# Bankim Sardar College
A College with Potential for Excellence

## Department of Chemistry
### Programme Specific Outcome (PSO) - Course Outcome (CO)

**Programme Specific Outcome (PSO)** –

**PSO 1.** The ability to explain theoretical knowledge of basic Principles, Strategies, Logic relating to Bond formation and Bond cleavage, three dimensional structures of compounds and other facts.

**PSO 2.** The ability to demonstrate practical knowledge of qualitative and quantitative analysis of various organic samples and solutions respectively.

| Sem. | Core Courses | Content of CU Syllabus | Course Outcome |
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| 1ST | CC1/ GE 1 | **Kinetic Theory of Gases and Real gases**<br>Concept of pressure and temperature; Collision of gas molecules; Collision number and mean free path. Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy Deviation of real gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states.<br>**Liquids**<br>Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)<br>**Chemical Kinetics**<br>Introduction of rate law, Order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by half-life and differential method. Temperature dependence of rate constant; Arrhenius equation, energy of activation; | Students will be able<br>*CO 01.* To understand kinetic theory of gases.<br>*CO 02.* To get an introduction to the basic concepts of pressure, temperature and velocity of ideal gases.<br>*CO 03.* To explain the key concepts of degree of freedom, equipartition of energy and specific heat.<br>*CO 04.* To get a concept of collision among molecules and with the wall.<br>*CO 05.* To understand deviation of real gas from ideal behavior.<br>*CO 06.* To understand critical constant and vanderwall's constant.<br>*CO 07.* To be able to derive rate equations from mechanistic data.<br>*CO 08.* To make use of simple models for predictive understanding of physical phenomena associated to kinetics.<br>*CO 09.* To study the dependence of the rate of chemical reactions on properties like pressure, temperature, presence of catalyst. |
| | | **Atomic Structure**<br>Bohr's theory for hydrogen atom and Bohr's model. Sommerfeld'smodel. Quantum numbers and their significance. Pauli's exclusion principle. Hund"s rule. Electronic configuration of many electron atoms. Aufbau principle and its limitation<br>**Chemical Periodicity**<br>Classification of elements on the basis of electronic configuration ; General characteristics of s- ,p- ,d- and f-block elements .Position of Hydrogen and noble gases. Atomic and ionic radii, ioni zation potential. Electron affinity and electronegativity. Periodic and groupwise variation of above properties in respect of s- and p- block | *CO 10.* To explain various theories and models relating to structure of atoms and their merits and demerits<br>*CO 11.* To explain varoius electrochemical properties of elements in the periodic table vis-à-vis electronic configuration.<br>*CO 12.* To discuss various theories pertaining to definition and classification of acids and bases |

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| | | elements'<br>**Acids and Bases**<br>Bronsted - Lowry concept, conjugate acids and bases. Relative strengths of acids and bases. Lewis acid – base concept, Lux Flood concept and solvent system concept. Hard and soft cids and bases. | |
| | | **Fundamentals of Organic Chemistry**<br>***Electronic displacements*:** inductive effect, resonance and hyperconjugation; nucleophiles and electrophiles; reactive intermediates: carbocations, carbanions and free radicals.<br>**Stereochemistry**<br>Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (upto two carbon atoms); asymmetric carbon atom; interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, meso compounds; threo and erythro, D and L, cis and trans nomenclature; CIP Rules: R/S (only one chiral carbon atoms) and E/Z nomenclature.<br>**Nucleophilic Substitution and Elimination Reactions**<br>Nucleophilic substitutions: SN1 and SN2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations. | *CO 13.* Various permanent Electronic Effects i.e., inductive effect, resonance and hyperconjugation etc with some examples<br>*CO 14.* Definitions of Nucleophiles and Electrophiles with suitable examples<br>*CO 15.* Reactive intermediates: carbocations, carbanions and free radicals.<br>*CO 16.* Students will gather knowledge about the three dimensional structure of any Sp3 hybridised chiral organic compound by explaining<br>*CO 17.* Classification of Isomerism, Projection Formulae, Representation and Interconversion of a three dimensional structure in Fischer and Newman projection, Chirality and asymmetry, Dextrorotatory and laevorotatory isomers<br>*CO 18.* Concept of chirality and optical activity, optical isomers e.g., Enantiomer and Diastereoisomer<br>*CO 19.* Definition and rules of writing Relative (D-L)and absolute (R-S)Configuration and also their Assignments, Examples of threo/erythro, cis/trans, E/Z<br>*CO 20.* Concept of meso compounds<br>*CO 21.* After studying this topic students will gain the knowledge of two unique types of reactions i.e., substitution and eliminations by learning the followings Concept, Types and elimentary mechanisms of elimination reactions.( E1 and E2)<br>*CO 22.* Orientation(Saytzeff/Hofmann rules |
| | | **Practical**<br>Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.<br>Estimation of oxalic acid by titrating it with KMnO4. | *CO 23.* By carrying out different types of estimations students will have an idea of quantitative experiments<br>*CO 24.* They also become capable of |

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| | | Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.<br>Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.<br>Estimation of Cu (II) ions iodometrically using $Na_2S_2O3$.<br>Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution | handling burette and pipette |
| | CC2/GE2 | **Chemical Thermodynamics:**<br>Intensive and extensive variables; state and path unctions; isolated,closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy and statement of first law; enthalpy, H; relation between heat capacities, calculations of q, w, ΔU and ΔH for reversible, irreversible and free expansion of gases. Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry, Kirchhoff's equations. Statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of Entropy; Entropy change of systems and surroundings for various processes and transformations; Auxiliary state functions (G and A) and Criteria for spontaneity and equilibrium.<br>**Chemical Equilibrium:**<br>Thermodynamic conditions for equilibrium, degree of advancement;Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Definitions of KP, KC and KX and relation among them; van't Hoff's reaction isotherm, isobar and isochore from different standard states; Shifting of equilibrium due to change in external parameters e.g. temperature and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle.<br>**Solutions**<br>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 Nernst distribution law and its applications, solvent extraction.<br>**Phase Equilibria**<br>Phases, components and degrees of freedom of a system, criteria of phase equilibrium; Gibbs Phase Rule; Derivation of Clausius – Clapeyron equation and its importance in phase equilibria; Phase diagrams of one-component systems (water and CO2).<br>**Solids**<br>Forms of solids, crystal systems, unit cells, Bravais lattice types, Symmetry elements; Laws of Crystallography- Law of constancy of interfacial angles, Law of rational indices; Miller indices of different planes and interplanar distance, Bragg's law; | *CO 01.* To understand the principle of conservation of energy and how this principle can be used to assess the energy changes that accompany physical and chemical processes.<br>*CO 02.* To examine the means by which a system can exchange energy with its surroundings in terms of the work it may do or the heat it may produce.<br>*CO 03.* To understand the thermodynamic description of mixtures state function, exact, inexact differential<br>*CO 04.* To understand the statements of 1st and 2nd laws of thermodynamics.<br>*CO 05.* To learn the thermodynamic aspects of various processes and reactions.<br>*CO 06.* To understand the concept of thermochemistry enthalpy change of different processes<br>*CO 07.* To get the concept of Entropy (S) from Carnot cycle and the significance of Helmholtz free energy(A) & Gibb's free energy (G)<br>*CO 08.* To explain the criteria of spontaneity in terms of S,H and G.<br>*CO 09.* To be able to derive important thermodynamic relations<br>*CO 10.* To learn the basic concept of equilibrium<br>*CO 11.* To understand Raoult's law<br>*CO 12.* To compare Henry's law and Raoult's law to explain ideal solutions<br>*CO 13.* To describe ideal liquid mixtures.<br>*CO 14.* To explain non-ideal liquid-vapour systems.<br>*CO 15.* To state and explain azeotropic mixtures.<br>*CO 16.* To explain partially miscible and immiscibele liquid systems by taking appropriate examples.<br>*CO 17.* To describe how a solute |

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| **2ND** | | | distribute itself in two immiscible liquids,<br>*CO 18.* To state and explain Nernst's distribution law,<br>*CO 19.* To apply and derive an expression for modified Nernst distribution law for a special case in which solute associate or dissociate in one of the solvent ,<br>*CO 20.* To classify systems as heterogeneous and homogeneous systems<br>*CO 21.* To define equilibrium and metastable equilibrium<br>*CO 22.* To appreciate the importance of phase rule equation in dealing with heterogeneous |
| | | **Aliphatic Hydrocarbons**<br>Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures. Alkanes: (up to 5 Carbons). Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis. Alkenes: (up to 5 Carbons). Preparation: elimination reactions: dehydration of alcohols and dehydrohalogenation of alkyl halides; cis alkenes (partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: addition of bromine, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration, ozonolysis. Alkynes: (up to 5 Carbons). Preparation: acetylene from CaC2; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides. Reactions: formation of metal acetylides, hydration reaction. | *CO 23.* General Preparation of different alkanes, alkenes and alkynes with mechanism<br>*CO 24.* Some important Chemical reactions of alkanes, alkenes and alkynes with mechanism<br>*CO 25.* Addition of an unsymmetrical addendum to an unsymmetrical substrate by applying Markonikoff's rule<br>*CO 26.* Acidity of protons of acetylene |
| | | **Redox Reactions**<br>Ion – electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials<br>With signm conventions. Nernst equation. Influence of complex formation, precipitation change ofpH on redox potentials. Formal potential. Feasibility of redox titration , redox potential at the equivalence point<br>**Error Analysis and Computer Applications**<br>Error analysis: accuracy and precision of quantitative analysis, determinate,indeterminate, systematic and random errors; methods of least squares and standard deviations. Computer applications: general introduction to computers, different components of a computer; hardware and software; input and output devices; binary numbers and arithmetic; Introduction to computer languages. | *CO 27.* To explain the concept of redox reactions on th basis of redox potentials.<br>*CO 28.* to discuss the feasibility of redox titration, redox indicators, redox potential at the equivalence point<br>*CO 29.* To explain the concept of redox reactions on th basis of redox potentials.<br>*CO 30.* To discuss the feasibility of redox titration, redox indicators, redox potential at the equivalence point |
| | | **Chemical Bonding and Molecular Structure**<br>Ionic Bonding-- General characteristics of ionic bonding. Lattice energy and salvation energy. Born –Lande equation. | *CO 31.* To discuss about the structure of ionic compounds and Their |

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| | CC3/GE3 | Born-Haber cycle. . Fajan's rule. dipole moment<br>Covalent Bonding – VSEPR Theory, Hybridisation. Structure of molecules, MO treatment of homo nuclear and heteronuclear molecule.<br>**Comparative study of p-block elements**<br>Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect and their important compounds.<br>**Transition elements (3d series)**<br>Electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complex etc. for Mn, Fe, Cu.<br>Electronic configuration, oxidation states, colour, magnetic properties relating to Lanthanides and Actinides.<br>**Coordination Chemistry**<br>Werner's co ordination theory ,Valence Bond theory<br>Inner and Outer orbital complexes of Cr, Fe, Co, Ni, Cu. Drawback of VBT , IUPAC system of nomenclature | important properties.<br>*CO 32.* Able to calculate the theoretical values of lattice energy and also experimental value.<br>*CO 33.* To discuss about covalent molecules, VSEPR theory. MO treatment of homonuclear and hetero nuclear molecules.<br>*CO 34.* To explain the concept ofelectronic configuration of p block elements,their common oxidation states , inert pair effect,about their important compounds.<br>*CO 35.* CO-1.To explain their knowledge relating electronic configuration,colour, magnetic properties, different oxidation states catalytic properties for Mn, Fe, Cu<br>*CO 36.* To discuss Werner's coordination theory, valence bond theory, drawback of VBT, complexities in orbitals of some selected elements etc. |
| **3RD** | | **ELECTROCHEMISTRY**<br>**1) Ionic Equilibria**<br>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; Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts; Buffer solutions; Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.<br>**2) Conductance**<br>Conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Ostwald's dilution law; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations (acid-base) Transport Number and principles Moving-boundary method.<br>**3) Electromotive force**<br>Faraday's laws of electrolysis, rules of oxidation/ reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry; Chemical cells, reversible and irreversible cells with examples; Electromotive force of a cell and its measurement, Nernst equation; Standard electrode | *CO 01.* To develop an understanding of electrochemistry and the methods used to study the response of an electrolyte through current of potential<br>*CO 02.* To understand why standard reduction potentials are used and how they are determined.<br>*CO 03.* To understand the relationship between chemical energy (Gibbs free energy change for a redox reaction) and electrical energy (electromotive force or cell potential) in an electrochemical cell.<br>*CO 04.* To explain the various terms such as specific conductance, equivalent conductance and molar conductance.<br>*CO 05.* To Explain the effect of dilution on specific conductance, equivalent conductance and molar conductance<br>*CO 06.* To understand the ionic mobility of different ions,<br>*CO 07.* methods of determination of ionic mobility of ions<br>*CO 08.* To understand Kohlrausch's law and its applications<br>*CO 09.* To understand the basic concepts |

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| | | (reduction) potential; Electrochemical series; Concentration cells with and without transference, liquid junction potential; pH determinationusing hydrogen electrode and quinhydrone; Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation) | of Arrhenius theory of electrolytic dissociation, evidences in support of Arrhenius theory of electrolytic dissociation and its limitation,<br>*CO 10.* To understand Ostwald's dilution law and its application in determination of Dissociation constant of weak electrolyt |
| | | **Aromatic Hydrocarbons**<br>Benzene: Preparation: from phenol, by decarboxylation, from acetylene. Reactions: electrophilic substitution reaction (general mechanism); nitration (with mechanism), halogenations (chlorination and bromination), and Friedel-Crafts reaction (alkylation and acylation) (up to 4 carbons on benzene).<br>**Organometallic Compounds**<br>Introduction; Grignard reagents: Preparations (from alkyl and aryl halide); Reformatsky reaction.<br>**Aryl Halides**<br>Preparation: (chloro- and bromobenzene): from phenol, Sandmeyer reactionand effect of nitro substituent (activated nucleophilic substitution)<br>**Practical:**<br>Qualitative semimicro analysis of mixtures containing two radicals. Emphasis should be given to the understanding of the chemistry of different reactions.<br>Cation Radicals: $Na^{+}$,$K^{+}$, $Ca^{2+}$, $Sr^{2+}$, $Ba^{2+}$, $Al^{3+}$, $Cr^{3+}$, $Mn^{2+}/Mn^{4+}$, $Fe^{3+}$, $Co^{2+}/Co^{3+}$, $Ni^{2+}$, $Cu^{2+}$, $Zn^{2+}$, $Pb^{2+}$, $Sn^{2+}/Sn^{4+}$, $NH_4^{+}$.<br>Anion Radicals: $F^{-}$, $Cl^{-}$, $Br^{-}$, $BrO_3^{-}$, $I^{-}$, $IO_3^{-}$, $SCN^{-}$, $S^{2-}$, $SO_4^{2-}$, $NO_3^{-}$, $NO_2^{-}$, $PO_4^{3-}$, $AsO_4^{3--}$,$BO_3^{3-}$, $CrO_4^{2-}$ / $Cr_2O_7^{2-}$ | *CO 11.* The preparation of benzene<br>*CO 12.* Mechanism and Reactivity of various Aromatic Electrophilic Substitution Reactions<br>*CO 13.* The preparations and use of Grigrand reagents<br>*CO 14.* The preparation and reactions of aryl halides<br>*CO 15.* To undertake Systematic Qualitative Analysis for basic and acid radicals in the given inorganic salts<br>*CO 16.* To undertake *Semimicro analysis* for basic and acid radicals in the given salts |
| | SEC-A2 | **ANALYTICAL CLINICAL BIOCHEMISTRY**<br>**Carbohydrates:** Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.<br>Isolation and characterization of polysachharides.<br>**Proteins:** Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β-pleated sheets, Isolation, characterization, denaturation of proteins.<br>**Enzymes:** Nomenclature, Characteristics (mention of Ribozymes), and Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.<br>**Lipids:** Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.<br>**Lipoproteins:** Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones. | *CO 01.* Explain the structure carbohydrates and amino acids, their physical and chemical properties and their function in living organisms.<br>*CO 02.* Describe the function of enzyme as a catalyst in maximum biological reaction and learn about the function of enzyme, and also see how they are related to things they come across in daily life.<br>*CO 03.* Understand the effect of cholesterol and triglycerides in human body<br>*CO 04.* Know about steroid hormone which regulates carbohydrate metabolism and has an anti-inflammatory effect on the body. It helps maintain blood pressure and regulate the salt and water balance in our body. |

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| | | Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of **DNA and RNA:** Replication, Transcription and Translation, Introduction to Gene therapy.<br>**Biochemistry of disease: A diagnostic approach by blood/ urine analysis.**<br>**Blood:** Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.<br>**Urine***:* Collection and preservation of samples. Formation of urine.Composition and estimation of constituents of normal and pathological urine. | *CO 05.* understand some of the types of disease that might be treatable by gene therapy<br>*CO 06.* understand how genetics may be used in the design of drugs.<br>*CO 07.* know various biochemical tests to determine glucose, lipids, creatinine and albumin in blood. Correlate laboratory test results with common diseases or conditions<br>*CO 08.* know the pathophysiological bases of the most relevant and prevalent diseases in our population; the main biological properties that are altered in these diseases and are examined in a clinical biochemistry laboratory; |
| **4th** | CC4/GE4 | **Alcohols, Phenols and Ethers**<br>Alcohols: (up to 5 Carbons).<br>Preparation: 1°-, 2°- and 3°- alcohols: using Grignard reagent, reduction of aldehydes, ketones, carboxylic acid and esters; Reactions: With sodium, oxidation (alkaline KMnO4, acidic dichromate).<br>Diols: Pinacol- pinacolone rearrangement (with mechanism) (with symmetrical diols only). Phenols: Preparation: cumene hydroperoxide method, from diazonium salts; acidic nature of phenols; Reactions: electrophilic substitution: nitration and halogenations; Reimer -Tiemann reaction, Schotten –Baumann reaction, Fries rearrangementand Claisen rearrangement.<br>Ethers: Preparation: Williamson's ether synthesis; Reaction: cleavage of ethers with HI.<br><br>**Carbonyl Compounds**<br>Aldehydes and Ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde): Preparation: from acid chlorides, from nitriles and from Grignard reagents; general properties of aldehydes and ketones; Reactions: with HCN, NaHSO3, NH2-G derivatives and with Tollens' and Fehling's reagents; iodoform test; aldol condensation (with mechanism), Cannizzaro reaction (with mechanism), Wittig reaction, benzoin condensation; Clemmensen reduction, Wolff- Kishner reduction<br>**Carboxylic Acids and Their Derivatives**<br>Carboxylic acids (aliphatic and aromatic): strength of organic acids: comparative study with emphasis on factors affecting pK values; Preparation: acidic and alkaline hydrolysis of esters (BAc2 and AAC2 mechanisms only) and from Grignard reagents.<br>Carboxylic acid derivatives (aliphatic): (up to 5 carbons). Preparation: acid chlorides, anhydrides, esters and amides from acids; Reactions: Interconversion among acid | *CO 01.* The structural differences of Alcohols: 1°-, 2°- and 3°- alcohols, Preparation, Identification of primary, secondary and tertiary alcohols, several reactions of alcohols with mechanism<br>*CO 02.* The preparation of diols, Pinacol-pinacolone rearrangement (with mechanism) using diols<br>*CO 03.* The various methods for preparing Phenols and their important reactions<br>*CO 04.* Preparation of aromatic Ethers and their reactions<br><br>**Carbonyl Compounds**<br>*CO 05.* The students will be learnt different types of Aliphatic and aromatic Carbonyl compounds both aldehydes and ketones by<br>*CO 06.* Preparations of them by different methods both oxidative and reductive<br>*CO 07.* Several types of reactions of them with mechanism<br>*CO 08.* Reactivity differences between aldehyde and ketones<br>*CO 09.* Different Condensation reactions of carbonyl compounds having α H atoms<br>*CO 10.* Some named reactions<br><br>**Carboxylic Acids and Their Derivatives**<br>*CO 11.* The students will have a |

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| | | derivatives. Reactions: Claisen condensation; Perkin reaction.<br>**Amines and Diazonium Salts**<br>Amines (aliphatic and aromatic): strength of organic bases; Preparation: from alkyl halides, Hofmann degradation;<br>Reactions: with HNO2 ( distinction of 1°-, 2°- and 3°-amines), Schotten – Baumann reaction , Diazo coupling reaction (with mechanism).<br>Diazonium salts: Preparation: from aromatic amines; Reactions: conversion to benzene, phenol, benzoic acid and nitrobenzene.<br>Nitro compounds (aromatic): reduction under different conditions (acidic, neutral and alkaline).<br>**Amino Acids and Carbohydrates**<br>Amino Acids: Preparations (glycine and alanine only): Strecker synthesis, Gabriel's phthalimide synthesis; general properties; zwitterion, isoelectric point.<br>Carbohydrates: classificationand general properties; glucose and fructose: constitution; osazone formation; oxidation-reduction reactions; ascending (Kiliani –Fischer method) and descending (Ruff's method) in monosaccharides (aldoses only); mutarotation. | knowledge about<br>*CO 12.* The structural differences and strengths of carboxylic acids : aliphatic and aromatic,<br>*CO 13.* The Preparations of acids<br>*CO 14.* several derivative of acids preparations<br>**Amines and Diazonium Salts**<br>*CO 15.* The structural differences of Aminess: 1°-, 2°- and 3°- amines, Preparation, Identification of primary, secondary and tertiary amines, several reactions of aminess with mechanism<br>*CO 16.* The preparation of diazonium salts from aromatic amines<br>*CO 17.* The various methods for preparing different organic compounds by using benzene diazonium salts<br>**Amino Acids and Carbohydrates**<br>*CO 18.* The students will be learnt different types of Amino acids and Carbohydrates by<br>*CO 19.* Preparations of them by different methods<br>*CO 20.* Several types of reactions of them with mechanism<br>*CO 21.* zwitterion, isoelectric point in case of Amino acids<br>*CO 22.* Different reactions of aldoses by ring size increasing and decreasingary<br>*CO 23.* Elimentary idea about Mutarotaion i.e, change in the specicific rotation of aldohexoses with time |
| | | **Crystal Field theory**<br>Crystal field effect,octahedral symmetry, tetrahedral symmetry, Crystal field stabilization energy. Comparison of CFSE for octahedral and tetrahedral complexes .John Teller distortion<br>**Practical**<br>**1. Qualitative Analysis of Single Solid Organic Compound(s)**<br>Experiment A: Detection of special elements (N, Cl, and S) in organic compounds. Experiment B: Solubility and Classification (solvents: $H_2O$, dil. HCl, dil. NaOH)<br>Experiment C: Detection of functional groups: Aromatic-$NO_2$, Aromatic -$NH_2$, -COOH, carbonyl (no distinction of –CHO and >C=O needed), -OH (phenolic) in solid organic compounds.<br>Experiments A - C with unknown (at least 6) solid samples containing not more than two of the above type of | *CO 24.* To express the concept of Crystal Field theory<br>**Qualitative Analysis of Single Solid Organic Compounds**<br>*CO 25.* After completing this module students will be able to analyse the given single solid organic compound by<br>*CO 26.* Detection of special element by Lassaigne's test<br>*CO 27.* Solubility and classification (solvents: $H_2O$, 5% HCl, 5% NaOH and 5% NaHCO3)<br>*CO 28.* Identification of nitrogeneous and non-nitrogeneous functional groups.<br>*CO 29.* The structure of the given compound may be achieved by |

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| | | functional groups should be done.<br>**2. Identification of a pure organic compound**<br>*Solid compounds*: oxalic acid, tartaric acid, succinic acid, resorcinol, urea, glucose, benzoic acid and salicylic acid.<br>*Liquid Compounds*:methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene. | corresponding suitable derivative preparation and Identification of a Pure Organic Compound<br>*CO 30.* The students will be able to identify a single compound<br>*CO 31.* Single organic compounds can be identified by checking its Physical state (Solid and Liquid)<br>*CO 32.* Then Identification of some solid and liquid compounds are done primarily by using<br>*CO 33.* litmus paper, Solubility test, Action of heat,$FeCl_3$ test, Silver mirror test, Fluorescence test, Fehling's test etc.<br>*CO 34.* After having the idea about the probable name and nature of the compound it is identified correctly by doing a single test for each solid and liquid compounds. |
| | SEC-A-2 | **PHARMACEUTICALS CHEMISTRY**<br>**Drugs & Pharmaceuticals**<br>Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti- inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).<br>**Module II: Fermentation**<br>Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.<br>**Module III: Hands On Practical**<br>1. Preparation of Aspirin and its analysis.<br>2. Preparation of magnesium bisilicate (Antacid). | *CO 01.* The drug designing<br>*CO 02.* The synthesis of several drugs e.g., Analgesics Agents, Antipyretic Agents, Anti-inflammatory Agents, Antibiotics Agents, Antifungal Agents, Antiviral Agents, and HIV-AIDS related drugs by adopting the general established method. Aerobic and anaerobic fermentation<br>*CO 03.* Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.<br>**<u>Hands On Practical</u>**<br>*CO 04.* Preparation of Aspirin and its analysis.<br>*CO 05.* Preparation of magnesium bisilicate (Antacid). |
| | | **INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**<br>**Silicate Industries:**<br>***Glass:*** Glassy state and its properties, classification (silicate and non-silicate glasses).Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.<br>***Ceramics:*** Important clays and feldspar, ceramic, their types and manufacture. Hightechnology ceramics and their | *CO 01.* Examine methodically the physico -chemical properties of different industrial raw materials and asses their suitability in the manufacturing processes , keeping in mind the fields of application of those products and byproducts like glasses, ceramics, cements.<br>*CO 02.* Examine methodically the physico chemical properties and |

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| **5TH** | DSE-A-2 | applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.<br>***Cements:*** Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.<br>**Fertilizers:**<br>Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.<br>**Surface Coatings:**<br>Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.<br>**Batteries:**<br>Primary and secondary batteries, battery components and their role, Characteristics of Battery.Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.<br>**Alloys:**<br>Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (Arand heat treatment, nitriding, carburizing). Composition and properties of different types of steels.<br>**Catalysis:**<br>General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.<br>Phase transfer catalysts, application of zeolites as catalysts.<br>**Chemical explosives:**<br>Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX).Introduction to rocket propellants.<br>**PRACTICALS**<br>1. Determination of free acidity in ammonium sulphate fertilizer.<br>2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.<br>3. Estimation of phosphoric acid in superphosphate fertilizer.<br>4. Electroless metallic coatings on ceramic and plastic material.<br>5. Determination of composition of dolomite (by | manufacturing processes for different chemicals used as fertilizers to find out their suitability for use in the production of different agricultural produce.<br>*CO 03.* Suggest appropriate methods of use of different types of surface coating materials from the angle of their varied physico-chemical properties vis a vis areas of application in the domestic and industrial fields.<br>*CO 04.* Classify different types of batteries used in industries according to their components, functions,<br>*CO 05.* Applications and suitability.<br>*CO 06.* Classify different types of alloys on the basis of their compositions, properties and scope of use. Narrate the methodology for manufacture of different types of steels in the industry.<br>*CO 07.* Classify different types of catalysts on the basis of their physico- chemical properties. Discuss industrial use of catalyst like zeolite.<br>*CO 08.* Discuss the chemistry of some selected items of explosives and the reasons behind such property of the chemicals.<br>*CO 09.* Analyze systematically the components present in selected chemical compounds and estimate their relative proportions.<br>*CO 10.* Undertake preparation of pigment in the laboratory. |

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| | | complexometric titration).<br>6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.<br>7. Analysis of Cement. | |
| **6TH** | DSE-B-2 | **Analytical Methods in Chemistry**<br>**Optical methods of analysis**<br>Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.<br>*UV-Visible Spectrometry:* Basic principles of instrumentation (choice of source,monochromator and detector) for single and double beam instrument<br>*Basic principles of quantitative analysis:* estimation of metal ions from aqueous solution,geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method<br>*Infrared Spectrometry:* Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument; sampling techniques.<br>Structural illustration through interpretation of data, Effect and importance of isotope substitution.<br><br>***Flame Atomic Absorption and Emission Spectrometry****:*<br>*Flame Atomic Absorption and Emission Spectrometry:* Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.<br>***Thermal methods of analysis:***<br>Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.<br>***Electroanalytical methods****:*<br>Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.<br>***Separation techniques:***<br>Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation.<br>Technique of extraction: batch, continuous and counter current extractions.<br>Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.<br>Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange.<br>Development of chromatograms: frontal, elution and displacement methods. | **ANALYTICAL METHODS IN CHEMISTRY**<br><br>*CO 01.* Optical methods of analysis:<br>*CO 02.* UV-Visible Spectrometry<br>*CO 03.* Basic principles of quantitative analysis<br>*CO 04.* Infrared Spectrometry<br>*CO 05.* Flame Atomic Absorption and Emission Spectrometry<br>*CO 06.* Thermal methods of analysis<br>*CO 07.* Electroanalytical methods<br>*CO 08.* Separation techniques:<br>*CO 09.* Solvent extraction: Classification, principle and efficiency of the technique.<br>*CO 10.* Mechanism of extraction: extraction by solvation and chelation<br>*CO 11.* . Technique of extraction: batch, continuous and counter current extractions.<br>*CO 12.* Qualitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.<br>*CO 13.* Quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media<br>*CO 14.* Chromatography: Classification, principle and efficiency of the technique.<br>*CO 15.* Mechanism of separation: adsorption, partition & ion exchange.<br>*CO 16.* Development of chromatograms: frontal, elution and displacement methods.<br>*CO 17.* Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.<br><br>*CO 18.* Role of computers in instrumental methods of |

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| | | Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.<br>Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).<br>Role of computers in instrumental methods of analysis<br><br>**PRACTICALS: Analytica Methods in Chemistry Methods in Chemistry**<br><br>***Module IX:* Separation Techniques by Chromatography**<br>**(a)** Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the $R_f$ values.<br>**(b)** Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their $R_f$ values.<br>**(c)** Chromatographic separation of the active ingredients of plants, flowers and juices by TLC<br><br>***Module X:* Separation Techniques by Solvent Extractions**<br>To separate a mixture of $Ni^{2+}$& $Fe^{2+}$ by complexation with DMG and extracting the $Ni^{2+}$-DMG complex in chloroform, and determine its concentration by spectrophotometry.<br><br>***Module XI: Analysis of soil:***<br>(i) Determination of pH of soil.<br>(ii) Estimation of calcium, magnesium, phosphate<br>***Module XII: Ion exchange:***<br>Determination of exchange capacity of cation exchange resins and anion exchange resins.<br>***Module XIII: Spectrophotometry***<br>1. Determination of pKa values of indicator using spectrophotometry.<br>2. Determination of chemical oxygen demand (COD).<br>3. Determination of Biological oxygen demand (BOD). | analysis.<br>*CO 19.* The students will be technically guided by the following ways<br>*CO 20.* Separation Techniques by Chromatography<br>*CO 21.* Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.<br>*CO 22.* Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.<br>*CO 23.* Chromatographic separation of the active ingredients of plants, flowers and juices by TLC<br>*CO 24.* Separation Techniques by Solvent Extractions<br>*CO 25.* To separate a mixture of Ni2+& Fe2+ by complexation with DMG and extracting the Ni2+-DMG complex in chloroform, and determine its concentration by spectrophotometry.<br>*CO 26.* Analysis of soil<br>*CO 27.* Determination of pH of soil.<br>*CO 28.* Estimation of calcium, magnesium, phosphate<br>*CO 29.* Ion exchange:<br>*CO 30.* Determination of exchange capacity of cation exchange resins and anion exchange resins.<br>*CO 31.* Spectrophotometry<br>*CO 32.* Determination of pKa values of indicator using spectrophotometry.<br>*CO 33.* Determination of chemical oxygen demand (COD).<br>*CO 34.* Determination of Biological oxygen demand (BOD). |