Department of Chemistry

Outcomes of the Course
Paper wise Learning Outcomes of the Course
Annual (1+1+1)
B.Sc. GENERAL Course (PART- I, II AND III)

Course objectives:

- To understand the basic of organic chemistry.
- To understand about the inorganic chemistry in detail.
- To understand the physical chemistry briefly specially about state of matters & thermodynamics
- To understand various aspects of industrial chemistry and to increase interest among student towards various industry.
- To understand about pesticides as well as polymer chemistry. It will also be helpful for the student who wants to do research in chemistry.

YEAR	PAPER	TOPIC	COURSE OUTCOME
Chemistry (General) Part-I			
1	PAPER-I	Group-A (Organic)	In this course the students will have the following knowledge: Understand hybridisation, electronic displacement, cleavage of bonds, empirical and molecular formula determination. Understand preparation, properties and various reactions of alkanes, alkenes, alkynes, alcohols, aldehydes and ketones. Detect extra elements in organic compounds.
		Group-B (Physical)	In this course the students will learn: 1. Gases: Deviations from ideal gas behaviour, Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states. Postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path, their temperature and pressure dependence, variation of viscosity with temperature. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable). 2. Thermodynamics: Concept of heat, Q, work, W, internal energy, U, 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 (ideal and van der Waals) under isothermal and adiabatic conditions Joule-

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			Thomson coefficient and inversion temperature. Heats of reactions: standard states; enthalpy of formation and enthalpy of combustion and its applications; effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Statement of the second law of thermodynamics. Carnot cycle. Concept of entropy. Gibbs free energy.
	PAPER- II	Group-A (Inorganic)	In this portion students will learn: 1. Radioactivity: Natural radioactivity; group displacement law, law of radioactive decay, half-life and average life of radio-elements, radioactive equilibrium, Stability of atomic nucleus, n/p ratio, nuclear binding energy, nuclear forces, nuclear reactions, fission, fusion, transmutation of elements, Age determination, radiocarbon dating. 2. Atomic structure: Bohr's theory for hydrogen atom, atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and theirsignificance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, Aufbau principle Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies. Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group-wise variation of above properties in respect of s- and p-block elements.
		Group-B (PHYSICAL)	In this course the students are expected to learn: 1. Chemical Equilibrium: Equilibrium constants and their quantitative dependence on temperature, pressure and concentration (Le Chatelier Principle, Quantitatively). 2. Phase rules: Clausius - Clapeyron equation and its applications. Phase rule and its application to one component system. Nernst distribution law. 3. Liquid: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid. Colligative Property: Relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses

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			of normal, dissociated and associated solutes in solution.
	PAPER-III	Practical	Students will have the experience of Organic qualitative analysis and organic compounds preparation with melting point determination through this course.
Chemistry (General) Part-II			
2	PAPER-IV	Group-A (Organic)	By the end of this course, students will be able to learn: 1. Preparation and application of Grignard reagent, ethyl acetoacetate. 2. Primary, Secondary and Tertiary amines: Basic concept, separation, preparation of primary amines: Hofmann hypobromite, Schmidt and Curtius reactions (mechanism omitted). 3. Optical isomerism: Chiral Centre, optical isomerism of lactic acid and tartaric acid, geometrical isomerism of maleic acid and fumaric acid. 4. Carbohydrates: Definition, classification, structure and properties of glucose. 5. Benzene: Rule of aromaticity, halogenation, Nitration, Friedel-Crafts reaction. 6. Aromatic amines: Diazonium salts, Benzoin condensation.
		Group-B (Inorganic)	By the end of this course, students will be able to understand: 1. Characteristics of transition metal, reason for their differences from representative metals. Comparative study: Gr. VB: N, P, As, Sb, Bi. Electronic configuration, valence. Hydrides- preparation, stability, basic properties. Gr. VI B: O, S-valence, Hydridesboiling points, acidic character. Gr. VII B: Special properties of Fluorine and Iodine. 2. Oxyacids: Name, structural formula, one method of preparation for each, nature of existence, basicity of (1) Chlorine (2) Per acids of sulphur. 3. Extraction and chemistry of Ni, Sn. 4. Chemistry of: Hydrazine, Sodium nitroprusside, Silicone, Borazene. 5. Carbonisation of coal: Superphosphate; Detergent Soap.
	PAPER-V	Group-A (Inorganic)	After the completion of this part students will be able to learn 1. Simple idea of Double salt and Complex salt. Perfect and imperfect complex, Nomenclature (IUPAC), Werner's coordination theory, ligand-monodentate, tri and tetradentate, ambidentate, Chelate, Innermetallic complex (first order), Geometrical and optical isomerism in inorganic complexes. 2. Principles of Fe^{2+}- $K_2Cr_2O_7$ titration, estimation of Cu^{2+}.

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			Calculation of errors - mean, median, mode, standard deviation.
		Group-B (Physical)	After the completion of this part students will be able to learn the following: 1. Chemical Reaction: Order and molecularity, Integrated rate laws for zero, first & second order reactions, Determination of order of reaction, Elementary treatment of opposing, consecutive, parallel reactions. Effect of temperature on reaction rate. 2. Photochemistry: Laws of photochemistry, quantum yield, Lambert-Beer's law and its application. Elementary ideas of Fluorescence, Phosphorescence. 3. Electrochemical cell: Reversible and irreversible cells, emf and its measurements, Galvanic cell, Electrical and electrochemical potential, Different types of half cells, cell reactions, Nernst equation, Reference electrodes. 4. Ionic equilibrium: Ionic equilibria: Solubility products, common-ion effect, ionic product of water, pH, Hydrolysis of salts, Buffers and Neutralization indicators. 5. Atomic structure Photoelectric effect, Wave particle duality, Uncertainty Principle, Principle of Pure Rotational and vibrational Spectroscopy. 6. Adsorption: Adsorption of gases by solids, Types of adsorption, Effect of temperature and pressure, Freundlich and Langmuir adsorption isotherm, Theory of homogeneous Catalysis. 7. Colloids: Classification, Preparation, Stability, Purification.
	PAPER-VI	Practical	Inorganic Qualitative Analysis
Chemistry (General) Part-III			
3	PAPER-VII	Industrial Chemistry	Students will be able to learn the following: 1. Fules: (i) Gaseous fuels: Manufacture & uses of Producer gas, Water-gas and Bio-gas. (ii) Liquid fuels: Crude of oil-refining, Gasolene, Octane number, Cetane number, Antiknock compounds.

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			2. Non-Conventional Sources of Energy; Solar energy. Wind energy. 3. Paints and Pigments: Methods of Preparation & uses of Ultramarine blue. 4. Ceramics: Manufacture of glazed porcelain (household items). 5. Insecticides: Different classes of insecticides -Organophosphorous, carbamates. 6. Oils and fats: Distinction between oils & fats, Saponification value, Iodine value, Hydrogenation of fats & oils. 7. Polymers: Preliminary ideas of polythene, PVC (composition & uses). 8. Cement: Cement-its composition, manufacture & uses, setting of cement.
	PAPER-VIII	Practical	Students will also have hands on experience of standard solution preparation in different concentration units and learn quantitative inorganic estimation of Fe^{3+} and Cu^{2+} through acid-base and redox reactions. Also will have the idea to do and report Project Work

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Paper wise Learning Outcomes of the Course
CHOICE BASED CREDIT SYSTEM (CBCS)
B.Sc. Program Course (SEM I, II, III, IV, V, VI)

SEMESTER	PAPER	TOPIC	LEARNING OUTCOMES
I	DSC-1	Section A: (Inorganic Chemistry)	1. Atomic theory and its evolution. 2. To predict the atomic structure and molecular geometry based on accepted models. 3. Chemical bonding e.g. covalent bonding & ionic bonding. Concept of lattice energy; Fagan's rules. 4. Characterize bonding between atoms, molecules, interaction and energetics. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bonddistancesand energies. MO Approach: MO treatment of homonuclear diatomic molecules and heteronuclear diatomic molecules such as CO, NO and NO^+. In practical, student will learn about volumetric analysis in inorganic part.
		Section B: (Organic Chemistry)	After the completion of this part students will be able to learn the following: 1. Fundamentals of Organic Chemistry: Electronic Displacements: Inductive Effect, Electrometric Effect, Resonance and Hyper conjugation; Nucleophiles and electrophiles; Reactive intermediates; acidity and basicity; Aromaticity. 2. Stereochemistry: Conformations Newman, Sawhorse and Fischer representations; Configuration; isomerism; chirality; R/ S and E / Z; Nomenclature. 3. Aliphatic Hydrocarbons: Alkanes: Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent; Reactions: Free radical Substitution: Halogenation. Alkenes: Preparation: Elimination reactions; cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: Markownikoff's and anti-Markownikoff's

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			addition, Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation. Alkynes: Preparation and reaction. In this practical, they will learn about detection of element in organic compound and paper chromatography in organic segment.
II	GE-2	Section A: (Physical Chemistry)	Upon successful completion students should be able to to understand the following: 1. Chemical Energetics: Basic Definitions and mathematical background. First Law, Enthalpy Functions, Relation between Cp and Cv, Joule-Thomson Experiment, Inversion of Temperature, Adiabatic Changes in State, Enthalpies of Chemical Changes, Important principles and definitions of thermochemistry. Hess's Law. The Second Law, Carnot Cycle and its efficiency. Variation of enthalpy of a reaction with temperature - Kirchhoff's equation. Statement of Third Law of thermodynamics. Entropy. 2. Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases. 3. Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. 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. In physical practical, student will learn about: 1. Determination of heat capacity of calorimeter for different volumes. 2. Determination of enthalpy of neutralization of

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			hydrochloric acid with sodium hydroxide
		Section B: (Organic Chemistry)	1. Electrophilic substitution: Nitration, halogenation and sulphonation. Friedel Craft's reaction (alkylation and acylation). Side chain oxidation of alkyl benzenes. 2. Alkyl and Aryl Halides: Alkyl Halides (Up to 5 Carbons). Types of Nucleophilic Substitution (SN1 and SN2) reactions. Preparation: Reactions: Williamson's ether synthesis: Elimination vs Substitution. 3. Aryl Halides Preparation: (Chloro, bromo and iodo-benzene): from phenol, Sandmeyer & Gattermann reactions. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3). 4. Alcohols and Phenols (Up to 5 Carbons): Alcohols: Preparation; Reactions; Oppeneaur oxidation. Pinacol Pinacolone rearrangement. Phenols: Preparation; Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer- Tiemann Reaction, Gattermann-Koch Reaction. 5. Aldehydes and ketones: (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde) Preparation: from acid chlorides and nitriles. Reactions - Reaction with HCN, ROH. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Benzoin condensation, Clemensen reduction. Account for the purification of organic compounds by crystallization, determination of melting point and boiling point, preparation of different organic compounds in laboratory.
III	DSC-3	Section A: (Physical Chemistry)	After successfully completion of 1st semester student will learn: 1. Solutions: 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.

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			3. Phase Equilibria: 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 system (water). 4. Conductance: Conductivity, equivalent and molar conductivity, weak and strong electrolytes. Kohlrausch law. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt, conductometric titrations. 5. Electrochemistry: Reversible and irreversible cells. Concept of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Calculation of thermodynamic properties (of a reversible cell): ΔG, ΔH and ΔS and equilibrium constant from EMF data. Potentiometric titrations-qualitative treatment. In practical part, student will learn about conductance of acid vs base and potentiometry.
		Section B: (Organic Chemistry)	After the completion of this part students will be able to learn the following: 1. Carboxylic acids and their derivatives: Preparation and Carboxylic acids, Acidic and Alkaline hydrolysis of ester, Hell - Vohlard - Zelinsky Reaction. Preparation of Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion. Reactions: Reformatsky Reaction, Perkin condensation. 2. Amines and Diazonium Salts Amines (Aliphatic and aromatic): Preparation: Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

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			Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO$_2$. Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol. 3. Amino Acids, Peptides and Proteins Preparation of Amino Acids: Strecker synthesis, Gabriel's phthalimide synthesis. Reactions of Amino acids: ester of –COOH group, acetylation of –NH_2 group, complexation with Cu2+ ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins, etermination of primary structure of peptides by degradation: Edmann degradation, (N terminal and C–terminal) (thiohydantoin and with carboxypeptidase enzyme). Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of absolute configuration of Glucose. Structure of disacharrides (sucrose) and polysaccharides' (starch and cellulose) excluding their structure elucidation. In practical part student will learn about Systematic Qualitative Organic Analysis of Organic Compounds possessing mono functional Groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.
	SEC-1 (DSC)	Pharmaceutical Chemistry.	Students will be able to know about antibiotics, analgesics and they will learn about the preparation of different types of drugs and their uses.
IV	GE-4	Section A: (Inorganic Chemistry)	After studying this course, students will learn about: 1. Transition Elements (3d series): General group trends with special reference to electronic configuration, variable valency, colour, magnetic properties, and ability to form complexes. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction.

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			3. Coordination Chemistry Valence Bond Theory (VBT): Inner and outer orbital complexes of Fe, Co, Ni and Cu. Structural and stereoisomerism in complexes 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature. 4. Crystal Field Theory: Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Δo. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Jahn-Teller distortion. In inorganic practical, student will try two types of experiment given below: 1. Semi-micro qualitative analysis: Detection of ions from a mixtures - not more than four ionic species (two anions and two cations, excluding insoluble salts). 2. Estimate the amount of nickel present in a given solution as bis (dimethylglyoximato) Nickel (Ii) in a given solution gravimetrically.
		Section B: (Physical Chemistry)	After studying this course, students will have the understandings of: 1. Gases: Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature. Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO2. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities. Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of

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			viscosity. 2. Liquids Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid. 3. Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation. Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories. In this practical segment, student will learn about: 1. Determination of the coefficient of viscosity of a liquid or dilute solution using an Ostwald's viscometer. 2. Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
	SEC-2 (DSC)	Green methods in chemistry	Students will be able to understand about green chemistry and its principles. They will also learn about some green approaches of some organic synthesis.
v	DSE-I (DSC)	Inorganic Materials of Industrial Importance	After successfully completion of 4th semester student will learn about industrial chemistry 1.Silicate Industries Classification and manufacture of Glass; Ceramics; Cements. 2. Fertilizers: Different types of fertilizers. Manufacture of the fertilizers. 3.Surface Coatings: Objectives of coatings surfaces, classification of surface coatings.

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			Paints and pigments-formulation, composition and related properties. Oil paint, Pigments, Special paints (eco-friendly paint), Dye, Water and Oil paints, anodizing. 3. Batteries: Primary and secondary batteries, Li-Battery, Fuel cells, Solar Cell. 4. Alloys: Classification of alloys, ferrous and non-ferrous alloys, Manufacture of Steel and surface treatment (argon treatment, heat treatment, nitriding, carburizing). 5. Catalysis: General principles and properties of catalysts, homogenous catalysis and heterogeneous catalysis, Deactivation or regeneration of catalysts, Phase transfer catalysts. In this part, student will learn about the practical related to the above chapters.
	SEC - 3 [DSC]	Pesticide Chemistry	1. General introduction to pesticides (natural and synthetic) 2. Benefits and adverse effects of pesticides 3. Changing concepts of pesticides 4. Structure activity relationship 5. Synthesis and technical manufacture and uses of representative pesticides in the following classes: (a) Organochlorines (DDT, Gammaxene) (b) Organophosphates (Malathion, Parathion) (c) Carbamates (Carbofuran and carbaryl) (d) Quinones (Chloranil) (e) Anilides (Alachlor and Butachlor) In this segment, student will learn about acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
VI	DSE-3	Polymer Chemistry	After successfully completion of 5th semester student will learn about industrial chemistry 1. Introduction and history of polymeric materials: Different schemes of classification of polymers,

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			Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. Classifications including di-,tri- and amphiphilic polymers. 2.Functionality and its importance: Addition and Condensation - Mechanism of Cationic, anionic and free radical addition polymerization. Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of Polymerization. Bifunctional systems, Poly-functional systems. 2. Kinetics of Polymerization: Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques. Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosetting (PVC, polythene). 4. Determination of molecular weight of polymers (Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. 5. Properties of Polymers (Physical, thermal, Flow & Mechanical Properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride), poly(vinyl acetate), polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Rubbers - natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization. In practical segment, student will learn about polymer related practical.
			1. Industrial Gases and Inorganic Chemicals Industrial Gases:

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	DSE-4	Industrial Chemicals and Environment	Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene. Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate. 3. Environment and its segments: Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution; Air pollutants; Photochemical Smog; Environmental effects of ozone, Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion Water Pollution: Hydrological cycle, water resources, Water purification methods. Effluent treatment plants, Industrial effluents from the following industries and their treatment; Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification. 4. Energy & Environment: Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management. In practical part, student will learn about practical related to the industrial chemicals and environment.

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