B. Sc.

Department of Chemistry

Goals

The Bachelor of Science Degree in Chemistry intended for students who are primarily interested in careers as professional chemists or wish a thorough grounding in chemistry.
This three years' undergraduate program prepares students by developing knowledge base in theory as well as expertise in experimental science.
Because South Gujarat is famous Chemical Industrial Zone, the main objective of this course is to increase the job opportunity of the students by preparing them with the experimental and theoretical aspects of this continuously evolving subject.

Program Outcomes (PO)

PO-1: Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Organic, Inorganic, Physical and Analytical Chemistries.

PO-2: To develop critical thinking, students carry out scientific experiments as well as accurately record and analyze the results of such experiments.

PO-3: Students will be skilled in independent problem solving, critical thinking and analytical reasoning as applied to scientific problems.

PO-4: Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

PO-5: Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, environment, health and medicine.

PO-6: To inculcate the scientific temperament in the students and outside the scientific community.

PO-7: To develop skills in the proper handling of apparatus and chemicals. To be exposed to the different processes used in industries and their applications.

Program Specific Outcomes (PO)

After successful completion of the course the student will be able to:

PSO-1: have sound knowledge about the fundamentals and applications of chemical and scientific theories;

PSO-2: demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the subject;

PSO-3: acquire technical skills required for synthesis, Identification and structural characterization of chemical compounds;

PSO-4: apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories. Handling of basic equipments, acquiring technical skills accurately and effectively communicate scientific ideas in graphic oral and written form;

PSO-5: be familiar with the different branches of chemistry like analytical, organic, inorganic, physical, environmental and polymer;

PSO-6: gain knowledge to correlate Chemistry with other disciplines of science;

PSO-7: help in understanding the causes of environmental pollution and can open up new methods for environmental pollution control;

PSO-8: develop analytical skills and problem solving skills requiring application of chemical principles.

F. Y. B. Sc.

Sem I Paper-I: Physical and Inorganic Chemistry

At the end of the course, student will be able to

CO-1: Study definition of space lattice, Unit cell, Difference between crystalline and amorphous state, types of crystals with illustrations, Law of crystallography. Steno's law and laws of symmetry, lattice planes, Miller indices, Bravais indices, type of cubic system, diagrammatic representation of cubic system and d100, d110, d111 planes, Bragg's equation (X-ray diffraction), Crystal structure of NaCl, KCl.(Numerical based on Bragg'sequation and Miller indices)

CO-2: understand basic concepts Arrhenius theory, Lowry Bronsted theory, Lewis theory, Solvent – Solute concept of acidbase, Soft-Hard acid base and its application

CO-3: Historical perspective of atomic structure; Ruatherford's atomic model, Bohr's theory and its limitation, Spectrum of Hydrogen atom (Lyman, Balmer, Paschen, Brackett &Pfund), Quantum numbers, Auf bau, Hund and Pauli exclusion principles, Penetration and shielding, Effective nuclear charge (Slater rule)

CO-4: Chemical kinetics and its scope, rate of reaction, factors affecting rate of reaction : temperature, concentration, pressure, solvent, light and catalyst, Molecularity of reaction, Classification of chemical reaction, Order of reaction with illustration (first order, second order, third order, zero order, pseudo first order) reaction, : second order (a=b), half life and mean life.

CO-5: Define of atomic and ionic radii, ionisation energy, electron affinity and electron negativity, S-Block elements: Comparative study, diagonal relationship, salient features of hydrides.

Sem I Paper-II: Organic Chemistry

At the end of the course, student will be able to

CO-1: describe and identify the isomerism to structures of organic compounds;

CO-2: define and identify the optical activity in to structures of organic compounds

CO-3: explain the chemical Preparation and separation of isomers;

CO-4: explain Stereochemistry of chiral and achiral chemistry organic compounds;

CO-5: interpret R/S Configurations of organic compounds;

CO-6: describe E/Z, Syn/Anti, D/L and R/S isomers;

CO-7: have basic information of heterocyclic compounds, nomenclature, classification, five and benzofused heterocyclic compounds, Aromaticity and resonance structure of heterocyclic compounds;

CO-8: five membered heterocyclic compound, synthesis and important chemical reactions and some examples, Benzofused heterocyclic compound, synthesis and important chemical reactions and some examples;

CO-9: have basic knowledge of poly cyclic aromatic hydrocarbon and type, classification and nomenclature, some examples of polycyclic aromatic hydrocarbon, important chemicals reactions of PAHs;

CO-10: understand oxidation and reduction and their uses.

Sem I: Chemistry Practical

At the end of course student will able to

CO-1: handle laboratory glassware's, hazardous chemicals safely in laboratory;

CO-2: set up the apparatus properly for the given experiments;

CO-3: perform all the activities in the laboratory with neatness and cleanness;

CO-4: to develop skills for quantitative estimation using the different branches of volumetric analysis;

CO-5: to develop skills required for the qualitative analysis of organic compounds.

Sem II Paper-I: Physical and Inorganic Chemistry

At the end of the course student will be able to

CO-1: Study definition of Electrical conductance, Specific conductance, equivalent conductance, Molar conductance, Effect of dilution on concentration, Cell constant, Determination of Cell constant, Ostwald's dilution law and its limitations, Acid & Basic buffer actions (Henderson-Hasselbach equation), Buffer capacity, Numeric

CO-2: understand Second law of thermodynamics (in detail), Carnot cycle and its efficiency, Entropy concept, Change of entropy for reversible isothermic, isobaric, isochoric and adiabatic processes. Entropy change for ideal gases (T & V as variables, P & T as variables), Numerical.

CO-3: Study [I] Dry Reaction: theory behind borax bead test with equation, Flame test (Theory, structure of non luminous Bunsen flame) [II] Analysis of Cation : Application of common ion effect, solubility product constant. Complexometric reactions involved in qualitative analysis; 1. For identification [reaction between Cu(II) ion with ammonia, Fe(III) with thiocyanide, NH^{4+} with Nessler Reagent]. 2. For masking [Cd^{+2}, Cu^{+2}]. 3. Separation of two ions [Ag-Hg, Zn^{+2}, Mn^{+2}]

CO-4: Study shape of d-orbitals, CFT – Basic assumption, splitting of d-orbitals in Octahedral, Tetrahedral, Square planer complexes, distribution of dx electrons in Octahedral and Tertahedral complexes and CFSE.

CO-5: Define chemical bonds (covalent, co-ordinate covalent, ionic, metallic, H-bond, Wan der walls forces of attraction), Polarisability (Fajan's rule), Molecular Orbital theory ; LCAO method, Bonding molecular orbital, non-bonding molecular orbital, anti-bonding molecular orbital, bond order, magnetic properties and molecular orbital energy level diagram of hetero diatomic molecule : CO and NO, VSEPR theory.

CO-6: Classification of physical properties (additive, constitutive, colligative, additive, constitutive), Atomic volume, Molar volume and Chemical constitution, Kopp's law, Surface tension, Drop number method, Parachor, Viscosity, Determination of viscosity by Ostwald viscometer, Define: Refraction, Specific refraction, molar refraction, Numerical.

Sem II Paper-II: Organic Chemistry

After completion of course student will able to

CO-1: define the terms related to organic reactions such as Homolytic and Heterolytic fission free radicals carbonium ions, carbanions, carbenes, arynes and nitrenes;

CO-2: classify organic reactions like Addition, substitution, elimination, rearrange-ments, addition, and substitution with respect toelectrophilic and nucleophilic, SN_1, SN_2, Mechanism of addition reaction to alkenes and dienes, substitution in benzene, Perkin reaction, Benzoin condensation and Cannizero's reaction;

CO-3: determine empirical formula and its relation with molecular formula determination of molecular weight of organic acid by titration and silver salt method and organic base by chioroplatinate method and its limitations;

CO-4: define the term carbohydrate, its classification, structure of glucose and fructose, conversion of glucose to fructose and fructose to glucose, step up, step down and kilyani synthesis;

CO-5: identify Alkenes: Nomenclature, method of preparation, properties and uses of ethylene and propylene Morkwonikoffs rule and Satytzeff rule, polymerization of ethylene styrene and vinyl chloride;

CO-6: identify dienes: nomenclature, classification of dienes methods of formation of butadiene chemical reactions 1, 2 and 1, 4 additions, Diel's – Aider reaction;

CO-7: identify Alkynes: nomenclature, methods of formation, chemical reactions, electrophilic and nucleophilic addition reactions if acetylene.

Sem II: Chemistry Practical

At the end of course student will able to

CO-1: explain mole concept and its application in the preparation of normal and molar solutions, and use of mole concept in quantitative calculations for inorganic analysis;

CO-2: develop skills for quantitative estimation using the different branches of volumetric Analysis;

CO-3: impart the students a thorough knowledge of Systematic qualitative analysis of inorganic compounds.

S. Y. B. Sc.

Sem-III Paper-III: Inorganic Chemistry

After completion of course student will able to

CO-1: acquire working knowledge of the quantum mechanics postulate on the evolution of physical system;

CO-2: solve the time independent Schrodinger's equation, derive the equation for particle in the one dimensional box, applies boundary conditions to constraint the set of possible states;

CO-3: understand wave function, probability function, well behaved wave function.

CO-4: define and derivation of different operators, derivation of Hamiltonian equation, Hamiltonian operators for H – atom, H_2^+, He_2^+ and Li;

CO-5: principle of chromatography, classification of chromatography according to mobile phase and stationary phase, types of paper chromatography, Rf values, use of paper chromatography in inorganic analysis, separation of groups, halide and amino acid;

CO-6: define d-block elements; explain characteristic properties of d-block elements and properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states;

CO-7: understand L-S coupling, J-J coupling (introduction) and term symbol, determination of microstate of *p* and *d* orbital for several atom, calculation of term symbol of C, N, O, Ni, Ni^{+2}, Fe, Fe^{2+}, Fe^{3+}, Cr, Cr^{3+}, Co^{2+}, V, V^{+3} and Cl^-;

CO-8: define potable water; explain different methods of purification of water for potable and industrial purposes, explain soft and hard water, discuss method of desalination of sea water by reverse osmosis and electro dialysis.

Sem-III Paper-IV: Organic Chemistry

After completion of course student will able to

CO-1: understand physical properties and chemical reactions of nitriles, isonitriles, carbamates, semi carbazides and their application in synthetic organic chemistry;

CO-2: learn structure and nomenclature of amines, preparation of aryl amines, physical properties and chemical reactions. Gabriel-pthalimide reaction, Hofmann Bromamide reaction;

CO-3: learn structure and nomenclature of acid chloride, ester, amides of monocarboxylic acid; method of formation of monocarboxylic acid derivatives and chemical reactions;

CO-4: recall Definition, Classification, IUPAC Nomenclature of heterocyclic compounds with synthesis of some heterocyclic compounds;

CO-5: define, classify, give nomenclature of polynuclear aromatic hydrocarbons with synthesis;

CO-6: study basics of Diazonium salt, its mechanism, mole ratio, different salts, preparation of the diazonium salt;

CO-7: give nomenclature of Diazonium salts;

CO-8: study reactions of Diazonium salts, replacement reactions in which nitrogen is eliminated, its application in the synthesis of aromatic compounds;

CO-9: study laws of coupling, coupling agents, synthesis of diazomino and aminizo compounds;

CO-10: learn to use of Reagents: Anhydrous aluminium chloride, NBS, Selenium oxide, Lithium aluminium hydride.

Sem-III Paper –V: Physical Chemistry

At the end of the course student will be able to

CO-1: explain Arrhenius theory and collision theory of rate of reaction, energy of activation, effect of catalysis on it. Solve numerical problems related to theories of reaction rate.

CO-2: understand fundamentals of photochemistry, Basics of electromagnetic radiations, photons, Thermal and Photochemical Laws (a) Grothus Draper's Law (b) Lambert Beer's Law (c) Einstein's Law of photochemical equivalence. Explain Quantum efficiency, Experimental determination of Quantum yields. Reasons of Low and high quantum efficiency, Primary and secondary photochemical reactions, Factors affecting quantum efficiency, Isomeric changes, polymerization, Photosensitization, Photophysical processes Fluorescence, Phosphorescence, Chemiluminescene. Factor affecting Fluorescence, Phosphorescence and Solve numerical problems related to quantum efficiency.

CO-3: Discuss formation of ions in solutions, Difference between metallic conductance and Electrolytic conductance, electrolysis, Migration of ions, Transport number of ions and its Determination by moving boundry method. Explain Kohlraush law of ionic conductance and application of Kohlraush law to (a) Determination of degree of dissociation of weak electrolyte. (b) Determination of equivalent conductivity of weak electrolyte at infinite diluation. (c) Determination of solubility and solubility product of sparingly soluble salts. (d) Determination of ionic product of water. Solve numerical problems related to determination of transport number and applications of Kohlrausch law.

CO-4: Explain basics of electromagnetic radiation with wavelength and energy. Radio frequency, Microwave, IR, UV/visible region, Pure rotational spectra, Vibrational and Vibrational-Rotational spectra, Raman spectra. Rotational spectra, calculation of bond-length. Vibrational rotational spectra, Hook's law, vibrational energy level. Solve numerical Problems related to Moment of inertia, Force constant, Redced weight and Bond length.

Industrial Chemistry

At the end of the course student will be able to

CO-1: study manufacturing process of Synthetic fibers with uses;

CO-2: get general Information and Synthesis of some synthetic and natural Rubber with Flow sheet diagram;

CO-3: study industrial important and manufacturing process of Plastics and Resins with flow sheet diagram;

CO-4: get knowledge about the synthesis of some herbicides, pesticides, insecticides and fungicides used for household and agriculture purpose;

CO-5: learn manufacturing process of soap and detergents with the classification of detergents;

CO-6: get general information and manufacturing process of explosive;

CO-7: explain therapeutic uses and manufacture processes of drugs;

CO-8: study industrial uses and manufacturing process of some important dye pigment and dye intermediate;

Sem-III: Chemistry Practical:

At the end of the course, student will be able to

CO-1: study the reaction kinetics practically [1st order];

CO-2: study the conduct metric and pH metric principles and application of conduct metric, and pH metric measurement in quantitative analysis;

CO-3: do viscosity measurement and its application;

CO-4: study the adsorption of given organic acid on charcoal;

CO-5: get trained in the quantitative analysis using gravimetric method;

CO-6: develop skills required for the qualitative analysis of organic compounds.

Sem-IV Paper – III: Inorganic Chemistry

At the end of course, students will able to

CO-1: define lanthanides and actinides, electronic configuration, sources, occurrence, extraction by solvent and ion exchange, properties, lanthanide contraction, use of lanthanide compounds, industrial use uranium and plutonium, misch metal;

CO-2: study of theory of hydrogen bonding, classification, importance of hydrogen bonding in ice, Effect of hydrogen bonding in various fields;

CO-3: define CFSE, chromatography, ion exchange, influent, effluent, sorption, desorption, elution, eluant, eluate, break through capacity;

CO-4: understand basic concept of CFT, CFSE, splitting of d-orbital in octahedral and tetrahedral geometry, interaction of visible light and complex compound, ion exchange chromatography, separation of ion through ion exchange chroma-tography, purification of water;

CO-5: explain effect of strong and weak ligand on CFSE, magnetic property and color of the metal complexes, synthesis of ion exchange resin, type of resin, steps of ion exchange chromatography, application of ion exchange chromatography, function of various metals in to biological system, importance of metallo-propyrins, hemoglobin (with reactions), myoglobin.

Sem-IV Paper – IV: Organic Chemistry

At the end of course, students will able to

CO-1: write and explain mechanism of Michael reaction Wolf-Kishner reduction, Wittig reaction, Fridel-Craft reaction, Mannich reaction, Dickmann reaction, Reimer-Tiemann reaction, Aldol Condensation;

CO-2: explain the Elimination reactions, stereo chemistry of elimination reaction, elimination reaction vs substitution reaction;

CO-3: learn carbohydrates: (a) General introduction: (b) Disaccharides: Structure elucidation of maltose, lactose and sucrose (c) Methods of methylating sugar;

CO-4: synthesize and study application of compound containing reactive methylene group like malonic ester and aceto acetic ester, Keto-enol tautomerism: factors affecting Keto-enol tautomerism and its mechanism;

CO-5: study aliphatic sulfur compounds: nomenclature, general methods of preparation and Reaction, Aromatic sulfonic acid: nomenclature, preparation, reactions and uses of sulfonic acids of toluene;

CO-6: learn UV and visible spectroscopy, ultraviolet absorption spectroscopy, absorption laws (Beer-Lambert law) terminology used in UV and visible spectra, molar absorptivity, types of electronic transitions, effect of conjugation, concept of Chromophore and Auxochrome and Hypsochromic shifts UV spectra of conjugated enes and enones, effect of solvent substitution on electronic transition. Problems based on calculation of λ max for conjugated dienes and unsaturated carbonyl compounds and substituted Benzene derivatives using relevant rule.

Sem-IV Paper –V: Physical Chemistry

At the end of course, students will able to

CO-1: explain Nernst distribution law and its conditions for the validity, complications arising in distribution law due to association of solute in one of the phases, dissociation of solute in one of the phases, dissociation of solute in both the phase, derivation of distribution law from kinetic consideration explanation of solvent extraction process;

CO-2: distinguish between adsorption and absorption, physical adsorption and chemical adsorption, explain heat of adsorption, characteristics of adsorption, Freundlich's adsorption isotherm, Langmuir's adsorption isotherm, catalysis, general features of catalysis, heterogeneous catalysis, adsorption theory of catalysis;

CO-3: explain free energy or work function [Gibbs free energy (G) and Helmholtz free energy (A)], Derive equation $G = G^0 + RT \ln p$, relation of ΔG and equilibrium constant KP (Vant Hoff isotherm), derive Clapeyron and Clapeyron-Clausius equations, apply Clapeyron–Clausius equation in the derivation of molal elevation constant and molal depression constant; solve numerical problems related to latent heat of fusion, latent heat of vaporization, elevation of boiling point and depression of freezing point;

CO-4: use principle of conductometric titrations to explain following titrations: (1) strong acid v/s strong base (2) strong acid v/s weak base (3) weak acid v/s strong base (4) weak acid v/s weak base (5) mixture of strong acid and weak acid v/s strong base (6) precipitation titrations of (i) $BaCl_2$ v/s K_2CrO_4 (ii) NaCl v/s $AgNO_3$, explain advantages of conductometric titrations over indicator method;

CO-5: discuss relation between degree of hydrolysis, hydrolysis constant and pH of solutions of (1) salts of weak acid and strong base (2) salts of strong acid and weak base (3) salts of weak acid and weak base, explain theories of acid-base indicators, choice of indicators, indicator exponent and useful range of pH of an indicator, solve numerical problems related to degree of hydrolysis, hydrolysis constant, determination of pH.

Industrial Chemistry

At the end of course, students will able to

CO-1: give details of the processes of manufacture of some industrial important inorganic chemicals with uses;

CO-2: industrial uses and manufacturing process of lime, cement and refractories;

CO-3: industrial preparation and uses of some important chemical such as potassium permanganate, potassium dichromate, titanium dioxide, bleaching powder, white lead;

CO-4: information about plant nutrient and symptoms of nutrient deficiency in plant kingdom. Classify fertilizer and industrial manufacturing process of widely used some fertilizer;

CO-5: classify fuel, information and synthesis of some synthetic and eco-friendly fuel;

CO-6: property, classification and industrial manufacturing process of glass use frequently for industries and house hold purpose;

CO-7: property and industrial making process of various ferrous and non-ferrous alloys;

CO-8: define fermentation, various factors affecting fermentation process, micro-organisms and various chemical nutrient uses for fermentation process.

Sem-IV: Chemistry Practical

At the end of course, students will able to

CO-1: develop laboratory skills for the purpose handling different instruments; interpret results of experiments and their correlation with theory;

CO-2: determine the molecular condition of benzoic acid in its solution in kerosene by the method of partition coefficient;

CO-3: determine the relative strength of mineral acids;

CO-4: study the conduct metric and pH metric principles and application of conduct metric, and pH metric measurement in quantitative analysis;

CO-5: maintain records of chemical and instrumental analysis; develop laboratory skills for the purpose of collecting, interpreting, analyzing, practical data;

CO-6: impart the students a thorough knowledge of systematic qualitative analysis of inorganic mixtures.

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Sem-V Paper-VI: Inorganic Chemistry

At the end of course, student will be able to

CO-1: study postulates of quantum mechanics, particles in three dimensional box, Schrodinger's wave equation in polar coordinates, its separation in to R, θ and Φ;

CO-2: Jahn Teller Theorem, distortation in octahedral complexes, crystal field splitting energy level diagram for octahedral and tetrahedral, tetragonal and square planar complexes;

CO-3: get concept of Ligand field theory;

CO-4: distinguish between atomic and molecular orbitals, bonding and antibonding molecular orbitals, different theories of co-ordination chemistry;

CO-5: draw MO energy level diagram for metal complexes and its magnetic properties;

CO-6: define and classify metal carbonyls, metal ligandπ–bonding (back bonding), Define EAN and 18-electron rule, calculate EAN for metal carbonyl, Bonding in metal carbonyl, structure and IR spectra in metal carbonyl. Differentiate between terminal and bridge carbonyl. Constitution of metal carbonyls $Ni(CO)_4$; $Fe(CO)_5$, $Fe_2(CO)_9$, $Mn_2(CO)_{10}$, $Cr(CO)_6$, $Co_2(CO)_8$;

CO-7: define boron hydride and its classification, Wade's rule, bonding and structure in tetra Borane (10), penta borane (9) and dodeca borane (12) anion;

CO-8: outline thermodynamic stability of metal complexes and factors affecting a stability of metal complexes. Lability and inertness, Factors affecting lability of metal complexes. Trans effect, theories of Trans effect (i) Electrostatic Polarization Theory (ii) - Bond Theory labile and inert complexes based on VBT and CFT;

CO-10: define and give importance of corrosion, types of corrosion: uniform, pitting, intercrystalline and stress cracking corrosion, electro-chemical theory of corrosion, protection methods and importance of coating, inhibitors (organic, inorganic, anodic, cathodic), anodic and cathodic protection.

Sem-V Paper-VII: Organic Chemistry

At the end of course, students will able to

CO-1: give (a) Different types of mechanism for esterification and hydrolysis: B_{AC}^2 A_{AC}^2 A_{AC}^1 A_{AL}^1 B_{AL}^2 (b) mechanism of formation and hydrolysis of amides. (c) pyrolytic elimination: Cope and Chugaev reactions;

CO-2: get introduction to Aromaticity, Huckel's Rule, Aromatic Character of Arenes, Definition & Examples of Aromatic, Non-Aromatic, Anti-Aromatic Compounds (Benzenoids and Non-Benzenoids);

CO-3: learn structural determinations of Pyriodoxine and Thyroxine and their synthesis, General introduction, structural determination of Ribofllevin (Lactoflavin) & its Synthesis;

CO-4: study basic concept of Alkaloids, Occurrence and classification of Alkalodis, General methods of determine of their structure, Analytical and synthetic evidence to prove the structure of Nicotine and papavarine (B) Vitamins and Hormons: 5 Hrs General Introduction, Classification, Structural determinations and Synthesis of Pyridoxine, Vitamin – C, Thyroxine and Adrenalene;

CO-5: have general discussion about carbohydrates, definition of carbohydrates, classification of carbohydrates with example, introduction of disaccharide and poly saccharide, structure determination of maltose, lactose starch;

CO-6: introduce drugs, definition of drugs and ideal drugs, classification of drugs based on pharmacological or functions, important synthesis and uses of Amylnitrate, Chloroquine, Pyrimethamine, Sulpha Pyrimidine, Diazepam, Lidocaine, Chlorpropamide, Dapsone, Isoniazide, 5-Fluoro Uracil;

CO-7: define and study structures of Amino Acid (In Tabular Form) Synthesis of Merry Field Method, Sangers method, Edman method, N-terminal determination, C-terminal determination by generation of amino alcohol and using digestive enzymes. End group analysis, selective hydrolysis of peptides classical levels of protein structure, protein denaturation / renaturation.

Sem-V Paper-VIII: Physical Chemistry

At the end of the course student will be able to

CO-1: understand and explain partial molal free energy, derive from Gibb's Duhem equation, chemical potential in case of a system of ideal gases, concept of fugacity, fugacity function, fugacity at low pressures, physical significance of fugacity, graphical method for determination of fugacity, Lewis fugacity rule, activity and activity coefficient, standard state of solid, liquid and gas, the Nernst heat theorem, its limitations, statement of the third law of thermodynamics, consequence of third law of thermodynamics, determination of absolute entropy of gases and liquids and solid, applications of third law of thermodynamics, concept of residual entropy, exceptions to the third law of thermodynamics, solve numerical problems related to fugacity, graphical method to determine fugacity and determination of absolute entropy;

CO-2: explain and discuss concept of Oxidation and Reduction, Electrochemical series, definition of half-cell and cell, single electrode potential, sign of electrode potential, standard electrode potential, Electrochemical process, Galvanic cell with example of Daniel cell, EMF of a cell and its measurements, Standard Weston cell, Different types of reversible electrodes, Determination of single electrode potential, Calculation of standard EMF of cell and Determination of cell reaction, Standard Hydrogen Electrode, Calomel electrode and Ag-AgCl electrode, Chemical and concentration cell, electrode and electrolyte concentration cell, liquid junction potential (LJP), salt bridge in elimination of LJP, concentration cell with and without transference, Free energy change and Electrical energy, Prediction of spontaneity of cell reaction,

Relation of standard free energy change with equilibrium constant, Temperature coefficient of EMF of a cell, Entropy change and Enthalpy change of cell reaction. Solve numerical problems related to cell construction from electrochemical reaction, electrode potential, EMF of various types of cell, rate constant, LJP;

CO-3: Explain Stable and unstable isotopes, separation of isotopes by different methods, gaseous diffusion, thermal diffusion, distillation, chemical exchange methods, Bainbridge velocity focusing mass spectrograph, Dempster's direction focusing mass spectrograph, Different types of Particle accelerators e.g. Linear accelerator, Cyclotron, Discovery of artificial disintegration, Classification of nuclear reaction based on overall energy transformations and - particles used as projectiles, Merits and demerits of different projectiles, Numerical problems on Cyclotron.

Sem-V Paper-IX: Industrial Chemistry

At the end of course, students will able to

CO-1: (A) study manufacture with flowsheet & uses of Acrylonitrile (Sohio Process), Bisphenol-A, Styrene, Industrial manufacture and uses of Polyolifines: Poly ethylene (HDPE & LDPE) and Polypropylene **(B)** Nomenclature of chlorofluoro derivatives of Methane & Ethane, General Methods of Preparation, Properties, Usesof fluoro carbons;

CO-2: study manufacture of Freon-12 from fluorspar, Manufacture of freon-12 fromvinylidene fluoride;

CO-3: pollution hazard of Fluoro carbons;

CO-4: Metallurgy of different metals (occurrence, extraction, properties and uses: (1) Tungsten (2) Molybdenum (3) Titanium (4) Chromium (5) Aluminium;

CO-5: learn small scale preparation of (1) Safety matches (2) Naphthalene balls (3) Wax candles (4) Shoe polish (5) Writing/ fountain pen ink (6) Chalk crayons (7) Plaster of paris;

CO-6: define nitration, Nitrating agent, Reaction mechanism of Nitration. Nitration of acetylene, nitration of Benzene, Nitration of Naphthalene, Nitration of Toluene, Artificial perfumes: Musk xylene, Musk ketone, Musk ambrette. Explosives: Trinitrophenol, Trinitrotoluene, Trinitro glycerine, Emitol;

CO-7: define amination, Amination by reduction: Metal - Acid reduction (strong & weak), Metal - Alkali reduction (strong and weak), Catalytic reduction, Sulphide reduction. Amination by ammonolysis: Amination of chlorobenzene, Phenol & Benzene Sulphonic acid, importance of amination in industry in the manufacture of Bismark brown dye from m-Phenylenediammine, Synthetic fibre (Nylon 6,6) from HMDA, Methyl Red Indicator from Anthranilic acid, Cyclonite explosive from Hexamethylenetetramine;

CO-8: define Sulphonation, methods of sulphonation, sulphonating agents, mechanism of sulphonation. Sulphonationof Benzene, Toluene, & Anthracene, Preparation of Phenol and Resorcinol from benzene, Importance of Sulponation reaction in industry in the manufacture of Saccharine, Chloramine T and Alizarine Red.

Sem-V Paper-X: Analytical Chemistry

At the end of course, students will able to

CO-1: get introduction to chemical and instrumental Analysis, advantages and disadvantages, Overview of methods used in Quantitative analysis, classification of classical and instrumental analysis, factors affecting the choice of Analytical Method (in brief), step in quantitative analysis (Flow diagram), Analytical methods on the basis of Sample size (in brief), Sampling methods. Sampling in different physical states;

CO-2: define and explain error, types of errors: determinates errors, indeterminate errors, constant and proportional errors, define and explain the following terms – accuracy and precision, mean, median, deviation, average deviation, standard deviation, variance, coefficient of variation, relative mean deviation, range, absolute errors, relative errors, minimization of determinates errors, normal error curve, rejection of result from a set of results, 2.5 d rule, 4.0 d rule and Q-test;

CO-3: study factors affecting solubility of precipitates: (1) common ion (2) diverse ions (3) pH (4) hydrolysis (5) complex formation, the precipitation process, nucleation growth, Von Weimarn's theory of relative super saturation. digestion of precipitates;

CO-4: factors affecting quality of precipitate: Co-precipitation and post precipitation, Precipitation from homogeneous solution with illustration of barium and aluminum; thermogravimetry, general principle, application with following two specific examples (1) CaC_2O_4. H_2O (2) MgC_2O_4. $2H_2O$;

CO-5: calculate pH at different stages of titrations of monobasic and dibasic acid with strong base construction of titration curve, titration of carbonate mixture, numerical;

CO-6: explain EDTA titration, absolute and conditional stability constant, distribution of various species of EDTA as function of pH, absolute and conditional stability constants, derivation of factors: α_4 for effect of pH, β_4 for the effect of auxiliary complexing agent, construction of titration curves: theory of metallochromic indicators, masking, demasking and kinetic masking, types of EDTA titrations.

Sem-V Paper-XI: General Chemistry

At the end of course, students will able to

CO-1: define spectroscopy, wavelength, frequency of radiation, wave number.

CO-2: classify spectroscopy atomic and molecular spectroscopy, different region of IR radiation.

CO-3: describe instrumentation of IR spectroscopy, preparation of sample for IR spectroscopy, stretching vibration of different molecule.

CO-4: explain effect of IR radiation on matter, factors affecting on absorption frequencies.

CO-5: calculate estimated absorption frequencies for various functional groups.

CO-6: study dry reaction: theory behind borax bead test with equation, flame test, analysis of cation: (a) application of common ion effect and solubility product constant. (b) complexometric reaction involved in qualitative analysis, for identification [Reaction between Cu (II) ion with ammonia, Fe (III) with thiocyanide, NH_4^+ with Nessler reagent 2, for masking $[Cd^{+2}, Cu^{+2}]3$, separation of two ion $[Ag\text{-}Hg, Zn]^{+2}$, Mn^{+2};

CO-7: organic qualitative analysis, elemental analysis, solubility of organic compounds;

CO-8: understand laboratory hygene and safety, handling of chemicals, general procedure for avoiding accidents, first aid techniques;

CO-9: define terms: solute, solvent, and solution composition of solution-normal solution, molar solution, molal solution, mole fraction, % solution, saturated, unsaturated and supersaturated solution and solubility, effect of temperature on various units of concentration, interconversion of one unit into another unit, preparation of solutions of some primary standard substances, standardization of the solution using primary standard solutions/standardized solution.

Sem-V: Petrochemicals

At the end of course, students will able to

CO-1: source of petrochemicals, natural gas: composition, natural gas as petro-chemical feed stock, crude oil: composition, distillation, and refining, utilization of various fractions;

CO-2: classify petrochemicals, first, second and third generation petrochemicals, conversion process: cracking reforming, isomerisation, hydrogenation, alkylation and

hydrodealkylation, dehydrocyclisation of petroleum products, polymerization of gaseous hydrocarbons;

CO-3: study Petrochemicals obtained from C_1 cut of petroleum manufacture and application of methanol, synthesis gas, ammonia, HCN, formaldehyde, hexamethylenetetramine, chlorinated methanes, per chloroethelene;

CO-4: Synthesis and uses of H-acid, J-acid, Neville Winther'sacid, DASDA Procian Red dye, Cellitone scarlet-B, Indanthrene Khakhi GG, Blankophor B, Sulphamylon, Chloramphenicol;

CO-5: Industrial fuels, Natural fuels, synthetic fuels, hydrogen fuel of tomorrow, fuel for rocket, Intermediates of Pharmaceuticals and Dyes;

CO-6: Petrochemicals obtained from C_2 cut of petroleum, Manufacture and industrial applications of chemicals obtained from ethylene: ethanol, acetaldehyde, ethylene oxide, ethylene glycol, ethanolamines, acrylonitrile, styrene, vinyl acetate, Manufacture and industrial application of chemicals obtained from acetylene, acrylic acid, acrylonitrile, vinylchloride ,vinylacetate, acetaldehyde, chloroprene, trichloethylene, methyl vinyl ether;

CO-7: General account of petrochemicals used as monomers in the manufacture of nylon –6, nylon–6-6, nylon –6-10, nylon –12 and nylon –8-6 fibers, industrial production of caprolactum, HMDA, adipic acid, sabecic acid, lauryl lactum.

Sem-V: Chemistry Practical

At the end of course, students will able to

CO-1: study and justify kinetics of 2^{nd} order reactions practically;

CO-2: study precipitation titration, mix acid titration using conductivity meter;

CO-3: determine degree of dissociation and dissociation constant of weak monobasic acid using pH metry;

CO-4: determine solubility and solubility product of sparingly soluble salt using potentiometry;

CO-5: study angle of rotation as well as specific rotation of optically polar substances using polarimeter;

CO-6: maintain records of chemical and instrumental analysis. Develop laboratory skills for the purpose of collecting, interpreting, analyzing, practical data;

CO-7: develop laboratory skills for the purpose handling different instruments, interpretation of results of experiments and their correlation with theory;

CO-8: get training in the quantitative analysis using gravimetric method;

CO-9: develop skills required for the qualitative analysis of organic mixture.

Sem-VI Paper-VI: Inorganic Chemistry

At the end of course, students will able to

CO-1: define symmetry, symmetry elements, symmetry operations;

CO-2: enlist symmetry elements, types of planes;

CO-3: define point group, Classification of molecules into point- groups, point – group of different molecules;

CO-4: study basic properties of a group theory;

CO-5: derive the multiplication table for C_{2v}, C_{3v} and C_{2h} point group;

CO-6: understand reaction mechanisms of ligand substitution in octahedral complexes (i) SN_1 (ii) SN_2 Acid hydrolysis and Base hydrolysis-Redox (Single Electron Transfer) reactions;

CO-7: define of hybridization Bond angles in sp, sp^2 and sp^3 hybrid orbital using wave function;

CO-8: study water pollution: types of water pollutants, trace elements in water and their effects; Determination of BOD, COD, DO, Total hardness, Total dissolved solids, Ozone treatment process for waste water;

CO-9: define, classify learn the structure and bonding in ferrocene, dibenzene chromium, Zeise ion and gaseous dimethyl beryllium, Tetramethyl Lead.

Sem-VI Paper-VII: Organic Chemistry

At the end of course, students will able to

CO-1: have basic concept of green chemistry, fundamental principle of green chemistry, green chemistry examples, green synthesis of important compounds

CO-2: have general discussion on polymers, definition of polymer, and classification of polymer with example, introduction of various type of polymerization, some important method of polymerization;

CO-3: study various types of resin phenol- formaldehyde resin, urea-formaldehyde resin, epoxy resin, natural and synthetic rubbers;

CO-4: understand pigments, classification of pigments;

CO-5: have general introduction of careteniods, analytical and synthetic evidence of β-carotene;

CO-6: get general introduction of anthocyanines and anthocyanidines analytical and synthetic evidence of Cyandine chloride;

CO-7: have an introduction of flavones and flavonols analytical and synthetic evidence of quercetin;

CO-8: learn conformation, conformational analysis, conformations of ethane, Butane and Cyclohexane. Conformational analysis of cyclohexane. Axial and equatorial Hydrogen in cyclohexane. Stability of monosubstituted cyclohexane;

CO-9: have general discussion about dyes, definition of dyes and pigments;

CO-10: discuss color and constitution – Witt's theory difference between dyes and pigments;

CO-11: classify dyes with example, introduction of various types of dyes;

CO-12: study mechanism of rearrangements involving C to C migrations as illustrated by Wagner – Meerwein and Pinocol-Pinacolone rearrangements;

CO-13: study mechanism of rearrangements involving C to N migrations as illustrated by Hoffmann, Curtius, and Beckmann rearrangements.

Sem-VI Paper-VIII: Physical Chemistry

At the end of course, students will able to

CO-1: discuss application of radio isotopes as tracers in medicines, agriculture, in studying reaction mechanism in photosynthesis and age determination by Carbon- Dating method, Q-value of nuclear reactions, chemical and physical atomic weight scale, mass defect and binding energy, packing fraction and its relation with the stability of the nucleus, nuclear fission, atom bomb, nuclear reactor for power generation and critical mass, stellar energy and hydrogen bomb, hazards of nuclear radiation, numerical problems on Q-value, binding energy, packing fraction, and energy released during nuclear reactions;

CO-2: apply EMF measurements in the determination of (1) solubility product and solubility of sparingly soluble salts (2) ionic product of water by galvanic cell (3) transport number of ions (4) equilibrium constant (5) pH by hydrogen, glass and quinhydrone electrodes, solve numerical based on above applications to determine solubility, solubility product, ionic product of water, equilibrium constant, transport number and pH of solution, have detail information on energy sources like Ni-Cd Cell and Li- ion cell;

CO-3: discuss statement and meaning of the terms phase, component, degree of freedom, phase rule, phase equilibria of one component system like water, CO_2, sulphur system,

phase equilibria of two component system like Pb-Ag systems, KI- Water system, desilverisation of lead, basics freezing mixtures and Definition of solid solutions with congruent and incongruent melting point using example;

CO-4: explain liquid-liquid mixtures, ideal liquid mixtures, Raoult's law, non-ideal or real solutions, positive and negative deviations from Raoult's law, temperature composition curves for ideal and non-ideal binary solutions of miscible liquids, azeotropes, partially miscible liquids explained using phenol-water systems, immiscible liquids, steam distillation, solve numerical problems related to this topic.

Sem-VI Paper-IX: Industrial Chemistry

At the end of course, students will able to

CO-1: understand pulp and paper industry, type of pulp, manufacture of chemical pulp and mechanical pulp;

CO-2: study manufacture of paper (conversion of pulp into paper, beating process, importance of fillings, sizing, colouring materials in manufacture of paper and calendaring);

CO-3: understand principles of detergency;

CO-4: classify of surface active agents, anionic detergents, cationic detergents, non-ionic detergents, amphoteric detergents, suds regulators, builders additives.

CO-5: get introduction, manufacture of sugar from sugarcane;

CO-6: study extraction of juice, purification of juice, concentration and crystallisation of purified juice, refining of sugar;

CO-7: define fermentation and fermentation process with example pH, temperature and substance;

CO-8: study various type compounds like ethanol, citric acid, acetone and penicillin –G manufacture and flow chart with uses;

CO-9: define insecticide type of insecticides, inorganic, organic, synthetic and natural insecticides, manufacture and uses of various type of compound like eldrin, dieldrin, BHC, TEPP;

CO-10: define of fungisides, bordex mixture, dithio carbamates, baygon, termik zineb

CO-11: study manufacture and uses of various compounds like methanol from synthesis gas, isopropanol from propylene, acetone from isopropanol, formaldehyde from methanol by oxidation dehydration method, acetylene from natural gas.

Sem-VI Paper-X: Analytical Chemistry

At the end of course, students will able to

CO-1: explain components of spectrophotometer –sources, grating and prism as dispersing device, sample handling, detectors – photo tub e, photomultiplier tube, block diagram and working of single beam and double beam spectro-photometer, terms involved in beer's law, causes of deviation from beer's law, analysis of unknown by calibration curves method, standard addition method, and ratio method, determination of Cu^{+2}, Fe^{+3}, NO_2^{-1} using spectrophotometer, problems based on quantitative analysis;

CO-2: Discuss classification of chromatography. Principles of GC separation. Components of GC, Sample introduction system, Columns: Packed column Capillary Column (WCOT, SCOT), Carrier gas and its selection - stationary phases: solid adsorbents, inert supports (selection criteria, diatomaceous earths,) and liquid stationary phases, detectors: FID, TCD. Qualitative and quantitative analysis using GC;

CO-3: know the limitation of conventional liquid chromatography, technique of HPLC, elementary idea about technique and layout diagrams of instrument, components of instrument of HPLC technique, elementary idea of TLC;

CO-4: study titrations involving Silver salts, detection of end points by Mohr's method, Volhard's method, adsorption indicators, construction of titration curves;

CO-5: study construction of titration curves for titration of Fe^{+2} and Ce^{+4}, explain types of indicator and theory of redox indicator, know about oxidants – $KMnO_4$, $K_2Cr_2O_7$, reductants – sodium thiosulphate, sodium arsenite and problems.

Sem-VI Paper-XI: General Chemistry

At the end of course, students will able to

CO-1: define adulteration;

CO-2: understand different types of adulteration, techniques of adulteration, methods of detection of different adulterants in some common food items like milk, milk products, oil and fats, food grains and their products, spices and miscellaneous product , hazardous effect of adulteration of human, consumer's rights and some legal procedures;

CO-3: realize their social responsibility and inspire to think its solution on a student of chemistry;

CO-4: study nano-particles, properties of nano-particles, semiconductors, ceramic nano-particles, catalytic aspects of nano-particles, carbon nano-tubes, applications of nano particles;

CO-5: study different types of pollutions such as: (1) gaseous pollution in air, acid rain, green house effect and ozone depletion, (2) radiation pollution cause, effect and control, (3) noise pollution and their effect and control, (4) oil pollution and their control;

CO-6: study Nuclear Magnetic Resonance Spectroscopy–Proton Magnetic Resonance (^1H NMR) Spectroscopy - nuclear shielding and deshielding – chemical shift and molecule structure, spin-spin splitting and coupling constants – areas of signals – interpretation of NMR spectra of simple organic molecule such as ethyl bromide, acetaldehyde, 1,1,2-tribromoethane, ethylacetate, toluene, acetophenone, nitrobenzene, cyclopropane, isomers of pentane and hexane.

Sem-VI: Petrochemicals

At the end of course, students will able to

CO-1: petrochemicals obtained from C_3-cut of petroleum, manufacture and industrial applications of chemicals obtained from propylene: iso propyl alcohol, acetone, propylene oxide, acrylonitrile, glycerol and isoprene, propylene tetramer, acrylic acid, n-butyraldehyde, methyl isobutyl ketone, acrolein, acrylamide, methyl methacrylate;

CO-2: have general account of petrochemicals used as monomers in the manufacture of polyester fibers, manufacture of DMT, terphthalic acid, phthalic anhydride, maleic anhydride, 1:4 butanediol and other monomers like penta erithritol and di-isocyanates;

CO-3: study method for the large scale production with flow diagram and uses of: (i) acetoacetanilide (ii) anthraquinone (iii) β-naphthol from naphthalene (iv) Bon acid (v) aspirin (vi) chloramphenicol (vii) paracetamol (viii) p-amino phenol (ix) saccharin (x) 2,4-D acid;

CO-4: define synthetic detergents, hard and soft detergents, synthesis of DDBS, basic petrochemical raw materials for organic dyes, dyes derived from these raw materials with uses, synthesis of fluoresein, malachite green, chrysoidine and indigo, definition of explosive, list of basic raw materials for explosives and list of explosives derives from these raw materials, synthesis of tetryl, PETN and dynamite;

CO-5: define insecticides, classification of insecticides on basis of mode of action. Synthesis of Methoxychlor, Captan, Parathion, Malathion and Perthane;

CO-6: study chemicals obtained from C4 and C5 cut of petroleum, manufacture and industrial applications of butadiene, butylalcohols, methyl terbutyl ether (MTBE) cyclopentadiene, sulpholane;

CO-7: study recovery process of BTX, manufacture and industrial applications of benzene, toluene, xylene, naphthalene, phenol, styrene, aniline, maleic anhydride, cyclohexanol.

Sem-VI: Chemistry Practical:

At the end of course, students will able to

CO-1: study and justify kinetics of 2^{nd} order reactions practically;

CO-2: determine quantity of active ingredient in commercial product [Vanila] using conductometric principles and conductometric titration;

CO-3: determine degree of dissociation and dissociation constant of weak monobasic acid by titration method using pH metry;

CO-4: verify Lambert-Beer law for colored solution using colorimeter/ spectro-photometer;

CO-5: determine normality and amount of given acid in mixture using conductivity meter;

CO-6: maintain records of chemical and instrumental analysis, develop laboratory skills for the purpose of collecting, interpreting, analyzing, practical data;

CO-7: develop laboratory skills for the purpose handling different instruments, interprete of results of experiments and their correlation with theory;

CO-8: get knowledge of Systematic qualitative analysis of Inorganic mixtures.