B TECH in CHEMICAL ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	MAT 2153	Engineering Mathematics – III	2	1	0	3	MAT 2254	Engineering Mathematics – IV	2	1	0	3
	CHE 2151	Chemical Engineering Thermodynamics-I	3	1	0	4	CHE 2251	Chemical Engineering Thermodynamics-II	3	1	0	4
	CHE 2152	Chemical Process Calculations	3	1	0	4	CHE 2252	Chemical Process Industries	3	0	0	3
	CHE 2153	Momentum Transfer	3	1	0	4	CHE 2253	Heat Transfer Operations	3	1	0	4
II	CHE 2154	Particle Technology	2	1	0	3	CHE 2254	Mass Transfer-I	3	1	0	4
	CHM 2151	Physical and Organic Chemistry	3	1	0	4	****	Open Elective – I				3
	CHM 2161	Physical & Organic Chemistry Lab	0	0	6	2	CHE 2261	Momentum Transfer & Particle Technology Lab	0	0	3	1
							CHE 2262	Numerical Methods for Chemical Engineers Lab	0	1	3	2
			16	**6**	**6**	**24**			**14**	**5**	**6**	**24**
	Total Contact Hours (L + T + P)		**28**				**Total Contact Hours (L + T + P)**		**25+3=28**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	HUM 3151	Engg Economics and Financial Management	2	1	0	3	HUM 3152	Essentials of Management	2	1	0	3
	CHE 3151	Chemical Reaction Engineering	3	1	0	4	CHE 3251	Design and Drawing of Chemical Process Equipment*	1	3	3	5
	CHE 3152	Mas Transfer-II	3	1	0	4	CHE 3252	Process Dynamics and Control	3	1	0	4
	CHE 3153	Process Modelling and Simulation	3	1	0	4	CHE****	Program Elective – I	3	0	0	3
III	CHE 3154	Transport Phenomena	2	1	0	3	CHE****	Program Elective – II	3	0	0	3
	****	Open Elective – II				3	****	Open Elective – III				3
	CHE 3161	Heat Transfer Lab	0	0	3	1	CHE 3261	Mass Transfer Lab	0	0	3	1
	CHE 3162	Process Modelling and Simulation Lab	0	1	3	2	CHE 3262	Reaction Engineering and Process Control Lab	0	0	3	1
	Total Contact Hours (L + T + P)		**13**	**6**	**6**	**24**	**Total Contact Hours (L + T + P) + OE**		**13**	**4**	**9**	**23**
			25+3=28						**26+3=29**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	CHE ****	Program Elective – III	3	0	0	3	CHE 4298	Industrial Training				1
	CHE ****	Program Elective – IV	2	0	3	3	CHE 4299	Project Work/Practice School				12
IV	CHE ****	Program Elective – V	3	0	0	3	CHE 4296	Project Work (Only for B.Tech honour Students)				20
	CHE ****	Program Elective – VI	3	0	0	3						
	CHE ****	Program Elective – VII	3	0	0	3						
	****	Open Elective – IV				3						
			14	**0**	**3**	**18**						**13**
	Total Contact Hours (L + T + P) +OE		**17 + 3 = 20**									

Minor Specializations

I. **Petroleum Engineering**
CHE 4051: Natural Gas Engineering
CHE 4052: Oil and Gas Reservoir Engineering
CHE 4053: Petroleum Refinery Engineering (Theory and Lab)*
CHE 4054: Process Integration for Petroleum Industries

II. **Pollution Control Engineering**
CHE 4055: Environmental Pollution Control Engineering
CHE 4056: Environmental Impact Assessment and Management Plan
CHE 4057: Industrial Waste Water Engineering (Theory and Lab)*
CHE 4058: Solid and Hazardous Waste Material Management.

III. **Environmental Biotechnology**
BIO 4051: Bioremediation
BIO 4052: Design of Biological Treatment Processes
BIO 4053: Microbial Treatment of Wastewater
BIO 4054: Solid Waste Management

IV. **Material Science**
PHY 4051: Physics of Low Dimensional Materials
PHY 4052: Physics of Photonic & Energy Storage Devices
CHM 4051: Chemical Bonding
CHM 4052: Chemistry of Carbon Compound

V. **Business Management**
HUM 4051: Financial Management
HUM 4052: Human Resource Management
HUM 4053: Marketing Management
HUM 4054: Operation Management

VI. **Computational Mathematics**
MAT 4051: Applied Statistics and Time Series Analysis
MAT 4052: Computational Linear Algebra
MAT 4053: Computational Probability and Design of Experiments
MAT 4054: Graphs and Matrices

Program Electives
CHE 4059: Advanced Process Control
CHE 4060: Applied Interfacial Engineering
CHE 4061: Chemical Reactor Theory
CHE 4062: Environmental Pollution Control Engineering
CHE 4063: Fuels and Combustion
CHE 4064: Introduction to Biochemical Engineering
CHE 4065: Introduction to Petroleum Engineering
CHE 4066: Materials Science and Engineering
CHE 4067: Non-Newtonian Flow in Process Industries
CHE 4068: Process Data Analysis
CHE 4069: Project Engineering
CHE 4070: Renewable Energy Engineering
CHE 4071: Risk and Safety Management in process Industries
CHE 4072: System Identification
CHM 4051: Analytical Techniques and Instrumentation

Open Electives
CHE 4301: Industrial Pollution Control
CHE 4302: Risk and Safety Management in Industries
CHE 4303: Water Treatment Technology

Department of Chemical Engineering

COURSE CONTENT: COURSE NAME, SYLLABUS, COURSE OUTCOMES AND REFERENCE BOOKS, 2018

- **B.TECH.3rd SEMESTER**

MAT 2153: ENGINEERING MATHEMATICS-III [2 1 0 3]

Periodic Functions, odd and even functions, Euler's formulae. Half range expansions, Harmonic analysis. Fourier integrals & transforms, Parseval's identity. Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. Conformal mappings, bilinear transformations. Gradient, divergence and curl, their physical meaning and vector identities. Line, surface and volume integrals. Green's theorem, divergence and Stokes' theorem, applications. Formation, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of Variables. Derivation of one-dimensional wave equation (vibrating string) and its solution by using the method of separation of Variables. D'Alembert's solution of wave equation. Derivation of one-dimensional heat equation using Gauss divergence theorem and solution of one-dimensional heat equation. Solution by separation of variables.

References:

1. Eewin Kreyszig, Advanced Engineering Mathematics, 7(e), John Wiley & Sons, Inc.1993.
2. Murray R.Spiegel., Vector Analysis, 2(e), Schaum Publishing Co., 2009.
3. Grewal, B.S., Higher Engineering Mathematics, 43(e), Khanna Publishers, 2014.
4. Ramana B.V., Engineering Mathematics, 2(e), Tata McGraw Hill Publishing Company limited, 2007.

Course outcomes

CO1: Understand the concept of Fourier Series, Fourier transforms, its properties and applications.

CO2: Understand the concept of vector differential and integral calculus, their properties and applications.

CO3: Understand analyticity of complex functions and its properties.

CO4: Understand the concepts and applications of contour integration.

CO5: Apply the concept of linear PDEs, to solve one dimensional Heat and Wave equations by different methods.

CHE 2151: CHEMICAL ENGINEERING THERMODYNAMICS-I [3 1 0 4]

Basic concepts, definitions and approaches for thermodynamics. First law of thermodynamics for different processes. The concept of heat capacity and enthalpy. PVT behaviour of gases, the concept of ideal gas, and the phase diagrams. Equations of state used for the real gases. Determination of deviation of a gas from ideal behaviour, different correlations used for the calculation of compressibility factor. Second law of thermodynamics, the difference between heat and work, the irreversibility of a process and the concept of entropy, thermodynamic temperature scale. Thermodynamic processes, Maxwell relations and its applications. The applications thermodynamics in refrigeration, liquefaction processes, steam power plant and internal combustion engines.

References:

1. Narayanan, K.V. A Text Book of Chemical Engineering Thermodynamics, Prentice Hall of India, 2006.
2. Smith, J.M., VanNess H.C., Abbot, M.M., Introduction to Chemical Engineering Thermodynamics, (7e), McGraw Hill, 2004.
3. Rao, Y.V.C., An Introduction to Thermodynamics, Universities Press, 2004.
4. Dauber t, T.E., Chemical Engineering Thermodynamics, McGraw–Hill, 1985.

Course outcomes

CO1: To know the properties of pure fluids and solutions.

CO2: To modify the thermodynamic properties with respect to solutions.

CO3: To evaluate the equilibrium, energy and transformation of energy for a certain process.

CO4: To use the laws of thermodynamics to realistic problems faced in process industries.

CO5: To illustrate the applications of thermodynamics.

CHE 2152: CHEMICAL PROCESS CALCULATIONS [3104]

Chemical engineering as a Profession – Role of Chemical Engineer – Unit operations and unit processes –Units and dimensions – Physical and chemical properties of compounds and mixtures – Techniques of problem solving – Choice of basis – Chemical equations and stoichiometry – Properties of gases – Ideal and real gases – Phase equilibrium – Vapor pressure – Raoult's law – Calculation of bubble point and dew point – Humidity and Saturation –Humidity charts and their use – Concepts of steady and unsteady state processes and material balance equations – Material balances involving unit operations and unit processes – Material balance with recycle, bypass and purge – Energy and energy balances – Balances on non-reactive and reactive systems – Heat of reaction, heat of formation and heat of combustion – Standard state – Calculation of heat of reaction at temperature different from standard state – Adiabatic reaction temperature and theoretical flame temperature.

References:

1. Sikdar, D.C., Chemical Process Calculations, Prentice Hall India, 2013.
2. Bhat B.I., Thakur, S.B., Stochiometry, (5e), Tata McGraw-Hill, New Delhi, 2010.
3. Himmelblau, D.M., Basic Principles and Calculations in Chemical Engineering, Eastern Economy ed., Prentice Hall India, (6e). 2009.
4. Felder R., Rausseau, R.W., Elementary Principles of Chemical Processes, (2e), John Wiley and Sons, 2004.
5. Denn, M.M., Chemical Engineering- an Introduction, Cambridge University Press, NY, 2012.

Course outcomes

CO1: Conversant with dimensions, unit systems, and conversion from one unit system to another and techniques of problem solving involving them.

CO2: Able to formulate, interpret and solve steady state material balances involving unit operations such as mixing, crystallization, evaporation, distillation, drying, extraction and leaching.

CO3: Able to demonstrate a general problem-solving methodology, apply it to analyse, evaluate and solve problems.

CO4: Able to analyze material balance operations with and without chemical reaction to construct, formulate, evaluate and solve problems.

CO5: Able to analyze energy balance operations with and without chemical reaction to construct, formulate, evaluate and solve problems.

CHE 2153: MOMENTUM TRANSFER [3 1 0 4]

Properties of fluids – Rheological classification - Fluid statics – Static pressure – Variation of pressure with elevation – Pressure measurement –Manometers – Introduction to fluid flow – Types of flow – Basic equations of fluid flow – Continuity equation – One dimensional Eulerand Bernoulli equation and applications – Laminar flow – Steady incompressible viscous

flow through circular pipes – Hagen-Poiseuilli equation – Flow between parallel plates – Flow through annuli – Turbulence – Turbulent flow in smooth pipes – Velocity profiles – Darcy equation – Flow in noncircular conduits – Losses in pipe flow - Power law of fluids – Flow of liquids in thin layers – Fluid flow past immersed bodies – Boundary layer and friction drag Drag coefficient – Motion of particles through fluids – Flow of fluids through bed of solids – Ergun equation – Principles of fluidization – Hydrodynamic characteristics – Pneumatic conveyance – Agitation and mixing of liquids – Dimensional analysis – Flow of compressible fluids – Basic equations of one-dimensional flow – Reversible adiabatic flow – Effect of area variation – Flow in convergent and divergent nozzles – Flow measurement – Venturi, Orifice and Pitot-tube – Variable area meter – Flow measurement in open channels – Introduction to unsteady flow – Time required for emptying tank – Fluid transportation machinery – Pumps and classification of pumps – Pump characteristics.

References:

1. McCabe and Smith, Unit Operations in Chemical Engineering, (5e), McGraw-Hill, NY,1993
2. Coulson and Richardson, Chemical Engineering –Vol I, (3e), Pargamon and ELBS, 1977
3. Foust et al, Principles of Unit Operations, (2e), John Wiley and Sons, NY, 1980
4. Badger and Banchero, Introduction to Chemical Engineering, McGraw-Hill, NY, 1990.

Course outcomes

CO1: To understand the concepts of fluid statics and its application to pressure measurement through problem solving.

CO2: Understand the fundamental equations of mass balance and energy balance and their applications to industrial problems.

CO3: Explain the types of fluids, fluid flow concepts, shear stress-velocity relations, boundary conditions and demonstrate them through problem solving.

CO4: Analyze the concepts of flow measurement systems, compare and contrast between different flow measuring instruments.

CO5: Appraise and solve compressible flow problems, flow past immersed bodies, fluid transportation systems and dimensional analysis.

CHE 2154: PARTICLE TECHNOLOGY [2 1 0 3]

Particle size analysis, Sphericity of particle, Shape factor, Specific surface area and specific number of particle in the sample mixture, Sieve methods of analysis, Ideal and actual screen, Effectiveness and capacity of screen, Screening equipment, Size reduction, Energy relationships, Size reduction equipment, Crushers, Grinders, Separation based on motion of particle through fluids, Terminal settling velocity of particle, Free and hindered settling, Sedimentation, design of continuous thickener, Classifiers, Filtration, Filter aids, design of filter, Filtration equipment.

References:

1. McCabe and Smith, Unit Operations in Chemical Engineering, (5e), McGraw-Hill, NY, 1993.
2. Foust et al, Principles of Unit Operations, (2e), John Wiley and Sons, NY, 1980.
3. Badger and Banchero, Introduction to Chemical Engineering, McGraw-Hill, NY, 1990.

4. Coulson and Richardson, Chemical Engineering –Vol II, (3e), Pargamon and ELBS, 1970.

Course outcomes

CO1: Recognize the behavior, nature of solid particles and to know the basic principles of separation process like screening, working operation of various screening equipment's.

CO2: Explain the basic principle of size reduction. To learn the principle, design and operation of size reduction equipment's.

CO3: Explain the basic principles of separation processes based on motion of particle through fluids. To learn the principle and working operation of equipment involved for solid-liquid separation.

CO4: Be familiar with filtration, centrifugation unit operation and explain the principle and working operation of various filtration, and centrifugation equipment's. Analyze the filtration and centrifugation problems.

CO5: Analyze the sedimentation operation and to design the continuous thickener.

CHM 2151: PHYSICAL AND ORGANIC CHEMISTRY [3 1 0 4]

Thermodynamic treatment of solutions, Ideal mixtures, Raoult's law Henrry's law Gibb's Duhem relation, colligative properties. Phase Equilibria: Pressure-Temperature Phase diagrams, Phase rule, Immiscible liquids, Eutectic formation, solid compound formation Boiling point diagrams, Distillation, adsorption isotherm. Electroanalytical methods of analysis: Conductometric and Potentiometric titrations Chemical Kinetics: Rate equation, First-order rate equations, second order rate equations, Half-life, Arrhenius equation, Numericals Stereochemistry: Constitutional isomerism - Geometrical isomerism, Polarimeter, specific rotation ,RS configuration, Enantiomers, Diasteromers, meso compounds Reaction Intermediates: Structure, Stability and reactions of intermediates Strengths of organic acids and bases: Factors affecting strength of acids and bases Aromatic and Heterocyclic compounds: Structure of benzene and aromaticity, Classification of Heterocyclic compounds, Basicity. Carbohydrates: Classification, Aldose to ketose and vice versa transformations, epimerisation, Monosaccharides, disaccharides and Polysaccharides. Amino acids & Proteins: Classification, Synthesis, Physical and chemical properties Dyes: Theories of dyes - Classification of dyes, Preparation and uses of Azodyes, Triphenyl methane dyes, Anthraquinone dyes.

References:

1. Gordon M. Barrow, Physical Chemistry, (5e), Tata Mc Graw Hill Education Private Limited, New Delhi Special Indian Edition, 2007.
2. Skoog D.A. West D.M. Holler F.J. Gouch S.R. Fundamentals of Analytical Chemistry, (8e), Thomson Brooks/Cole, Singapore, 2004.
3. Atkins. P., J. de Paula, Physical Chemistry, (7e), Oxford Publication, New York, 2002.

4. Puri,B.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, (46e), Vishal Publications, Jalandhar, 2012.
5. Finar I.L., Organic Chemistry, Vol I, (6e). Pearson Education, Singapore, 2009.
6. Morrison R.T. Boyd R.N. , Organic Chemistry, (6e), Prentice – Hall New Delhi, 2007.
7. Bruice P.Y., Organic Chemistry, (3e). Dorling Kindersley, New Delhi, 2009.
8. Bahl B.S. Arun Bahl, Advanced Organic Chemistry, (15e), S. Chand & Co. Ltd., New Delhi, 2001.

Course outcomes

CO1: Correlate the principle of thermodynamic treatment of solutions and summarize the process a chemical kinetics.

CO2: Comprehend the phase equilibria and demonstrate the applications of conductometry and potentiometry.

CO3: Sketch the different stereoisomers and correlate the structure – reactivity of intermediates

CO4: Attribute structure with acidity and basicity and aromaticity.

CO5: Predict the structure-property of biomolecules.

CHM 2161: PHYSICAL AND ORGANIC CHEMISTRY LAB [0 0 6 2]

Physical Chemistry: Titration of a given mixture of weak and strong acids against a strong base by conductometric method ,Precipitation titration between lithium sulphate and barium chloride by conductometric method, Redox titration of Mohr's salt against $K_2C_{r2}O_7$ by potentiometric method, Colorimetric determination of Copper, Percentage composition of binary mixture using viscometer, Bimolecular reaction between $K_2S_2O_8$ and KI, Determination of velocity constant for the saponification of ethyl acetate, Determination of surface tension of a liquid using stalagmometer, Kinetics of inversion of sucrose using polarimeter, Determination of percentage composition of binary mixture using Abbe's refractometer Organic Chemistry: Preparation of m-dinitrobenzene from nitrobenzene, Preparation of acetanilide from aniline, preparation of p-bromo acetanilide from acetanilide, preparation of benzoic acid from benzaldehyde, preparation of salicylic acid from methyl salicylate. Determination of the % purity of phenol by Winkler's method. Determination of the amount of acetone by iodoform method. Determination of the % purity of acetic acid by titration method. Determination of the amount of acetamide by alkali hydrolysis method, Determination of acid value, iodine value and saponification value of the given sample of oil.

Course outcomes

CO1: Understand the principle and do experiments based on conductometry, colorimetry and potentiometry.

CO2: Perform experiments to determine percentage composition, density and surface tension of binary mixture using refractometer, viscometer and stalgmometer.

CO3: Carry out reactions like saponification, inversion and find the rate and order of reactions.

CO4: Develop skills in organic synthesis, recrystallization and determination of melting point of prepared compounds.

CO5: Analyze different organic compounds both qualitatively and quantitatively.

- **B.Tech. 4th SEMESTER**

MAT 2254: ENGINEERING MATHEMATICS-IV [2 1 0 3]

Formation of Linear Programming problem, Graphical method, Simplex method, Penalty cost and two-phase methods. Finite sample spaces, conditional probability and independence, Bayes' theorem. One dimensional random variable, mean, variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least squares principles of curve fitting. Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential. Finite difference expressions for first and second order derivatives (ordinary and partial). Solution of BVP's in ODE. Classification of second order linear partial differential equations. Numerical solutions of two-dimensional Laplace and Poisson equations by standard five-point formula. Solution of one-dimensional heat and wave equations by explicit methods. Crank-Nicolson method. Finite element method, Introduction, simple applications. Difference equations representing physical systems, the z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms, convolution theorem**.**

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 7(e), John Wiley & Sons, Inc., 1993.
2. Meyer P.L., Introduction to probability and Statistical applications, 2(e), American Publishing Co., 1970.
3. Hamdy A Taha - Operation research, (7e), Pearson Education, Inc., 2002.
4. Grewal B.S - Higher Engineering Mathematics, (43e), Khanna Publishers, 2014.
5. Sastry S.S., Introductory methods for Numerical Analysis, (5e), PHI Learning Private Limited, 2012.

Course outcomes

CO1: Obtain the solution of boundary value problems of ODE and PDE using finite difference methods.

CO2: Discuss the relevance of probability in engineering problems and explain the concepts of random variable.

CO3: Identify situations where different discrete probability distributions can be applied and use suitable continuous distributions to various situations.

CO4: Formulate the linear programming problems and solve by graphical, simplex, penalty cost or two-phase methods.

CO5: Solve difference equations by Z-transforms.

CHE 2251: CHEMICAL ENGINEERING THERMODYNAMICS-II [3 1 0 4]

Thermodynamic properties of pure fluids, fugacity. The concept of solution thermodynamics, the concept of partial molar properties, its determination. Gibbs Duhem equation, its applications, property change of mixing, excess properties. The criteria of phase equilibrium, vapour liquid equilibrium, phase diagrams for binary solutions, azeotropes and its types, activity coefficient and dew point and bubble point calculations, thermodynamic consistency of VLE data. Introduction to LLE. The criteria of chemical reaction equilibria, equilibrium constant, Gibbs free energy change, effect of temperature, pressure and composition on equilibrium constant.

References:

1. Narayanan, K.V., A Text Book of Chemical Engineering Thermodynamics, Prentice Hall of India, 2006.
2. Smith, J. M., VanNess H.C., Abbot, M.M., Introduction to Chemical Engineering Thermodynamics, (7e), McGraw Hill, 2004.
3. Daubert, T. E., Chemical Engineering Thermodynamics, McGraw –Hill, 1985.
4. Rao, Y. V. C., An Introduction to Thermodynamics, Universities Press, 2004.

Course outcomes

CO1: To understand the properties of pure fluids and solutions.

CO2: To modify the thermodynamic properties of solutions containing various components.

CO3: Develop the relationship between various properties of the system when equilibrium is established.

CO4: Determine the composition in multiphase separation processes.

CO5: To determine the equilibrium yield for a chemical reaction.

CO6: To optimize the conditions and the feasibility of a chemical reaction.

CHE 2252: CHEMICAL PROCESS INDUSTRIES [3 0 0 3]

Indian industry – A brief review - Description of the processes along with neat flow diagrams. Industrial gases: Carbon dioxide – Hydrogen – Oxygen – Nitrogen – Synthesis gas Chloralkali industry: Common salt – Caustic soda – Chlorine – Hydrochloric acid – Bleaching powder – Soda ash , Fertiliser industry: Ammonia – Nitric acid – Ammonium nitrate – Ammonium sulfate – Ammonium chloride – Urea , Oils, fats and waxes: Edible oils – Extraction of vegetable oil – Hydrogenation of oil – Soaps and detergents – Manufacturing processes – Glycerin recovery Petroleum industry: Processing and refining of petroleum, Pulp and paper. Chemical and mechanical pulp – Pulping methods – Chemical recovery of black liquor – Paper and paper board Sugar and starch: Sugar – Starch and modified starches – Glucose – Fermentation – Media for growth - Industrial alcohol – Absolute alcohol – Acetone and Butanol , Polyethylene – Viscose rayon, Nylon 6 and Nylon 66 – Natural and synthetic rubber

References:

1. Groggins, P.H., Unit processes in organic synthesis, (5e), Tata Mcgraw-Hill, 2004.
2. Austin, G.T., Shreve's Chemical Process Industries, (5e), McGraw- Hill, 2017.
3. Dryden, C.E., Outlines of Chemical Technology, (3e), East Press Ltd., 1997.

Course outcomes

CO1: Review the scenario of Indian chemical industries; manufacturing and process flow diagrams of industrial & Synthesis gases and Chlor-alkali compounds in industries.

CO2: Understand the manufacturing and process flow diagrams of Sulphur, Phosphate and Fertilizer compounds in industries.

CO3: Describe the manufacturing and process flow diagrams of Paper & pulp and Oil & fat compounds in industries.

CO4: Explain the manufacturing and process flow diagrams of Sugar, Fermentation and Petroleum compounds in industries.

CO5: Summarize the manufacturing and process flow diagrams of Polymer and Rubber compounds in industries.

CHE 2253: HEAT TRANSFER OPERATIONS [3 1 0 4]

Mechanism of heat transfer; Heat transfer flux and resistance. Conduction: Thermal conductivity; Fourier's law of conduction; Conduction through plane, cylindrical and spherical and composite walls; Heat losses and insulation; Critical insulation thickness; Selection of insulating materials Convection: Natural and forced convection; Individual film and overall heat transfer coefficients; Convection in laminar and turbulent flows; Introduction to thermal boundary layer. Heat exchanger: Types of heat exchangers; Co-current and counter-current flows; Equivalent diameter; Fouling factors; Process design of heat exchangers including double pipe heat exchanger, shell and tube heat exchanger, extended surfaces and cross flow heat exchangers. Heat transfer with phase change. Evaporators: Types; Single and multiple effects: Boiling point rise; Feeding; Steam economy; Process design of evaporators. Heat transfer equipment auxiliaries: Steam trap. Radiation: Radiant energy-distribution; Black body; Emissive power; Exchange of energy between two surfaces; View factor; Furnace calculations. Combined heat transfers by conduction, convection and radiation. Crystallization: Nucleation and crystal growth; Controlled growth of crystals; Industrial crystallizers.

References:

1. Kern D.Q., Process Heat Transfer, McGraw Hill, 2009.
2. McCabe and Smith, Unit Operations in Chemical Engg, (7e), McGraw Hill 2005.
3. Coulson and Richardson, Chemical Engineering, Vol.1 (6e), Elsevier India private limited 2006.
4. Dutta B. K., Heat transfer: Principles and Applications, PHI, 2001.

Course outcomes

CO1: To know the basic principles of conduction, convection and radiation heat transfer.

CO2: To extend the basic principle of conservation of energy to systems which involve conduction, convection and radiation heat transfer.

CO3: To identify, formulate and solve engineering problems involving conduction heat transfer.

CO4: To identify, formulate and solve engineering problems involving forced convection heat transfer, natural convection heat transfer, and heat exchangers.

CO5: To identify, formulate and solve engineering problems involving radiation heat transfer among black surfaces and among diffuse gray surfaces.

CHE 2254: MASS TRANSFER-1 **[3 1 0 4]**

Introduction to mass transfer operation, Diffusion and mass Transfer: Molecular diffusion in fluids and solid, mass transfer coefficients, interphase mass transfer coefficient. Gas Liquid Operations: Equipment for gas liquid operations, Humidification operation, Gas absorption. Solid-Fluid Operations: Adsorption, Drying.

References:

1. Treybal, R.E. Mass Transfer Operations (3e), McGraw Hill Education, 2017.
2. McCabe, W., Smith, J., Harriott, P., Unit Operations of Chemical Engineering (7e), McGraw Hill Education;, 2017.
3. Patil, K.D., Principles and Fundamentals of Mass Transfer Operations–1 (4e), Nirali Prakashan Publications, 2013.
4. Dutta, B.K., Principles of Mass Transfer and Separation Processes, Prentice Hall India Learning

Private Limited, 2006.

Course outcomes

CO1: Understand the basic mechanism of diffusion in gases, liquids and solids.

CO2: Evaluate the inter and intra phase mass transfer coefficients.

CO3: Understand the contact patterns of gas and liquid phases.

CO4: Understand and apply the phenomena of absorption, desorption and adsorption.

CO5: Calculating the theoretical stages required for given separation in absorption and striping tower.

OPEN ELECTIVE -I- CHE 4301: INDUSTRIAL POLLUTION CONTROL [3 0 0 3]

Symbiosis between man and environment, Nutrient and hydrologic cycles, Types of pollution, Legislation to environmental pollution, Phases involved in establishment of plant monitoring and control system, Evaluation and characterization of wastewater, Treatment methods, Concept of Zero Liquid Discharge, Sludge treatment and disposal , Solid waste management, Noise pollution and control, E-waste – sources and effects, e-waste management, Ambient air and stack gas sampling, Analysis of air pollutants, Plume behaviour, Meteorological factors affecting air pollution, Equipment for control and abatement of air pollution, Pollution from automobiles – control mechanisms.

References:

1. Mahajan S.P., Pollution Control in Process Industries, Tata McGraw Hill, 1990.
2. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern, 1992.
3. Noel De Nevers, Air pollution Control Engineering, (2e), McGraw-Hill, 1999.
4. Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, (2e), McGraw-Hill, 2002.

Course outcomes

CO1: Apply knowledge of basic sciences and engineering to analyze water resources systems for socio-economic development.

CO2: To evaluate various physical and chemical treatment options for treatment of water and wastewater.

CO3: To design various physicochemical units for the treatment of water and wastewater.

CO4: To study about various biological treatment processes and its operations for the wastewater treatment.

CO5: To provide the knowledge about the kinetics of biological growth and its application in the design of biological reactors

CHE 2261: MOMENTUM TRANSFER AND PARTICLE TECHNOLOGY LAB [0 0 3 1]

Bernoulli's Experiment – Calibration of flow meters, flow through circular pipe, annulus, v-notch, packed bed and fluidized bed – Centrifugal pump characteristics – Screen effectiveness, verification of laws of size reduction, particle size analysis, filtration, sedimentation.

References:

1. McCabe and Smith, Unit Operations in Chemical Engineering, (5e), McGraw-Hill, NY,1993.
2. Coulson and Richardson, Chemical Engineering –Vol. I, (3e), Pargamon and ELBS,1977.
3. Foust et al, Principles of Unit Operations, (2e), John Wiley and Sons, NY, 1980.

Course outcomes

CO1: Analyze fluid flow problems with the application of the equation of continuity.

CO2: Comprehend closed channel and open channel flow measurements.

CO3: Understand the interaction between bed of solids and liquids in fluid particle systems.

CO4: Apply the concepts of particle technology and analyze the experiments.

CO5: Demonstrate the working of equipment used for various particle technology.

CHE 2262: NUMERICAL METHODS FOR CHEMICAL ENGINEERING LAB [0 1 3 2]

Chemical engineering problems related to Process Calculations, Momentum Transfer, Heat Transfer and Mass Transfer-I will be solved using numerical methods such as Bisection method, False position method, Secant method, Newton-Raphson method, Linear Algebraic Equations, Runge-Kutta method, Predictor-Corrector method, Shooting method, Finite difference method, Crank-Nicholson method; Bender Schmidt method with the help of computer software such as MAT LAB and EXCEL.

Course outcomes

CO1: Learn to use MATLAB and EXCEL software.

CO2: Formulate algorithms and programs for different numerical methods.

CO3: Solve various chemical engineering problems using numerical methods.

CO4: Use software tools to write codes to solve engineering problems.

- **B.TECH. 5TH SEMESTER**

HUM 3051: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [3 0 0 3]

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis.

Break-even analysis for single product and multi product firms, Breakeven analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, Declining balance method of depreciation, Sum-of-the-years digits method of depreciation,

Sinking fund and service output methods, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios.

References:

1. Prasanna Chandra., Fundamentals of Financial Management, Tata Mc-Graw Hill Companies, New Delhi, 2005.
2. James L Riggs, David D Bedworth and Sabah U Randhawa., Engineering Economics, Tata McGraw – Hill Publishing Company Ltd, New Delhi, 2004.
3. T. Ramachandran., Accounting and Financial Management, Scitech Publications Pvt. Ltd. India, 2001.
4. Eugene F. B. & Joel F. H., Fundamentals of Financial Management, (12e), Cengage Learning Publisher, 2009.
5. M. Y. Khan & P. K. Jain., Financial Management, (5e), Tata McGraw Hill Publication, New Delhi, 2008.
6. Thuesen G.J., Engineering Economics, Prentice Hall of India, New Delhi, 2005.
7. Blank Leland T. Tarquin Anthony J. Engineering Economy, McGraw Hill, Delhi, 2002.
8. Chan S. Park, Fundamentals of Engineering Economics, (3e), Pearson Publication, 2013.

Course Outcomes:

CO1: To know the basic economic and elementary accounting procedures

CO2: To understand the significance of the balance sheet and income statement of a company as process engineer

CO3: To analyze the design and selection of equipment in process operations and process development

CO4: To evaluate the cost data required for a process problem and employ realistic cost data based on experience

CHE 3151- CHEMICAL REACTION ENGINEERING [3 1 0 4]

Elementary and Non elementary reaction kinetics, Kinetics of homogeneous chemical reactions, Rate expressions, Temperature dependence of rate, differential, integral, half-life and total pressure method, Isothermal reactor design, Design of batch, semi-batch, CSTR and PFR, Reactors in series or/and parallel, Recycle reactor, Series and parallel reactions in flow reactors, Product distribution, Yield and selectivity, Maximizing the desired product in parallel and series reactions, Isothermal non-ideal flow reactors, RTD in chemical reactors, distribution functions, Conversion in non-ideal flow reactors, Single and multi-parameter models.

References:

1. Fogler S. H., Elements of Chemical Reaction Engineering(4e), Prentice Hall, 2005.

2. Levenspiel O., Chemical Reaction Engineering (3e), Wiley & Sons, 2003.

3. Rawlings J.B. and Ekerd, J.G., Chemical Reactor Analysis and Design Fundamentals, Nole. Hill, 2002.

4. Smith, J.M, Chemical Engineering Kinetics (3e), McGraw-Hill, International student edition

5. Davis M.E., Davis R.E., Fundamentals of Chemical Reaction Engineering (1e), McGraw-Hill, 2003

6. Missen R.W., Mims C.A., Saville B.A., Introduction to chemical reaction engineering and kinetics, John Wiley & Sons Inc.

Course Outcomes:

CO1: Understand basic definitions, concepts and development of rate equations

CO2: Design and analyze Ideal Batch and Flow Reactors

CO3: Design and analyze Multiple ideal reactor combinations & Recycle reactor

CO4: Design and analyze reactors for Multiple reactions

CO5: Evaluate conditions and consequences of non-ideality in reactors

CHE 3152: MASS TRANSFER-II [3 1 0 4]

Distillation: binary component distillation- Flash vaporization, simple distillation, steam distillation, multicomponent distillation: Flash vaporization, simple distillation, Multi stage tray towers: Ponchon and Savarit & McCabe and Thiele. Liquid-Liquid Extraction: Liquid Equilibria, separation of solute by stage-wise, cross current and continuous contact of solvent. Membrane Separations: introduction to membranes, Reverse osmosis, Nano filtration, Ultra and Micro filtration, Pervaporization, Dialysis.

References:

1. Treybal R.E., Mass Transfer Operations (3e), McGraw Hill Education, 2017.

2. McCabe W., Smith J., Harriott P., Unit Operations of Chemical Engineering (7e), McGraw Hill Education, 2017.

3. Dutta B.K., Principles of Mass Transfer and Separation Processes, Prentice Hall India Learning Private Limited, 2006.

4. Kaushik N., Membrane Separation Processes, PHI Learning, 2008.

Course Outcomes:

CO1: Understand the vapor liquid equilibrium for binary & multi component solutions

CO2: Calculating the number of theoretical stages required for given separation using various methods i.e. P-S and M T methods

CO3: Understand the LLE and Liquid Liquid separation method along with minimum liquid required for given separation

CO4: Understand the solid liquid equilibrium and leaching operation

CO5: Membrane separation process: introduction

CHE 3153: PROCESS MODELING AND SIMULATION [3 1 0 4]

Models and model building, principles of model formulation, precautions in model building, Classification of models. Numerical solutions of mathematical equations : Algebraic equation in one and two variables; simultaneous linear equations; ordinary differential equation in one variables and more than one variable, stiff differential equations. Lumped parameter Models: steady and unsteady state- tank model, Reaction –kinetic systems, Vapour –liquid equilibrium operation. Distributed parameter models (steady state): solution of split boundary value problems, counter current heat exchanger, tubular reactor with axial dispersion, counter current gas absorber, pipe line gas flow, permeation process, pipe line flasher, spray tower humidifier, packed bed catalytic reactor. Distributed parameter models (unsteady state, one dimension):

Finite difference method, convection problems- explicit and implicit centered difference methods; diffusive problems- Crank Nicolson finite difference scheme, heat exchanger, gas absorbers and dynamics of tubular reactor with dispersion. Introduction to population balance models

References:

1. Ramirez W.F., Computational Methods in Process Simulations (2e), Butterworth publishers, 1997.

2. Franks R.E., Modelling and simulation in Chemical Engineering, John Wiley & Sons, 1972.

3. Hangos K., Cameron I., Process Modelling and Model Analysis, Academic Press, 2001.

4. Ramakrishna D., Population Balance-Theory and Applications to Particulate systems in Engineering (1e), Academic Press, 2000.

Course Outcomes:

CO1: Describe the basics of modeling and simulation, procedure for modeling and classification of models.

CO2: Apply & modify unsteady state concept to solve mass, heat and momentum balance problems.

CO3: Identify and apply numerical method to solve mathematical model. Develop steady state lumped parameter models and give brief solution procedure

CO4: Develop unsteady state lumped parameter and steady state distributed parameter models along with brief solution procedure.

CO5: Develop unsteady state distributed parameter along with brief solution procedure.

CHE 3154: TRANSPORT PHENOMENA [2 1 0 3]

Prediction of transport coefficients: viscosity, thermal conductivity and diffusivity and their dependence with temperature, pressure and composition. Kinetic theories of viscosity, thermal conductivity and diffusivity. Shell balance for momentum, energy and mass transfer: unidimensional velocity-temperature and concentration profiles momentum, energy and mass flux at the surface. Introduction to general transport equations for momentum, energy and mass transfer in Cartesian – cylindrical and spherical co-ordinates- simple solutions in one dimension.

References:

1. Bird R.B., Stewart W.E., Lightfoot E.W., Transport Phenomena (2e), John-Wiley, 2002

2. Brodkey R.S., Hershey C.,Transport Phenomena- A unified approach, McGraw Hill Book Company,1988

3. Slattery J.C., Advanced Transport Phenomena, Cambridge University Press, 1999

4. Geankoplis C.J, Transport Process and Unit Operation (3e) , Prentice-Hall , 1993.

Course Outcomes:

CO1: Understand the scientific aspects related to fluid flow, heat flow, and mass transfer

CO2: Learn about related equations, in the above context

CO3: Setup shell balances for conservation of momentum transport

CO4: Setup shell balances for conservation of energy transport

CO5: Setup shell balances for conservation mass transport

CHE 4301: INDUSTRIAL POLLUTION CONTROL [3 0 0 3]

Symbiosis between man and environment, Nutrient and hydrologic cycles, Types of pollution, Legislation to environmental pollution, Phases involved in establishment of plant monitoring and control system, Evaluation and characterization of wastewater, Treatment methods, Concept of Zero Liquid Discharge, Sludge treatment and disposal , Solid waste management, Noise pollution and control, E-waste – sources and effects, e-waste management, Ambient air and stack gas sampling, Analysis of air pollutants, Plume behaviour, Meteorological factors affecting air pollution, Equipment for control and abatement of air pollution, Pollution from automobiles – control mechanisms.

References:

1. Mahajan S.P., Pollution Control in Process Industries, Tata McGraw Hill, 1990

2. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern, 1992.

3. Noel De Nevers, Air pollution Control Engineering, (2e), McGraw-Hill, 1999

4. Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, (2e), McGraw-Hill, 2002.

Course Outcomes:

CO1: Foster awareness on the importance of pollution control, to analyse and evaluate pollution problem through disturbances in the nutrient and hydrologic cycle

CO2: Describe and evaluate different pollution control methods for industrial air pollution

CO3: Describe and evaluate different techniques for the characterization, sampling & analysis of various pollutants and to apply them to design measurement systems for various industries

CO4: Describe and evaluate different pollution control methods for industrial wastewater

CO5: Describe and evaluate different pollution control methods for solid wastes biomedical wastes and E- waste

CHE 3161: HEAT TRANSFER LAB [0 0 3 1]

Experiments are based on the following topics: conduction, convection, radiation, overall heat transfer coefficient, dirt resistance calculation. Surface renewable coefficients, bare and finned tube heat exchangers, film and drop condensation.

Course Outcomes:

CO1: Foster awareness of the safety precautions to be taken and perform the experiments individually

CO2: Understand steady state, unsteady state heat conduction, natural and forced convection and radiation

CO3: Comprehend and interpret the experimental results

CO4: Evaluate performance of various heat transfer equipment

CO5: Comprehend technical data from data sheets and graphs

CHE 3162: PROCESS MODELING AND SIMULATION LAB [0 1 3 2]

Experiments based on a) simulation of steady state – flash drum, reactors, distillation column, absorber and chemical plants using ASPEN PLUS. b) Simulation of unsteady state operation of chemical plants using ASPEN PLUS.

Course Outcomes:

CO1: Describe the basics of ASPEN simulation software

CO2: Apply steady state concepts for simulation of single equipment's like flash drum, reactors, distillation, absorber etc using ASPEN PLUS

CO3: Demonstrate the steady state simulation of chemical plant using ASPEN PLUS

CO4: Illustrate the concepts of Unsteady state simulation to chemical plants using ASPEN dynamics.

- **B.TECH. 6TH SEMESTER**

HUM 3052: ESSENTIALS OF MANAGEMENT [3003]

Definition of management and systems approach, Nature & scope. The functions of managers. Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, policies & planning premises. Strategic planning process and tools. Nature & purpose of organising Span of management, Factors

determining the span, Basic departmentation, Line & Staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership- leadership behaviour & styles, Managerial grid. Basic control process, Critical control points & standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA, Application of Theory Z. The nature & purpose of international business & multinational corporations, Unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections

References:

1. Harold Koontz & Heinz Weihrich., Essentials of Management, McGraw Hill, New Delhi, 2012.

2. Peter Drucker., Management: Tasks, Responsibilities and Practices, Harper and Row, New York, 1993.

3. Peter Drucker., The Practice of Management, Harper and Row, New York 2004.

Course Outcomes:

CO1: Understand the roles of managers, principles of management, managerial skills, and strategies required to run a business successfully with social and ethical responsibilities

CO2: Develop an organizational structure and plan for manpower in a given business organization

CO3: Apply leadership and motivational theories in the organizational contexts

CO4: Acquire budgetary skills through process and techniques of controlling

CO5: Differentiate the managerial practices internationally; Prepare a business plan by identifying business opportunities, conducting market analysis and preparing feasibility reports; Business Ethics, Ethical and Social Responsibilities

CHE 3251: DESIGN AND DRAWING OF CHEMICAL PROCESS EQUIPMENT [1 3 3 5]

Introduction to equipment process design, piping design and economic pipe diameter, data collection and design information, Design of heat exchangers, condensers, evaporators, design of separators, distillation columns, absorption columns. Introduction to mechanical design, Vessel classification, design codes and general design consideration, Design of cylindrical and spherical vessels under internal pressure, Design of heads, closures and flanges, Design of cylindrical and spherical vessels under external pressure and stiffeners, Compensation of opening and pipes, Design vessels subjected to combined loading, Design of tall vessels, Design of vessel supports, Design of storage tanks and mixing equipment, Design of shell and tube heat exchangers, Design of high pressure vessels.

References:

1. Coulson and Richardson's Volume 6, Chemical Engineering design (4e), Elsevier Butterworth-Heinemann Publishers, 2005.
2. Kern D.Q., Process Heat transfer, McGraw-Hill Publishers, 1978.
3. Badger W. L., Banchero J. T., Introduction to Chemical Engineering, McGraw-Hill Publisher, 1998.
4. Joshi M.V., Mahajani V.V., Process Equipment Design (3e), MacMillan Publishers, 1998
5. Indian Standard for unfired pressure vessel, IS 2825-1969
6. Indian Standard for Heat Exchangers, BIS 4503-1967
7. Bhattacharya B.C., Introduction to Chemical Equipment Design – Mechanical aspects, CBS Publishers, 2012.
8. Brownell L.E., Young E.H., Process Equipment Design, Wiley Publications, 2009.

Course Outcomes:

CO1: Differentiate between Process and Mechanical design of Chemical equipment's

CO2: Collect Data required for design from Code books/Handbooks and make informed choices about possible outcomes keeping in mind constrains

CO3: Design heat transfer equipment's like STHE, evaporators

CO4: Design equipment's like Absorbers, various vessels supports

CO5: Design heat transfer equipment's like Distillation columns (Tall towers)

CHE 3252: PROCESS DYNAMICS AND CONTROL [3 1 0 4]

First Principles model development; Introduction to Laplace Transform, Process dynamics for first, second and higher order systems: linearization, transfer function models, effect of poles, zeros and time delays on system response; Empirical models from data; control system instrumentation; introduction to feedback control: objectives, PID control; analysis of closed loop systems: stability, root locus, frequency response using Bode plots; control design techniques: design criteria, time and frequency domain techniques, model based design, tuning; advanced control strategies: cascade and feed forward, introduction to multivariable control; controller implementation through discretisation.

References:

1. Seborg D.E., Edgar T.F., Mellichamp D.A., Process Dynamics and Control (2e), John Wiley and Sons, 2004.

2. Stephanopoulos G., Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall, New Delhi, 1984.

3. Coughanowr D.R., Process Systems analysis and Control (2e), McGraw Hill, 1991.

4. Marlin T.E., Process Control: Designing of Processes and Control Systems for dynamic performance (2e), Mc Grew Hill, 2000.

5. Harmon Ray W., Ogunnaike B., Process dynamics, modeling and control (1e), Oxford University press. 1994

6. Bequette B.W., Process Control, Modelling, Design and Simulation, Prentice Hall International, 2003.

Course Outcomes:

CO1: Demonstrate a mathematical skill required for the development of control relevant mathematical model

CO2: Develop a Transfer function model of chemical process and its simplification

CO3: Analyze the dynamic response of different system using mathematical model of chemical process.

CO4: Analyze the different control algorithm and its closed loop response.

CO5: Demonstrate close loop controller response, stability and its design strategy

CO6: Appreciate the need of advanced control strategy, its concept and exposure to MATLAB software.

PE-I CHE 4055: ENVIRONMENTAL POLLUTION CONTROL ENGINEERING [3 0 0 3]

Man and environment Nutrient and hydrologic cycles Types of pollution Legislation to environmental pollution Aspects of pollution control Evaluation and characterization of wastewater Treatment methods Advanced wastewater treatment Sludge treatment and disposal Solid waste management. Noise pollution and control: Ambient and stack gas sampling analysis of air pollutants, Principles of air pollution Plume behavior Meteorological factors affecting air Pollution. Equipment for control and abatement of air pollution. Pollution control of effluent in chemical industries such as Fertilizer, Petroleum refinery, Pulp and paper and Tannery industries.

References:

1. Mahajan S.P., “Pollution Control in Process Industries”, Tata McGraw Hill, 2008.

2. Rao C.S., "Environmental Pollution Control Engineering", (2e), New Age International Publishers, 2006.

3. Cavaseno V, "Industrial Air Pollution Engineering", McGraw Hill, NY, 1980

Course Outcomes:

CO1: Understand and analyze the problems related to air, water, land and noise pollution in chemical industries

CO2: Understand the environmental Legislations & polices in the country, the quality standards for the air and water and soil

CO3: Understand the different techniques for the characterization, sampling analysis of various pollutants and to apply them to design the measurement system for various chemical industries

CO4: Understand the treatment plants in chemical industries for control and abatement of air, water and solid waste management

PE-I CHE 4052: OIL AND GAS RESERVOIR ENGINEERING [3 0 0 3]

Basic concepts of reservoir engineering: calculation of hydrocarbon volumes, fluid pressure regimes, recovery factor, volumetric gas reservoir study, hydrocarbon phase behaviour; PVT analysis for oil: definition of parameters, fluid sampling, laboratory testing and conversion to field conditions; Material balance applied to oil reservoirs: general form of equation, reservoir drive mechanisms, solution gas drive, gas cap drive, natural water drive; Darcy's law and applications: Darcy's law, fluid potential, radial steady state flow, well stimulation, two phase flow: effective and relative permeability, supplementary recovery; Radial flow differential equation, conditions of solution; Application of the stabilized inflow equations.

References:

1. Dake L. P., Fundamental of Reservoir Engineering, Elsevier, 2011.

2. Smith H. C., Tracy G. W., and Farrar R. L., Applied Reservoir Engineering: Volume I and II, OGCI, 1999.

3. Salter A., Baldwin J., and Jespersen R., Computer-Aided Reservoir Management, Pennwell, 2000.

4. Ahmed Tarek, Reservoir Engineering Handbook (4e), Gulf professional publishers, 2010.

Course Outcomes:

CO1: Understand the basic concepts of reservoir engineering & hydrocarbon phase behaviour and solve problems related to reservoir hydrocarbon volume

CO2: Carryout the Pressure-Volume-Temperature (PVT) analysis for reservoir fluids

CO3: Derive the material balance equations for oil reservoirs for different drive mechanisms

CO4: Know the Darcy's law and its applications for oil reservoir well stimulation

CO5: Derive the basic differential equation for radial flow in a porous medium and solve it various flow conditions

PE-I BIO 4053 Microbial Treatment of Wastewater [3 0 0 3]

Need for wastewater treatment; Characterization of wastewater- Biological- BOD, COD, TOC, MPN, Bacterial count, BOD kinetic parameter fitting by Least square, Fujimoto, Daily difference, Thomas and Moments-Methods; Physical characterization such as solids, Turbidity, and Chemical characterizations. Bacterial metabolism in treatment, Decomposition of organic compounds in Ecosystem, Biology, Mass energy balance for Aerobic respiration, and Anaerobic respiration, General considerations for Aerobic Vs. Anaerobic treatment, Kinetic aspects, Hydrolysis of cellulose-biological aspects, Anaerobic degradation of lignocellulose and cellulose, proteins, fats; Various types of anaerobic treatment reactors-UASB and its variations, calculation of biogas by Buswell equation, Nitrification and denitrification processes, and Anammox process, Biological Phosphorus removal processes.

References:

1. Metcalf and Eddy, Wastewater Engineering - Treatment, Disposal and Reuse, Tata McGraw Hill Publishing Co. Ltd, 1991

2. C.S.Rao, Environmental Pollution Control Engineering, New Age International (P) Ltd. Publishers, 1991

3. H.J. Jordening, and J.Winter, Environmental Biotechnology: Concepts and Applications, Wiley-VCH Verlag GmbH & Co, 2005

Course Outcomes:

CO1: Understand the need for waste water treatment, highlight various characterizations for wastewater

CO2: Model BOD parameters

CO3: Elucidate aerobic and anaerobic metabolism of proteins, carbohydrates, cellulose and fats

CO4: Describe the nutrient (N &P) removal strategies

CO5: Explain various rectors used for aerobic and anaerobic digestion of wastewater.

PE-II CHE 4058: SOLID AND HAZARDOUS WASTE MANAGEMENT [3 0 0 3]

Classification of solid wastes, Functional elements of Solid Waste Management (SWM), Regulatory aspects of SWM, Waste Characteristics, Environmental and health effects, Solid waste storage and collection, Transfer stations, Waste Processing techniques, Source reduction, recycle and recovery, Sanitary landfill, Landfill liners, Leachate and landfill gas management, Composting, Biogasification, Incineration, Introduction to Hazardous Waste Management (HWM), Guidelines for (HWM), International regulatory framework for HWM, Characterization of hazardous wastes, Packing and labelling of hazardous wastes, Storage, transport and disposal of hazardous wastes, Concept of Integrated waste management.

References:

1. Tchobanoglous G., Theisen H., Eliassen R., Solid Wastes: Engineering Principles and Management Issues, McGraw Hill, 1977.
2. Freeman H. W., Standard Handbook of Hazardous waste Treatment and Disposal (2e), McGraw Hill, 1997.
3. McBean E. A., Rovers F. A., Farquhar G. J., Solid Waste landfill Engineering and Design, Prentice Hall, 1995.
4. Lees F., Lees' Loss Prevention in the Process Industries: Hazard identification, assessment and control (3e), Butterworth- Heinemann, 2004.
5. Rao M. N., Sultana R., Kota S. H., Solid and Hazardous Waste Management: Science and Engineering (1e), B S Publications (imprinted by Elsevier), 2016.

Course Outcomes:

CO1: Summarize the source and physico-chemical properties of municipal solid wastes and to design the appropriate methods for storage, collection and transfer of solid wastes

CO2: Demonstrate the design and operation of sanitary landfill

CO3: Discuss about the waste processing techniques and to identify the relevant recovery and recycling techniques for solid wastes

CO4: Describe the bioremediation techniques like composting and bio gasification

CO5: Explain the energy recovery from incineration process and to develop an understanding on hazardous waste management system

PE-II CHE 4053: PETROLEUM REFINERY ENGINEERING (THEORY AND LAB) [2 0 3 3]

Theory: Crude oil origin, composition, characterization and classification; Refinery products and test methods; Design of crude oil distillation column; Refinery processes: thermal, catalytic, and hydrocracking, catalytic reforming, isomerization, alkylation, polymerization, lube oil processing, coking, hydro treatment, gas processing; New trends in petroleum refinery operations.

Lab: Experiments are based on determination of vapour pressure, flash point, fire point, pour point, smoke point, aniline point, viscosity, viscosity index, calorific value, carbon residue, softening point, and penetration index of petroleum fractions.

References:

1. James G Speight, The Chemistry and Technology of Petroleum (4e), CRC Press, 2006.
2. Nelson W. L., Petroleum Refining Engineering (4e), McGraw-Hill, 1974.
3. Bhaskara Rao B. K., Modern Petroleum Refining Processes (5e), Oxford& IBH, 2009.
4. Meyers R. A., Handbook of petroleum refining processes (3e), McGraw-Hill, 2004.

Course Outcomes:

CO1: Understand the origin and introduction to crude oil composition and classifications.

CO2: Calculation of physical and chemical properties of petroleum and petroleum products.

CO3: Acquaint the knowledge on uses, tests, specifications, and blending of refinery products.

CO4: Discussion on process diagram on refinery processes like cracking, reforming, isomerization, alkylation etc.

CO5: Gain knowledge of treatment of petroleum products like hydrodesulphurization, de-asphalting, solvent extraction etc.; and trends in refinery operations

PE-II BIO 4052: DESIGN OF BIOLOGICAL TREATMENT PROCESSES [3 0 0 3]

Flow and Mass loading for treatment plants; Various Physical units operations equalization tank design, sedimentation tank design by solid flux and batch data, dissolved air flotation; Filtration mechanism in water treatment and design of filters, Chemical treatment and precipitation; Activated sludge process and different types of active sludge processes; Mathematical model development for active sludge process, and design, Sequencing batch reactors (SBR), Plug flow aerobic treatment, Rotating Biological contactor and model, Trickling filters and roughing filters and various design parameters, Various pond processes, Disinfection-Mechanisms, Mathematical Models for disinfection, Breakpoint chlorination and calculations; Design considerations in anaerobic processes; Water reuse and reclamation technologies, Risk assessment.

References:

1. Metcalf and Eddy, Wastewater Engineering - Treatment, Disposal and Reuse, Tata McGraw Hill Publishing Co. Ltd, 1991
2. C.S.Rao, Environmental Pollution Control Engineering, New Age International (P) Ltd. Publishers, 1991
3. H.J. Jordening, and J.Winter, Environmental Biotechnology: Concepts and Applications, Wiley-VCH Verlag GmbH & Co, 2005

Course Outcomes:

CO1: Design various physical processes involved in water treatment

CO2: Describe the role of coagulation and activated sludge process

CO3: Illustrate the importance of trickling filters and rotating biological contactor in treatment of waste water

CO4: Highlight the disinfection methods and reuse of the treated water

OE-III CHE 4071: RISK AND SAFETY MANAGEMENT IN PROCESS INDUSTRIES [3 0 0 3]

Safety in plants: Hazard analysis, damage minimisation, fires, fire extinguishers, handling, contamination removal, reduction methods, personal protective devices, Plant and personal safety. Pressure vessels, handling and transportations of liquids and gases under high pressure, explosive chemicals and handling. Safety administration, safety committee, safety education. First aid principles and methods, plant inspection. Engineering design for safety considerations. Hazards in work places, workers exposure to hazardous chemicals, threshold limit values of chemicals, engineering control of hazards and accidents due to fire and explosives and natural causes in different industries. Safety management, safety performance, motivation of employees, supervisors, managers and management, legal aspects of safety. Case studies: Major explosions in Chemical Industry: Bhopal disaster, Flixborough disaster, Seveso disaster, Philips disaster, Texas disaster.

References:

1. Roland P.Blake, Industrial safety, (2e), Prentice Hall Inc, New York, 1953
2. Muir G.D, Hazards in Chemical Laboratory, (2e), The Chemical Society, London, 1980
3. Judson and Brown, Occupational Accident Prevention, John Wiley, New York, 1980
4. Handley W., Industrial Safety Hand Book, McGraw Hill, London, 1969\

Course Outcomes:

CO1: Foster awareness regarding safety aspects in industry

CO2: Understand, explain and illustrate the various safety analysis procedures and risk assessment

CO3: Define hazard, its types and devise methods to control them

CO4: Understand plant inspection and appraise plant safety

CO5: Evaluate and interpret the root causes of major industrial disasters

CO6: Define the role of management and safety engineer in implementation of a safety program in a plant. Understand the various safety standard codes

CHE 3261: MASS TRANSFER LAB [0 0 3 1]

Experiments are based ob following topics: Vapour-liquid equilibria, Simple distillation – vaporization and thermal efficiency of steam distillation – distillation under total reflux in a packed column – studies in batch adsorption – diffusivity by stephen's method – mass transfer coefficient in dissolution of solid – liquid-liquid extraction –simple and cross flow leaching – experimental determination of liquid-liquid equilibrium data – drying of solids in fluidized bed dryer – extraction of solute in packed bed column – crystallization process in an batch crystallizer – tray efficiency of bubble cap distillation column

Course Outcomes:

CO1: Be familiar the separation principle of simple and steam distillation and to analyze the experimental data

CO2: Understand the mechanism of batch crystallization and adsorption operation and to interpret the experimental data

CO3: Evaluate to generate equilibrium data of packed bed distillation and vapour-liquid equilibrium and interpret the experimental results

CO4: Be familiar to calculate diffusivity of acetone and mass transfer coefficient of benzoic acid-water system

CO5: Understand the principle of extraction, leaching and drying operation, analyze and interpret the data from various unit operations.

CHE 3262: REACTION ENGINEERING AND PROCESS CONTROL LAB [0 0 3 1]

Experiments based on the following topics: Homogeneous non-catalytic liquid phase kinetic studies using batch reactor, semi-batch reactor, PFR and CSTR. Studies on recycle reactor. RTD Studies in PFR and CSTR - Dynamic response of systems: first order non-linear, thermometric; second order non-interacting and interacting by introducing a step input. Linearization of a non-linear system and comparison of dynamic response with the actual response, Valve characteristics, Studies on P, PI, and PID controllers; control of systems with cascading and ratio effects

Course Outcomes:

CO1: Relate the topics learnt, with the actual experimental setup

CO2: Plan experiment procedures to obtain data

CO3: Comprehend and present the experimental data meaningfully

CO4: Apply theoretical concepts for data analysis and interpretation

CO5: Understand the experimental techniques related to Chemical reaction engineering and Process control

- **B.TECH. 7TH SEMESTER**

PE-III BIO 4001: BIOREMEDIATION [3 0 0 3]

Introduction, Advantages and Disadvantages of Bioremediation; Factors influencing Bioremediation Microbial ecology and metabolism; Biodegradation of common contaminant compounds;

Bioremediation processes; Biological Filtration Processes for Decontamination of Air Stream; Biotreatment of Metals; Phytoextraction; Rhizofiltration; Phytostabilization; Biomonitoring; Biomembrane Reactors; Successful and Unsuccessful Case Studies in Bioremediation Process

References:

1. Martin Alexander, *Biodegradation and Bioremediation*, Academic press, 1999
2. John. T. Cookson, Jr, *Bioremediation engineering; design and application ,*McGraw Hill, Inc., 1995
3. Eweis, Ergas, Chang Schroeder, *Bioremediation Principles,* McGraw-Hill Series in Water Resources and Environmental Engineering, 1998

Course Outcomes:

CO1: Understand the fundamentals of environmental microbiology and the concepts of various aspects of environmental pollution

CO2: Examine the methods of bioremediation of toxic metals, organic and inorganic contaminants

CO3: Acquire knowledge on treatment methods of environmental issues

CO4: Analyze engineering strategies for bioremediation

CO5: Explain the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments

PE-III CHE 4051: NATURAL GAS ENGINEERING [3 0 0 3]

Natural gas industry, types of natural gas resources; Properties of natural gas; Gas reservoir deliverability: analytical and empirical methods, construction of IPR curve, shale gas wells, well deliverability testing; Well bore performance: single-phase gas well and mist flow in gas wells; Choke performance: sonic and subsonic flow, dry and wet gas flow through chokes; Well deliverability: nodal analysis, production forecast; Natural gas processing: separation of gas and liquids, stage and low- temperature separation; dehydration; Compression and cooling; Natural gas measurement and transportation; Liquid loading, hydrate cleaning and pipeline cleaning; Advances in natural gas production engineering.

References:

1. Guo B., Ghalambor A., Natural Gas Engineering Handbook, Gulf Publishing Company, 2005.
2. Katz D. L., Lee R. L., Natural Gas Engineering, McGraw Hill, 1990.

3. Guo B., Lyons W. C., Ghalambor A., Petroleum Production Engineering: A Computer Assisted Approach, Elsevier, 2007.
4. Ahmed T., McKinney P. D., Advanced Reservoir Engineering, Elsevier, 2005.

Course outcome

CO1: To understand different types of wells, well integrity tests, PVT Behavior of gas wells, determination of pseudocritical properties, and z-factor.

CO2: To detail understanding of gas well deliverability or inflow performance relationship (IPR).

CO3: To introduce well (WPR), choke performance relationship (CPR) and Nodal Analysis.

CO4: To understand Natural Gas Downstream Processing – Role of production separators, sweetening and dehydration process, design of the separators and absorber columns.

CO5: To understand Hydrocarbon dew point system, compressors and measurement of the natural gas.

PE-III CHE 4057: INDUSTRIAL WASTEWATER ENGINEERING [2 0 3 3]

Wastewater treatment quality criteria and effluent standards, Water and wastewater characteristics, Preliminary treatment processes: Screens, grit chamber, flow equalization, Primary sedimentation tank, Primary treatment process: Sedimentation, Coagulation and Flocculation, Softening, Sand filtration, Biological treatment processes: Introduction to microbiology, microbial kinetics, Aeration ponds and lagoons, Activated sludge process, Nitrification and denitrification, Trickling filters and rotating biological contactors, Sludge treatment, Advanced treatment processes: Adsorption, Chemical oxidation, Ozonation, Photo catalysts, wet air oxidation, evaporation, Ion exchange, Membrane Technologies, Concept of zero liquid discharge, Wastewater disposal in receiving bodies, Case studies: Effluent treatment plants in Textile, Tanneries, Pulp and paper, Sugar and distilleries and Pharmaceutical industries.

Lab may include tests for water quality, pH, turbidity, COD, BOD, total solids, suspended solids, dissolved solids, fluoride, residual chlorine, determination of particulate matter in air, high volume sampler, determination of SO_2, COD, determination of SPM, PM10 and PM 2.5 using a High-volume sampler

References:

1. Metcaff and Eddy, Wastewater Engineering: Treatment and Reuse (5e), McGraw Hill, 2007.
2. Edwards J. D., Industrial Waste Water Treatment: A Guide Book (1e), CRC Press, 1995.
3. Patwardhan A. D., Industrial Waste Water Treatment, Prentice Hall India, 2008.
4. Ranade V. V., Bhandari V. M., Industrial Wastewater Treatment, Recycling and Reuse (2e), Prentice Hall India, 2017.

5. Droste R. L., Theory and Practice of Water and Wastewater Treatment, John Wiley & Sons, 2005.

Course Outcome

CO1: Apply knowledge of engineering to analyze physical, chemical and biological characteristics of waste water

CO2: To evaluate various physical and chemical treatment options for treatment of wastewater

CO3: To design various physicochemical units for the treatment wastewater

CO4: To study about various biological treatment processes and its operations for the wastewater treatment

CO5: To provide the knowledge about the kinetics of biological growth and its application in the design of biological reactors

PE-IV CHE 4054: PROCESS INTEGRATION FOR PETROLEUM INDUSTRIES [3 0 0 3]

Energy consumption scenario in petroleum industries, Basic concepts of in Process Synthesis, Understand the importance of energy integration in a petroleum industry, Energy integration, Different Methods of Energy Integration, Focus on Pinch Analysis: Need of Pinch Technology, Role of thermodynamics, Problem addressed by Pinch technology. Key Steps of Pinch Technology: Data extraction, Targeting, Designing, and Optimization. Basic Elements of Pinch Technology: Grid diagram, Composite curve, Problem table algorithm, Grand composite curve. Heat Exchanger Network (HEN): Energy targeting, Area targeting, Number of units targeting, Shell targeting, cost targeting. Designing of HEN: Pinch design methods, Heuristic rules, Stream splitting, Design of maximum energy recovery (MER);Heat Integration of Equipment's: Heat engine, Heat pump, Distillation column, Reactor, Ideal distillation systems, Heat integrated distillation processes, Synthesis of distillation sequences, Refrigeration systems. “HINT” Software Practice of software for HEN using Pinch Technology

References:

1. Ian C Kemp, Pinch, Analysis and Process Integration: A User Guide on Process Integration for the efficient use of energy (2e), Butterworth-Heinemann (Elsevier), publisher, 2007.
2. Robin M. Smith, “Chemical Process: Design and Integration”, John Wiley & Sons, 2005.
3. Biegler, L. T.; Grossmann I. E.; Wasterberg, A. W., “Systematic Methods of Chemical Proces Design”, Prentice Hall, New-Jersey, 1997.
4. El-Halwagi, M. M., “Process Integration”, Process System Engineering series vol. 7, Academic

press, San Diego, 2005.

Course Outcomes

CO1: Understand the importance of energy integration in a process industries.

CO2: Develop a Hot and cold composite curves

CO3: Develop a PINCH for the given stream data.

CO4: Evaluate a Hot and Cold utility required for the given process

CO5: Understand to place and Integrating of process equipment's.

PE-IV CHE 4056: ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT PLAN [3 0 0 3]

Environmental impact assessment (EIA), definitions and concepts, rationale and historical development of EIA, EIA process in India and other countries, EIA laws and regulations, The Environmental protection Act, The water presentation Act, The Air (Prevention & Control of pollution Act.), Wild life Act etc.

E I A Methodologies: introduction, Criteria for the selection of EIA Methodology, E I A methods, Adhoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods and cost/benefit Analysis. Initial environmental examination, Introduction and Methodology for the assessment of ground water, surface water, Assessment of Impact of development Activities on Vegetation and wildlife, Assessment of air, soil. Case studies.

Environmental management - principles, problems and strategies; Environmental audit, definitions and concepts, partial audit, compliance audit, methodologies and regulations; introduction to ISO and ISO 14000; Life cycle assessment; Triple bottom line approach; Ecological foot printing; Carbon trading; Sustainable development

References:

1. Canter L. W., Environmental Impact Assessment, (2e), McGraw-Hill, 1997
2. Anjaneyulu Y., Environmental Impact Assessment Methodologies, by, B.S. Publication, Sultan Bazar, Hyderabad (2006).
3. Judith P., Eduljee G., Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1994
4. Burke G., Singh B. R., Theodore L., Handbook of Environmental Management and Technology,

(2e), John Wiley & Sons, 2000
5. Eccleston C. H., Environment Impact Statements: A Comprehensive Guide to Project and Strategic Planning, John Wiley & Sons, 2000
6. Welford R., Corporate Environmental Management - Systems and Strategies, Universities Press, 1996
7. Whitelaw K., Butterworth, ISO 14001: Environmental System Handbook, 1997
8. The Economist Intelligence Unit, Best Practices - Environment, Universities Press, 1993
9. Therivel R., John Glasson, Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2005

Course Outcome

CO1: Summarize the nature, evolution, and role of environmental impact assessment (EIA) in environmental planning and management from a sustainability perspective.

CO2: Determine the requirements and components of the EIA process.

CO3: Explore the EIA process, its practice, and implementation.

CO4: Critically assess EIA practice based on case studies of recent applications.

PE-IV BIO 4004: SOLID WASTE MANAGEMENT [3 0 0 3]

Integrated solid waste management, operation of waste management systems. Legislative Trends and Impacts; Composition of municipal solid wastes, Properties of MSW; transformations of solid waste; Properties, classification and transformation of Hazardous wastes and its management; Collection of solid waste, Separation, processing and Transformation of solid waste, Transfer and Transport, Disposal; Landfill methods & its design; Biological principles, aerobic composting, Anaerobic digestion, Biological transformation processes. Energy production from biological conversion products, Fermentation and compost processes: design parameters & Applications; Meeting federal and state mandated diversion goals; Recycling, Implementation of solid waste management options; planning, siting and permitting of waste management facilities.

References:

1. George Tchobanoglous, Integrated solid waste management: Engineering principles and management issues, Mcgraw Hill, 1993
2. William D Robinson, The solid waste handbook: A practical guide, John Willy & sons, 1986

Course Outcomes:

CO1: Discuss the concept of waste management and operations of solid waste management system

CO2: Analysis the physical, chemical and biological properties of waste management

CO3: Analysis the operation of hazardous waste management system

CO4: Apply the principles for collection to transformation of solid waste management

CO5: Evaluate engineering principles for disposal of solid wastes

PE-V CHM 4051: ANALYTICAL TECHNIQUES AND INSTRUMENTATION [3 0 0 3]

Spectroscopic methods of analysis – Introduction to spectroscopy – Energy concepts, properties of EMR,

General features of spectroscopy, Types of molecular spectra, Interaction of EMR with matter, Instrumentation, Application. Microwave spectroscopy, Raman spectroscopy, Infrared spectroscopy, UV-visible spectroscopy, NMR spectroscopy. Chromatographic Techniques – General concepts, Classification, Column chromatography, HPLC, Instrumentation, Applications, Thin layer chromatography, Experimental techniques, Applications, Advantages and disadvantages, Gas chromatography, principles, instrumentation and applications Electroanalytical methods– Conductometric titrations – basic principles, Applications in titrations involving weak and strong acids and bases, Potentiometric titrations- Fundamental principles, Applications involving neutralization, redox, precipitation and complexation types

References:

1. Skoog D.A., Holler J., Nieman F.T.A., Principles of Instrumental Analysis, (5e), Saunders, Philadelphia, 1992
2. Skoog D. A., West D. M. and Holler F. J., Fundamentals of Analytical Chemistry, (5e), Saunders College Publishing, Philadelphia, 1988.
3. Jeffery G.H., Vogel's Textbook of Quantitative Chemical Analysis, (5e), John Wiley & Sons Inc, 1989
4. Chatwal G, Anand. S., Instrumental Methods of Chemical Analysis, Himalaya Publishers, Bombay, 1996
5. Ewing G.W., Instrumental Methods of Chemical Analysis, Mc-Graw- Hill, 1989
6. Banwell C.N., McCash C.N., Fundamentals of Molecular Spectroscopy, McGraw-Hill, London, 1972

Course outcomes:

CO1: Explain the interaction of electromagnetic radiation with matter and energy concepts

CO2: Explain the principle and instrumentation involved in microwave, IR, Raman, UV-Visible and NMR spectroscopy

CO3: Apply these spectroscopic techniques in analyzing the organic compounds

CO4: Propose the chromatographic technique to be used for the separation of components from mixture

CO5: Apply the concept of electro-analytical method to identify the method to quantify the analyte

PE-V CHE 4069: PROJECT ENGINEERING [3 0 0 3]

Preliminary data on projects; Process engineering, Block flow diagram, Process flow diagram, Piping and instrumentation diagram, Pilot plants, General considerations for plant location and layout, piping design, plant utilities, insulation, instrumentation, safety in chemical plant, Project engineering management, Project scheduling and its importance, PERT and CPM techniques, Gantt chart, Optimum project design, optimum production rates, selected examples such as heat exchangers, pumps , vessels, evaporators, and driers.

References:

1. Howard F. Rase, M.H. Barrow, Project Engineering of Process Plants, John Wiley, 1957
2. Warren Sieder, J.D. Seader, Daniel Lewin, Product and Process Design Principles, John Wiley, 2004
3. Gael D.U., A Guide to Chemical Engineering Process Design and Economics, John Wiley, 1984
4. Peters M. S, Klaus D. T., Ronald E. W., Plant Design and Economics for Chemical Engineers, McGraw- Hill, 2003
5. Ludwig E.E., Applied Project Engineering, Gulf Publishing Co., Houston, 1988
6. Modes J, Philips, Project Engineering with CPM & PERT, Renhold Publishing Co.
7. Coulson and Richardson's Chemical Engineering Series Chemical Engineering Volume 6, Chemical Engineering Design, (3e), 2003

Course Outcome

CO1: Understand the role of a Project engineer and the major steps in Plant design

CO2: Estimate total production cost and time value of money

CO3: Apply the knowledge of Chemical Engineering in Process design and flowsheet development

CO4: Identify the Optimum design and design strategy

CO5: Illustrate the details of engineering design, equipment selection and construction

PE-V CHE 4061: CHEMICAL REACTOR THEORY [3 0 0 3]

Non-isothermal reactors, Nature of the problem, Energy balances, Temperature effects, Design of adiabatic and non-isothermal batch semi-batch and flow reactors, Optimum temperature progression, multiple steady states. Heterogeneous reactions, Rate equation for heterogeneous systems, Fluid-particle non-catalytic reactions, Different models, Kinetic regimes, Multiphase reactors, Heterogeneous catalysis, Types and classification of catalysts Selection and preparation of catalysts for industrial reactions, Kinetics of heterogeneous solid catalyzed gas reactions, Mathematical models on different mechanism, External transport processes, Intrapellet mass transfer, Heat transfer, Effectiveness factors.

References:

1. Scott Fogler, H, Elements of Chemical Reaction Engineering, (4e), PHI, 2005.

2. Octave Levenspiel, Chemical Reaction Engineering, (3e), Wiley & Sons, 2003.

3. Rawlings J.B. and Ekerd, J.G., Chemical Reactor Analysis and Design Fundamentals Nole. Hill 2002.

4. Smith, J.M, Chemical Engineering Kinetics, 3rd edition, McGrawl-Hill, International student edition

5. Mark E Davis, Robert E Davis, Fundamentals of Chemical Reaction Engineering, (1e), McGrawl-Hill, 2003

6. Ronald W. Missen, Charles A. Mims, Bradley A. Saville; Introduction to chemical reaction engineering and kinetics, John Wiley & Sons, Inc.

Course Outcome

CO1: Design non-isothermal reactors for reactions and optimize operating conditions.

CO2: Develop mathematical models for various fluid, solid contact- heterogeneous systems.

CO3: Describe the mass, heat transfer and reaction phenomena occurring in heterogeneous reactions.

CO4: Make informed choices of reactor types and catalyst kinetics.

CO5: Write and simplify appropriately the overall rate and balance equations for catalytic/multiphase reactions.

PE-VI CHE 4064: INTRODUCTION TO BIOCHEMICAL ENGINEERING [3 0 0 3]

Introduction – Principles of microbiology, Chemicals of life – Lipids – Sugars and polysaccharides of cellular organization – cell nutrients – Macronutrients – Growth media Kinetics of enzymes – Enzyme substrate complex and enzyme action – Isolation and utilization of enzymes – Production, purification, immobilization and application of enzymes. Metabolic pathways and energetic of the cell – Glucose metabolism - Metabolism of nitrogenous compounds – Nitrogen fixation – Metabolism of hydrocarbons – Overview of biosynthesis – Anaerobic metabolism – Photosynthesis - Autotropic metabolism – transport across cell membranes, Cell growth – Batch growth – Growth patterns and kinetics in batch culture – Factors affecting growth kinetics-Quantification of growth kinetics – Unstructured non-segregated models to predict specific growth rate – Models with growth inhibitors – Logistic equation - Growth models for filamentous organisms.

References:

1. Bailey J.S.and Ollis D.F., Biochemical Engineering Fundamentals, McGraw-Hill, NY, 1986
2. Shuler M.L.and Kargi F., Bioprocess Engineering Basic Concepts, Prentice Hall of India, New Delhi, 1998
3. Blanch H.W. and.Clerk D.S, Biochemical Engineering, Mercel Dekker Inc., 1996

Course Outcome

CO1: Describe basic concepts of biochemistry, microbiology and development of media for industrial bioprocess

CO2: Explain the enzyme catalysis, simple enzyme kinetics, immobilization, production and purification of enzymes

CO3: Estimate the kinetic constant for various factors affecting enzymatic reaction

CO4: Describe the major metabolic pathways

CO5: Develop kinetic models for the growth of microorganism and product formation and evaluate model parameters

PE-VI CHE 4070: RENEWABLE ENERGY ENGINEERING [3 0 0 3]

Solar radiation, availability, measurement and estimation; empirical relations, solar collectors and types,

Selective coatings Solar water heating, Solar cooking, Solar drying, Solar distillation and solar refrigeration, Active and passive heating and cooling of buildings, Solar Chimney, Solar drying Solar thermal power generation - Energy Storage - Sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change-Glauber's salt-organic compounds. Solar pond. Energy in wind-wind energy applicable to Indian standards–Variables in wind energy conversion systems – wind power density – power in a wind stream– wind turbine efficiency – Forces on the blades of a propeller – Solidity and selection curves. HAWT, VAWT– tower design- power duration curves- wind rose diagrams- study of characteristics- wind turbine circuits. Biomass - Sources and Classification - Chemical composition, properties of biomass - Energy plantations. Size reduction, Briquetting, Drying, Storage and handling of biomass. Biogas technology Feedstock for biogas, Microbial and biochemical aspects - operating parameters for biogas production. Kinetics and mechanism- High rate digesters for industrial waste water treatment. Incineration- Processing for liquid fuel production. Pyrolysis - Effect of particle size, temperature, and products obtained. Gasification - Effect of pressure, temperature, steam and oxygen. Bio-ethanol and bio-diesel technology Production of fuel ethanol by fermentation of sugars, gasohol as a substitute for petrol. Trans-esterification of oils to produce bio-fuels, Pyrolysis and gasification of biomass, Thermo- chemical conversion lignocelluloses biomass. Combustion of biomass and co-generation systems Environmental aspects of biofuel utilization - Techno economic features of bio fuels – Co-generation in biomass processing industries.

References:

1. Goswami D.Y., Frank Kreith, Jan. F. Kreider, “Principles of Solar Engineering”, 2ndEdition, Taylor & Francis, 2000, Indian reprint, 2003
2. Anderson E.E, “Fundamentals for solar energy conversion”, Addison Wesley Publ. Co., 1983.
3. Duffie J. A and Beckman, W .A., “Solar Engineering of Thermal Process”, John Wiley,1991. 4. G. N. Tiwari and M. K. Ghosal, “Fundamentals of Renewable energy Sources”, Narosa Publishing House, New Delhi, 2007
4. Sukhatme S. P., Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hil, New Delhi, 1996
5. Wind energy Handbook, Edited by T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, John Wiley & Sons, 2001
6. Mukund & Patel R., Wind and Solar Power Systems., 2nd Edition, Taylor & Francis, 2001
7. Freris B. L .L., Wind Energy Conversion Systems, Prentice Hall, 1990.

8. Chakraverthy A, “Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes”, Oxford & IBH publishing Co, 1989.
9. Mital K.M, “Biogas Systems: Principles and Applications”, New Age International publishers (P) Ltd., 1996.
10. Rezaiyan. J and Cheremisinoff N. P., “Gasification Technologies, A Primer for Engineers and Scientists”, Taylor & Francis, 2005
11. Samir Kumar Khana Bioenergy and Biofuel from Biowastes and Biomass , ASCE Publications, 2010

Course Outcome

CO1: Understand the concepts of Solar radiation, availability, measurement and estimation, Solar drying, and active and passive heating

CO2: Understand the concepts of solar thermal power generation - energy Storage - thermo-chemical storage and solar refrigeration

CO3: Understand the concepts of Energy in wind- wind energy applicable to Indian standards – wind power density-. HAWT, VAWT– tower design power duration curves

CO4: Understand the concepts of Biomass - Sources and Classification – Chemical composition, properties of biomass - Energy plantations. Size reduction, Briquetting, Drying, Storage and handling of biomass

CO5: Understand the concepts of Biogas technology - Feedstock for biogas, Microbial and biochemical aspects – operating parameters for biogas production. Kinetics and mechanism- High rate digesters for industrial waste water treatment

PE-VI CHE 4073 MACHINE LEARNING IN CHEMICAL ENGINEERING [3 0 0 3]

Introduction: Introduction to machine learning, supervised learning, unsupervised learning Linear regression with one variable: Linear regression predicts a real valued output based on an input value. Notion of cost/ objective function, Introduction of gradient descent method for learning. Linear algebra review. MATLAB Tutorial: Introduction to MATLAB, How to write programming using MATLAB. Linear Regression with multiple variables: gradient descent method for multiple variables, features and polynomial regression, closed form solution (normal equation). Example: soft sensor design. Programming. Logistic regression: Method to classify data into discrete outcomes, introduce the notion of classification, objective function of logistic regression and application logistic regression to multiclassification. Programming. Regulrization: Problem of over fitting, Cost function, Regularized linear regression, regularized logistic regression, Programming. Neural Networks: Nonlinear hypothesis, nerons and brain, model representation, multiclass classifiction and examples. Advice for applying machine learning: Evaluating hypothess, Model selection, Diagnising Bias Vs variance, Regularization and Bias/Variance, earning curves, error analysis Support vector machines: optimization and objective, Mathematics behind the large margin classificcation, Kernels, Programming. Unsupervised learning: Introduction, K-means algorithem, optimization objective, Dimensionlaity reduction: - Data compression, Principal component analysis, optimizing the number of principal components, application to sensor fault detection, Programming. Anomaly detection: Problem motivation, gaussian distribution, developing and evaluation fault detection algorithem for process monitoring. Anomaly detection Vs supervised learning. Programming. Application Example: few example related to process monitoring. Programming.

References:

1. Stephen Marsland, "Machine Learning" , Second edition CRC Press, 2014

2 Alpaydin Ethem, "Introduction to Machine Learning", Edn. 2, PHI, New Delhi.

3.Shalev-Shwartz Shai;Ben-David Shai, "Understanding machine learning", Cambridge Univerwity Press, 2017.

4. Saikat Dutt, Subramanian Chandramouli and Amit Kumar Das, "Machine Learning" 1st edition, Pearson, 2018.

5. Lecture Notes on "Fault detection and Diagnosis" by Prof. R.D.Gudi, Indian Institute of Technology, Bombay

Course Outcomes:

CO1: Understand the importance of machine learning concepts in the chemical engineering domain, their applications in the chemical engineering domain, and able to distinguish between supervised and unsupervised learning algorithms

CO2: Able to formulate the problem for regression and classification and obtain the solution using MATLAB.

CO3: Understand the concept of underfitting and overfitting of the model and take the correct decision to address the bias and variance of a model.

CO4: Understand and develop the support vector machine algorithms as classification learning algorithms and their solution using MATLAB.

CO5: Understand the concept of dimensionality reduction and its application? Develop a principal component analysis algorithm using MATLAB.

PE-VII CHE 4067: NON-NEWTONIAN FLOW IN THE PROCESS INDUSTRIES [2 1 0 3]

Classification of fluid behaviour, Rheometry for non-Newtonian fluids: capillary, rotational, normal stress, controlled stress, yield stress rheometers, Power law fluids flow in pipes and in conduits, Flow of multiphase mixtures in pipes: two phase gas non Newtonian liquid flow.

References:

1. Chhabra R..P. and Richardson J. F., Non-Newtonian flow in the process Industries, Butterworth and Heinemann, 1999.
2. McCabe W., Smith J., Harriott P., Unit Operations of Chemical Engineering (7e), McGraw Hill Education, 2017.
3. Carreau P. J., DeKee D. C. R., Chhabra R. P., Rheology of Polymeric Systems: Principles and Applications, Hanser Publishers, 1997.

Course Outcome

CO1: Types of non-Newtonian fluids and Applications of non-Newtonian fluids and its importance in process industries

CO2: Various measuring instruments and mathematical derivations to the apparent viscosity of non-Newtonian fluids

CO3: Flow regions identification and friction factor calculations in Laminar region for various flow models

CO4: Flow of non-Newtonian fluids in non-circular shapes. Flow of two phase

CHE 4071: RISK AND SAFETY MANAGEMENT IN PROCESS INDUSTRIES [3 0 0 3]

Safety in plants: Hazard analysis, damage minimisation, fires, fire extinguishers, handling, contamination removal, reduction methods, personal protective devices, Plant and personal safety. Pressure vessels, handling and transportations of liquids and gases under high pressure, explosive chemicals and handling. Safety administration, safety committee, safety education. First aid principles and methods, plant inspection. Engineering design for safety considerations. Hazards in work places, workers exposure to hazardous chemicals, threshold limit values of chemicals, engineering control of hazards and accidents due to fire and explosives and natural causes in different industries. Safety management, safety performance, motivation of employees, supervisors, managers and management, legal aspects of safety. Case studies: Major explosions in Chemical Industry: Bhopal disaster, Flixborough disaster, Seveso disaster, Philips disaster, Texas disaster.

References:

1. Roland P.Blake, Industrial safety, (2e), Prentice Hall Inc, New York, 1953
2. Muir G.D, Hazards in Chemical Laboratory, (2e), The Chemical Society, London, 1980
3. Judson and Brown, Occupational Accident Prevention, John Wiley, New York, 1980
4. Handley W., Industrial Safety Hand Book, McGraw Hill, London, 1969

Course Outcomes

CO1: Foster awareness regarding safety aspects in industry

CO2: Understand, explain and illustrate the various safety analysis procedures and risk assessment

CO3: Define hazard, its types and devise methods to control them

CO4: Understand plant inspection and appraise plant safety

CO5: Evaluate and interpret the root causes of major industrial disasters

CO6: Define the role of management and safety engineer in implementation of a safety program in a plant. Understand the various safety standard codes

CHE 4063: FUELS AND COMBUSTION [3 0 0 3]

Solid fuels: Testing methods – Proximate and ultimate analysis – Calorific value – Weathering and grindability index of coal – Theories of origin and stages of formation – Coal washing techniques – Carbonisation – Coke ovens – Gasification – Briquetted and pulverized fuels. Liquid fuels: Testing methods – Aniline point – Viscosity index – ASTM distillation – Flash and fire point – Carbon residue – Moisture – Smoke point and char value – Calorific value – Origin, composition and classification of petroleum – Distillation of crude and purification of petroleum products. Gaseous fuels: Fuel gas and flue gas analysis – Calorific value – Production and utilization of Natural gas, producer gas, water gas and carbonated water gas. Combustion Stoichiometry, theoretical & actual combustion processes –Air fuel ratio. Combustion Thermodynamics- calculation of heat of formation & heat of combustion – First law analysis of reacting systems. Heat Treatment Furnaces- Industrial furnaces – process furnaces – Kilns – Flame, Flame Structure, Ignition and Igniters – flame propagation – deflagration – detonations- flame front – Ignition – self & forced ignition – Ignition temperature Combustion Appliances- Gas burners- Functional requirement of burners – Gas burner Classification –Stoker firing –pulverized system of firing.

References:

1. Sharma, S.P.and Chander Mohan, Fuels and Combustion, Tata McGraw-Hill, 1982
2. Saha, A.K., Combustion Engineering and Fuel technology, Oxford Press
3. Gilchrist, J.D., Fuels, Furnaces and Refractories, Pergamon Press, 1977
4. Samir Sarkar, Fuels and Combustion, (3e), Universities Press, 2010

Course Outcome

CO1: Understand the different types of solid fuels - requisite properties, testing methods, production, processing and utilization
CO2: Analyse the different types of liquid fuels - testing of properties, production, processing and utilization
CO3: Understand the different types of gaseous fuels - testing of properties, production, processing and utilization
CO4: Apply different types of combustion techniques and related appliances, calculation of air requirement in industrial applications

CHE 4065: INTRODUCTION TO PETROLEUM ENGINEERING [3 0 0 3]

Overview and history of the petroleum industry; Petroleum reserves, production and consumption statistics of the world; Crude oil origin, exploration, drilling; Crude composition, characterization and classification; Estimation of oil and gas in place; Hydrocarbon phase diagrams; Reservoir properties and drive mechanisms; EOR; Fundamentals of refinery major operations and processes; Refinery products and test methods.

References:

1. Nelson W. L., Petroleum Refining Engineering, (4e), McGraw-Hill, 1990.
2. Dake L. P., Fundamental of Reservoir Engineering, Elsevier, 2011. 3.Ahmed Tarek, Reservoir Engineering Handbook, (4e), Gulf professional publishers, 2010.
3. Bhaskara Rao B. K., Modern Petroleum Refining Processes, (5e), Oxford& IBH, 2009.

Course Outcomes:
CO1: Familiar with the origin and history of petroleum crude
CO2: Obtain the basic knowledge of oil exploration, and drilling
CO3: Familiar with the basic concepts of reservoir engineering and technologies for oil recovery

CO4: Obtain the basic knowledge on the types, properties and different fractions of petroleum crude

CO5:Acquire the basic concepts on the major processes of oil and gas refineries

B.TECH. 8TH SEMESTER

CHE 4298: INDUSTRIAL TRAINING [0 0 0 1]

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

Course outcome

CO1: Expose the students to the actual working environment including rules, regulations and safety practices that will prepare them to join the workforce in the future.

CO2: Understand the unit operations and processes in chemical industries Or incase it is not a chemical industry, to lean the operations, processes or research of the particular company or institute.

CHE 4299: PROJECT WORK/PRACTICE SCHOOL [0 0 0 12]

The project work may be carried out in the institution/industry/research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

Course outcome

CO1: Construct a scientific research plan to execute and finish within a stipulated time frame

CO2: Follow the SOPs (Standard operating procedures) and adhere to GLP (Good Laboratory Practices)

CO3: Apply the theoretical concepts to solve practical problems

CO4: Analyze and report the results from the practical research exercise in written and oral forms

CO5: Acquire collaborative skills through working in a team to achieve common goals