physical methods of preservation. 4. Detection of adulteration in different foods and estimation of some constituents. 5. Use of sensory properties and estimation of specific constituents of cosmetics.	The students will be able to 1. Use various methods of food preservation. Determine specific constituents. 2. Distinguish various type of foods. 3. Use specific methods in analysis of some foods. 4. Study the composition of cosmetics. 5. Use of analytical methods for estimation of certain components.
Unit IV	THERMAL METHODS AND ANALYTICAL METHODS VALIADTION Thermal Methods: Introduction to various thermal methods (TGA, DTA and Thermometric titration) Thermogravimetric Analysis (TA) Instrumentation-block diagram, thermobalance (Basic components: balance, furnace,	The student will be imparted with the knowledge of 1. Various thermal methods like TGA DTA, thermometric titrations.	The students will be able to 1. Draw basic block diagrams of the instruments. 2. Draw Thermograms and DTA curves.

	temperature measurement and control, recorder) Thermogram (TG curve) for $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$ Factors affecting thermogram-Instrumental factors and Sample characteristics Applications: Determination of drying and ignition temperature range Determination of percent composition of binary mixtures (Estimation of Calcium and Magnesium oxalate) Differential Thermal Analysis (TA): Principle, Instrumentation, and Reference material used Differential thermogram (DTA curve) $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$ Applications Comparison between TGA and DTA. Thermometric Titrations Principle and Instrumentation. Thermometric titrations of : 1) HCl v/s NaOH 2) Boric acid v/s NaOH 3) Mixture of Ca^{+2} and Mg^{+2} v/s EDTA 4) Zn^{+2} with Disodium Tartarate. Analytical Method Validation: Introduction and need for validation of a method Validation Parameters: Specificity, Selectivity, Precision, Linearity, Accuracy and Robustness	2. Their instrumentations. 3. Block diagrams basic components used applications of these techniques. 4. Validation of methods and parameters.	3. Draw graphs for thermometric titration curves. 4. Validate methods and parameters. 5. Decide upon the requirement for validation purpose.
Paper V			
Unit I	Drug Discovery, Design and Development Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation, Lipinski's rule of 5. Medicinal properties of compounds from Natural Sources: Antiinfective and anticancer properties of Turmeric (Curcumin) Development of drug: The Pharmacophore identification, modification of structure or functional group, Structure activity relationship (Sulphonamides). Structure modification to increase potency: Homologation, Chain branching and Extension of the structure. Computer assisted drug design. Drug Metabolism: Introduction, Absorption, Distribution, Biotransformation, Excretion Different types of chemical transformation of drugs with specific examples. Chemotherapeutic Agents: Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable.	The learner will be imparted with the knowledge of 1. Drug discovery, lead compound. 2. Designing and development of new drugs. 3. CADD 4. Drug metabolism. 5. Chemotherapeutic agents, their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable. Antibiotics and antivirals.	The students will be able to 1. Understand the intricacies of drug discovery. He will know the process of selection of a Lead compound. 2. Design and develop new drugs. 3. Understand and use CADD methods to develop new drugs. 4. Various drug metabolism that take place in the body and hence the precautionary measures. 5. Understand the chemical structure, chemical class, therapeutic uses, side

	Antibiotics and antivirals: Definition, Amoxicillin (β - lactum antibiotics); Cefpodoxime (Cephalosporins); Doxycycline (Tetracyclines); Levofloxacin (Quinolones) (Synthesis from 2,3,4 – Trifluro -1-nitrobenzene); Aciclovir/Acyclovir (Purines). Antimalarials: Types of malaria; Symptoms; Pathological detection during window period (Life cycle of the parasites not to be discussed); Chloroquine (3-Amino quinolones); Artemether (Benzodioxepins). Following combination to be discussed: Atremether-Lumefantrine (no structure). Anthelmintics and AntiFungal agents: Drugs effective in the treatment of Nematodes and Cestodes infestations. Diethyl carbamazine (Piperazines); Albendazole (Benzimidazoles) (Synthesis from 2- Nitroaniline); Clotrimazole (Imidazole); Fluconazole (Triazole) (Synthesis from 1- Bromo – 2,4- difluorobenzene).	Antimalarials. Anthelmintics and antifungals.	effects and introduction to MDR wherever applicable. Antibiotics and antivirals. Antimalarials. Anthelmintics and antifungals.
Unit II	Antiamoebic Drugs: Types of Amoebiasis; Metronidazole, Ornidazole, Tinidazole (Imidazole) Synthesis of Metronidazole from glyoxal by Debus-Radziszewski imidazole synthesis route. Following combination therapy to be discussed: CiprofloxacinTinidazole. Antitubercular and Antileprotic Drugs: Types of Tuberculosis; Symptoms and diagnosis of Tuberculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. PAS (Amino salicylates); Isoniazide (Hydrazides); Pyrazinamide (Pyrazines); (+) Ethambutol (Aliphatic diamines) (Synthesis from 1- Nitropropane); Dapsone(Sulphonamides) (Synthesis from 4-Chloronitrobenzene); Clofazimine (Phenazines); Bedaquiline (Quinoline). Following combination therapy to be discussed: (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide Anti-Neoplastic Drugs: Idea of malignancy; Causes of cancer. Brief idea of Immuno Stimulants &Immuno depressants. Lomoustine (Nitrosoureas); Anastrozole(Triazoles) (Synthesis from 3,5-bis (bromo methyl) toluene); Cisplatin (Chloro Platinum);; Vincristine, Vinblastine, Vindesine) (Vinca alkaloids) (structure not expected) Anti-HIV Drugs:	The learner will be imparted with the knowledge of Chemotherapeutic agents, their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable. Antiamoebic Drugs. Antitubercular and Antileprotic Drugs. Anti-Neoplastic Drugs. Anti-HIV Drugs. 2. Drug Intermediates. 3. Introduction to Nano particles in Medicinal Chemistry	The students will be able to understand and use the information of Chemotherapeutic agents, their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable. Antiamoebic Drugs. Antitubercular and Antileprotic Drugs. Anti-Neoplastic Drugs. Anti-HIV Drugs. 2. Various drug intermediates and their uses in reactions as well as in synthesis. 3. Understand the concept of nano chemistry and use of it in medicine like drug delivery, drug loading etc.

	Idea of HIV pathogenicity, Symptoms of AIDS. AZT/Zidovudine, Lamivudine, DDI (Purines) Drug Intermediates: Synthesis and uses 1. 2,3,6-Triamino-6- hydroxypyrimidine from Guanidine 2. p-[2'-(5-Chloro-2-methoxy benzamido) ethyl]- benzenesulphonamide from Methyl-5-chloro-2- methoxybenzene 3. 3-(p-Chlorophenyl)-3- hydroxypiperidine from 3- Chloroacetophenone 4. p-Acetyl amino benzenesulphonyl chloride from Aniline 5. Epichlorohydrine from propene Nano particles in Medicinal Chemistry: Introduction; Carbon nano particles (structures) and Carbon nano tubes: Functionalization for Pharmaceutical applications; Targeted drug delivery; In vaccine (Foot and mouth disease); Use in Bio-physical treatment. Gold nano particles in treatment of: Cancer; Parkinsonism; Alzheimer. Silver nano particles: Antimicrobial activity. Drugs and Environmental Aspects: Impact of Pharma-industry on environment, International regulation for human experimentation with reference to: "The Nuremberg Code" and "The Helsinki Declaration".		
Unit III	Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes (Synthesis of the dyes marked with * is expected) i)Nitro Dye: Naphthol Yellow S ii) Nitroso Dye: Gambine Y iii)Azo dyes: a) Monoazo dyes: Orange IV *(from sulphanilic acid) & Eriochrome Black T* (from β- naphthol) b) Bisazo dyes: Congo Red* (from nitrobenzene) c) Trisazo Dye: Direct Deep Black EW* (from benzidine) iv)Diphenylmethane dye: Auramine O* (from N,N-dimethyl aniline) v)Triphenylmethane dye: a) Diamine series: Malachite Green* (from benzaldehyde) b) Triamine series: Acid Magenta c) Phenol series: Rosolic acid vi)Heterocyclic Dyes: a) Thiazine dyes: Methylene Blue b) Azine dyes: Safranin T* (from o-toluidine) c) Xanthene Dyes: Eosin* (from phthalic anhydride) d) Oxazine Dyes: Capri Blue e) Acridine Dyes: Acriflavine vii)Quinone Dyes: a) Naphthaquinone:	The learner will be imparted with the knowledge of 1. Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes. 2. Dyes and their Remediation Processes.	The students will be able to 1. Classify different dyes based on Chemical Constitution. 2. Write reactions for synthesis of selected dyes and use the knowledge in manufacturing. 3. Understand the various Remediation Processes in relation to dyes.

	Naphthazarin b) Anthraquinone Dyes: Indanthrene Blue* (from anthraquinone). viii) Indigoid Dyes: Indigo* (from aniline + monochloroacetic acid) ix) Phthalocyanine Dyes: Monastral Fast Blue B. Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes. Impact of the textile and leather dye Industry on the environment with special emphasis on water pollution. Health Hazards: Toxicity of dyes w.r.t food colours. Effluent Treatment Strategies: Brief introduction to effluent treatment plants (ETP) Primary Remediation processes: (Physical Processes) Sedimentation, Aeration, Sorption (activated charcoal, fly ashetc.) Secondary Remediation processes: Biological Remediation – Biosorption, bioremediation and biodegradation Chemical Remediation: Oxidation Processes (chlorination), Coagulation-flocculation-Precipitation		
Unit IV	Non-textile uses of dyes: Biomedical uses of dyes i) Dyes used in formulations (Tablets, capsules, syrups etc) Indigo carmine, Sunset yellow, Tartrazine. ii) Biological staining agents Methylene blue, Crystal violet and Safranine T. iii) DNA markers Bromophenol blue, Orange G, Cresol red. iv) Dyes as therapeutics Mercurochrome, Acriflavine, Crystal Violet, Prontosil. Dyes used in food and cosmetics: i) Properties of dyes used in food and cosmetics ii) Introduction to FDA and FSSAI iii) Commonly used food colours and their limits Paper and leather dyes: i) Structural features of paper and leather ii) Dyes applicable to paper and leather Miscellaneous dyes: i) Hair dyes ii) Laser dyes iii) Indicators iv) Security inks iv) Coloured smokes and camouflage colours Pigments: Definition of pigments, examples, properties of pigments, difference between dyes and pigments. Definition of Lakes and Toners. Dyestuff Industry - Indian Perspective: Growth and development of the Indian Dyestuff Industry. Strengths, Weaknesses, Opportunities and	The learner will be imparted with the knowledge of 1. Use of different dyes on different substrates. 2. Process of application of dyes. 3. Dye industry in India.	The students will be able to 1. Use dyes on different substrates according to their properties. 2. Understand the process of application of dyes on to the surfaces. 3. Focus on the future of Dye Industry in India and improvisation.

	Challenges of the Dyestuff industry in India. Make in India - Future Prospects of the Dye Industry.		