B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-201 PROCESS FLUID MECHANICS

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:
To make the students understand the basic concepts of fluids and fluid flow which are essential in majority of the engineering applications. After undergoing this course the students will have the knowledge of various pressure measuring instruments, Fluid statics, Types of fluid motion, Fluid dynamics, Pipe flow, The concept of boundary layer, Lift and drag etc.

UNIT-I	Basic fluid concepts, Velocity and stress fields, Classification of fluids. Basic equation for pressure field, Manometers. Dimensional Analysis, Methods of dimensional analysis.
UNIT-II	Fluid Flow Phenomena, Types of flows, Methods of analysis. Basic Equations of Fluid Flow, Differential analysis, Potential flows, Velocity Potential, Navier-Stokes equation, Energy (Bernoulli) equation. Flow Through Pipes, Introduction to turbulent flows, K factors, Valves, Pipe networks.
UNIT-III	Flow Measuring Devices, Impinging jet, Pitot tube, Orifice meter, Rotameter, V-notch, Water current meter etc. Pumps and Compressors, Types, Working, Basic equations.
UNIT-IV	Flow of Compressible Fluids, Basic equations, Isentropic Flow through nozzles, Adiabatic friction flow, Isothermal friction flow. Agitation and Mixing of Liquids, Power consumption, Mixing times, Scale up. Flow Through Coils, Helical coils and spherical coils.

Recommended Books,

- Kumar D S, Fluid Mechanics and Fluid power Engineering, Katson Publications
- McCabe W, Smith J and Harriott P, Unit Operations of Chemical Engineering, McGraw-Hill
- Fox R W, MacDonald A T and Pritchard P J, Introduction to Fluid Mechanics, Wiley & Sons Inc
- Denn M, Process Fluid Mechanics, Prentice Hall
- Foust A S, Wenzel L A and Clump C W, Principles of Unit Operations, John Wiley & Sons Inc

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-203 MECHANICAL OPERATIONS

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

To make the students understand the basic concepts of mechanical operations which are essential in majority of the engineering applications. After undergoing this course the students will have the knowledge of Particle Size Analysis, Size Reduction, Storage of Solids, Particle Mechanics, Sedimentation and Floatation, Flow Through Packed Beds, Fluidization, Filtration, Fluid-Solid Conveying etc.

UNIT-I	Determination of mean particle size, Particle shape, And particle size distribution, Screening, Types of screens, Screen effectiveness and efficiency, Particle size analysis using screens, Size Reduction, Principles of crushing and grinding, Laws of size reduction, Industrial size reduction equipment, Closed and open circuit grinding.
UNIT-II	Fluid-Solid Separations, Stoke's law, Free and hindered settling, Clarifiers and thickeners, Settling chambers, Elutriation, Bag filters, Electrostatic precipitators, Froth-flotation, Magnetic separators, Centrifugal separators, Flow Past Immersed Bodies, Friction in flow through beds of solids,. Motion of particles through fluids.
UNIT-III	Fluidization, Mechanism of fluidization, Determination of minimum fluidization velocity, Determination of velocity range for the operation of a fluidized bed, Types of fluidization, Applications of fluidization. Filtration, Theory of filtration and filtration equipment.
UNIT-IV	Handling of Solids, Storage of solids, Sizing of hoppers and bins, Mechanical, Pneumatic and hydraulic conveying systems, Mixing of solids and power index.

Recommended Books:

- McCabe W L, Smith J C, And Harriott P, Unit Operations of Chemical Engineering. McGraw-Hill
- Coulson J M, And Richardson J F, Chemical Engineering, Vol. 2, Butterworth-Heinemann
- Narayanan C M and Bhattacharya B C, Mechanical Operations for Chemical Engineers, Khanna Publishers
- Foust A S, Wenzel I A, Clump C W, Maus I B, Principles of Unit Operations, John Wiley & Sons
- Perry R H and Green D W, Chemical Engineer's Handbook, McGraw-Hill

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-205 CHEMICAL TECHNOLOGY-I

L	T	P	Cr
4	-	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The aim of the course is to study process technologies, Availability of raw materials, Production trends, Material and energy balances, Flow sheets, Engineering problems pertaining to materials of construction, Waste regeneration/recycling, Environmental and energy conservation measures, For various inorganic chemical industries.

UNIT-I	Introduction to Chemical Engineering, Unit operations and unit processes, Functions of a chemical engineer in chemical and bio-chemical process industries. Industrial and Fuel Gases, Oxygen, Nitrogen, Hydrogen, Carbon dioxide, Natural gas, LPG, Producer gas, Water gas, Carbureted water gas, Coke oven gas, Synthesis gas.
UNIT-II	Nitrogen Industries, Ammonia, Nitric acid, Ammonium sulphate, Ammonium nitrate, Urea, Calcium ammonium nitrate. Phosphorus Industries, Phosphorus, Phosphoric acid, Phosphatic fertilizers. Mixed Fertilizer, N P K fertilizers, Diammonium hydrogen phosphate.
UNIT-III	Chlor-Alkali Industries, Brine electrolysis, Manufacture of caustic soda and chlorine in mercury cells, Diaphragm cells, Membrane cells, Hydrochloric acid. Soda ash. Sulphur Industries, Sulphur dioxide, Sulphuric acid, And oleum.
UNIT-IV	Ceramic Industries, Portland Cement, Other Cement, Lime, Gypsum, Glass Industries, Methods of manufacture of glass and special glasses. Explosives, Propellants, And Toxic Chemical Agents, Types and characteristics of explosives, Industrial explosives, Propellants, Rockets and Missiles, Propellants for rockets. Metallurgical Industries, Iron and steel, Cryogenics, Applications in chemical industry.

Recommended Books:

- Rao M G and Sittig M, Dryden's outlines of Chemical Technology-For the 21st century, Affiliated East West Press
- Austin G T, Shreve's Chemical Process Industries, McGraw-Hill
- Faith W L, Keyes D B and Clark R L, Industrial Chemicals, John Wiley

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-207 NUMERICAL METHODS IN CHEMICAL ENGINEERING

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

This course covers the application of different computational techniques for solving and analyzing the chemical engineering problems.

The first part of this course begins with the introduction to matrix algebra and numerical techniques. Attention has been paid to the analysis of linear and nonlinear system behaviors.

The second part of the course is designed to give students the ability to develop mathematical models and to obtain numerical solution of steady-state and unsteady-state problems related to chemical engineering systems.

UNIT-I	Errors, classification, Significant digits and numerical stability, Linear algebraic equations, Cramer's rule, Gauss elimination, Decomposition Gauss-Jordan elimination, Gauss-Seidel and relaxation methods.
UNIT-II	Eigen values and Eigen vectors of matrices, faddeev leverrier's method, Power Method. Non linear algebraic equations, single variable successive substitutions (fixed point method), Multivariable successive substitutions, Single variable Newton-Raphson technique, Multivariable Newton-Raphson technique.
UNIT-III	Fuction evaluation, least squares curve-fit (linear regression), Newton's interpolation formulae (equal intervals), Newton's divided difference interpolation polynomial, Lagrangian interpolation unequal intervals), Differentiation formulae, Integration formulae or quadratures (trapezoidal, Simpson's 1/3 and 3/8 rules), Extrapolation technique of Richardson and Gaunt.
UNIT-IV	Ordinary differential equations (initial value problems and boundary value problems), the finite difference technique. Introduction of finite element methods.

Recommended Books:

- Jain M K, Jain R K, Iyengar S R K, Numerical Methods for Scientific and Engineering Computation by New Age International
- Finlayson B A, Nonlinear Analysis in chemical engineering, McGraw Hill, New York
- Villadsen J, And Michelsen M L, Solution of Differential Equation Models by Polynomial approximation, Prentice Hall, N J
- Richard G Rice & Duong D Do, Applied Mathematics and Modeling for Chemical Engineers, John Wiley & Sons, Inc

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-209 MATERIAL AND ENERGY BALANCES

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

To teach students fundamental knowledge of chemical engineering and application of this knowledge in the solving of material and energy balances of chemical processes. After undergoing this course the students will have the knowledge of basics such as units and dimensions, Stiochiometry to the simultaneous application of material and energy balances with and without occurrence of chemical reaction, Behaviour of ideal gases including the procedures for estimation of vapour pressure and heats of vaporization, Humidity and saturation along with the use of humidity chart and steam tables.

UNIT-I	Introduction, Role of chemical engineering in industry, Schematic flow sheets including symbols, Unit operations and unit processes with reference to MEB calculations. Introduction to units systems, Units and dimensions, Mole, Specific gravity, Specific volume, Concentrations, Stoichiometry of chemical equations, Mole fraction and weight fraction, Degrees of freedom.
UNIT-II	Behavior of Gas and Liquid Mixtures, Real gases, Bubble point and dew point temperatures, Henry's law, Duhring's plot. Saturation, Partial saturation, Relative saturation.
UNIT-III	Material Balance Calculations, Law of conservation of mass and component. Simple mass balances, Material balance calculations without chemical reactions, Material balance calculations involving chemical reactions, Recycling, Bypass, Purge, Analysis of degree of freedom for material balance problems.
UNIT-IV	Energy Balance Calculations, Internal energy, Enthalpy, Heat capacity of gases, Liquids, And solids, Latent heats, Heats of formation, Combustion, Reaction and dissolution, Enthalpy-concentration chart, Fuel heating value, Theoretical flame temperature, Energy balance calculations in unit operations and systems with and without chemical reactions, Humidity and humidity chart, Energy balance calculations in humidification and adiabatic cooling.

Recommended Books:

- Himmelblau D M, Basic Principles and Calculations in Chemical Engineering, Prentice Hall of India
- Bhatt B I, And Vora S M, Stoichiometry, Tata McGraw-Hill
- Hougen O A, Watson K M and Ragatz R S, Chemical Process Principles, Volume I, CBS Publications
- Felder R M and Rousseau R W, Elementary Principles of Chemical Processes, John Wiley

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

HS-201 ESSENTIALS OF MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

To help the students lay a foundation to an understanding of Management and Organizational behavior which are essential fields of study to make a success of both their professional and personal lives.

UNIT-I	Concept of management, Characteristics and Importance, Management vs Administration, Management as an art a science and as a profession, Levels of Management, Contributions of Henry Fayol, FWTaylor & Elton Mayo, Management Functions, Planning, Organizing, Staffing, Directing and Controlling.
UNIT-II	Concept & significance of Organizational Behavior, Challenges and opportunities in the field of OB, Model of OB. Learning, Attitude, Job Satisfaction, Personality, Perception and Individual Decision-making, Motivation, Theories of Motivation by Maslow, Herzberg and McGregor.
UNIT-III	Classification of Groups, Stages of Group Development, Group Properties, Group Decision-making. Types of Teams, Creation of an Effective Team, Difference between a group and a team. Styles of Leadership, Theories of Leadership by Blake and Mouton, Contingency Theory by Fiedler.
UNIT-IV	Organizational Structure, Common Organizational Design, New Organization Design options, Change, Organizational Change, Planned Change, Resistance to Change, Models of Organizational Change.

Recommended Books:

- Koontz , Essentials of Management, Tata McGraw Hill
- Robbins and Coulter, Management, PHI, 8th Ed.
- Robbins and Judge, Organizational Behavior, Pearson
- Pareek, Understanding Organizational Behavior, Oxford
- Luthans, Organizational Behaviour, McGraw Hill Education

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-211 PROCESS FLUID MECHANICS LAB

L	T	P	Cr
-	-	2	1

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 02 Hours

EXPERIMENTS	• Verification of Bernoulli's theorem • Calibration of venturimeter • Calibration of orifice meter • Determination of friction factor for pipes of different materials • Determination of hydraulic coefficients of an orifice • Determination of loss coefficients for various types of pipe fittings • Calibration of a triangular notch • Calibration by Rotameter • Characteristic curves of centrifugal pumps • Determination of stability of floating body • Measurement of losses due to contraction and expansion • Verification of laminar/ turbulent flow regime in a flow process

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-213 MECHANICAL OPERATIONS LAB

L	T	P	Cr
-	-	3	1.5

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• Verification of Stokes Law. • Screen analysis of given sample for it's particle size distribution. • Determination of variation in pressure drop & bed height w.r.t superficial velocity for a bed of solids. • Determination of minimum fluidization velocity for a bed of solids. • Operating characteristics of crushing and grinding equipments,(Jaw crusher, Roll crusher) • Determination of %age recovery of coal in froth from coal and sand mixture. • Determination of thickener capacity using batch sedimentation. • Determination of the separation efficiency of the classifier. • To determine filtration constants for a given slurry in the Leaf filter. • To plot power function Vs. Reynolds number for various size of impellers in agitated vessel. • To study the specific rate of breakage of a particular feed size of the given feed material in the lab scale ball mill. • To plot characteristics curves for centrifugal pump. • To determine crushing law constant by using Rittinger's law, Bond's law and Kick's law.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-217 NUMERICAL METHODS IN CHEMICAL ENGINEERING LAB

L	T	P	Cr
-	-	3	1.5

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• Solution of a system of linear equations in unknowns by Gaussian elimination. • Gauss-Seidel iterative method to solve a linear system of equations. • To find the inverse of matrix by Gauss-Jordan method. • Application of Faddeev-Leverrier's method. • Method for finding dominant Eigen value and corresponding Eigen vectors by power method. • Solution of nonlinear equation by Newton Raphson method. • Application of Newton's formulae for interpolation. • Application of LaGrange polynomial interpolation formula. • Application of Newton's formula for numerical differentiation. • Numerical integration by Trapezoidal rule. • Numerical integration by Simpson's rules. • Solution of an O.D.E. by Runga Kutta Methods. • Application of finite difference technique.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ELGA-201 ENGLISH LANGUAGE AND GENERAL AWARENESS-III

L	T	P	Cr
2	-	-	-

Internal Evaluation: 50 Marks

Course Objective:
To help the students acquire the ability to develop a well-structured paragraph and also to provide them basic knowledge of issues relating to poverty in India.

UNIT-I	**Paragraph Development** • Guidelines for effectiveness of a paragraph • Fog Index (an indication of clarity of any text) by Robert Gunning • Expanding an idea into a paragraph
UNIT-II	**General Awareness** (a) Poverty in India • The concept of poverty • Various estimates of poverty • Economic reforms and reduction of poverty • Poverty eradication programs: a review (b) Biography: Ratan Tata (c) Book Review: Ignited Minds by APJ Abdul Kalam (d) Industry Overview: Small Scale Industries

Recommended Books:

- Barun K Mitra, Effective Technical Communication, Oxford
- Tyagi Kavita & Misra Padma, Basic Technical Communication, PHI
- Raman Meenakshi & Sharma Sangeeta, Technical Communication, Oxford
- Datt & Sundharam, Indian Economy, S Chand
- Sharma R C, Krishna Mohan, Business Correspondence and Report Writing, TMH

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-202 INDUSTRIAL POLLUTION ABATEMENT

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The aim of this course that the students will learn the essential principles used in Industrial pollution abatement and understand important issues in Industrial pollution abatement and pertinent environmental legislations. After undergoing this course the students will have the knowledge of surface water and ground water quality and the remediation technologies, The design processes for treatment of environmental Pollutants, Indoor air pollution and control, As well as global atmosphere change.

UNIT-I	Introduction, Industrial pollution, Different types of wastes generated in an industry, Different water pollutants, Air pollutants and solid wastes from industry, Their effects on living and non-living things, Environmental regulatory legislations and standards, Importance of industrial pollution abatement, Concept of sustainable development, Green house gases, Global warming and climate change.
UNIT-II	Water Pollution, Identification, Quantification and analysis of wastewater, Classification of different treatment methods into physico-chemical and biochemical techniques, Physico-chemical methods, General concept of primary treatment, Liquid-solid separation, Design of a settling tank, Neutralization and flocculation, Biological methods, Concept of aerobic digestion, Design of activated sludge process, Concept of anaerobic digestion, Biogas plant layout, Different unit operations and unit processes involved in conversion of highly polluted water to potable standards.
UNIT-III	Air Pollution, Classification of air pollutants, Nature and characteristics of gaseous and particulate pollutants, Analysis of different air pollutants, Description of stack monitoring kit and high volume sampler, Atmospheric dispersion of air pollutants, Gaussian model for prediction of concentration of pollutant down wind direction, Concept of temperature inversion, Plume and its behavior, Concept of effective stack height, Operating principles and simple design calculations of particulate control devices like gravity settling chamber, Cyclone, Bag filters, Electrostatic precipitators and scrubbers, Brief concepts of control of gaseous emissions by absorption, Adsorption, Chemical transformation and combustion.
UNIT-IV	Solid Wastes, Analysis and quantification of hazardous and nonhazardous wastes, Treatment and disposal of solid wastes, Land filling, Leachate Treatment, Incineration. Environmental Management System, Environment impact assessment, Its concept and constituents, Environmental audit, ISO-14000 system.

Recommended Books:

- Peavy H S, Rowe D R, And Tchobanoglous G, Environmental Engineering, McGraw Hill International
- Rao C S, Environmental Pollution Control Engineering, Wiley Eastern
- Metcalf & Eddy, Wastewater Engineering, Tata McGraw-Hill Education Private Limited
- Masters G M, Introduction to Environmental Engineering and Science, Prentice hall off India
- De Nevers N, Air Pollution Control Engineering, McGraw-Hill.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-204 HEAT TRANSFER

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

To expose students to heat transfer applications in industry. After undergoing this course the students will have the knowledge of heat transfer principles, Behavior of thermal systems, Development of the governing differential, Algebraic and finite difference equations associated with thermal systems and to investigate the influences of boundary and initial conditions and system parameters on the resulting steady or transient response of the system.

UNIT-I	Heat Transfer, Introduction, Applications, Relation between heat transfer and thermodynamics, And transport properties Conduction, Fourier's law of conduction, Thermal conductivity. Heat conduction equation in rectangular, Cylindrical and spherical coordinates, Composite wall structure, Thick walled tube, Sphere, Insulation and optimum thickness of insulation, Extended surfaces. Unsteady state conduction.
UNIT-II	Convection, (a) Natural convection. Heat transfer in laminar and turbulent flows inside tubes. Dimensional analysis, Boundary layer, Colburn analogy. Heat transfer by external flows across cylinders, Tube bank and spheres. (b) Convection with Phase Change, Condensation, Boiling and heat pipes. Radiation, Basic equations, Emissivity, Absorption, Black and gray body, Thermal radiation between two surfaces.
UNIT-III	Heat Exchangers, Classification, Introduction to LMTD and ε-NTU methods. Design of heat exchangers such as double pipe heat exchanger, Shell-and-tube exchanger, Plate heat exchangers, Compact heat exchangers, Fouling.
UNIT-IV	Evaporators, Classification, Single and multiple effect evaporators, Enthalpy balance, Performance of evaporators such as capacity and economy, Methods of feeding.

Recommended Books:

- Holman J P, Heat Transfer, McGraw-Hill
- Kern D Q, Process Heat Transfer, International Student Edition, Tata McGraw-Hill
- McCabe W L, Smith J C, Harriott P, Unit Operations of Chemical Engineering, McGraw-Hill
- Frank P I and David P D, Fundamentals of Heat and Mass Transfer, John Wiley & Sons

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-206 CHEMICAL TECHNOLOGY-II

L	T	P	Cr
4	-	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

There has been continuous upgradation in technologies for improving the overall economy of the chemical processes. After undergoing this course the students will have the knowledge of various process technologies, Production trends, Material and energy balances, Flow sheets, Engineering problems pertaining to materials of construction, Waste regeneration/recycling, Environmental and energy conservation measures, For various organic chemical industries.

UNIT-I	Study of the following chemical industries/processes involving process details, Production trends, Material and energy balances, Flow sheets, Engineering problems pertaining to materials of construction, Regeneration/recycling, Environmental and energy conservation measures. Petroleum and Petrochemical Industries: Origin and composition of petroleum, Classification of petroleum, Manufacture of petroleum products and their uses and properties. Petroleum refining, Physical and chemical conversion products, Lubricating oils, Petrochemical precursors, Methane, Olefins, Acetylenes and aromatics. Coal and Coal Chemicals, Types of coal, Destructive distillation of coal, Distillation of coal tar, Chemicals from coal.
UNIT-II	Pulp and Paper Industries, Cellulose derivatives, Pulp, Paper and boards. Types of raw material for pulping, Various pulping methods, Recovery of chemicals from black liquor. Manufacture of paper, Quality improvement of paper. Sugar and Starch Industries, Raw and refined sugar, Byproducts of sugar industries, Starch and starch derivatives.
UNIT-III	Oils and Fats, Types of oil, Different fatty acids, Extraction of oil from seeds, Oil purification, Hydrogenation of oil. Soaps and Detergents, Types of soaps, Soap manufacture, Recovery and purification. Types of detergents, Their cleansing action. Surface coating industries, Paints, Pigments, Varnishes, Industrial coatings Food Industries, Food processing, Food additives and preservatives, Food processing equipments.
UNIT-IV	Fermentation and Enzyme Industries, Production of industrial alcohol, Acetic acid, Citric acid and lactic acid. Introduction to enzymes and their applications. Polymers, Monomers, Thermoplastic and Thermosetting materials (such as polyethylene, Polypropylene, Polyvinyl chloride, Polystyrene) and PF resins; Epoxy and polyesters - Natural rubber; Synthetic rubber such as SBR, NBR, CR - Fundamental methods of processing of synthetic Rubbers. Synthetic fiber and Film Industries, Viscose rayon, Cuprammonium and cellulose acetate, Nylons, Polyesters, Acrylics.

Recommended Books:

- Rao M G and Sittig M, Dryden's outlines of Chemical Technology-For the 21st century, Affiliated East West Press
- Austin G T, Shreve's Chemical Process Industries, McGraw-Hill
- Faith W L, Keyes D B and Clark R L, Industrial Chemicals, John Wiley.
- Groggins P H, Unit Processes in Organic Synthesis, Tata McGraw-Hill

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-208 MASS TRANSFER-I

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The course covers mass transfer fundamentals such as diffusion, Film theory, Mass transfer rate and mass transfer coefficients for various different systems. In this course analogy between momentum, Heat and mass transfer is also covered. Further different types of equipments have also been covered for more industrial exposure, How the basis mechanism behind this equipment they work.

UNIT-I	Diffusion in Fluids, Molecular diffusion, Diffusion through stagnant gas film, Equation of continuity for binary systems, Correlation for diffusivity in gases and liquids for binary and multi-component systems, Mass Transfer Coefficients, Basic concepts and definitions of mass transfer coefficients (k_G, K_L, Etc.), Mass transfer coefficients for falling liquid film, Turbulent mass transfer and eddy diffusion, Theories of mass transfer.
UNIT-II	Analogy between momentum, Heat and mass transfer (Reynold's and Colburn's analogies), Simultaneous heat and mass transfer and prediction of wet-bulb temperature. Interphase Mass Transfer, Equilibrium curve, Diffusion between phases, Overall mass transfer coefficient, And Operating lines for co-current and counter-current operations, Theoretical stages and multistage cascading, Kremser equation for dilute gas mixtures.
UNIT-III	Mass transfer equipment like Wetted wall columns, Packed columns, Plate columns. Gas Absorption, Isothermal and adiabatic gas-liquid contact, Choice of solvents, Design of absorption towers, NTU, HTU, Gas absorption with chemical reaction.
UNIT-IV	Humidification and Dehumidification, Adiabatic saturation curves, Adiabatic saturation temperature, Wet bulb temperature and humidity, Cooling towers. Crystallization, Mechanism, Seeding, Particle size distribution, Classification of crystallizes. Drying, Mechanism and rate of drying, Calculations for batch and continuous drying, Types of dryers.

Recommended Books:

- Treybal R E, Mass Transfer Operations, McGraw Hill
- McCabe W L, And Smith J C, Unit Operations of Chemical Engineering, McGraw Hill
- Dutta B K, Mass Transfer and separation process, Prentice Hall of India
- Geankoplis, Transport Processes and Unit Operations, Prentice-Hall of India
- Sherwood T K, Pigford R L, And Wilkes C R, Mass Transfer, McGraw Hill

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-210 CHEMICAL ENGINEERING THERMODYNAMICS

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The aim of this course is to understand of the laws of thermodynamics and their application in the analysis of Chemical and engineering problems. After undergoing this course the students will have the knowledge of equations of state for calculating thermodynamics properties of fluids and fluid mixtures, Equilibrium compositions of chemical reactions and two-phase liquid/vapor mixtures.

UNIT-I	Laws of thermodynamics and their application to real processes, Heat capacities, Heat effects during phase change, Reaction, Formation, Combustion and mixing, Enthalpy-concentration diagram, Thermodynamic analysis of flowing fluids.
UNIT-II	Thermodynamic properties of fluids and equation of state, Relationships among thermodynamic properties. Behavior of gases in multi-component systems, Thermodynamic properties of gases and their mixtures, Thermodynamic diagrams, Equation of state and generalized property correlations for gases.
UNIT-III	Vapor/liquid equilibrium and solution thermodynamics, Criteria for equilibrium. Fugacity of gases and liquids, Pure component and mixtures Composition of phases in equilibrium, Generalized correlations for the fugacity coefficients, Models for the excess Gibbs energy, Effect of pressure and temperature on phase behavior, Chemical Reaction Equilibria.
UNIT-IV	Refrigeration and liquefaction, Refrigeration cycle, Vapor compression cycle, Eco-friendly refrigerants, Absorption and adsorption refrigeration, Liquefaction processes.

Recommended Books:

- Smith J M and Van Ness H C, Chemical Engineering Thermodynamics, Tata McGraw-Hill
- Rao Y V C, Chemical Engineering Thermodynamics, University Press
- Kyle B G, Chemical and Process Thermodynamics, Prentice- Hall
- Weber H C & Meissner H P, Thermodynamics for Chemical Engineers, John Wiley & Sons Inc

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
HS-202 FUNDAMENTALS OF BUSINESS & ECONOMICS

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:
To provide the students a basic understanding of Business and Economics which are vital constituents of the overall professional environment of an Engineer.

UNIT-I	Nature and Significance of Human Resource Management, Functions of Human Resource Management, Manpower Planning, Job Analysis, Job Description & Job Specification, Recruitment, Selection, Training & Development, Compensation Management, Performance Appraisal, Employee Welfare, Safety and Health, Human Resource Development.
UNIT-II	Meaning, Scope and Goals of Financial Management, Investment Decision, Nature, Importance, Evaluation Criteria, Financing Decision, Long Term Sources of Funds, Cost of Capital, Capital structure, Leverage, Dividend Decision, Models and determinants of dividend decision, Working Capital Management, Theories and determinants, Forecasting of working capital, Management of Cash.
UNIT-III	Concepts of market, Marketing and marketing management, Marketing Environment-Analyzing needs & trends in macro environment, Economic environment, Technical environment, Political environment, And socio-cultural environment, Market Segmentation, Targeting and positioning strategies, Marketing mix, Product, Meaning, Product mix, Levels of product, Product life cycle, Price, Meaning, Importance, Pricing objectives and strategies, Place, Importance, Functions of distribution channels, Promotional mix-advertising, Sales promotion, Personal selling, Public relations, Direct marketing.
UNIT-IV	Meaning and significance of Economics, Role of economics in engineering and technology, Basic economic terms, Utility, Saving, Investment, Equilibrium, Micro and macro economics, Economic policies, Globalization, Privatization, Liberalization, Demand &Supply Analysis, Meaning of demand and supply, Law of demand and supply, Elasticity of demand and its measurement, Production, Factors of production, Law of variable production, Production function, Cost Analysis, Types of costs and shapes of different cost curves, Theory of Firm and Pricing, Types of markets, Equilibrium of firm and industry under perfect, Monopoly and imperfect competition.

Recommended Books:

- Dessler, Human Resource Management, Pearson
- Rao V S P, Human Resource Management, Excel
- Khan M Y and Jain P K, Financial Management, Tata McGraw Hill
- Pandey I M, Financial Management, Vikas
- Kotler Philip, Marketing Management, Pearson
- Kotler Philip & Armstrong Gary, Principles of Marketing, Pearson
- Ahuja H L, Micro Economic Theory, S Chand
- Ruder Dutt & Sundharam, Indian Economy, S Chand

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-212 INDUSTRIAL POLLUTION ABATEMENT LAB

L	T	P	Cr
-	-	2	1

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• Determination of Free CO_2 in a given sample of water. • To determine alkalinity of given water sample is due to the presence of carbonate and hydroxide ion. • Determination of acidity of a water sample. • Ambient air quality measurement by high volume sampler (Particulate, SO_X, NO_X). • Determination of sludge volume index. • Determination of the percentage of CO_2, CO, O_2 and N_2 in a flue gas (or automobile exhaust) by Orsat's apparatus. • Determination of Phosphorus in waste water sample. • Determination of ammonical as well as organic nitrogen in waste water sample. • Estimation of fluoride.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-214 HEAT TRANSFER LAB

L	T	P	Cr
-	-	3	1.5

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• To determine the thermal conductivity of insulating powdered material say asbestos powder. • To determine the value of stefen Boltzmann constant assuming black body concept placed at the centre of hemisphere. • To determine the emissivity, Absorbtivity and reflectivity of the given non-black Aluminum surface at the various temperatures. • To study the double pipe hair pin heat exchanger and to determine experimentally the above all heat transfer coefficients at various liquid Reynolds number and estimate the film heat transfer coefficients on Hot water side. • To compute film heat transfer coefficients using standard equation and compare with those expt. obtained. • To calculate the heat transfer coefficient in natural convection. • Wilson Plots. Unsteady state heat transfer in jacketed vessels. • Correlation of instantaneous heat transfer, Coefficients with time for steady deposition of scale on a heating surface. • Heat losses from insulated pipes. • Study and operation of long tube, Forced circulation and multiple effect evaporators. • Duhring's plot for solutions involving non-volatile solutes • To find heat transfer coefficient for parallel flow and counter flow for double pipe heat exchanger. • To find heat transfer coefficient loosing heat by forced convection to air flowing through it for different air flow rates & heat flow rates.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-216 CHEMICAL TECHNOLOGY LAB

L	T	P	Cr
-	-	3	1.5

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• To perform proximate analysis of a given sample. • Determination of HCV and LCV of a given fuel by bomb calorimeter. • To determine the acid value of an oil/fat. • To determine the saponification value of an oil/fat. • To determine the iodine value of an oil/fat. • To determine the neutralization no. of an oil/fat. • Preparation of phenol-formaldehyde. • Preparation of urea-formaldehyde. • Preparation of soap using fatty acids and alkali. • To carry out hydrogenation of a polyunsaturated oil. • Preparation of an oil based paint. • Determination of N-P-K Values of Fertilizers • Determination of micronutrients of Fertilizers • Cement: Loss of ignition, Silica, Insoluble's • Estimation of Mg, Ca, Fe in cement.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ELGA-202 ENGLISH LANGUAGE AND GENERAL AWARENESS-IV

L	T	P	Cr
2	-	-	-

Internal Evaluation: 50 Marks

Course Objective:
To help the students master the art of condensation this is an essential skill in technical communication and, through the General Awareness section, To sensitize the students on Human Development Index.

UNIT-I	**Précis Writing** • Importance of précis in technical communication • Essentials of an effective précis • Steps to effective précis writing • Précis writing exercises
UNIT-II	**General Awareness** (a) Human Development in India • The concept of Human Development • Measuring human development • India's position in human development • National Human Development Report (b) Biography: Azim Premji (c) Book Review: The World is Flat by Thomas L Friedman (d) Industry Overview: Iron and steel

Recommended Books:

- Mitra Barun K, Effective Technical Communication, Oxford
- Tyagi Kavita & Misra Padma, Basic Technical Communication, PHI
- Raman Meenakshi & Sharma Sangeeta, Technical Communication, Oxford
- Datt & Sundharam, Indian Economy, S Chand
- Sharma R C, Krishna Mohan, Business Correspondence and Report Writing, TMH

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-301 CHEMICAL PLANT SAFETY AND RISK ASSESMENT

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

In the chemical process industry plant safety is important. Knowledge of plant safety is essential to prevent accidents and damages while working in plant. A safety audit and risk analysis prepares the plant operators and managers to develop a safe protocol and minimize potential damages to process equipments, People and the environment. This course will give an overview of the safety regulations and practices, Plant hazards and their control, Risk management principles and techniques and accident analysis.

UNIT-I	Plant Safety and Safety regulation, Importance & objectives of safety, Safety in chemical industry, Criteria for setting & layout of chemical plant. Factories Act and Safety Regulations.
UNIT-II	Plant Hazards, Fire hazards. Chemical hazards, Toxic hazards, Explosion hazards, Electrical hazards, Mechanical hazards, Radiation hazards, Noise hazards. Control, Precautions & prevention, Safety measures in plant.
UNIT-III	Safety Audit, Objective of safety audit, Procedure for safety auditing. Audit report, Safety report. Storage & Transportation of chemicals Characteristics of chemical with special reference to safe storage & handling of chemicals. Layout of storage. Various modes of transport and Safety precautions in transportation of different types of chemicals.
UNIT-IV	Risk Analysis Techniques, Hazard & Operability (HAZOP) studies. Hazard Analysis (HAZAN). Fault Tree Analysis. Consequence Analysis. Onsite and Offsite emergency management plans. Economics of Risk Management.

Recommended Books:

- Crowl D A and Louvar J F, Chemical Process Safety-Fundamentals with Applications, Prentice Hall
- Vasandhani V P, And Kumar D S, Heat Engineering, Metropolitan Book Co. Pvt. Ltd
- Banerjee S, Industrial Hazards and Plant Safety, Taylor & Francis
- Sanders R E, Chemical Process Safety-Learning from Case Histories, Oxford

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-303 CHEMICAL REACTION ENGINEEERING

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

This course provides the students a through introduction of fundamentals aspects of chemical kinetics and reactors. In this students will learn about different rate reactions, Their dependences on pressure, Temperature and other parameters. Further reactions conditions in various simple and complex reactors like CSTR, PFR and fluidized beds. Also different working conditions of single and multi reactions have also been covered in this course.

UNIT-I	Introduction, Overview of chemical reaction engineering, Classification of reactions, Variables affecting rate, Definition of reaction rate, Single and multiple reactions, Elementary and non-elementary reactions, Molecularity and order of reaction, Reaction pathways, Effects of temperature, Pressure, Heat and mass transfer on rate, Arrhenius law, Activation energy, Reversible and irreversible reactions, Reaction equilibrium.
UNIT-II	Kinetics, Constant volume and variable volume batch, CSTR and PFR reactor data, Analysis of total pressure data obtained from a constant-volume batch reactor, Integral and differential methods of analysis of data, Autocatalytic reactions, Reversible reactions, And Bio-chemical reactions. Homogeneous Single Reactions, Performance equations for ideal batch, Plug flow, Back-mix flow and semi batch reactors for isothermal condition, Size comparison of single reactors, Multiple-reactor systems, Recycle reactor, Autocatalytic reactions, Optimum recycle operations.
UNIT-III	Multiple Reactions, Parallel reactions of different orders, Yield and selectivity, Product distribution and design for single and multiple-reactors, Series reactions, first-order reactions and zero-order reactions, Mixed series parallel complex reactions, Choice of reactors for simple and complex reactions.
UNIT-IV	Temperature Effects for Single and Multiple Reactions, Thermal stability of reactors and optimal temperature progression for first order reversible reactions, Adiabatic and heat regulated reactions, Design of non-isothermal reactors, Effect of temperature on product distribution for series and parallel reactions.

Recommended Books:

- Levenspiel O, Chemical Reaction Engineering, John Wiley & Sons
- Fogler H S, Elements of Chemical Reaction Engineering, Prentice Hall of India
- Smith J M, Chemical Engineering Kinetics, McGraw Hill, New York
- Denbigh K G, And Turner J C R, Chemical Reactor Theory - An Introduction, Cambridge University Press, UK

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-305 MASS TRANSFER-II

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

This second course on mass transfer introduces the fundamental concepts, Principles and applications of mass transfer processes. The modeling, Design and performance calculation aspects of separation processes using rate-based and equilibrium stage based modeling approaches are then developed. After undergoing this course the students will have the knowledge of various separation processes absorption, Distillation, Extraction, Adsorption, Drying etc.

UNIT-I	Absorption, Equilibria for absorption systems – use of Raoult's law, Henry's law for solubility predictions, Selection of absorbent, Limiting liquid gas ratios, Absorption factor use in design of plate absorbers. Kremser equation for ideal plates and translation of ideal plates to real plates using various efficiencies. Concept of transfer units for the design of packed absorbers.
UNIT-II	Distillation, Limitations and applications, Prediction of VLE using thermodynamic & experimental techniques. Dew point & bubble point estimations for binary & multicomponent mixtures. Distillation methods – flash distillation, Differential distillation for binary systems,steam distillation, Optimum reflux ratio. Fractionation of binary mixtures using McCabe – Thiele method and enthalpy concentration method (Ponchon and Savarit method). Packed distillation columns. Azeotropic & extractive distillation preliminaries and molecular distillation.
UNIT-III	Liquid-Liquid Extraction, Ternary Equilibria and its representation on various plots. Selection criteria for solvent, Multistage extraction using partially miscible & immiscible solvents. Stagewise contact for countercurrent and crosscurrent extraction. Constructional details of equipment like mixer-settler, Packed columns, Pulsed extractor, Sieve-tray extractor and centrifugal extractor.
UNIT-IV	Leaching, Preparation of solid, Countercurrent and crosscurrent contact Shank's system. Constructional details of equipment like Rotocel extractor, Hildebrandt extractor, Boll-man extractor, Kennedy Extractor & Beet-Sugar Diffusion battery extractor. Adsorption, Types of adsorption, Nature of adsorbents, Equilibria for adsorption systems. Brief manufacture and commercial applications and characteristics for common adsorbents. Stage-wise &continuous contacting of fluid and solid phase. Description of contact filtration adsorption system. Hypersorber Ion-exchange system.

Recommended Books:

- Treybal R E, Mass Transfer Operations, McGraw Hill
- McCabe W L, And Smith J C, Unit Operations of Chemical Engineering, McGraw Hill
- Dutta B K, Mass Transfer and separation process, Prentice Hall of India
- Sherwood T K, Pigford R L, And Wilkes, C.R, Mass Transfer, McGraw Hill
- Geankoplis, Transport Processes and Unit Operations, Prentice-Hall of India

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-307 BIOCHEMICAL ENGINEERING

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The aim of this course to understand the basics of biochemical engineering and its industrial applications. After undergoing this course the students will have the knowledge of kinetics of enzyme catalysis, Immobilized enzymes, Metabolic pathways, Biosynthesis, Microbial growth, Analysis and stability of bioreactors and manufacture of biochemical products etc.

UNIT-I	Introduction to Biochemical Engineering, Comparative study of chemical and biochemical processes, Basic concepts of microbiology. Biochemical Kinetics, Enzyme Kinetics with one or two substrates, Modulation and regulation of enzyme activity, Enzyme reactions in heterogeneous systems, Immobilized enzyme technology, Industrial application of enzymes.
UNIT-II	Microbial Fermentation Kinetics, Fermentation and its classification, Growth-cycle phases (for batch cultivation), Continuous culture, Biomass production in cell culture, Mathematical modeling of batch growth, Product synthesis kinetics, Overall kinetics and thermal death kinetics of cells and spores, Analysis of multiple interacting microbial population. Bioreactors, Classification and characterization of different bioreactors e.g. Batch and continuous, Mechanically and non-mechanically agitated, CSTR type, Tower, Continuous, Rotating, Anaerobic etc.
UNIT-III	Design and Analysis of Bioreactors- C.S.T.R. and Air Lift Reactor, Scale up considerations of bioprocesses. Transport Phenomena in Bioprocess Systems, Agitation and aeration-gas-liquid mass transfer, Oxygen transfer rates, Determination of k_La, Heat balance and heat transfer correlations, Sterilization.
UNIT-IV	Commercial production of bioproducts, Concept of primary and secondary metabolites, Production processes for yeast biomass, Antibiotics, Alcoholic beverages and other products. Instrumentation and control in bioprocess, Various control parameters for bioprocesses, pH, DO foam/level controller Etc.

Recommended Books:

- Shuler Michael, Kargi Fikret, Bioprocess Engineering: Basic Concepts, Prentice Hall, Englewood Cliffs
- Bailey J E and Ollis D F, Biochemical Engineering Fundamentals, McGraw Hill
- Aiba S, Humphrey A E and Millis N F, Biochemical Engineering, Academic Press
- Weith, John W F, Biochemical Engineering – Kinetics, Mass Transport, Reactors and Gene Expression, Wiley and Sons Inc

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-309 CHEMICAL ENGINEERING DESIGN-I

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The aim of this course to give up-to-date knowledge for designing the process equipments generally used in the chemical industries. It emphasizes to provide knowledge about design principles of heat and mass transfer equipment used in chemical plants. It also aims to impart knowledge about IS Codes used in the mechanical design of chemical engineering equipments. After undergoing this course the students will have the knowledge to analyze a problem and finding a design method and mechanical specifications to accomplish a particular process objective.

UNIT-I	Design Preliminaries, Introduction, General design procedure, Equipment classification, Design codes, Design considerations, Design pressure, Design temperature, Design stress, Factor of safety, Design wall thickness, Corrosion allowance, Weld joint efficiency factor, Design loadings, Stress concentration, Thermal stress and Criteria of failure.
UNIT-II	Design of process vessels under internal pressure, Thin wall vessels, Cylindrical vessels, Tubes, Pipes, Spherical vessels, Design of heads and closures such as different heads, Nozzle, Flange joints, Gaskets, Types & design of non- standard flanges and Bolts. Design of process vessels under external pressures, Introduction, Determination of safe pressure against elastic failure, Circumferential stiffeners, Spherical shells, Pipes and tubes under external pressure
UNIT-III	Design of tall vessels, Introduction, Equivalent stress under combined loadings and Longitudinal stresses. Design of support for process vessels, Introduction, Different types of supports, Design of supports. Design of thick walled higher pressure vessels, Introduction, Stresses and theories of elastic failure.
UNIT-IV	Equipment fabrication and testing, Welding joints, Inspection and Non-destructive testing of equipment. Design of some special parts, Introduction, Expansion joints and its design, Expansion loop in piping system, Design equations for expansive forces in pipe lines, Shafts and Keys. Storage tanks, Introduction, Classification of storage tanks, Filling & breathing looses, Design of liquid and gas storage tanks.

Recommended Books:

- Bhattacharyya B C, Introduction to Chemical Equipment Design, Mechanical Aspects, CBS Publishers and Distributors.
- Joshi M V and Mahajani V V, Process Equipment Design, Macmillan India Limited.
- Brownell L E and Young E H, Process Equipment Design, Wiley Eastern India Limited.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-311 TRANSPORT PHENOMENA

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The basic principles of these fields are here generalized and reformulated so as to be able to deal with chemically-reacting flow systems of current and future engineering interest. Principles are developed and illustrated here for the rational design of engineering equipment (chemical reactor analysis, Separation processes, Multiphase transport, Etc.). Emphasis will be placed on the use of fundamental laws, And a judicious blend of experimental, Analytical and numerical methods to develop required understanding and necessary mathematical models for essential portions of engineering problems involving transport processes. After undergoing this course the students will have the knowledge of mechanisms of momentum, Energy and mass transport, Shell balances and its applications, Transport phenomena in polymeric liquids.

UNIT-I	Transport of momentum, Heat and mass by molecular motion-Newton's law of Viscosity, Fourier's law of heat conduction, Fick's law of diffusion. Transport properties – Viscosity, Thermal conductivity and mass diffusivity. Emphasis on the analogy between momentum, Heat and mass transfer with respect to transport mechanism and governing equations.
UNIT-II	Development of mathematical models of transfer process through shell momentum balance, Shell energy balance and shell mass balance for solving specific problems of transport of momentum, Heat and mass in laminar flow or in solids in one dimension.
UNIT-III	Development of general differential equations of fluid flow, Heat transfer and mass transfer and their applications in solving one-dimensional steady state and unsteady state problems of momentum, Heat and mass transfer.
UNIT-IV	Interphase transport of momentum, Heat and mass and dimensionless correlation for each one of them. Momentum, Heat and mass transfer analysis.

Recommended Books:

- Bird R B, Stewart W E, And Lightfoot E N, Transport Phenomena, Wiley
- Geankoplis C J, Transport Processes and Unit Operations, Prentice-Hall
- Bennett C O, And Myers J E, Momentum, Heat, And Mass Transfer, McGraw-Hill
- Welty J R, Wicks C E, And Wilson R E, Fundamentals of Momentum, Heat, And Mass Transfer, John Wiley and Sons

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-313 CHEMICAL REACTION ENGINEEERING LAB

L	T	P	Cr
-	-	3	1.5

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• Study of non-catalytic homogeneous reaction in a batch reactor. • Study of non-catalytic homogeneous reaction in a plug flow reactor. • Residence time distribution (RTD) studied in a packed bed reactor. • Residence time distribution (RTD) studied in a CSTR. • Study of non catalytic homogeneous reaction in a series of three CSTR • To study the performance of a cascade of three equal volume CSTR in series for the saponification of ethyl acetate with NaOH. • Study of non-catalytic homogeneous reaction in a semi-batch reactor. • Study of non-catalytic fluid solid reaction in a Muffle furnace. • To study the series reaction using fluid flow analogy to determine rate constant. • To study the kinetics of diacetone alcohol decomposition using dilatometer. • To follow a reaction in a fixed bed catalytic reactor for a given reaction system. • To study the kinetics of solid phase reaction i.e. calcium carbonate decomposition.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-315 MASS TRANSFER LAB

L	T	P	Cr
-	-	3	1.5

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• Vapor-Liquid Equilibrium data - To find out the B.P's of CCl_4-Toluene mixture comprising of different compositions at constant pressure. • Solid in Air diffusion - To calculate the mass transfer coefficient for vaporization of Naphthalene in air using a packed bed of spherical particles of Naphthalene. • Vapour in air Diffusion - To determine the diffusion coefficient of an organic vapor, CCl_4 in air and to study the effect of temperature on the diffusion coefficient. • Liquid-Liquid Extraction of benzoic acid from toluene in a Packed Bed. o To determine overall mass transfer coefficient based on continuous phase(water), $K_w a$. o To determine overall mass transfer coefficient based on dispersed phase (toluene), $K_t a$. o To determine overall Height of Transfer Units based on continuous phase (water), $HTU_{ow.}$ o To determine individual Height of Transfer Unit based on continuous phase (water), HTU_w and dispersed phase(toluene), $HTU_{t.}$ • Absorption with chemical reaction in a Packed Bed (CO_2 absorption NaOH solution). o Determine the numbers of transfer units, NTU o Determine the height of transfer units, HTU o Plot $K_G a$(kgmoles/m^3-h-atm) vs mass velocity of liquid, L (kgmoles/m^3-h) on log-log plot for the given packing. • To find out the critical moisture context of the given material and to find out the equations for constant and falling rate period. • To verify the Rayleigh's equation for distillation. • To find the height equivalent to a theoretical plate and height of a transfer unit for the packed distillation column under total reflux. • Steam Distillation • To determine gas film coefficient in wetted wall column using air water system. • To determine the yield of MgSO4.7H2O crystals in a Batch Crystallizer.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE- 317 BIOCHEMICAL ENGINEERING LAB

L	T	P	Cr
-	-	2	1

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 02 Hours

EXPERIMENTS	• To demonstrate the use of rennet in casein coagulation in different pH conditions. • To determine the concentration of proteins by Lowry's method. • To demonstrate the presence of microorganisms everywhere in the environment. • To hydrolyze protein-based stains in fabrics into soluble amino acids. • To analyze amino acid concentrations by the ninhydrin colorimetric method during the enzymatic hydrolysis of a protein. • To study the kinetics of alkaline phosphatase. • Amino Acid Assay by Ninhydrin Colorimetric Method. • To compare the enzymatic and acid hydrolysis of cellulose. • To study the various parameters that affects the kinetics of alpha-amylase catalyzed hydrolysis of starch. • To recover proteins/enzymes from a solution by salting-out • To recover proteins/enzymes from a solution by adding acetone. • To compare the effectiveness of three methods of enzyme immobilization by gel entrapment. • To demonstrate the use of microorganisms in food processing by using yogurt as an example. • To study the batch growth kinetics of a submerged culture.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ELGA-301 ENGLISH LANGUAGE AND GENERAL AWARENESS-V

L	T	P	Cr
2	-	-	-

Internal Evaluation: 50 Marks

Course Objective:
To facilitate the learning of the principles of writing effective formal and business letters and also to help them develop an understanding of the infrastructure development initiatives in the country.

UNIT-I	**Formal Correspondence** • Parts of a letter • Format of a formal/business letter • Formal letters • Business Letters • Job application letters (covering letter & resume/CV)
UNIT-II	**General Awareness** (a) Infrastructure Development • Infrastructure and economic development • Energy • Power • Transport • Roads and highways • Communication system (b) Biography: L N Mittal (c) Book Review: Imagining India by Nandan Nilekani (d) Industry Overview: Civil Aviation

Recommended Books:

- Mitra Barun K, Effective Technical Communication, Oxford
- Tyagi Kavita & Misra Padma, Basic Technical Communication, PHI
- Raman Meenakshi & Sharma Sangeeta,Professional Communication, Oxford
- Datt & Sundharam, Indian Economy, S Chand
- Sharma R C, Krishna Mohan, Business Correspondence and Report Writing, TMH

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-302 CHEMICAL ENGINEERING DESIGN-II

L	T	P	Cr
2	2	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The aim of this course to give up-to-date knowledge for designing the process equipments such as heat and mass transfer equipments used in chemical plants. After undergoing this course the students will have the knowledge to analyze a problem and finding a process design method for heat and mass transfer equipments used in chemical plants.

UNIT-I	Introduction, Design factors, Equipment selection, General design procedure. Process design calculations for heat transfer equipment, Shell and Tube heat exchangers-general description, Estimation of heat transfer coefficients and pressure drop by Kerns' and Bell's methods.
UNIT-II	Condenser and re-boiler design, Plate type heat exchanger design, Finned tubes, Heat Transfer in stirred vessels, Codes & standards and Heat-exchanger nomenclature, Mechanical turbulators.
UNIT-III	Process design calculations for binary and multi-component distillation, Fenske-Underwood-Gilliland Method, Selection of two key components, Fenske equation for minimum equilibrium stage, Gilliland correlations for actual reflux ratio and theoretical stages, Minimum reflux ratio by Underwood method, Feed stage location,
UNIT-IV	Type of towers, Types of plate contractors, Sieve tray layout and hydraulic design, Packed towers – column internals, Types of packing, General pressure drop correlation, Column diameter and height. Piping System Design, Piping classification, Important fittings and their use, Symbols, Layouts, And Color codes for pipe lines.

Recommended Books:

- Sinnott Ray and Towler Gavin, Coulson and Richardson's Chemical Engineering series Chemical Engineering Design
- Ludwig E E, Applied Process Design in Chemical and Petrochemical Plants Vol I, II, III, Gulf Publishing Co.
- Kern D Q, Process Heat Transfer, International Student Edition, McGraw Hill
- Seader J D, Henley E J, Separation Process Principles, Wiley
- Bausbacher Ed and Hunt Roger, Process Plant Layout and Piping Design, PTR Prentice Hall

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-304 PROCESS CONTROL AND INSTRUMENTATION

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

This course Process Control and Instrumentation goes deeper into the various aspects of control engineering along with bringing out the theories and practical knowledge of control engineering. Instrumentation part will consist of valve characteristics, Various measuring devices, Instrumentation symbols and introduction to P&ID. After undergoing this course the students will have the knowledge of dynamic behavior of chemical processes, Stability aspects, Design of feedback controller and control strategies.

UNIT-I	Instrumentation, Classification of measuring instruments, Elements of measuring instruments, Static and dynamic characteristics of instruments, Error analysis. Instruments for the measurement of temperature, Pressure, Liquid level, And moisture content, Instruments and sensors for online measurements.
UNIT-II	General Principles of process control, Time domain, Laplace domain and frequency domain dynamic and control. Linear Open loop Systems, Laplace domain analysis of first and second orders systems, Linearization, Response to step, Pulse, Impulse and ramp inputs, Physical examples of first and second order systems such as thermocouple, Level tank, U-tube manometer etc., Interacting and non-interacting systems distributed and lumped parameter systems, Dead time.
UNIT-III	Linear Closed-loop Systems, Controllers and final control elements, Different types of control valves and their characteristics, Development of block diagram, Transient response of simple control systems, Stability in Laplace domain, Root locus analysis. Frequency Response, Frequency domain analysis, Control system design by frequency response, Bode stability criterion, Different methods of tuning of controllers.
UNIT-IV	Process Applications, Introduction to advanced control techniques as feed forward, Feedback, Cascade, Ratio, Smith predictor, Internal model control, Digital computer control, Direct digital control and supervisory control and data acquisition, Multivariable control, Applications to equipments such as heat exchangers, Distillation columns, Reactors etc.

Recommended Books:

- Coughanour D R, Process Systems analysis and Control, McGraw Hill
- Stephanopoulous G, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall of India
- Eckman D P, Industrial instrumentation, John Wiley & Sons

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-306 ENERGY TECHNOLOGY

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

After passing the course the student shall be able to show deeper knowledge about different forms of energy and transferring from one energy form to another show knowledge and understanding about different methods for use of renewable energy and the technology in practice show ability to asses, Analyze, And integrate knowledge about different forms of renewable energy and their suitability in environments with different conditions.

UNIT-I	Energy Scenario, Indian and global, Energy crisis, Classification of various energy sources, Renewable and Non-renewable energy sources, Pattern of energy consumption, Present and future energy demands. Solid Fuels, Coal its origin and formation, Coal analysis, Coal classification, Coal preparation, Coal washing and coal blending, Coal carbonization, Treatment of coal gas and Recovery of chemicals from coal tar, Coal gasification, Liquid fuel synthesis from coal, Carbonization of coal, Briquetting of fines, Bio Mass.
UNIT-II	Liquid and Gaseous Fuels, Crude petroleum, Physical processing of crude petroleum, Fuels from petroleum, Storage and handling of liquid fuels, Natural gas and Liquefied Petroleum gases, Gas hydrates, Gasification of liquid fuels, Carbureted water gas, Bio gas.
UNIT-III	Fuel Characterization, Viscosity, Viscosity index, Flash Point, Cloud point, Pour point, Fire point, Smoke point and Char value, Carbon residue, Octane number, Cetane number, Aniline Point and Performance number, Acid value, ASTM distillation, Calorific value, Proximate and ultimate analysis.
UNIT-IV	Energy Conversion without Combustion, Solar energy, Radiation measurement, Applications and types of collectors and storage, Wind power, Principle of energy from wind applications, Geothermal energy, Biomass, Biogas and Thermal gasification, Nuclear power, Fuel cells.

Recommended Books:

- Gupta O P, Elements of Fuel, Furnaces and Refractories, Khanna Publishers
- Rai G D, Non-Conventional Energy Sources, Khanna Publishers
- Rao S and Parulekar B B, Energy Technology-Non-conventional, Renewable and Conventional, Khanna Publishers
- Brame J S S and King J G, Edward Arnold, Fuel Solid, Liquid and Gases

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-308 PROCESS MODELING AND SIMULATION

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The Process Modeling and Simulation of Chemical engineering processes has attracted the attention of scientists and engineers for many decades and is still a subject of major importance for the knowledge of unitary processes of transport and kinetics. After undergoing this course the students will have the knowledge of models development for heat transfer equipments, Separation processes and reactors, Parameter estimations, Application of numerical methods for solution of models and tools of simulation.

UNIT-I	Introduction, Use and scope of mathematical modeling, Principles of model formulation, Role and importance of steady-state and dynamic simulation, Classification of models, Model building, Modeling difficulties, Degree-of-freedom analysis, Selection of design variables, Types of equations.
UNIT-II	Fundamental Laws, Equations of continuity, Energy, Momentum, Transport, And state, Transport properties, Equilibrium and chemical kinetics, Review of thermodynamic correlations for the estimation of physical properties like phase equilibria, Bubble and dew points etc, Prediction of enthalpy departure and VLE characteristics from equation of state by the application of numerical methods.
UNIT-III	Modeling of Specific Systems, Constant and variable holdup CSTRs under isothermal and non-isothermal conditions, Stability analysis, Gas phase pressurized CSTR, Two phase CSTR, Non-isothermal PFR, Batch and semi-batch reactors, Heat conduction in a bar, Laminar flow of Newtonian liquid in a pipe, Gravity flow tank, Single component vaporizer, Multi-component flash drum, Absorption column, Ideal binary distillation column and non-ideal multi-component distillation column, Batch distillation with holdup etc.
UNIT-IV	Simulation, Simulation of the models, Sequential modular approach, Equation oriented approach, Partitioning and tearing, Introduction and use of process simulation software (ASPEN/Hysis) for flow sheet simulation.

Recommended Books:

- Luyben W L, Process Modeling, Simulation, And Control for Chemical Engineering, McGraw-Hill
- Himmelblau D M and Bischoff K B, Process Analysis and Simulation: Deterministic Systems, John Wiley
- Babu B V, Process Plant Simulation, Oxford University Press
- Denn M M, Process Modeling, Longman Sc & Tech
- Holland C D, Fundamentals and Modeling of Separation Processes: Absorption, Distillation, Evaporation and Extraction, Englewood Cliffs, Prentice-Hall

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-310 CHEMICAL REACTION ENGINEERING-II

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

This is a typical second course in the subject of chemical reaction engineering with an emphasis on heterogeneous reaction engineering and nonideal reactors. After undergoing this course the students will have the knowledge of Kinetics and design of reactors for noncatalytic gas-liquid and fluid-solid reactions, Residence time distributions.

UNIT-I	Non-ideal Flow, Residence time distribution of fluids in vessels, Models for non-ideal flow- one and two parameter, Conversion calculation using RTD data for first order reactions.
UNIT-II	Non-catalytic Heterogeneous Reactions, Fluid-Solid reaction kinetics, Fluid-solid reaction models, Determination of rate controlling step, Prediction of mean conversion in flow reactors, Fluid-solid contacting schemes, Reactor design.
UNIT-III	Solid-catalyzed Reactions, Interaction of physical and chemical rate processes, Kinetics of catalytic reactions and application to reactor design for isothermal and adiabatic operations, Experimental reactors, Design of fixed and fluidized bed reactors, Introduction to slurry and trickle-bed reactors.
UNIT-IV	Fluid-fluid Reactions, Introduction to fluid-fluid reaction systems, Rate equations, Reactor design for straight mass transfer and for mass transfer with chemical reaction.

Recommended Books:

- Levenspiel O, Chemical Reaction Engineering, John Wiley & Sons
- Fogler H S, Elements of Chemical Reaction Engineering, Prentice Hall of India
- Smith J M, Chemical Engineering Kinetics, McGraw Hill
- Nauman E B, Chemical Reactor Design, John Wiley & Sons

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-312 PROCESS ENGINEERING ECONOMICS

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

In many UG curriculums, Elementary process design is taught without relevance to economics. However, Economics and cost invariably affect the design aspects of several chemical processes and optimization is often regarded as a key issue in due course of design. After undergoing this course the students will have the knowledge of cost estimation of chemical process plant, Taxes and insurance, Depreciation etc.

UNIT-I	Cost estimation, Factors affecting investment and production costs. Capital investments, Fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimating capital investment. Estimation of total product cost. Different costs involved in the total product costs. Different cost involved in the total product for a typical chemical process plant.
UNIT-II	Interest and Investment Costs, Simple and compound interest. Nominal and effective rates of interest. Continuous interest ordinary annuity. Perpetuities and capitalized costs. Taxes and Insurance, Types of taxes and tax returns, Types of insurance and legal responsibility. Depreciation, Types of depreciation, Service life salvage value, Present value and methods of determining depreciation, Single unit and group depreciation.
UNIT-III	Profitability, Alternative Investments and Replacements, Mathematical methods of profitability evaluation. Cash flow diagrams. Determination of acceptable investments. Alternatives when an investment must be made and analysis with small increment investment, Replacement. Breakeven analysis. Balance sheet and income statement.
UNIT-IV	Optimum Design, Procedure with one variable, Optimum reflux ratio in distillation and other examples. Preliminary Steps in Plant Design, Plant design factors, Project organization, Plant location, Preliminary data collection, Process engineering

Recommended Books:

- Peters M A and Timmerhaus K D, Plant Design and Economics for Chemical Engineers, McGraw Hill
- Kumar Anil, Chemical Process Synthesis and Engineering Design, Tata McGraw Hill
- Ulrich G D, A Guide to Chemical Engineering Process Design and Economics, John Wiley & Sons
- Perry R H and Green D, Chemical Engineer's Handbook, McGraw-Hill

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE- 314 PROCESS CONTROL AND INSTRUMENTATION LAB

L	T	P	Cr
-	-	2	1

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 02 Hours

EXPERIMENTS	• To measure the pressure by using pressure transducer. • Calibration of a thermocouple by using mercury thermometer. • To determine the kinematic viscosity of given sample. • Characteristics of on-off controller. • Dynamic response of single tank system. • Dynamics of a two tank non-interacting liquid level system. • Dynamics of a two tank interacting liquid level system • Response of CSTR heater system. • Characteristics of PID controller. • To obtain the time constant of a thermometer • Valve characteristics • Flow, Level and temperature control using proportional, Proportional-integral and proportional-integral-derivative control action. • Tuning of controller

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-316 ENERGY TECHNOLOGY LAB

L	T	P	Cr
-	-	2	1

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• To determine moisture volatile and ash contents in a given coal sample by proximate analysis. • To determine the flash point and fire point of given oil by Pensky-Martens flash point apparatus. • To determine the flash point and fire point of a given oil by Abel's flash point apparatus. • To determine cloud and pour point of a lubricating oil. • Determination of viscosity of the given lubricating oils using Redwood viscometer. • To determine the surface tension of the provided liquid sample. • Determination of viscosity of the given lubricating oils using Saybolt viscometer. • To determine the calorific value of the given fuel using calorimeter. • To determine the specific gravity of a given liquid sample using specific gravity balances. • To determine the Reid vapour pressure of the gasoline sample. • To determine saponification value of a given oil sample. • To determine acid value of a given oil sample. • To perform the ASTM distillation of the fuel sample.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-318 PROCESS MODELING & SIMULATION LAB

L	T	P	Cr
-	-	2	1

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• Develop a computer programme for the solution of multivariable non linear algebraic equations. • Develop a computer programme for the solution of multivariable ordinary differential equations. • Develop a computer programme for the solution of second order ordinary differential equations. • Modeling and Simulation of bubble point temperature. • Modeling and Simulation of dew point temperature. • Modeling and Simulation of T-xy and P-xy of a binary mixture. • Modeling and Simulation of isothermal CSTR • Modeling and Simulation of non- isothermal CSTR • Modeling and Simulation of isothermal batch reactor • Modeling and Simulation of non - isothermal batch reactor • Modeling and Simulation of isothermal of distillation column. • Simulation of chemical engineering systems by the use of available software (Aspen Plus, Aspen Hysis or CHEMCAD etc.)

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-320 UG SEMINAR

Internal Evaluation: 50 Marks

L	T	P	Cr
-	-	2	1

SEMINAR	The student is required to deliver an independent seminar on any of emerging areas/ application of Chemical Engineering courses. Senior faculty will supervise the students in selecting and preparation of the same. The student will submit two copies of seminar report (at least one week prior to the presentation) and shall make oral presentation as per time schedule decided by the faculty concerned. Internal Evaluation will be made on the basis of report, presentation and the discussion during the presentation.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

ELGA-302 ENGLISH LANGUAGE AND GENERAL AWARENESS-VI

L	T	P	Cr
2	-	-	-

Internal Evaluation: 50 Marks

Course Objective:
To help the students understand the nuances of technical writing that would enable them to communicate effectively and efficiently at their workplace, And, Through the General Awareness section, An overview of economic planning in India.

UNIT-I	**Technical Writing** • Guidelines for technical writing • Effective use of charts, Graphs, Tables etc. • Technical reports o Types of reports o Steps in writing a report o Guidelines for writing a report
UNIT-II	**General Awareness** (a) Economic Planning in India • Objectives of economic planning in India • Review of 60 years of planning in India • 11th Plan (2007-12): achievements and failures • 12th Plan (2012-17): objectives, Targets & strategy (b) Biography: Bill Gates (c) Book Review: A Better India; A Better World by N R Narayana Murthy (d) Industry Overview: Renewable Energy

Recommended Books:

- Barun K Mitra, Effective Technical Communication, Oxford
- Tyagi Kavita & Misra Padma, Basic Technical Communication, PHI
- Raman Meenakshi & Sharma Sangeeta, Technical Communication, Oxford
- Datt & Sundharam, Indian Economy, S Chand
- Sharma R C, Krishna Mohan, Business Correspondence and Report Writing, TMH

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-411 INDUSTRIAL TRAINING/PROJECT

L	T	P	Cr
-	-	32	16

Internal Evaluation: 200 Marks
External Examination: 200 Marks

INDUSTRIAL TRAINING/ PROJECT	Each student is expected to undergo one complete semester of industrial/field/Lab training (UG level) in order to connect the class room teaching with real time practical applications. A supervisor (faculty from the Department) shall be assigned to the student approved by the competent authority. The training and placement officer (TPO) will facilitate the students for the purpose with the consent of his/her supervisor and also considering the interests of the student. During training the student will undertake a project involving design/experimental/analytical/computational work including case studies etc. The progress of the project work will be evaluated by the concerned supervisor and TPO by visiting the site/industry/lab etc. The student will complete the training/project by the end of the semester and a comprehensive training/project report will be submitted by the student under the signature of his/her supervisor. The external examination shall be taken by a panel of examiners comprising of concerned supervisor, The training and placement officer and an external examiner (from the relevant field) nominated/approved by the competent authority. Hard copies of report are required to be submitted by the student before the external examination. The candidate shall appear before the evaluation committee for oral examination and presentation on the scheduled date.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-421/422/423/424 PETROCHEMICAL TECHNOLOGY

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

Petroleum and petrochemical industries are the most prolific and dynamic industries. The main objective of this course is to provide students a thorough understanding in the area of crude oil refining, Hydrocarbon processing and trends in refinery operations which is the current need of the country. The physical and chemical properties of petroleum and petroleum products will be described, Along with major refining processes.

UNIT-I	Introduction, World petroleum resources, Petroleum industry in India, Origin, Exploration, Drilling and production of petroleum crude, Transportation and pretreatment of crude oil.
UNIT-II	Characterization, Composition and classification of petroleum crude, ASTM, TBP and EFV distillation of crude oil, Properties and specifications of petroleum products - LPG, Gasoline, Naphtha, Kerosene, Diesel oil, Lubricating oil, Wax etc.
UNIT-III	Separation Processes, Pretreatment of crude, Crude distillation, Vacuum distillation, Gasoline treatment and operation of topping, Tube still furnaces, Solvent extraction processes for lubricating oil base stocks and for aromatics from naphtha and kerosene, Dewaxing.
UNIT-IV	Conversion Processes, Thermal and catalytic cracking, Vis-breaking and coking processes, Reforming, Hydroprocessing, Alkylation, Polymerisation and isomerisation, Product finishing processes.

Recommended Books:

- Bhaskar Rao B K, Modern Petroleum Refining Processes, Oxford and IBH
- Nelson W L, Petroleum Refinery Engineering, McGraw Hill
- Gary J H and Handwerk G E, Petroleum Refining, Technology, And Economics, Marcel Dekker
- Sarkar G N, Advanced Petroleum Refining, Khanna Publishers

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-421/422/423/424 FLUIDIZATION ENGINEERING

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The aim of this course is to give basic concept in fluidization engineering and its application in industry. After undergoing this course the students will have the knowledge of flow around immersed solids, Sedimentation and packed bed pressure drop, Minimum fluidization velocity, Fluidization regimes, Homogeneous fluidized beds, Turbulent and fast fluidization, Heat and mass transfer in fluidized beds, CFD and flow visualization techniques, Three phase fluidization.

UNIT-I	Fluidization phenomenon, Review of flow around immersed solids - forces on single particles, sedimentation - Richardson-Zaki equation, Packed beds and Ergun equation, Classification of solid particles and powders - relevant properties and measurements, Effect of fluid velocity on pressure gradient, Minimum fluidization velocity - measurement, Prediction and correlations, Regimes of fluidization - Homogenous fluidized bed models.
UNIT-II	Stability of homogeneous fluidization - qualitative and quantitative, Kinematic and dynamic wave propagation, Bubbling bed (heterogeneous fluidized bed) models, Davidson model for bubble in a fluidized bed, And its implications.
UNIT-III	Turbulent and fast fluidization, Entrainment and Elutriation, Slugging, Spouted beds, Dilute and dense phase transport - Circulating Fluidized Beds.
UNIT-IV	Heat and mass transfer in fluidized systems, Pneumatic conveying of solids in vertical and horizontal conduits, Hydraulic conveying of solids in vertical and horizontal conduits, Modern simulation techniques - CFD models, Modern experimental techniques - flow visualization and quantitative measurements, Three-phase fluidization.

Recommended Books:

- Kunii D, Levenspiel O and Robert E, Fluidization Engineering, Butterworth-Heinemann
- Coulson J M and Richardson J F, Chemical Engineering, Vol. 2, Asian Books: Private Limited
- Rhodes M, Introduction to Particle Technology, 2nd Ed., Wiley
- Gibilaro L G, Fluidization - Dynamics, Butterworth - Heinemann

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-421/422/423/424 COMPUTATIONAL FLUID DYNAMICS

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The aim of this course is to provide an in-depth introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems. Model problems are used to study the interaction of physical processes and numerical techniques. Contemporary methods for boundary layers, Incompressible viscous flows, And inviscid compressible flows are studied. After undergoing this course the students will have the knowledge of modeling approaches for multiphase flow, Discretization of the governing equations using finite difference/volume/element methods, Concepts of consistency, Stability and convergence, Solution of discretized equations and coupled equations and structured and unstructured grids generation.

UNIT-I	Importance and applications of computational fluid dynamics in engineering, Illustration of the CFD approach, CFD as an engineering analysis tool, Derivation of flow governing equations, Turbulence modeling, Modeling approaches for multiphase flow, Initial and boundary conditions, Wellposedness.
UNIT-II	Turbulence modeling, Discretization of the governing equations using finite difference/volume/element methods, Concepts of consistency, Stability and convergence; template for the discretization of a generic unsteady transport equation.
UNIT-III	Spectral analysis of errors and TVD schemes. Solution of discretized equations; direct methods; classical iterative methods; advanced methods for structured matrices; conjugate gradient techniques; multigrid methods. Solution of coupled equations, methods for compressible flows; evaluation of pressure in incompressible flows; pressure-velocity coupling algorithms.
UNIT-IV	Structured and unstructured grids; structured grid generation; unstructured grid generation. Benchmarking; calibration. Application of SIMPLE, SIMPLER and MAC algorithm to solve fluid flow problems, Simulation of coupled heat and momentum transfer problem. Case studies for simulation of CFD problems by use of general CFD software.

Recommended Books:

- Niyogi P, Chakrabarty S K and Laha M K, Introduction to computational fluid dynamics, Pearson education
- Muralidhar K and Sundararajan T, Computational Fluid Flow and Heat Transfer, Narosa Publishing House
- Hirsch C, Numerical Computation of Internal and External Flows, Vol. 1 and 2, John Wiley
- Ferziger J H and Peric M, Computational Methods for Fluid Dynamics, Springer

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-421/422/423/424 POLYMER TECHNOLOGY

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

The aim of this course is to provide students a thorough understanding in the area of polymer science and technology and its application. After undergoing this course the students will have the knowledge of basic concepts of polymer science, Polymer Properties and synthesis, Polymer Processing and different types of polymer composites.

UNIT-I	Basic concepts of polymer science, Classification of polymers, Molecular architecture and molecular weight distribution, Thermal characteristics, Rheological characteristics, Properties and Additives.
UNIT-II	Introduction to polymer Synthesis, Addition polymerization, Condensation polymerization, Modification of Preformed Polymers, Commercial Production Technology of common polymers including Polyethylene, Polypropylene, Nylon, Polyethylene terepthalate.
UNIT-III	Introduction to polymer Processing, Chemical engineering fundamentals for polymer processing, Extrusion, Injection molding, Other processes such as calendaring, Film Blowing, Thermoforming.
UNIT-IV	Polymer Blends, Compatibility, Types, Properties, Glass transition temperature. Polymer Composites, Types, Properties, Preparation. Polymer Nanocomposites, Basic concepts, Preparation, Characterization.

Recommended Books:

- Billmeyer F W Jr, Text Book of Polymer Science, Wiley & Sons
- Tadmo Z, Gogos C G, Principles of polymer processing, Wiley Interscience
- Polymer Processing: Principles and Modelling, By Agassant, Avenas, Sergent, Carreau
- Crawford R J, Plastics Engineering
- Odian George, Principles of Polymerization

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-421/422/423/424 SCALE-UP AND PILOT PLANT METHODS IN CHEMICAL ENGINEERING

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

This course will provide concepts, Methods and advice on how to scale-up or translate a process or model to larger sizes. Emphasis throughout the course will be on proper designs, Modeling and processing. The importance of the process geometry will be emphasized. The course will cover the different scale-up methods and how to establish viable process objectives.

UNIT-I	Scale up, Description and evolution of a process system, Introduction to Scale up procedures, Dimensional analysis, Similitude. Reactors for Fluid Phase Processes Catalyzed by Solids, Pseudo-homogeneous and heterogeneous models, Two-dimensional models, Scale up considerations.
UNIT-II	Fluid-fluid Reactors, Scale-up considerations in packed bed absorbers and bubble columns, Applicability of models to scale-up. Mixing Processes, Scale-up relationships, Scale-up of polymerization units, Continuous stages gas-liquid slurry processes, Liquid-liquid emulsions
UNIT-III	Fluidized Beds, Major scale-up issues, Prediction of performance in large equipment, Practical commercial experience, Problem areas. Solid-Liquid Separation Processes, Fundamental considerations, Small scale studies for equipment design and selection, Scale-up techniques, Uncertainties.
UNIT-IV	Continuous Mass Transfer Process, Fundamental considerations scale-up procedure for distillation, Absorption, Stripping and extraction units.

Recommended Books:

- Bisio A and Kabel R L, Scale-up of Chemical Processes, John Wiley
- Johnstone R E and Thring M W, Pilot Plants, Models and Scale-up Methods in Chemical Engineering, McGraw-Hill

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-421/422/423/424 WATER SUPPLY AND TREATMENT

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:
This course will help students to understand proper usage of water for drinking purpose - from identification of source, Planning the treatment systems, Distribution of treated water with development of distribution of layout and necessity of maintenance.

UNIT-I	Water supply Engineering: Importance and necessity of community water supply schemes, Essentials of water supply engineering, Quantity of water, Forecasting population, Rate of consumption for various purposes, Factors affecting consumption, Fluctuations in demand.
UNIT-II	Sources of water, Surface water sources, Suitability of the source with respect to quantity and quality, Intakes of various surface water sources, Design of intakes, Ground water sources, Development and protection of groundwater sources, Estimation of yield from various ground water sources, Construction of tube wells, Maintenance. Quality of water, Drinking water standards, Physical, Chemical and bacteriological analysis of water.
UNIT-III	Treatment of water- aeration, Coagulation, Flocculation, Sedimentation, Design of sedimentation tanks, Filtration- slow and rapid filter design, Disinfection, Design of all the units of water treatment plant, Miscellaneous treatments- removal of colour, Taste and odor, Iron and manganese, And hardness, Fluoridation and deflouridation.
UNIT-IV	Water supply schemes, Gravitational, Pumping and combined schemes, Transmission of water, Classification of conduits, Shape and strength of conduits, Location of conduits, Materials of conduits, Design of gravity and pumping main, Distribution systems, Different layout of pipe networks, Analysis of pipe networks, House connection from mains, Laying and joining of pipes, Appurtenances, Different valves, Meters and hydrants, Detection and prevention of leaks in distribution system, Cleaning and maintenance of distribution system.

Recommended Books:

- Garg S K, Environmental Engineering Vol I, Khanna Publishers, 1992
- Birdie G S and Birdie J S, Water Supply and Sanitary Engineering, Dhanpat Rai & Sons, 1996
- Duggal K N, Elements of Environmental Engineering, S Chand & Co Ltd, 2008

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-421/422/423/424 PROCESS OPTIMIZATION

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

In "Process Optimization" the various aspects of traditional process optimization and newer developments like genetic algorithms and mixed integer optimization and their applications in process engineering will be covered. Each topic will be developed in a logical progression with up-to-date information with references from open literature. The topics will cover basics of optimization, Establishing conditions for finding the stationary point under different conditions, Traditional line search techniques, Unconstrained and constrained optimization, Direct and indirect methods, Genetic algorithms and multi-objective optimization, Mixed integer optimization.

UNIT-I	Basic concepts of optimization**,** Continuity of functions, Unimodal versus multimodal functions, Convex and concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function, Interpretation of the objective function in terms of its quadratic approximation. Optimization of unconstrained functions, One dimensional search Scanning and bracketing procedures, Newton's, Quasi-Newton's and Secant methods of uni dimensional search, Region elimination methods, How to apply one dimensional search in a multidimensional problem.
UNIT-II	Unconstrained multivariable optimization, Direct methods, Random search, Grid search, Univariate search, Simplex method, Conjugate search directions, Powell's method. Indirect methods (first order), gradient method, Conjugate gradient method. Indirect methods (second order), Newton's method, Forcing the Hessain matrix to be positive definite, Relation between conjugate gradient methods and Quasi-Newton method.
UNIT-III	Linear programming and applications**,** Basic concepts in linear programming, The simplex method of solving linear programming problems, Standard LP form, Obtaining a first feasible solution, LP applications.
UNIT-IV	Nonlinear programming with constraints, The Lagrange multiplier method, Necessary and sufficient conditions for a local minimum, Quadratic programming, Generalized reduced-gradient method, Penalty function and augmented Lagrangian methods. Successive quadratic programming, NLP applications.

Recommended Books:

- Beveridge G S and Schechter R S, Optimization theory and practice, McGraw Hill, International Student Edition, New York
- Deb K, Optimization for engineering design: Algorithms and examples, Prentice Hall of India, New Delhi
- Edgar T F and Himmelblau D M, Optimization of chemical processes, McGraw Hill, International editions, Chemical Engineering Series, New York

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-421/422/423/424 CHEMICAL REACTOR ANALYSIS

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

This course will help students to learn how to derive and apply the energy and material balances that are required to design isothermal and non-isothermal batch, Plug flow and continuous stirred tank reactors. They will also learn how to approach and solve variable density and multiple independent reaction problems. The course presents the fundamentals of reaction Stiochiometry, Reaction analysis, and simple kinetic analysis of homogeneous and heterogeneously catalyzed reactions. The course addresses mixing and covers simple, One-parameter non-ideal reactor models.

UNIT-I	Isothermal Reactor Design, Design equations for batch, Plug flow, Back-mix flow and semi batch reactors. Multiple Reactions, Maximizing desired product in parallel reactions and series reactions, Algorithm for solution to complex reactions.
UNIT-II	Steady State Non-isothermal Reactor Design, Combining material and energy balances for non-isothermal CSTR and Plug flow reactors (adiabatic and with heat exchange), Adiabatic temperature and equilibrium conversion, Optimum feed temperature, Multiple steady states, Non-isothermal multiple reactions.
UNIT-III	Gas-Solid Reactions, Shrinking core model, Determination of rate controlling step and corresponding rate law, Prediction of mean conversion in flow reactors, Design of reactors for gas-solid reactions. Solid Catalyzed Reactions, Diffusion and reaction in spherical catalyst pellets, Estimation of diffusion and reaction limited regimes, Mass transfer and reaction in a packed bed, Multiphase reactors, Fluidized bed reactors.
UNIT-IV	Non-ideal Reactors, Measurement of RTD, Characteristics of RTD, RTD in ideal reactors, Reactor modeling using RTD, One and two parameter models for non-ideal reactors.

Recommended Books:

- Fogler H S, Elements of Chemical Reaction Engineering, Prentice-Hall India
- Levenspiel O, Chemical Reaction Engineering, John Wiley
- Froment G F, And Bischoff K G, Chemical Reactor Analysis and Design, John Wiley
- Smith J M, Chemical Engineering Kinetics, McGraw-Hill
- Denbigh K G, And Turner J C R, Chemical Reactor Theory: An Introduction, Cambridge University Press

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
CHE-421/422/423/424 PROCESS INTEGRATION

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

Process integration, A part of Process Intensification, Is a fairly new term that emerged in 80's and has been extensively used in the 90's to describe certain systems oriented activities related primarily to process design. Process Integration has evolved from a heat recovery methodology in the 80's to become what a number of leading industrial companies in 90's regarded as a "major strategic design and planning technology". This course will help understanding students, different ways to significantly reduce the operating cost of existing plants, While new processes often can be designed with reduction in both investment cost and operating cost.

UNIT-I	Introduction to process Intensification and Process Integration (PI), Areas of application and techniques available for PI, Onion diagram. Pinch Technology-an overview, Introduction, Basic concepts, How it is different from energy auditing, Roles of thermodynamic laws, Problems addressed by Pinch Technology, Key steps of Pinch Technology like Concept of ΔT , Data Extraction, Targeting, Designing, Optimization-Super targeting, Basic Elements of Pinch Technology, Grid Diagram, Composite curve, Problem Table Algorithm, Grand Composite Curve.
UNIT-II	Targeting of Heat Exchanger Network, Energy Targeting, Area Targeting, Number of units targeting, Shell Targeting and Cost targeting. Designing of HEN, Pinch Design Methods, Heuristic rules, Stream splitting, Design of maximum energy recovery(MER), Use of multiple utilities and concept of utility pinches, Design for multiple utilities pinches, Concept of threshold problems and design strategy, Network evolution and evaluation-identification of loops and paths, Loop breaking and path relaxation.
UNIT-III	Design tools to achieve targets, Driving force plot, Remaining problem analysis, Diverse pinch concepts, MCp ratio heuristics, Targeting and designing of HENs with different ΔTmin values, Variation of cost of utility, Fixed cost, TAC, Number of shells and total area with ΔTmin Capital-Energy trade-offs, Process modifications-Plus/Minus principles, Heat Engines and appropriate placement of heat engines relative to pinch. Heat pumps, Appropriate placement of heat pumps relative to pinch.
UNIT-IV	Steam Rankin Cycle design, Gas turbine cycle design, Integration of Steam and Gas turbine with process. Refrigeration systems, Stand alone and integrated evaporators. Heat integrations and proper placement of Reactors for batch Processes as well as continuous processes, Retrofit of distillation systems, Case studies.

Recommended Books:

- Linnhoff B, Townsend D W, Boland D, Hewitt G F, Thomas B E A, Guy A R and Marsland R H, A User Guide on Process Integration for the Efficient Uses of Energy, Inst. of Chemical Engineers
- Kumar A, Chemical Process Synthesis and Engineering Design, Tata McGraw Hill
- Shenoy U V, Heat Exchanger Network Synthesis, Gulf Publishing Company
- Smith R, Chemical Process Design, McGraw-Hill

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-421/422/423/424 NUCLEAR REACTOR TECHNOLOGY

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

This course aims to introduce to students of final year Chemical Engineering disciplines, The Indian Nuclear programme, The types of nuclear reactors, Principle of heat generation, Heat removal & control in thermal reactors, Concept of breeding, Fast breeder neutronics, Core configuration & heat removal in fast breeder reactors.

UNIT-I	Introduction to reactor system & Three stage Indian nuclear power programme. Classification of reactors, Characteristics of research, Test & power reactors with examples, Core configuration & cycle diagrams of thermal reactors (BWR, PWR, PHWR, AGR, HTGR, AHWR) and Fast Reactors, Reactors – Characterisitics, Selection criteria and comparison of different core and structural materials for reactor internals.
UNIT-II	Thermal Reactors, Basic principles of heat generation, Heat sources and distribution, Steps involved in heat removal from reactor systems, Heat flow and temperature distribution in plate and solid cylindrical fuel elements, Primary heat transport system including steam generators, Shut down cooling, Emergency core cooling system, Moderator system. Auxiliary systems, Ventilation, Annulus gas, Process water and fire water systems.
UNIT-III	Secondary systems, Description of flow sheet and major components, Comparison of operating conditions, thermal cycles and major components of thermal and nuclear units Typical reactivity balance, Reactor control system – requirements of physics aspects, Reactor shut down mechanisms. FBR neutronics, Neutron spectrum, Reaction cross-section, Core characteristics, Blanket characteristics, Breeding potential, Breeding ratio, Breeding gain and doubling time. Fast Breeder Reactors, Breeding, Breeders as inexhaustible energy source.
UNIT-IV	Characteristics and types of fast reactors, Comparison of some characteristics of fast and thermal reactors, Role of fast reactors in Indian nuclear power programme. General features of fast reactor core, Introduction, Specific power, Power density, Linear heat rating, Burnup, Fluence, Operating condition, Requirement and choice of core materials, Fuel, Absorber, Coolant & structural materials. Core engineering, Design constraints - linear rating, Maximum temperature of clad, Coolant velocity, Outlet temperature of coolant, Pressure drop in core, Core height/diameter ratio, Blanket thickness, Shielding thickness Heat transport system, Introduction to sodium technology – Properties, Characteristics and complexities. Heat transport circuit system components

Recommended Books:

- John R, Lamarsh J R and Baratta A R, Introduction to Nuclear Engineering, Prentice-Hall.
- El-Wakil M M, Nuclear Power Engineering, McGraw-Hill.
- Glasstone S, Sesonske A and Von-Nostrand, Nuclear Reactor Engineering, Vol. 1 & 2
- Murray R L, Nuclear Energy: An Introduction to the Concepts, Systems, And Applications of Nuclear Processes, 5/e, Butterworth Heinemann
- Walter A E and Reynolds A B, Fast Breeder Reactors, Pergamon Press

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-421/422/423/424 ENERGY MANAGEMENT IN PROCESS INDUSTRIES

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:
The aim of this course to give exposure to the basic aspects of energy management, Creating awareness of energy saving methods & practices. The course discusses various techniques of energy management applicable to buildings as well as industrial applications. Further, This course has been well organized to facilitate in-depth learning of alternate sources of energy and audit to supplement the conservation techniques in demand side management.

UNIT-I	Introduction, Energy scenario - supply and demand, Energy intensive industries, Industrial use of energy, Importance of energy in industrial promotion and employment. Energy Audit, Importance of energy audit and questionnaire, Instruments used in energy audit.
UNIT-II	Identification of quality and cost of various energy inputs, Evaluation of energy consumption pattern in different processes, Heat loss analysis, Electrical energy input analysis.
UNIT-III	Energy Conservation, Analysis of scope and potential for energy conservation, Good housekeeping practice, Energy storage such as thermal insulation, Accumulators and storage media, Co-generation practice, Efficiency improvement in boilers, Furnaces etc. and heat recovery techniques, Energy saving aspects of environment, Electrical energy conservation by using variable speed drives and motor controllers, Analysis of pumps, Process integration as a measure of energy conservation.
UNIT-IV	Water Management, Sources of water, Importance of water in industrial applications, Flow monitoring devices, Quality and cost of water, Water distribution in process industries and scope for water conservation, Analysis of effluents, Treatment and recycle of water.

Recommended Books:

- Kenney W F, Energy Conservation in the Process Industries, Academic Press
- Reay D A, Industrial Energy Conservation, Pergamon Press

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

CHE-421/422/423/424 WASTE WATER TREATMENT

L	T	P	Cr
3	1	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

To expose students to the area of waste treatment - with emphasis on domestic liquid wastes - its characterization, Collection, Treatment and disposal at individual household level to community level (rural and urban). To impart the basic concepts of solid waste management and air pollution control.

UNIT-I	Importance of sanitation, Systems of sewerage- separate, Combined and partially separate. Quantity of sanitary sewage and variations. Shapes of sewer - circular and egg shaped. Design of sewers, Self-cleansing velocity and slopes, Construction and testing of sewer lines. Sewer materials. joints and appurtenances. Quality parameters of sewage, BOD, COD, Solids, D.O., Oil & Grease. Indian Standards for disposal of effluents into inland surface sources and on land.
UNIT-II	Objectives of wastewater treatment, Effluent standards, KSPCB Standards, BIS Standards. Layout of conventional treatment plant, Preliminary, Primary, Secondary and tertiary treatments in general. Preliminary process- screens, Types of screens, Design, Disposal of screenings, Grit chamber and its function, Design, Construction and operation, Disposal of grit, Detritus tank, Skimming tank and its function, Design and operation, Disposal of skimming Sedimentation: Theory of sewage sedimentation, Design construction and operation, Rectangular and circular tanks, Disposal of sludge.
UNIT-III	Biological process- principle and theory of biological treatment. Sewage filtration; trickling filters, Design, Construction and operation. Activated sludge process: Design, Construction and operation of conventional and extended aeration, Aeration methods. Miscellaneous methods, Stabilization ponds, Oxidation ditch, Aerated lagoons, Rotating biological contactors; disinfection of sewage effluents.
UNIT-IV	Sludge treatment and disposal- quantity of sludge, Characteristics of sludge, Sludge thickening, Digestion, Conditioning and disposal, Design of sludge digesters only. Septic Tanks: Design (as per Ministry of urban development) construction, Disposal of effluents, Cleaning of tanks, Imhoff tanks. Sewage treatment by high rate anaerobic methods: Anaerobic digestion suspended growth, Contact process, UASB, Attached growth, Filters, Expanded bed, Only basics.

Recommended Books:

- Garg S K, Sewage Disposal and Air Pollution, Khanna Publishers, New Delhi, 1996
- Punmia B C, Jain A K, Jain A K, Waste Water supply Engineering, Laxmi Publication, 2005
- Metcalf and Eddy, Waste water Engineering 4th Ed., McGraw Hill International Editions, 2003
- Hammer M J, Water and waste water technology, John Wiley and Sons, Inc., 2011

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-612 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

L	T	P	Cr
4	-	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:
To allow students to understand the basic concepts of environmental chemistry and basics of microbiology.

UNIT-I	Introduction and basic concepts of environmental chemistry: Environmental composition, Stratospheric chemistry (ozone), Tropospheric chemistry (smog, Precipitation), Atmospheric aerosols, Chemistry of global climate (greenhouse gases). Environmental issues related to aqueous organic matter, Water pollution and wastewater treatment chemistry. Chemistry of solid wastes, Organic biocides.
UNIT-II	Colloids-Redox potentials -partition coefficient-Beer-Lambert's Law -Limitations, UV visible spectroscopy - basic principles, Application, Atomic absorption spectroscopy-Principles, Applications, Gas chromatograph -Principles and applications, Principles of green chemistry, Error Analysis of Environmental Data.
UNIT-III	Transport and transformation of chemicals - DO, BOD and COD - Photo catalysis - Degradation of food stuffs, Detergents, Pesticides and hydrocarbons. Soil chemistry-acid-base and ion-exchange reactions in soil - salt affected soil and its remediation. Classification of microorganisms- prokaryotic, Eukaryotic, Structure, Characteristics, Nucleic acids-DNA, RNA, Replication.
UNIT-IV	Culturing of microorganisms-Environmental factors influencing microbial growth Distribution of microorganisms-Water, Air and Soil, Indicator organisms, Coliforms-fecal coliforms, E. coli, Streptococcus, Clostridium, Significance in water. Algae in water supplies-problems and control. MPN and MFT. Ecotoxicology-toxicants and toxicity, Factors influencing toxicity, Effects-acute, Chronic, Concentration response relationships, Test organisms, Toxicity testing, Bio concentration, Bioaccumulation, Bio magnification, Bioassay, Bio monitoring.

Recommended Books:

- Sawyer C N, MacCarty P L and Parkin G F, Chemistry for Environmental Engineering and Science, Tata McGraw-Hill, New Delhi
- Vanloon G W and Duffy S J, Environmental chemistry - a global perspective, Oxford University press, New York
- Tortora G J, Furke B R and Case L, Microbiology - An Introduction, Benjamin/Cummings Publ. Co. Inc., California
- Pelczar M J, Chan E C S and Krieg N R, Microbiology, Tata Mcgraw Hill,New Delhi

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-614 WATER TREATMENT PROCESSES

L	T	P	Cr
4	-	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:
This course will make students to understand advanced methods of water treatment processes.

UNIT-I	Water Treatment Processes: Theory, Design and Application - aeration, Solids separation, Settling operations, Coagulation and flocculation, Adsorption, Filtration, Chlorination and other disinfection processes, Softening, Taste and odour removal, Corrosion phenomenon, And other water treatment processes like removal of fluoride, Arsenic, Iron and manganese.
UNIT-II	Mixing, Clarification-Sedimentation; Types; Aeration and gas transfer - Coagulation and flocculation, Coagulation processes - stability of colloids - destabilization of colloids transport of colloidal particles, Clariflocculation.
UNIT-III	Filtration - theory of granular media filtration; Classification of filters; slow sand filter and rapid sand filter; mechanism of filtration; modes of operation and operational problems; negative head and air binding; dual and multimedia filtration, Design.
UNIT-IV	Adsorption, Adsorption equilibria- adsorption isotherms, Disinfection - chlorine dioxide; chloramines; ozonation; UV radiation. Ion Exchange-processes, Application Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodyalisis.

Recommended Books:

- Water Quality and Treatment: A Handbook of Public Water Supply by The American Water Works Association (AWWA), McGraw Hill Inc New York
- Manual on Water Supply and Treatment, CPHEEO, GOI, N Delhi
- Peavy H S, Rowe D R and Tchobanoglous G, Environmental Engineering, McGraw-Hill Book Co. NY
- Weber W J, Physicochemical Processes for Water Quality Control, Wiley Interscience, NY
- Sincero A P and Sincero G A, Environmental Engineering, PHI, New Delhi
- Garg S K, Environmental Engineering (Vol. I), Khanna Publishers, N Delhi
- Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw-Hill, New Delhi

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-616 ENVIRONMENTAL ENGINEERING LAB-I

L	T	P	Cr
-	-	2	1

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• To determine the pH of a given sample of water. • To determine the various forms of alkalinity and acidity in water sample. • To determine the chloride content in a given water sample. • To determine temporary and permanent hardness in a given sample of water. • To determine total, dissolved, suspended and volatile residues in water sample. • To determine the dose of coagulant required for optimum coagulation. • To determine the dissolved oxygen (DO) in a given sample of water. • To determine the sulphate concentration in a given sample of water. • To determine the coliform bacteria by total count method in a given sample of water. • To determine the most probable number of coliform bacteria in a given water sample by British technique.

Recommended Books and Codes:

- Standard Methods for the Examination of Water and Wastewater, APHA Washington DC.
- Sawyer C N and McCarty P L, Chemistry for Environmental Engineering, McGraw-Hill Book Agency
- IS: 3025, Methods of Sampling and Test (Physical and Chemical) for Water and Wastewater
- IS: 2720, Method of Test for Soils

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-618 PG SEMINAR

L	T	P	Cr
-	-	4	2

Internal Evaluation: 50 Marks

SEMINAR	Each one of the students will be assigned to work on a Seminar Topic in the current and advanced areas of environmental science & engineering, including application of other engineering disciplines in civil engineering. The student has to conduct a detailed literature review on the assigned topic and prepare a report. The student will make an oral presentation followed by a brief question and answer session. The Seminar (including presentation and report) will be evaluated by the faculty members assigned for this purpose.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

ESE-621 ECOLOGY

L	T	P	Cr
4	-	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Introduction: definitions, Scope and importance. Ecosystems: concept, Structure & function and classification of ecosystems. Types, Characteristic features, Structure and function of major ecosystems.
UNIT-II	Energy flow within the ecosystems: energy and material, Energy flow, Food chains & food webs, Trophic level and ecological pyramids. Biogeochemical cycles and limiting factors. Population ecology: population attributes, Simple models of population growth, Growth form, Growth rates, Interactions among organisms, Survival and extinction. Human population growth.
UNIT-III	Biodiversity: definition, Levels, Measurement and value/importance of biodiversity. Biogeographical classification of India. Biodiversity at global, National and local levels. Hotspots of biodiversity. Threats to biodiversity. Conservation of biodiversity. Biodiversity Treaty.
UNIT-IV	Ecosystem development and evolution: definition, Models of succession, Significance of ecological development. Evolution of the ecosystem. Ecosystem management.

Recommended Books:

- Odum E P and Barrett G W, Fundamentals of Ecology, Thomson Brooks/Cole, USA
- Beeby A and Brennan A N, First Ecology, Oxford University Press
- Deswal S and Deswal A, A Basic Course in Environmental Studies, Dhanpat Rai & Co. (P) Ltd., N Delhi
- Dash M C, Fundamentals of Ecology, Tata McGraw Hill
- Sharma P D, Ecology and Environment, Ashish Publication
- Bharucha E, The Biodiversity of India, Mabin Publishing, Ahmedabad

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-623 AIR AND NOISE POLLUTION

L	T	P	Cr
4	-	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Introduction: definition, Atmospheric composition, Origin of air pollution, Sources, Classification and effects of air pollutants and their effect on human health vegetation and property- Effects - Reactions of pollutants and their effects-Smoke, Smog and ozone layer disturbance - Greenhouse effect.
UNIT-II	Meteorological aspects of air pollution: dispersion of air pollutants, Plume behaviours, Air diffusion models, Design of stacks, Effects of air pollution on meteorological conditions.
UNIT-III	Air pollution sampling: ambient and stack sampling, Ambient air quality monitoring, Air quality standards. Engineered methods of air pollution control: atmospheric cleansing processes, Approaches to contaminant control, Control devices for particulate contaminants and gaseous contaminants.
UNIT-IV	Definition, Unit of measurement, Loudness, Hearing mechanism, Measurement of noise and weighting networks, Sources of noise, Psychological & pathological effects of noise, Strategies for noise pollution control, Noise monitoring and standards.

Recommended Books:

- Peavy H S, Rowe D R and Tchobanoglous G, Environmental Engineering, McGraw Hill Inc. New York
- Perkins H C, Air Pollution, McGraw Hill Publishers, New York
- Rao and Rao, Air Pollution, Tata McGraw Hill Publishers, New Delhi
- Deswal S and Deswal A, A Basic Course in Environmental Studies, Dhanpat Rai & Co. (P) Ltd. N Delhi
- Sincero A P and Sincero G A, Environmental Engineering, PHI, N Delhi

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-625 WASTEWATER TREATMENT PROCESSES

L	T	P	Cr
4	-	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Wastewater flow rates, Wastewater composition. Characteristics and examination, Effluent standards. Sources -Significant parameter - Fundamentals of Process Kinetics, Zero order, First order, Second order Reactions, Enzyme reactions - Bio reactors- Types-Classification - Design principles.
UNIT-II	Design of wastewater treatment systems-Primary, Secondary and tertiary treatments-Evaluation of Biokinetic Parameters- Activated Sludge and its process - Modifications, Biological Nitrification and denitrification. Design of low cost systems like septic tanks, Aerobic pond, Aerated lagoons, Facultative pond, Anaerobic ponds-polishing ponds, Aerated Lagoons.
UNIT-III	Aeration- Fundamentals of gas transfer- Attached Growth Biological Treatment Systems-Trickling Filters- Rotating Biological Contactors- Activated Biofilters and their designs.
UNIT-IV	Anaerobic processes-Process fundamentals-Standard, High rate and hybrid reactors, Anaerobic filters-Expanded /fluidized bed reactors-Upflow anaerobic sludge blanket reactors,Expanded granular bed reactors- Two stage/phase anaerobic reactors, Sludge Digestion, Sludge disposal.

Recommended Books:

- Metcalf and Eddy, Wastewater Engineering - Treatment, Disposal and Reuse, Tata McGraw Hill Publishing Co., New Delhi
- Benefield L D and Randall C W, Biological Processes Design for wastewaters, Prentice-Hall, Inc. Eaglewood Cliffs
- Grady Jr. C.P.L and Lin H C, Biological wastewater treatment: Theory and Applications, Marcel Dekker, Inc New York, 1980.
- Fair G M, Geyer J C and Okun D A, Water and Wastewater Engineering (Vol. I & II), John Wiley & Sons Inc New York NY
- Sincero A P and Sincero G A, Environmental Engineering, PHI, N Delhi
- Garg S K, Environmental Engineering (Vol. II), Khanna Publishers, N Delhi
- CPHEEO, Manual on Sewerage and Sewage Treatment, GOI, N Delhi

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-627 DESIGN OF EXPERIMENTS AND RESEARCH METHODOLOGY

L	T	P	Cr
4	-	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Introduction, Objectives for experimental designs, Basic design concepts, Steps for the design of experiments, Types of experimental designs, Analysis of Means, Experimental designs and six sigma. Statistical Inference, Generation of hypotheses, Testing of hypotheses, OC curve, Tests on means, Tests on variances, Assessing normality, ANOVA rationale, Confidence limits on means, Components of variance.
UNIT-II	Completely Randomized Design: Model for a completely randomized design with a single factor, ANOVA for a completely randomized design, Randomized block design, Incomplete block design, Latin square design, One way, Two way ANOVA, Balanced ANOVA. Full and Fractional Factorial Designs with Two Levels: Nature of Factorial Designs. Deleterious effects of Interactions, Effect Estimates, The 23 Design, Built-in-Replication, Role of expected mean squares in experimental design, 2k-1 Designs, Effect Estimates and Regression Coefficients, 2k-2 Designs, Basic Concepts, Design Efficiency, John's 3/4 Designs.
UNIT-III	Robust Designs, DOE and Taguchi Approach, Experimental Design using orthogonal arrays, Experimental Designs with Two-Level Factors only, Experimental Designs with Three and Four Level Factors, Analysis using Signal to Noise Ratios, Some case studies, Response Surface Methodology, Response surface experimentation, Process improvement with Steepest Ascent, Analysis of Second-order response surfaces, Central Composite Designs, Box-Behnken Designs, Analyzing the fitted surface, Design-Expert Software.
UNIT-IV	Methods of Research, Descriptive research design-survey, Case study, Content analysis, Ex-post Facto Research, Co relational and Experimental Research, Tests, Questionnaires, Checklists, Observation schedules, Selecting a standardized test, Data collection methods, Approaches to data collection, Interpretation of statistical analysis, Procedure for writing a research proposal, Types and components of research proposal, Procedure for writing a research report, Audiences and types of research reports, Format of research report and journal articles.

Recommended Books:

- Ryan Thomas P, Modern Experimental Design, John Wiley Publishers, NY, 2003
- Roy Ranjit K, Design of Experiments using the Taguchi Approach, John Wiley, NY, 2006
- Hicks Charles R, Fundamental Concepts in Design of Experiments, Oxford University Press, NY, 1999
- Ryan Thomas P, Modern Experimental Design, John Wiley
- Myers R H and Montgomery Dc, Response Surface Methodology, John Wiley
- Borg W and Gall M, Educational Research: An Introduction, New York, Longman
- Cohen L, Educational Research in Classrooms and Schools! A Manual of Materials and Methods NY, Harper and Row Publishers
- CPSC: Developing Skills in Technician Education Research Modules 1 to 11 Singapore; Colombo Plan Staff College for Technician Education
- Gay L R, Educational Research, Ohio: Charles E. Merril Publishing Company
- Wiersma William Research Methods in Education-An Introduction London, Allyn and Bacon Inc.2000

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-629 ENVIRONMENTAL ENGINEERING LAB-II

L	T	P	Cr
-	-	2	1

Internal Evaluation: 25 Marks
External Examination: 25 Marks
Duration of Examination: 03 Hours

EXPERIMENTS	• To determine the pH of a given sample of sewage / soil. • To determine the various forms of alkalinity and acidity in sewage sample. • To determine total, dissolved, suspended and volatile residues in sewage sample. • To determine the chemical oxygen demand (COD) of a given sewage sample. • To determine the biochemical oxygen demand (BOD) of a given sewage sample. • To determine the sulphate concentration in a given sample of soil. • Determination of concentration of suspended particulate matter in air. • Determination of gaseous pollutants from vehicles fitted with internal combustion engines. • Measurement of noise in residential, industrial and traffic areas.

Recommended Books and Codes:

- APHA Washington DC. Standard Methods for the Examination of Water and Wastewater
- Sawyer C N and McCarty P L, Chemistry for Environmental Engineering, McGraw-Hill Book Agency.
- IS: 3025, Methods of Sampling and Test (Physical and Chemical) for Water and Wastewater.
- IS: 2720, Method of Test for Soils
- IS 5182 "Methods for Measurement of Air Pollution"
- IS 14600 Automotive Vehicles-Exhaust Emissions-Gasous Pollutants from Vehicles Equipped with ICE.
- IS 9989 Assessment of Noise with respect to Community Response.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

ESE-631/633/635 SOLID AND HAZARDOUS WASTE MANAGEMENT

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Types and Sources of solid and hazardous wastes, Need for solid and hazardous waste management, Legislations on management and handling of municipal solid wastes, Hazardous wastes, And biomedical wastes.
UNIT-II	Waste generation rates, Composition, Hazardous Characteristics, TCLP tests, Waste sampling, Source reduction of wastes, Recycling and reuse. Handling and segregation of wastes at source, Storage and collection of municipal solid wastes.
UNIT-III	Analysis of Collection systems - Need for transfer and transport, Transfer stations - labeling and handling of hazardous wastes. 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, Landfill remediation Elements of integrated waste management.

Recommended Books:

- George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management,McGraw- Hill, New York
- CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-631/633/635 AIR QUALITY MANAGEMENT

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Air pollutants - Sources and classification of pollutants and their effect on human health vegetation and property- Effects - Reactions of pollutants and their effects- Smoke, Smog and ozone layer disturbance - Greenhouse effect - Ambient and stack sampling.
UNIT-II	Atmospheric diffusion of pollutants - Transport, Transformation and deposition of air contaminants - Air sampling & pollution measurement methods - Ambient air quality and emission standards - Air pollution indices, Air act.
UNIT-III	Control principles - Removal of gaseous pollutants by adsorption, Absorption, Reaction and other methods.Particulate emission control- settling chambers, Cyclone separation, Wet collectors, Fabric filters, Electrostatic precipitators and other removal methods like absorption, Adsorption, Precipitation, Biological air pollution control technologies - bioscrubers, Biofilters, And Indoor air quality.
UNIT-IV	Air quality models - Micrometeorological processes - wind rose - dispersion - stability classes - Gaussian dispersion model - Regional air quality models, Line source models, Noise - Decibel - Decibel Addition - Octave band spectrum.

Recommended Books:

- Wark Kenneth and Warner C F, Air pollution its origin and control. Harper and Row Publishers, New York
- Rao C S, Environmental pollution control Engineering, New age international Ltd, New Delhi
- Peavy H S, Rowe D R, Tchobanoglous G, Environmental Engineering, McGraw Hills, New York

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-631/633/635 ENVIRONMENTAL GEOTECHNOLOGY

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Soil as a multiphase system- Soil-environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium. Soil mineralogy- significance of mineralogy in determining soil behaviour; Mineralogical characterization.
UNIT-II	Mechanisms of soil-water interaction- Diffuse double layer models; Force of attraction and repulsion; Soil-water-contaminant interaction, Theories of ion exchange; Influence of organic and inorganic chemical interaction.
UNIT-III	Introduction to unsaturated soil mechanics- water retention property and soil-water characteristic curve; flow of water in unsaturated soil. Concepts of waste containment facilities; desirable properties of soil; contaminant transport and retention; contaminated site remediation.
UNIT-IV	Introduction to advanced soil characterization techniques- volumetric water content; gas permeation in soil; electrical and thermal properties; pore-size distribution; contaminant analysis.

Recommended Books:

- Mitchell J K and Soga K, Fundamentals of Soil Behavior, John Wiley and Sons Inc
- Fang H Y, Introduction to Environmental Geotechnology, CRC Press
- Daniel D E, Geotechnical Practice for Waste Disposal, Chapman and Hall
- Rowe R K, Quigley R M and Booker Clay, Barrier Systems for Waste Disposal Facilities, JRE & FN Spon
- Rowe R K, Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers
- Reddi L N and Inyang H F, Geoenvironmental Engineering - Principles and Applications, Marcel Dekker Inc
- Sharma H D and Lewis S P, Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation, John Wiley & Sons Inc

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-641/643/645 BIOREMEDIATION - PRINCIPLES AND APPLICATIONS

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:
This course will help students understand the use of microorganism in removing various pollutants.

UNIT-I	Introduction- Engineering of bioremediation processes, Current bioremediation practice and applications; Microbial systems of bioremediation.
UNIT-II	Factors influencing bioremediation (environmental factors, Physical factors and chemical factors); Genetic responses of microorganisms to the presence of pollutants (plasmid coded inducible degradative enzymes).
UNIT-III	Application of genetically engineered microorganisms for hazardous waste management; Microbial transformation reactions (aerobic and anaerobic bio-transformations); Microbial detoxification of specialty chemicals (insecticides, Herbicides, Fungicides, Polychlorinated biphenyls, Heavy metals).
UNIT-IV	Bioremediation systems and processes (solid, Liquid and slurry phase bioremediation); Microbial cleaning of gases (biofiltration and bioscrubbing); In situ bioremediation; Laboratory scale bio-treatability studies for bioremediation; Management of bioremediation project.

Recommended Books:

- Crawford R L and Crawford D L, Bioremediation: principles and applications, Cambridge University Press
- Singh Ajay, Kuhad Ramesh C, Ward Owen P, Advances in Applied Bioremediation
- Anderson W D, Bioremediation: Innovative Site Remediation Technology, American Academy of Environmental Engineers
- Sikdar and Irwin, Bioremediation: Principles and Practice, Technomic Publications, Lancaster, PA, USA

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-641/643/645 INDOOR AIR QUALITY

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Indoor activities of inhabitants - Levels of pollutants in indoor and outdoor air, Design and operation of buildings for improvements of public health, Indoor air quality policy issues, Sustainability.
UNIT-II	Air pollutants in indoor environments- private residences- offices, Schools-public buildings ventilation. Control of several pollutant classes, Radon, Toxic organic gases, Combustion by products microorganisms such as molds and infectious bacteria.
UNIT-III	Concepts and tools- exposure, Material balance models- statistical models. Indoor air pollution from outdoor sources, Particulate matter and ozone, Combustion byproducts, Radon and its decay products, Volatile organic compounds, Odors and sick building syndrome.
UNIT-IV	Humidity-Bio aerosols, Infectious disease transmission, Special indoor environments, A/C units in indoor, Measurement methods, Control technologies, Control strategies.

Recommended Books:

- Thaddes Godish, Indoor air and Environmental Quality, CRC press
- Nazaroff W W and Alvarez-Cohen L, Environmental Engineering Science, Wiley sons, Newyork

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-641/643/645 CONTAMINANT TRANSPORT MODELING

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Transport phenomenon, Diffusion, Dispersion, Advection, Adsorption, Conservative and non-conservative pollutants. Governing Equations for flow and transport in surface and subsurface waters, Chemical and biological process models, Simplified models for lakes, Streams, And estuaries.
UNIT-II	Model complexity, Model resolution, Coupled and uncoupled models, Linear and nonlinear models, Solution techniques, Calibration, Application and evaluation of environmental control, Bioremediation.
UNIT-III	Numerical models: FDM, FEM and Finite volume techniques, Explicit vs. implicit methods, Numerical errors, High resolution techniques.
UNIT-IV	Stream quality modeling using software QUAL2K, Groundwater transport modeling using various softwares such as VISULA, MODFLOW.

Recommended Books:

- Chunmiao Zheng and Gordon D. Bennett, Applied contaminant transport modeling, Wiley-Interscience
- Martin L J and McCucheon S C, Hydrodynamics of transport for water quality modeling, Lewis Publishers, Boca Raton
- Freeze R A and Cherry J A, Groundwater, Prentice Hall
- Vedat Batu, Applied flow and solute transport modeling in aquifers: fundamental principles and analytical and numerical methods, Taylor & Francis

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-659 DISSERTATION (PHASE-I)

L	T	P	Cr
-	-	8	4

Internal Evaluation: 100 Marks

DISSERTATION	The primary objective of this course is to enhance the student ability to analyze and carry out independent investigations etc. Each student will carry out independent work which should involve creativity, Innovation and ingenuity. A dissertation supervisor (s) having at least post- graduate qualification, From industry/research organization shall be assigned to the student approved by the competent authority. In no case, The candidate can have more than two dissertation supervisors. Industry oriented projects should be encouraged for the purpose. The whole Dissertation work will be carried out and reported in two phases in 9^{th} semester and 10^{th} semester. Dissertation work (Phase-I) in 9^{th} semester shall comprise of literature survey, Problem formulation, Finalization of goals to be achieved, Outlines of the methodology to be used for achieving the targeted goals and final decision about S/W, H/W tools to be used for dissertation work in 10^{th} semester. The entire work will be documented in the form of report.

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-622 ENVIRONMENTAL IMPACT ASSESSMENT

L	T	P	Cr
4	-	-	4

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Overview of Environmental Impact Assessment (EIA)- Preparation and Review of Environmental Impact Assessment Report. Evolution of EIA, Concepts, Methodologies, Screening, Scoping, Base line studies, Mitigation, Matrices, Check list. Rapid and Comprehensive EIA, Legislative and Environmental clearance procedures in India, Prediction tools for EIA.
UNIT-II	Assessment of impacts, Air, Water, Soil, Noise, Biological. Socio cultural environment, Public participation, Resettlement and rehabilitation. Documentation of EIA, Environmental Management plan, Post project monitoring.
UNIT-III	Environmental Audit- Life Cycle Assessment. Environmental Management Systems Standards- ISO 14000 (EMS). Related Issues in Environmental Management. Environmental Design. Environmental Economics. Geographic Information System (GIS) and Remote Sensing in Environmental Management.
UNIT-IV	Principles of Environmental Management- Principles of Ecology, Environment & Environmental Management. Policies and Legal Aspect of Environmental Management.

Recommended Books:

- Kulkarni Vijay & Ramachandra T V, Environmental Management, Teri Press
- Krishnamoorthy Bala, Environmental Management, Prentice hall of India
- Canter R L, Environmental Impact Assessment, Mc Graw Hill International Edition
- Rau John G and Wooten David C(Ed), Environmental Impact Analysis Handbook, McGraw Hill Book Company

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-632/634/636 SURFACE AND GROUND WATER MODELLING

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Land Processes - Subsurface and Channel Processes- Precipitation - Rain gauge network, Abstractions, Infiltration, Evaporation, Transpiration, Process and models Unit Hydrograph & S curve hydrograph, Dimensionless unit hydrograph, GUIH, Watershed Model and Conceptual Models.
UNIT-II	Occurrence and Movement of Ground water, Properties of aquifer, Groundwater flow equations, Dupuit Forchheimer assumptions, Well hydraulics, Partial penetration of wells, Interference of wells, Collector wells and Infiltration galleries.
UNIT-III	Pumping tests, Analysis for unconfined and non leaky and leaky confined aquifer and water table aquifer, Locating hydro geologic boundaries, Well design criteria.
UNIT-IV	Natural and Artificial Recharge of Ground water- Salt water intrusion, Application of Finite Difference in ground water.

Recommended Books:

- Ven Te Chow, Applied Hydrology, Mc Graw Hill Science Publishers
- Singh Vijay, Elementary Hydrology, Prentice Hall
- Raghunath, Ground Water, Mc Graw Hill
- Bear J, Hydraulics of Ground water, Mc Graw Hill

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-632/634/636 INDUSTRIAL WASTE MANAGEMENT

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Industrial wastes: characteristics and composition of different industrial effluents, Effects of disposal of industrial effluents, Prevention versus control of industrial pollution, Linkage between technology and pollution prevention, Standards for disposal of industrial effluents.
UNIT-II	Strategies of industrial waste management: process changes, Housekeeping - pretreatment of wastes - collection of waste segregation - equalization - reduction in volume and strength by other methods - theories of neutralization - equalization and proportioning, Chemical precipitation, Etc. Water and energy use in industry.
UNIT-III	Treatment strategies for industrial effluents: Mixing different effluent streams partially or fully, Treatment of combined effluent. A review of the methods adopted for the removal of suspended colloidal and dissolved organic solids removal of in organic dissolved solids - disposal of sludge solids - selection of site for the plant.
UNIT-IV	Treatment of specific characteristics of industrial effluents. Process flow chart, Effluent generation, Composition and treatment of effluents from following industries: Food Industries: Sugar, Fermentation, Meat, Dairy and Rice-milling. Material Industries: Paper, Steel, Metal plating and petroleum refineries. Miscellaneous Industries: Textile, Tanning, Fertilizers and Atomic energy plants

Recommended Books:

- Rao M N and Dutta A K, Industrial Wastewater Treatment, Oxford and IBH publishing company, New Delhi
- Bridge A V, Mumford C J, Water Recycling & Pollution Control Handbook, Van Nostrand Reinhold Company New York.
- Mahajan S P, Pollution Control in Process Industries, Tata McGraw Hill Publishing Co. Ltd, New Delhi
- Azad Hardom Singh, Industrial Wastewater Management Handbook, McGraw Hill Book Co., New York
- Gurnham C Fred, Principle of Industrial Waste Treatment, John Wiley & Sons Inc, New York
- Lund Herbert F, Industrial Pollution Control Handbook, McGraw

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-632/634/636 MODELING OF ENVIRONMENTAL SYSTEMS

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Introduction - Principles of Global Environmental Systems, Systems View of the Environment, Systems Approaches to Environmental Problems, Basic Modeling Concepts- Linear/Exponential Growth.
UNIT-II	Basic Modeling Concepts - Overshoot and logistic growth, Basic Modeling Concepts: Oscillation Modeling Strategies I: Definition, Validation, Calibration, Exploratory Analysis, Sensitivity and Case Analysis.
UNIT-III	Modeling Predator - Pray Systems, Modeling Ecosystem Energy Balance - Global Modeling Ecosystem Energy Balance - Ecosystems, Modeling Ecosystem Water Cycling - Global, Modeling Ecosystem Water Cycling - Ecosystems, Modeling Ecosystem Nutrient Cycling - Global, Modeling Ecosystem Nutrient Cycling - Ecosystems.
UNIT-IV	Surface Water Contamination - Modeling Surface Water Contamination, Greenhouse Gas and Global Warming, Spatial Ecosystem Modeling with GIS, Models in Ecosystem Science

Recommended Books:

- Deaton Michael L and Winebrake James J, Dynamic Modeling of Environmental Systems, Springer, New York
- Richmond Barry, An Introduction to Systems Thinking, USA: High Performance Systems Inc.
- Botkin Daniel B and Keller Edward A, Environmental Science: Earth as a Living Planet. USA: Wiley
- Aber John and Melillo Jerry, Terrestrial Ecosystems, USA: Academic Press

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-642/644/646 ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Environmental Biotechnology: Principles and concepts, Usefulness to mankind. Degradation of high concentrated toxic pollutants, Halogenated, Non halogenated, Petroleum hydrocarbons, Metals, Mechanisms of detoxification, Oxidation, Dehalogenation, Biotransformation of metals, Biodegradation of solid wastes.
UNIT-II	Biotechnological remedies for environmental pollution: decontamination of groundwater, Bioremediation, Production of proteins, Biofertilizers, Physical, Chemical and microbiological factors of composting, Health risk, Pathogens, Odor management, Microbial cell/enzyme technology, Adapted microorganisms, Biological removal of nutrients, Algal biotechnology, Extra cellular polymers, Biogas technology.
UNIT-III	Concept of rDNA technology - expression vectors, Cloning of DNA, Mutation, Construction of microbial strains, Radioactive probes, Protoplast fusion technology, Applications.
UNIT-IV	Environmental effects and ethics of microbial technology - genetically engineered organisms- Microbial containment-Risk assessment.

Recommended Books:

- Chaudhury G R, Biological degradation and Bioremediation of toxic chemicals, Dioscorides Press, Oregon
- Martin A M, Biological degradation of wastes, Elsevier Applied Science, London
- Blaine Metting F (Jr.,) Soil Microbiology Ecology, Marcel Dekker Inc

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

ESE-642/644/646 ENVIRONMENTAL SYSTEMS ANALYSIS AND APPLIED STATISTICS

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Systems Engineering - Analysis, Design, Synthesis, Applications to environmental engineering Systems. Role of optimization models, Deterministic models/Linear programming, Dynamic programming, Separable and Nonlinear programming models. Formulation of objective functions and constraints for environmental engineering planning and design.
UNIT-II	Probabilistic models - fuzzy models, Simulation models. Random variable, Two dimensional random variables, Standard probability distributions-Binomial Poisson and normal distributions, Moment generating function.
UNIT-III	Sampling distributions-confidence interval estimation of population parameters, Testing of hypotheses, Large sample tests for mean and proportion, T-test, F-test and Chi-square test, Curve fitting-method of least squares.
UNIT-IV	Regression and correlation, Rank correlation, Multiple and partial correlation, Analysis of variance-one way and two way classifications, Experimental design, Latin square design, Time series analysis. Modern tools- Neural networks, Genetic Algorithm - Case studies.

Recommended Books:

- Rich L G, Environmental Systems Engineering, McGraw Hill
- Thoman R V, Systems Analysis & water Quality control, McGraw Hill
- Venkatraman M K, Numerical Methods in Science and Engineering, National Publisher Company

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING

ESE-642/644/646 DESIGN OF AIR POLLUTION CONTROL SYSTEMS

L	T	P	Cr
3	-	-	3

Internal Evaluation: 50 Marks
External Examination: 50 Marks
Duration of Examination: 03 Hours

Course Objective:

UNIT-I	Industrial sources of air pollution- Emission factors-regulations- control strategies-policies.
UNIT-II	Particulate Pollutant Control: Settling chambers - laminar and turbulent flow-Filtration, Interception, Impaction, Convective diffusion, Collection of particles by cylindrical fibres and granular beds, Electrostatic precipitation, Cyclones, Wet collectors.
UNIT-III	Gaseous Pollutant Control: Gas absorption in tray and packed towers- Absorption with/without chemical reaction- Removal of SO2 - Adsorption in fixed beds-Breakthrough.
UNIT-IV	Removal of HCs/ VOCs- NOX removal - Wet scrubbers, Integrated air pollution control systems.

Recommended Books:

- Wang Lawrence K, Perelra Norman C, Hung Yung-Tse, Air pollution control Engineering, Tokyo
- Nevers Noel de, Air pollution control Engineering, McGraw Hill, New York

B TECH: CHEMICAL ENGINEERING
M TECH: ENVIRONMENTAL SCIENCE & ENGINEERING
ESE-660 DISSERTATION (PHASE-II)

L	T	P	Cr
-	-	20	10

Internal Evaluation: 50 Marks
External Examination: 200 Marks

DISSERTATION (PHASE-II)	The complete dissertation work shall comprise of literature survey, Problem formulation, Methodology used, S/W, H/W tools used, Results and discussion followed by the conclusions & further scope of work in that area. The submission of dissertation in 10^{th} semester shall be allowed only after ensuring that the research work carried out by the candidate has attained the level of satisfaction of the 'Dissertation Supervisor (s)' and proof of communication/ acceptance of the research paper (if any, And certified in the report) in the relevant refereed journal/ conference. The final dissertation external examination in 10^{th} semester shall be taken by a panel of examiners comprising of concerned Supervisor (s), One external examiner (from the relevant field) nominated/approved by the competent authority. Hard copies of dissertation, One for each supervisor (s), Examiner and the university/ department, Are required to be submitted by the student before the final dissertation external examination. The candidate shall appear before the examining committee for oral examination and presentation on the scheduled date.