Syllabus for 3 years Diploma in Chemical Engineering

Introduction to Chemical Engineering

UNIT I Chemistry, Chemical Engineering and Chemical Technology; Chemical process industries: History and their role in Society; Role of Chemical Engineer; History and Personalities of Chemical Engineering; Greatest achievements of Chemical Engineering.

UNIT II Components of Chemical Engineering: Role of Mathematics, Physics, Chemistry and Biology; Thermodynamics, Transport Phenomena, Chemical Kinetics and Process dynamics, design and control.

UNIT III Concept of Unit Processes and Unit Operations; Description of different Unit Processes and Unit Operations; Designing of equipments; Flowsheet representation of process plants,

UNIT IV Role of Computer in Chemical Engineering; Chemical Engineering Software; Relation between Chemical Engineering and other engineering disciplines; Traditional vs. modern Chemical Engineering; Versatility of Chemical Engineering: Role of Chemical Engineers in the area of Food, Medical, Energy, Environmental, Biochemical, Electronics etc.

UNIT V Paradigm shifts in Chemical Engineering; Range of scales in Chemical Engineering; Opportunities for Chemical Engineers; Future of Chemical Engineering.

Industrial Chemistry

UNIT-I: Organic Chemistry Nomenclatures of organic compounds, functional groups.

UNIT-II: Classification of organic compounds, aliphatic Compounds, closed chain compounds, unsaturated. Alkanes, alkenes, alkyans, cycloalkanes. Halogenations, saturated halogenation Reaction of alkenes, oxidation, halogenation, Nitration, pyrolysis, isomerisation, dehydrogenation, Structures and reactivity of alkanes, cyclo alkanes. Alkenes, preparation, properties and reactions, Action of ozone, hydrogenation, halogenation, action of halogen acids, sulphuric acid, polymerization, uses of alkenes.

UNIT-III: Aromatic Compounds, alkyl halides, alchohol and phenols. Concept of aromacity, structure of benzene, properties of benzene, reactions of benzene, halogenation, hydrogenation, pyrolysis, Classification of alkyl halides, isomerism in alkyl halides, properties of alkyl halides, substitution reaction, elimination reaction, alcohols. Classification of alcohols, preparation, properties, reaction, phenols Classification, preparation, reaction.

UNIT-IV: Phase rule, Phase rule, phase, component, degrees of freedom, One component system

UNIT -V: Adsorption Definition, nature of adsorption, types of adsorption, Langmuir adsorption isotherm, Freundlich adsorption Isotherm, application, Solutions and Indicators Ideal solution, non-ideal solution, Azeotropic Mixture, and theory of indicators

CHEMICAL PROCESS CALCULATIONS

UNIT-I: Basics of unit operations and unit processes, Units and dimensions.

UNIT-II: Stoichiometric principles – composition relations, density and specific gravity. Behaviour of Ideal gases - application of ideal gas law - gaseous mixtures - volume changes with change in composition.

UNIT-III: Vapour pressure - effect of Temperature on vapour pressure - vapour pressure plots – vapour pressure of immiscible liquids - solutions. Humidity and Solubility: Humidity - saturation - vaporization - wet and dry bulb thermometry.

UNIT-IV: Material Balance - Processes involving chemical reaction - Combustion of coal, fuel gases and sulphur - Recycling operations - bypassing streams - Degree of conversion – excess reactant - limiting reactant. Unsteady state problems

UNIT-V: Energy Balance: Thermo chemistry - Hess's law of summation - heat of formation, reaction, combustion and mixing - mean specific heat - Theoretical Flame Temperature.

MOMENTUM TRANSFER

UNIT-I: Properties of fluids and concept of pressure: Introduction - Nature of fluids - physical properties of fluids - types of fluids. Fluid statics: Pressure - density - height relationships. Pressure measurement. Dimensional analysis. Similarity - forces arising out of physical similarity - dimensionless numbers.

UNIT-II: Momentum Balance and their Applications: Kinematics of fluid flow; Newtonian and non-Newtonian fluids - Reynolds number - experiment and significance - Momentum balance - Forces acting on stream tubes - Bernoulli's equation - Correction for fluid friction

UNIT-III: Flow of incompressible fluids in pipes – laminar and turbulent flow through closed conduits - velocity profile & friction factor for smooth and rough pipes - Head loss due to friction in pipes, fitting etc.

UNIT-IV: Flow of Fluids through Solids: Form drag - skin drag - Drag co-efficient. Flow around solids and packed beds. Friction factor for packed beds. Ergun's Equation - Motion of particles through fluids - Terminal settling velocity. Fluidisation - Mechanism, types, general properties – applications

UNIT-V: Transportation and Metering: Measurement of fluid flow: Orifice meter, Venturi meter, Pitot tube, Rotameter, weirs and notches Wet gas meter and dry gas meter. Hot wire and hot film anemometers. Transportation of fluids: Fluid moving machinery performance. Selection and specification. Positive displacement pumps, Rotary and Reciprocating pumps, Centrifugal pumps and characteristics, Introduction to Fans, Blowers & Compressors

MECHANICAL OPERATIONS

UNIT-I: Characteristics of Particulate Material: Properties and characterisation of particulate solids, Flow properties of particulates.

UNIT-II: Introduction to size reduction equipment, energy and power requirement in milling operations

UNIT-III: Separation of solids, Solid – Solid Separation Equipments

UNIT-IV: Particulate Processes: Solid-Liquid and Gas-Solid separation methods, Equipments Classification by size, agitation and mixing of solids and liquids,

UNIT- V: Handling of Particulate Material: Conveying methods, Storage methods, Feeders and elevators.

Engineering Thermodynamics

UNIT-I: Basic Concepts and Definitions: Energy conversion and efficiencies - System, property and state - Thermal equilibrium - Temperature - Zeroth law of Thermodynamics.

UNIT-II: First Law of Thermodynamics: The concept of work and adiabatic process - First law of thermodynamics - Conservation of Energy principle for closed and open systems - Calculation of work for different processes of expansion of gases

UNIT-III: Second Law of Thermodynamics: Equilibrium and the second law - Heat engines - Kelvin-Planck statement - Reversible and irreversible processes - Carnot principle - Clausius inequality-Entropy –Third Law of Thermodynamics

UNIT-IV: Gas Power Cycles: Air standard cycles: - Air standard Otto cycle, diesel cycle, dual cycle and Bryton cycles and their efficiencies

UNIT-V: Refrigeration Cycles and Systems: Reverse Carnot cycle - COP - Vapor compression refrigeration cycle and systems (only theory) - Gas refrigeration cycle - Absorption refrigeration system (only theory)- Liquification and solidification of gases

PROCESS HEAT TRANSFER

UNIT-I: Basic modes of heat transfer and the laws governing them. Steady state conduction through plane and composite walls general heat conduction equation, concepts of thermal diffusivity and equivalent thermal conductivity.

UNIT-II: Convection – Dimensional analysis and empirical correlations, Critical insulation thickness for cylindrical and spherical surfaces, Physical significance of the dimensionless groups.
UNIT-III: Thermal Radiation laws, spectrum of electromagnetic radiation, Black and Gray bodies and configuration factor – typical examples. Boiling and condensation.
UNIT-IV: Heat Exchangers – classification, overall and individual film coefficients, mean temperature difference, LMTD correction factor for multiple pass exchanger
UNIT-V: Evaporation, single and multiple effect operation, material and Energy balance in evaporators, boiling point elevation, Duhring's rule, effect of liquid head.

MASS TRANSFER - I

UNIT-I: Definition- Ficks law, Molecular and eddy diffusion, Diffusion in gaseous mixtures, liquid mixtures and solids, measurement and calculation of diffusivities. Mass transfer coefficients - Individual and overall with relations, Theories of mass transfer, Analogies between momentum, heat and mass transfer to predict mass transfer coefficients.
UNIT-II: Absorption – Solubility, theory of gas absorption, Concept of Equilibrium and operating lines. Mass Transfer Equipments- Batch and continuous, Stage wise contactors and Differential contactors, Concept of HTU and NTU, Tower packings and packing characteristics,
UNIT-III: Humidification Theory, Psychometric Chart, Adiabatic Saturator, Wet Bulb Theory, Methods of Humidification and dehumidification, Cooling towers,
UNIT-IV: Drying Theory and Mechanism, Drying Characteristics, Estimation of Drying time, drying rate curve, Classification of Driers, Description and Application of Driers, Continuous driers.
UNIT-V: Crystallization, Solubility curve, Types of crystals, Principles of Crystallization, Supersaturation Theory, Factors governing nucleation and crystal growth. Theory of crystallization, Classification of crystallizers and their applications

CHEMICAL ENGINEERING THERMODYNAMICS

UNIT-I: Introduction to Basic laws and Terminologies in Thermodynamics- Statement of First law, P-V-T behavior of pure fluids - Heat effects accompanying chemical Reactions - Statements of second law- Clausius Inequality-Mathematical Statement of Second law-Third Law of Thermodynamics.
UNIT-II: Applications to Laws of Thermodynamics - Flow processes: Flow in pipes, Flow through nozzles, Compression- Refrigeration
UNIT-III: Thermodynamic Properties of Pure Fluids- Classification of Thermodynamic properties – Work function and Gibb's Free energy-Fundamental Property relations-Maxwell's equations Clapyeron equation- -Differential equations of Entropy Relationship between Cp and Cv-Effect of pressure and volume on Cp and Cv- Gibb's Helmholtz Equation
UNIT-IV: Thermodynamic Properties of Solutions - Introduction to fugacity and activity, Activity coefficients-Partial molar properties- Lewis Randall rule-Roults and Henry's law-Gibbs Duhem Equation
UNIT-V: Phase Equilibria and Chemical Reaction Equilibria - Criteria for phase equilibrium, Criterion of stability, Phase equilibria in single and multiple component systems, Duhem's theorem, VLE for Ideal solutions, Reaction stoichiometry-Equilibrium constant- Feasibility of reaction- Effect of temperature, pressure, volume and other factors

CHEMICAL TECHNOLOGY

UNIT-I: Natural Products Processing: Production of pulp, paper and rayon, Manufacture of sugar, starch and starch derivatives, Gasification of coal and chemicals from coal.
UNIT-II: Industrial Microbial Processes and Edible Oils: Fermentation processes for the production of ethyl alcohol, citric acid and antibiotics, Refining of edible oils and fats, fatty acids, Soaps and detergents.

UNIT-III: Alkalies and Acids: Chlor - alkali Industries: Manufacture of Soda ash, Manufacture of caustic soda and chlorine - common salt. Sulphur and Sulphuric acid: Mining of sulphur and manufacture of sulphuric acid. Manufacture of hydrochloric acid.
UNIT-IV: Cement Gases, Water and Paints: Types and Manufacture of Portland cement, Glass: Industrial gases: Carbon dioxide, Nitrogen, Hydrogen, Oxygen and Acetylene - Manufacture of paints – Pigments
UNIT-V: Fertilisers: Nitrogen Fertilisers; Synthetic ammonia, nitric acid, Urea, Phosphorous Fertilisers: Phosphate rock, phosphoric acid, super phosphate and Triple Super phosphate

CHEMICAL ENGINEERING DRAWING

UNIT-I: P & ID symbols – Line numbering – line scheduling – Typical P & ID diagrams, Different types of valves, Pumps, Gland & Stuffing box
UNIT-II: Drawing of vessels & supports such as bracket, saddle, skirt.
UNIT-III: Storage Tanks, Cyclone separators centrifuges, thickeners and filtration equipments.
UNIT-IV: Crystallizers, agitated vessel, jacketed and coil heated vessels.
UNIT-V: Double Pipe & Shell & Tube Heat Exchangers, Tray Columns & Packed

MASS TRANSFER – II

UNIT-I: Principle, theory, Vapour Liquid Equilibria calculations, Effect of Pressure and temperature on VLE, Methods of distillations, batch, continuous, flash, steam distillation.
UNIT-II: Stage-wise and continuous contactors operations, Mc-Cabe Thiele Method, Azeotropic distillation and Extractive distillation, Introduction - Multi component Flash and differential distillation.
UNIT-III: Liquid - Liquid Equilibria, Effect of Pressure and Temperature on LLE, Solubility criteria, Batch and continuous extraction towers for miscible and immiscible systems. Industrial Applications.
UNIT-IV: Theory, Mechanism, Types of leaching, Solid - Liquid equilibria, Batch and continuous extractors. Equipments and industrial applications.
UNIT-V: Types of adsorption, nature of adsorbents, Adsorption isotherms, Operation of adsorption columns. Batch and continuous operations

CHEMICAL REACTION ENGINEERING

UNIT-I: Basics of Rate process and Chemical Kinetics: Introduction – Rate of a Chemical Reaction, kinetics of homogeneous reactions: Concentration dependent, Temperature dependent term of rate equation, Searching for a mechanism. Interpretation of Batch Reactor data.
UNIT-II: Types and Mechanisms of Chemical Reactions, Single Ideal Reactors, Batch, Mixed flow reactors and plug flow reactors – Performance equations
UNIT-III: Reactors for Multiple Reactions. Size comparison of single reactors for single reactions. Multiple Reactor system for single reactions. Reactions in parallel, reactions in series and series - parallel reactions of first order. Recycle reactor, auto catalytic reactions.
UNIT-IV: Heat Effects: Temperature and pressure effects on single and multiple reactions.
UNIT-V: Non - ideal flow: Residence time distribution studies: C, E, F and I curves

PROCESS CONTROL & INSTRUMENTATION

UNIT-I: Laplace transforms - properties of Laplace transform, solution of linear differential equations using Laplace transform techniques, piecewise continuous functions
UNIT-II: Dynamic behaviour of systems - derivation of transfer functions for first and second order systems, liquid level, temperature, pressure, flow and concentration control processes, linearization of nonlinear systems, interacting and non-interacting systems.
UNIT-III: Transient response of first and second order systems, natural frequency, damping factor, overshoot, decay ratio, rise time and settling time.

UNIT-IV: Transient analysis of control systems - block diagram algebra, overall transfer function of closed loop control systems, regulator and servo problems, transient response of first and second order systems with P, PI and PID controller. Definition of stability of control systems, Routh test, limitations of Routh test.

UNIT-V: Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

PROJECT ENGINEERING

UNIT-I: Plant location and site selection, CCOE Clearance, MoEF Clearance, plant layout, factors affecting plant location, project planning and scheduling of projects, project financing, Flow sheeting, Selection of Process Equipment. Process utilities, process water, boiler feed water, steam distribution including appropriate mechanical valves and instrumentation, process pumps, compressors, Refrigeration plant.

UNIT-II: Piping design and piping, Connecting pipes to process equipment, layout, Support for piping insulation, plant constructions, star-up and commissioning.

UNIT-III: Value of money, Equations for economic studies and equivalence. Amortization, Capital recovery and Depreciation. Project implementation steps, Feasibility studies, Capital requirements for process plants, Cost indices, Equipment cost, Service facilities.

UNIT-IV: Balance sheet, Variable cost, Fixed cost, Income statement, Economic production charts. Capacity factors, Taxes and Insurance, Cash flow analysis.

UNIT-V: Economics of Selecting Alternates: Annual cost method, Present worth method, Equivalent alternates, Rate of return and Pay out time. Overall Cost Analysis and Economic Trade Offs: Economic balance: Economic balance in batch operations, Overall cost analysis for the plant, Economic tradeoffs.

MATERIAL SCIENCE AND TECHNOLOGY

UNIT-I: Atomic Bonding: Classes of engineering materials - engineering requirement of materials - selection of materials - structure of atoms and molecules - Bonding in solids - types of bonds and comparison of bonds.

UNIT-II: Structure and Imperfections in Crystals: Crystal structure Crystal geometry, structure of solids, methods of determining structures. Imperfection in crystals - types of imperfection. Point imperfection

UNIT-III: Properties and Corrosion of Material: Mechanical, Electrical and magnetic properties of materials - Deformation of materials - Heat Treatment techniques - corrosion, theories of corrosion - control and prevention of corrosion.

UNIT-IV: Metals: Engineering materials - ferrous metals - Iron and their alloys Iron and steel Iron carbon equilibrium diagram. Non-ferrous metals and alloys - Aluminium, copper, Zinc, lead, Nickel and their alloys with reference to the application in chemical industries.

UNIT-V: Non Metals: Inorganic materials: Ceramics, Glass and refractories - organic materials: wood, plastics, and rubber and wood - Advanced materials (Biomaterials, nanomaterials and composites) with special reference to the applications in chemical Industries.

PETROLEUM REFINING & PETROCHEMICAL TECHNOLOGY

UNIT-I: Introduction & primary processing: Origin & formation of crude oil, Classification of crude, Characterization of crude, Distillation practise, Atmospheric distillation, Vacuum distillation.

UNIT-II: Secondary Processing: FCCU, Hydro cracking, Visbreaking, Coking, Reforming, Alkylation, Isomerisation and polymerization processes.

UNIT-III: Treatment Techniques: Physical & chemical impurities in petroleum fractions, General mechanisms for removal of Sulphur, Treatment of LPG, Gasoline, Kerosene, Diesel and Lube oils. Properties of ATF and Bitumen.

UNIT-IV: Petrochemical: Building blocks, intermediates, major petrochemicals and their applications,
UNIT-V: Chemicals from methane and synthesis gas, Chemicals from olefins, Chemicals from aromatics, Synthetic fibres, plastics and rubber

FOOD TECHNOLOGY

UNIT-I: Fundamentals of Food Process Engineering, Application of Quantitative methods of Material & Energy balances in Food Engineering Practices. Constituents of Food, Quality and Nutritive aspects, Food Adulterations, Deteriorative factors and Control
UNIT-II: Fluid Flow, Thermal Process Calculations, Refrigeration, Evaporation and Dehydration operations in Food Processing
UNIT-III: Fundamentals of Food Canning Technology, Heat Sterilization of Canned food, Containers – metal, Glass and Flexible packaging. Canning Procedures for Fruits, Vegetables, Meat, Poultry and Marine Products
UNIT-IV: Preservation by Heat and Cold, Dehydration, Concentration, Drying, Irradiation, Microwave heating, Sterilization and Pasteurization, Fermentation and Pickling, Packaging Methods
UNIT-V: Cereal, Grains, Pulses, Vegetables, Fruits, Spices, Fats and Oils, Bakery, Confectionary and Chocolate Products. Soft and Alcoholic Beverages, Dairy Products, Meat, Poultry and Fish Products.

INSTRUMENTAL METHOD OF ANALYSIS

UNIT-I: INTRODUCTION OF SPECTROMETRY: Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio – sources of noise – Enhancement of signal to noise – types of optical instruments – Principle of Fourier Transform optical Measurements.
UNIT-II: MOLECULAR SPECTROSCOPY: Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Instrumentation – Applications -Theory of fluorescence and Phosphorescence –Instrumentation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications.
UNIT-III: MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY: Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR spectrometers – ap -plications of 1H and 13C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applica -tions of molecular mass – Electron paramagnetic resonance- g values – instrumentation.
UNIT-IV: SEPARATION METHODS: General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography-principles of GC and applications – HPLC- Capillary electrophoresis – Applications.
UNIT-V: ELECTRO ANALYSIS AND SURFACE MICROSCOPY: Electrochemical cells- Electrode potential cell potentials – potentiometryreference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry. Study of surfaces – Scanning probe microscopes – AFM and STM

SAFETY IN CHEMICAL PROCESS INDUSTRIES

UNIT-I: Hazard identification methodologies, risk assessment methods - PHA, HAZOP, MCA, ETA, FTA, consequence analysis,
UNIT-II: Hazards in work places - nature and type of work places, types of hazards, hazards due to improper house-keeping, hazards due to fire in multi-floor industries and buildings, guidelines and safe methods in the above situations.

UNIT-III: Workers' exposures to hazardous chemicals, TLVs of chemicals, physical and chemical properties of chemicals leading to accidents like fire explosions, ingestion and inhalation, pollution in work places due to dangerous dusts, fumes and vapours, guidelines and safe methods in chemicals handling, storage and entry into confined spaces.
UNIT-IV: Hazards peculiar to industries like fertilizer, heavy chemicals, petroleum, pulp and paper, tanneries, dyes, paints, pesticides, glass and ceramics, dairy and sugar industries, guidelines for safeguarding personnel and safeguarding against water, land and air pollution in the above industries.
UNIT-V: Safety education and training - safety management, fundamentals of safety tenets, measuring safety performance, motivating safety performance, legal aspects of industrial safety, safety audit.

PLANT UTILITIES

UNIT-I: IMPORTANT OF UTILITIES: Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.
UNIT-II: STEAM AND STEAM GENERATION: Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.
UNIT-III: REFRIGERATION: Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.
UNIT-IV: COMPRESSED AIR: Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air –Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.
UNIT-V: FUEL AND WASTE DISPOSAL: Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. Internal Combustion Engine, Petrol and Diesel Engine. Waste Disposal.

PETROLEUM ENGINEERING

UNIT-I: Earth science - occurrence of petroleum Rocks and traps. Reservoir rocks and properties. Classification of oil and gas reserves Reservoir mechanics and drive mechanism.
UNIT-II: Drilling – introduction to drilling of oil and gas wells. Drilling rigs and equipments. Drilling fluids and cementing.
UNIT-III: Logging techniques. Various types of logs. Formation parameters. Log applications. Formation evaluation. Well completion.
UNIT-IV: Petroleum exploration – well testing, production potential and well performances. Material balance, Artificial lift, Improved recovery methods.
UNIT-V: Surface equipments, processing of oil and gas. Transportation of oil and gas. Effluent treatment. Petroleum economics. Supply and demand trends.

ENERGY ENGINEERING

UNIT-I: Fuels - Classification, Properties, tests and analysis. Solid Fuels - Coal, origin, classification, storage and handling, carbonization, gasification and briquetting - gasification of biomass.
UNIT-II: Liquid fuels - Petroleum based fuels, synthetic fuels, alcohol and blended fuels, storage and handling.
UNIT-III: Gaseous fuels - Water gas, carbureted water gas, producer gas, coal gas and natural gas.
UNIT-IV: Combustion - Air requirement for solid, liquid and gaseous fuels, Combustion equipment
UNIT-V: Solar energy, Wind energy, Tidal energy, Hydropower, Geothermal energy, Nuclear energy.

MODERN SEPARATION TECHNIQUES

UNIT-I: Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipments design and Applications. Zone Melting

UNIT-II: Chromatographic techniques, Equipment and Commercial processes, Molecular Sieves.

UNIT-III: Cryogenic, Supercritical fluid extraction and Azeotropic separation.

UNIT-IV: Principle of membrane separations process; Classification: Reverse osmosis, Ultra-filtration, Micro-filtration, Nano-filtration and Dialysis; Membrane modules and application; Electro-dialysis; Per-vaporation and gas separation using membranes; Electrophorosis; Liquid membranes.

UNIT-V: Foam and bubble separation: Principle; Classification; Separation techniques; Column operations. Surface Adsorption, Nature of foams.

WASTE MANAGEMENT

UNIT- I: Types and Sources of Solid and Hazardous Wastes - Need for Solid and Hazardous Waste Management, Waste Generation Rates - Composition – Hazardous Characteristics,

UNIT-II: Waste Sampling - Source Reduction of Wastes - Recycling and Reuse - Handling and Segregation of Wastes at Source - Storage and Collection of Municipal Solid Wastes - Analysis of Collection Systems - Need for Transfer and Transport - Transfer Stations - Labelling and Handling of Hazardous Wastes.

UNIT-III: Waste Processing - Processing Technologies - Biological and Chemical Conversion Technologies - Composting - Thermal Conversion Technologies - Energy Recovery - Incineration - Solidification and Stabilization of Hazardous Wastes - Treatment of Biomedical Wastes –

UNIT-IV: Disposal in Landfills - Site Selection - Design and Operation of Sanitary Landfills - Secure Landfills and Landfill Bioreactors - Leachate and Landfill Gas Management - Landfill Closure and Environmental Monitoring - Closure of Landfills - Landfill Remediation –

UNIT-V: Legislations on Management and Handling of Municipal Solid Wastes, Hazardous Wastes, and Biomedical Wastes - Elements of Integrated Waste Management

PROCESS EQUIPMENT DESIGN

UNIT-I: Design of Pressure Vessels: Design of vessels and its components

UNIT-II: Design of heads/closures, design of supports and design of high pressure vessels.

UNIT-III: Design of Storage tanks, Agitated vessels and Reaction vessels.

UNIT-IV: Design of Phase Separation Equipment - Design of physical separation equipments.

UNIT-V: Design of Heat Transfer Equipments such as heat exchangers without and with phase change. Design of Mass Transfer Equipments: Design of mass transfer equipments such as distillation columns, absorption columns, extraction columns.

COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING

UNIT-I: INTRODUCTION: Review on Programming languages, Basic, Fortran, Review on operating system commands.

UNIT-II: SPREAD SHEETS: Application in Density, molecular weight, mole and percentage compositions, Empirical and Molecular formula calculations, Heat of mixing, Gas laws, Vapour pressure, Chemical Kinetics calculations.

UNIT-III: SPREAD SHEETS: Application in data processing, Statistical analysis of data, Regression. Analysis of variance, Interpolation, Graphical representations of various Chemical Engineering problem both in laboratory exercise and core subjects such as Mechanical operation, Reaction Engineering, Distillation etc.,

UNIT-IV: DATABASE: Design and developments of simple databases on Chemical and Physical properties of substances. Retrieval and Database in report, query and other formats, Interfacing with other software. Preparation of Material and energy Balances preparation of plant layout.

UNIT-V: MATHEMATICAL PROGRAMMING: Linear Programming, Transportation, Assignment, Dynamic Programming in Chemical Engineering, Formulation and solution through PC based programmes.

Note: The above syllabus is indicative and the questions in the test may include similar other topics pertaining to the level and content of essential qualification.