CHEMICAL ENGINEERING DEPARTMENT

B.Tech. CHEMICAL ENGINEERING

Course of Study & Scheme of Examination
2016-17

Maulana Azad National Institute of Technology
Bhopal

SCHEME

B. Tech. Third Semester

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
MTH211	Mathematics - III	3	-	-	3
CHE 212	Introduction to Chemical Engineering	3	-	-	3
CHE 213	Chemical Process Calculations	3	-	-	3
CHE 214	Fluid Mechanics	3	-	-	3
CHE 215	Chemical Process Technology - I	3	-	-	3
CHE 216	Chemical Engineering Thermodynamics	3	-	-	3
CHE 217	Chemical Technology Lab	-	-	4	2
CHE 218	Fluid Mechanics Lab.	-	-	4	2
					Total Credit-22

B. Tech. Fourth Semester

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
CHE 221	Chemical Reaction Engineering - I	3	-	-	3
CHE 222	Mechanical Operations	3	-	-	3
CHE 223	Heat Transfer - I	3	-	-	3
CHE 224	Chemical Process Technology - II	3	-	-	3
CHE 225	Mass Transfer - I	3	-	-	3
CHE 226	Instrumentation and Process Dynamics Control	3	-	-	3
CHE 227	Heat Transfer Lab.	-	-	4	2
CHE 228	Mechanical Operations Lab			4	2
					Total Credit-22

B. Tech. Fifth Semester

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
CHE 311	Heat Transfer - II	3	-	-	3
CHE 312	Mass Transfer - II	3	-	-	3
CHE 313	Chemical Reaction Engineering - II	3	-	-	3
	Department elective- 1	3	-	-	3
	Department elective-2	3	-	-	3
	Open elective-1	3	-	-	3
CHE 314	Mass Transfer Lab	-	-	6	3
CHE 315	Process Control Lab	-	-	4	2
					Total Credit-23

B. Tech. Sixth Semester

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
CHE 321	Process Modeling and Simulation	3	-	-	3
CHE 322	Transport Phenomena	3	-	-	3
CHE 323	Process Equipments Design Drawing -I	3	-	-	3
	Department elective-3	3	-	-	3
	Department elective-4	3	-	-	3
	Open elective-2	3	-	-	3
CHE 324	Chemical Reaction Engg. Lab.	-	-	2	1
CHE 325	Modeling and Simulation Lab.	-	-	2	1
CHE 326	Minor Project & Seminar	-	4	2	3
					Total Credit-23

List of Departmental electives for 5th and 6th semester

CHE331 Bio Chemical Engineering	CHE332 Oil and Paint Technology
CHE333 Petroleum Refinery Engineering	CHE334 Fertilizer Technology
CHE335 Pharmaceutical Technology	CHE336 Corrosion Engineering
CHE337 Novel Separation Techniques	CHE338 Ceramic Technology
CHE339 Environment Pollution & pollution control	

List of Open Electives for 5th and 6th semester

CHE 351 Risk analysis and Hazard	CHE 352 Environmental Impact and Assessment and Environmental Audit
CHE 353 Petrochemical Technology	CHE 354 Polymer Technology
CHE 355 Food Technology	

B. Tech. Seventh Semester

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
CHE 411	Process Equip. Design & Drawing - II	3	-	-	3
	Department elective-5	3	-	-	3
	Department elective-6	3	-	-	3
	Open elective-3	3	-	-	3
	Open elective-4	3	-	-	3
CHE 412	Process Equip. Design & Drawing 2	-	6	-	3
CHE 413	Major project & Seminar	-	4	2	3
CHE 414	Educational Tour & Training	-	4	-	2
					Total Credit-20

B. Tech. Eighth Semester

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
CHE 421	Process Engg. & Costing	3	-	-	3
	Department elective-7	3	-	-	3
	Department elective-8	3	-	-	3
	Open elective-5	3	-	-	3
	Open elective-6	3	-	-	3
CHE 422	Major Project & Seminar	-	4	2	3
CHE 423	General Proficiency	-	4	-	2
					Total Credit-20

List of Departmental electives for 7th and 8th semester

CHE431 Multiphase Reactions	CHE432 Industrial Pollution Control
CHE433 Computer Aided Process Control & Design	CHE434 Process Piping Design
CHE435 Fluidization Engineering	CHE436 Fuels and Combustion
CHE437 Industrial Catalysis	CHE438 Multi Phase Flow
CHE439 Advanced Process Optimization	CHE440 Computational Fluid Dynamics
CHE441 Cleaner Technologies in Chemical Process Industries	CHE442 Sustainability and Green Chemistry
CHE 443 Nanotechnology in Catalysis	

List of Open electives for 7th and 8th semester

CHE451 Bio Energy Technology	CHE452 Solid Waste Management
CHE453 Optimization Techniques	CHE 454 Advanced Analytical Techniques
CHE 455 Industrial Safety & Hazard Management	

SYLLABUS

B. Tech. 3rd Semester

MTH 211-MATHEMATICS-3		
Syllabus		
Numerical Methods: Solution of algebraic and transcendental equations, Solution of linear Simultaneous Equations, Finite Differences, Interpolation and Extrapolation, Inverse Interpolation, Numerical Differentiation and Integration, Numerical solution of Ordinary & Partial Differential Equations.		
References		
1.	Introduction to Numerical Analysis	Hildebrand, F.B.
2.	Numerical Mathematical Analysis	Scarborough, J.B.
3.	Numerical Methods for Scientific and Engineering Computation	Jain, M.K. Iyengar, S.R.K., Jain, R.K.
4.	Numerical Methods	E. Balagurusamy,
5.	Numerical Methods for Scientific and Engineering	M.K.Jain

CH 212-INTRODUCTIONS TO CHEMICAL ENGINEERING		
Syllabus		
Historical overview of Chemical Engineering: Concepts of unit operations and unit processes, and recent developments, Fuels –Solid, liquid and Gaseous fuels, Chemical Kinetics Constant Rate constant order and molecularity of a reaction, zero, 1st, 2nd, and 3rd order reactions. Kinetics of opposing reactions, methods of determination of order of reactions. Reaction rate theories, Arrhenius Parameters, Catalysis (including enzyme catalysis), effect of catalysis on reaction rate, Introduction to Heat Transfer, Conduction, Convection, Radiation, Flow Arrangement in Heat Exchangers, Variation of Fluid Temperature in Heat Exchangers, Heat Transfer Equipment, Evaporation, Problems, Introduction to Mass Transfer, crystallization, distillation, evaporation absorption. **Process intensification, Biomass conversion, Ionic liquids, Environmental catalysis.**		
References		
1.	Introduction to Chemical Engineering	Ghoshal, S. K., Sanyal, S. K., Datta, S**.**
2.	Introduction to Chemical Engineering	Enderson & Belzil
3.	Elementary Principles of Chemical Processes	R. M. Felder and R.W. Rousseau
4.	Introduction to Chemical Engineering	Bezer & Banchoro

CH 213-CHEMICAL PROCESS CALCULATIONS		
Syllabus		
Stoichiometry: Introduction- Units and Dimensions - stoichiometric principles composition relations, density, specific gravity and basis of calculation. Ideal gases and vapor pressure: Behaviors of Ideal gases -kinetic theory of gases -application of ideal gas law- gaseous mixtures - volume changes with change in composition. Vapor pressure- effect of Temperature on vapor pressure. Humidity and solubility: Humidity - saturation - vaporization - condensation – wet and dry bulb temperature, dew point, adiabatic saturation temperature, Solubility and Crystallization-Dissolution -solubility of gases. Material balance: Material Balance - Processes involving with chemical reaction and without chemical reaction - Combustion of coal, fuel gases and sulphur - Recycling operations -bypassing streams - Degree of conversion -excess reactant - limiting reactant, Energy balance: Thermo chemistry - Hess's law of summation - heat of formation, reaction, combustion and mixing - mean specific heat -Theoretical flame Temperature.		
References		
1.	Chemical Process Principles	O.A.Hougen, K. M. Watson and R. A. Ragatz
2.	Basic Principles and Calculations in Chemical Engineering	D. Himmelblau
3.	Process Calculations	V.Venkataramani & N. Anantharaman
4.	Stochiometry	Bhutt & Vora

CH 214-FLUID MECHANICS		
Syllabus		
Properties of fluid, forces on fluid, stresses, fluid statics, Normal forces on fluid, pressure Measurement, forces on submerged, forces on submerged bodies, buoyancy, stability. Newtonian and Non-Newtonian fluid, Viscosity measurement, Equations of Continuity & Equation of Motion. Navier stokes equation, concept of Reynolds number and friction factor, friction factor for rough and smooth pipes, loss of head due to friction in pipes and fittings. Boundary layer theory, Bernoulli's equation, fluid machinery pumps, fans, blowers, and compressor. Flow of incompressible fluid in conduits and thin layers, flow past immersed bodies. Dimensional analysis, Buckingham π theorem, dimensionless numbers and their significances, similitude criteria. Pitot tube, Orifice meter, Venture meter, Rotameter, Weirs and Notches. Rayleigh's theorem, **Flow in microchannel.**		
References		
1.	Unit operations in chemical engg.	W. L. McCabe & I.C. Smith
2.	Chemical engineering – Vol. I & II	J.M. Coulson & J.F. Richardson
3.	Mechanics of fluid	B.S. Maney, zel (SI) Van Nostand & Reinhold
4.	Fluid mechanics for engg. and technology	I. Grannet

CH 215-CHEMICAL PROCESS TECHNOLOGY 1		
Syllabus		
Chlor-alkali Industries: Manufacture of Soda ash, Manufacture of caustic soda and chlorine - common salt. Sulphur and Sulphuric acid: Mining of sulphur and manufacture of sulphuric acid. Manufacture of hydrochloric acid. Cement: Types and Manufacture of Portland cement. Glass: Manufacture of glasses and special glasses. Ceramics: Refractories. Industrial Gases: Carbon dioxide, Nitrogen, Hydrogen, Oxygen and Acetylene - Manufacture of paints - Pigments. Nitrogen Fertilizers: Synthetic ammonia, nitric acid, Urea, Ammonium Chloride, CAN, Ammonium Sulphate - Phosphorous Fertilizers: Phosphate rock, phosphoric acid, Super phosphate and Triple Super phosphate, MAP, DAP. Potassium Fertilizers: Potassium chloride and Potassium sulphate.		
References		
1.	Shreeves Chemicals Process Industries	Austine G.T.
2.	Outlines of Chemical Technology.	Dryden C.E., M. Gopala Rao
3.	Outlines of Chemical Technology	R. Gopal Rao and M.Sittig,"Dryden's
4.	Text book of Chemical Technology	S.D. Shukla and G.N. Pandey

CH 216-CHEMICAL ENGINEERING THERMODYNAMICS		
Syllabus		
Fundamental Concepts and Definitions. PVT relationships. First law of Thermodynamics. Application of law to different processes in closed systems. Second Law of Thermodynamics. Physical meaning of entropy. T-S diagrams. Relations among thermodynamic properties. Thermodynamic functions in terms of measurable properties. Construction of thermodynamic charts. Third Law of Thermodynamics. Thermodynamics of flow processes. Application of first law to flow processes. Power and Refrigeration Cycles. Single Component Systems. Multicomponent Systems. Phase Equilibria. Thermodynamics of Electrolytes. Statistical Thermodynamics.		
References		
1.	Introduction to Engineering Thermodynamics	J. M. Smith and Van Ness.
2.	Introduction to Chemical Engineering Thermodynamics	Rao Y.V.C.
3.	Chemical Engineering Thermodynamics	B. F. Dodge
4.	Chemical Engg. Thermodynamics.	Rao Y.V.C.

CH 217-CHEMICAL TECHNOLOGY LABORATORY	
Experiments	
1.	To determine the viscosity of a viscous liquid by falling sphere method.
2.	Determination of saponification value of oil sample
3.	Application of pH meter to find acidity and alkalinity of a solution.
4.	To Study the Colorimeter.
5.	To Study the Ion-Analyzer.
6.	To study the hydrolysis of cane sugar solution in the presence of an acid by Fehling‘s solution method and find out the reaction constant.
7.	To Study the adsorption of benzoic acid on animal charcoal and room temperature and to determine the Freundlich constants kn.
8.	Determination of the strength of unknown hydrochloric acid by titrating it against caustic soda by conducto-metric method.
9.	To determine the % composition of a given binary liquid solution by polarimeter.
10.	To determine the solubility of a sparingly soluble salt in water by conductance measurement.
11.	Determination of pH of mixture of CH_3COOH and CH_3COONa and the dissociation constant of the acid.
12.	Preparation of laundry soap and to determine its yield.
13.	To study the Gas Chromatograph.

CH 218-FLUID MECHANICS LABORATORY	
Experiments	
1.	To determine the local velocity pressure with the help of pilot tube.
2.	To find out the terminal velocity of a spherical body in water.
3.	To determine the viscosity of a given viscous liquid by capillary tube flow method.
4.	To find the pressure drop in a packed bed.
5.	To study the flow behavior of a non-Newtonian fluid and to determine to flow constants.
6.	To determine to power-number-Reynolds number curve for an agitated vessel.
7.	To differentiate between laminar and turbulent flow using Reynolds experiment.
8.	To study the characteristics of an air compressor.
9.	To study the characteristics of a centrifugal pump.
10.	To study the flow of a fluid in a pipeline and to prepare the friction factor – Re plot.
11.	To determine velocity through orifice meter, venture meter.
12.	To prepare the calibration curve for an orifice meter and Rota meter.
13.	To calculate to prepare the calibration curve for venturimeter.

B. Tech. 4th Semester

CH 221-CHEMICAL REACTION ENGINEERING 1		
Syllabus		
Classification of reaction, Definition of reaction rate, Variables affecting the rate, concept of reaction equilibria, order of reaction and its determination, theoretical study of reaction rates, collision and activated complex theory, determination of kinetic parameters using batch and continuous reactors; Interpretation of data using differential and integral techniques, batch reactor data for constant volume and varying volume systems using integral and differential methods for, effect of temperature on rate constant. Classification of Reactors: Concept of ideality, design equation for single reaction systems using batch- and semi batch-reactors, CSTR, PFR and recycle reactor, auto catalytic reactions, reactor choice for single reaction, combination of reactors, Reactors with recycle, yield. Design for Multiple Reactions: Parallel and series reactions, analysis of product distribution and determination of reactor size for different types of ideal reactors, selectivity and yield factors, reactor choice for multiple reactions. Non-ideal Flow: Residence time distribution (RTD) theory, role of RTD in determining reactor behavior, age distribution (E) of fluid, experimental methods for finding E, relationship between E and F curve; Models for non ideal flow – single parameter and multi parameter models, **Chemical vapor deposition.**		
References		
1.	Chemical Reaction Engineering	O. Levenspiel
2.	Elements of Chemical Reaction Engineering	Fogler, H.S
3.	Chemical Engineering Kinetics	J.M. Smith.
4.	Chemical Process Principles Part – III – (Kinetics & Catalysis)	Houghen Watson & Ragatz

CH 222-MECHANICAL OPERATIONS

Syllabus

Properties and characterization of particulate solids, analysis and technical methods for size and surface area distribution of powder; Introduction to size reduction equipment, energy and power requirement in milling operations, computer simulation techniques for mill performance. Mechanical classifiers: Screening equipment, capacity and effectiveness. Filtration equipment, filtration media and filter aids, principles of filtration and clarification, estimation of filtration parameters for compressible and incompressible cakes and calculations, centrifugal filtration equipment and principles of operation. Separation based on the motion of particles through fluids, gravity settling processes, Sedimentation, Kynch theory of sedimentation, equipment for sedimentation thickness, rate of sedimentation and sedimentation zones in continuous thickeners, design of thickeners and clarifiers, principles of centrifugal sedimentation and characteristics and sedimenting centrifuges. Introduction to agitation and mixing of liquids, agitation equipment, Axial and radial flow impellers and flow patterns in agitated vessels ,prevention of swirling, power consumption in agitated vessels, Blending and mixing, dispersion operations, mixing of solids and pastes and types of mixers. Introduction to storage and conveying of solids, bins, hoppers and silos, flow out of bins, design consideration of bins, loading and unloading of solids. Bucket elevators, apron conveyors. Belt conveyors: types of belt conveyors, selection considerations.

References		
1.	Unit Operation of Chemical Engineering	McCabe and J.C.Smith
2.	Chemical Engineering", Vol.II	J.M.Coulson and J.F .Richardson
3.	Materials Handling Handbook	Raymond A. Kulweic
4.	Introduction to Chemical Engineering	Badger and Banchero

CH 223-HEAT TRANSFER 1		
Syllabus		
Heat Transfer: Introduction, Applications, Relation between heat transfer and thermodynamics, and transport properties. Conduction: Fourier's law of conduction, Thermal conductivity, Heat conduction equation in spherical, cylindrical, and rectangular co-ordinates. Composite wall structure. Thick wall tube. Sphere, insulation and optimum thickness of insulation, extended surfaces. Unsteady state condition. Convection: Natural & Forced convection. Heat transfer in laminar &turbulent flow insides tubes, Dimensional analysis, boundary layer, Colburn analogy. Heat transfer by external flows across cylinders, tube bank, spheres. Radiation: Basic equations, emissivity, absorption, black and gray body, Thermal radiation between two surfaces.		
References		
1.	Heat Transfer	Holman J.P.
2.	Fundamentals of Heat & Mass Transfer	Incropera F. P. and Dewitt D.P.
3.	Unit operations of chemical engineering	McCabe W.L., Smith J.C., Harriott. P
4.	Fundamentals of heat & mass transfer	Foust A.S., Wemzel L.A., Clump C.W., Maus L., and Anderson L.B

CH 224-CHEMICAL PROCESS TECHNOLOGY 2

Syllabus

Production of pulp, paper and rayon. Manufacture of sugar, starch and starch derivatives. Gasification of coal and chemicals from coal. Fermentation processes for the production of ethyl alcohol, citric acid and antibiotics. Refining of edible oils and fats, fatty acids. Soaps and detergents. Petroleum refining to produce naphtha, fuel hydrocarbons and lubricants. Processes for the production of petrochemical precursors: ethylene, propylene, butadiene, acetylene, synthetic gas, benzene, toluene and xylene. (Cracking, Catalytic reforming and separation of products) Plastics: Production of thermoplastic and thermosetting resins such as polyethylene, polypropylene, phenolic resins and epoxy resins; Polymers and their applications in engineering practice. Synthetic fibres: polyamides, polyesters and acrylics from monomers. Processes for the production of natural and synthetic rubbers.

References

1.	Shreve's Chemical Process Industries	G.T. Austins
2.	Dryden's Outline of Chemical Technology	R. Gopal Rao and M. Sittig
3.	Text Book of Chemical Technology	S. D. ShukIa and G.N. Pandey

CH 225-MASS TRANSFER 1		
Syllabus		
Diffusion: Diffusion in fluids: Molecular and eddy diffusion measurement and calculation of diffusivities. Ordinary diffusion in multicomponent gaseous mixtures. Diffusion in solids. Interphase mass transfer: Interphase Mass Transfer: Mass transfer coefficients. Theories of mass transfer. Analogies between momentum Heat and mass transfer. Mass Transfer Equipments: Batch and continuous Stage wise contactors- Differential contactors Absorption Theories of gas absorption - design of absorption towers. Absorption with chemical reactions. Adsorption: Types of adsorption, nature of adsorbents, Adsorption isotherms, Operation of adsorption columns. Batch and continuous operations, Design of adsorbers Drying: Equilibrium, Drying operation, Method of operation, the mechanisms of Batch drying, types of equipments.		
References		
1.	Mass Transfer Operations	R. E. Treybal
2.	Unit Operations in Chemical Engg.	W. L. Mccabe, J. C. Smith and P. Harriot
3.	Chemical Engineering. Vol - II,	M. Coulson and J. F. Richardson
4.	Transport Processes in Chemical Operations	C. J. Geankopolis

CH 226-INSTRUMENTATION AND PROCESS DYNAMICS CONTROL		
Syllabus		
First Order Systems: Linear open loop systems - First order and Linearised first order systems - Response to various disturbances. Higher Order Systems: First order in series - Higher order systems - Response to various disturbances. Block Diagram: Controls - Block Diagram - closed loop transfer function - Transient response - Simple alarm Modes of control and controller characteristics. Stability Analysis: Stability - Routh analysis - Frequency response - Control system design - Controller tuning. Special Controls: Cascade - feed forward and ratio control - dead time compensation - Internal Model Control - Control valves - Process identification. Instrumentation: Introduction: Temperature measurement, Pressure measurement, Flow measurement, Level measurements Viscosity measurement, Moisture and humidity measurements. Conductivity meter- pH meter, Analytical instruments – Liquid chromatography – HPLC – Mass spectroscopy - Computer aided analysis – process instruments and automatic analysis.		
References		
1.	Process Systems Analysis and Control	D. P. Coughnowr & Koppel
2.	Industrial Instrumentation	D.P. Eckman
3.	Principles and Practice of Automatic Process Control	C. A. Smith and A. B. Corripio
4.	Process Control	P. Harriot

CH 227-HEAT TRANSFER LABORATORY	
Experiments	
1.	To determine the thermal conductivity of metal rod.
2.	To determine the equivalent thermal conductivity of composite wall.
3.	To determine heat transfer coefficient in force convection.
4.	To determine heat transfer coefficient in Natural convection.
5.	To determine heat transfer coefficient with the help of Stefan Boltzmann Apparatus.
6.	To calculate emissivity of the test plate by emissivity measurement apparatus.
7.	To determine heat transfer coefficient in double pipe heat exchanger.
8.	To study the heat transfer characteristics of a shell and tube heat exchanger (heating/cooling) of water.
9.	To determine heat transfer coefficient in parallel and counter flow heat exchanger.
10.	To measure the rate of evaporation using an open pan evaporator.
11.	To measure the rate of condensation of pure water vapor and to determine the heat transfer coefficient.
12.	Demonstrate the film-wise drop-wise condensation and determination of the heat transfer coefficient.
13.	To study the single effect evaporator and find out the transfer coefficient.

CH 228-MECHANICAL OPERATIONS LABORATORY	
Experiments	
1.	Sphericity factor on friction losses.
2.	Agitated vessel
3.	Settling studies
4.	Drag studies
5.	Filtration (constant rate)
6.	Filtration (constant pressure)
7.	Screening
8.	Elutriation Clarification, cyclone separator
9.	Jaw crusher
10.	Ball mill
11.	Particle size distribution
12.	Storage of Solids
13.	Cyclone studies, multiple cyclone, mixer – screw type ribbon type

B. Tech. 5th Semester

CH 311-HEAT TRANSFER 2		
Syllabus		
Heat Exchanger: Classification, Design of shell- tube and double pipe heat exchanger, compact heat exchanger, plate heat exchanger, fouling , Extended surface for heat transfer, effectiveness and NTU of heat exchanger, Boiling: Boiling characteristics, Nucleate pool boiling and forced convection boiling, boiling mechanism, boiling curve & heat transfer correlations, Condensation: mechanism & types of condensation, Nusselt equation for film wise condensation on vertical surface and its extension to inclined and horizontal surfaces, condensation number, film condensation inside horizontal tubes, Evaporator: classification and its use in process industries, evaporator calculation in process industries, effect of boiling point elevation and hydrostatic head on evaporator performance, fouling in evaporator, estimation of surface area in multiple effect evaporator.		
References		
1.	Heat Transfer	Holman J.P
2.	Fundamentals of Heat & Mass Transfer	Incropera F.P and Dewitt D.P
3.	Unit operations of chemical engineering	McCabe W.L., Smith J.C., Harriott. P
4.	Fundamentals of heat & mass transfer	Foust A.S., Wemzel L.A., Clump C.W., Maus L., and Anderson L.B

CH 312-MASS TRANSFER 2		
Syllabus		
Distillation: Vapour Liquid Equilibrium Data, Methods of distillation-batch, continuous, flash, steam, vacuum. Continuous Fractionation: Stage - wise and continuous contact operations. Design calculations. Reboilers and condensers, Multicomponent Distillation: Azeotropic distillation and Extractive distillation, Multi component Flash and differential distillation. Continuous fractionation. Liquid - Liquid Extraction: Liquid - Liquid Equilibrium data. Batch and continuous operations. Design of extraction towers. Leaching: Solid - Liquid equilibria, Batch and continuous operations. Equipments, **Reactive distillation, Reactive extraction, Divided wall column and Hybrid adsorbers.**		
References		
1.	Mass Transfer Operations	R. E. Treybal
2.	Unit Operations in Chemical Engg.	W. L. McCabe, J. C. Smith and P. Harriot
3.	Chemical Engineering. Vol - II	M. Coulson and J. F. Richardson
4.	Transport Processes in Chemical Operations	C. J. Geankopolis

CH 313-CHEMICAL REACTION ENGINEERING 2

Syllabus

Heterogeneous processes: Catalysis and adsorption; Classification of catalysts, Preparation of catalysts. Promoters and Inhibitors, General mechanism of catalytic reactions surface area and pore size distribution Rate equation of fluid solid catalytic reactions, Hougen-Watson & law models, Procurement and analysis of kinetic data, kinetics of catalyst deactivation. External transport processes and their effects on heterogeneous reactions yield and selectivity Reaction and diffusion in porous catalysts, isothermal and nonisothermal effectiveness factors, Effect of intraphase transport on yield, selectivity and 30 poisoning, Global reaction rate. Design of catalytic reactors, Iso thermal & adiabatic fixed bed reactor staged adiabatic reactors, Non-Iso thermal non-adiabatic fixed bed reactors, Fluidized bed reactors, Slurry reactors, Trickle bed reactors. Models for fluid-solid non-catalytic reactions, controlling mechanisms, Diffusion through gas film controls. Diffusion through ash layer controls, Chemical reaction controls, fluidized bed reactors with and without elutriation. Gas-liquid reactions and liquid-liquid reaction, Rate equation based on film theory, Reaction design for instantaneous reactions ad slow reactions, Aerobic Fermentation, Application to Design Tools for Fast Reactions. **Environmental catalysis, monolithic reactors, Pressure and temperature swing reactors, Zeolites catalyst.**

References

1.	Chemical Reaction Engineering	O. Levenspiel
2.	Elements of Chemical Reaction Engineering	Fogler, H.S.
3.	Chemical Engineering Kinetics	J.M. Smith
4.	Chemical Theory – An Introduction to Re-Actors	K.G. Denbig & K.G. Turner
5.	Chemical Kinetics and Reactor Engineering	G. Cooper & G.V.J. Jefferys
6.	Fluidization Engineering	Daizō Kunii and Octave Levenspiel
7.	Chemical Reaction and Reactor Engineering	Y T Shah, M M Sharma

CH 314-MASS TRANSFER LABORATORY	
Experiments	
1.	To Study the flooding and loading of packed columns using different types of packing.
2.	To study different types of plates and packing.
3.	To prepare the vapor-liquid equilibrium and Boiling point diagram for a binary liquid mixture.
4.	Determination of relative volatility of a given system of acetic acid water.
5.	To verify Rayleigh equation for differential distillation of binary system.
6.	To carry out the steam distillation.
7.	To study batch distillation.
8.	To study continuous distillation.
9.	Studies on packed tower distillation unit.
10.	Studies on the sieve plate distillation unit.
11.	Studies on bubble cap distillation column.
12.	To study the absorption of a gas in a packed column and calculation of NTU and HTU.
13.	To perform batch adsorption and verify Freundlich law and Langmuir isotherm.

CH 315-PROCESS CONTROL LABORATORY	
Experiments	
1.	To study the open loop or manual control
2.	To study the proportional control.
3.	To study the Two mode (P+I) control.
4.	To study the Two mode (P+D) control
5.	To study the Three mode (PID) control
6.	To study the tuning of controller (Open loop method) using Zeigler-Nichols method.
7.	To study the stability of the system using the BODE plot.
8.	Characteristics of PID controller
9.	Two tank interacting liquid-level system
1.	To study the open loop or manual control
2.	To study the proportional control.
3.	To study the Two mode (P+I) control.
4.	To study the Two mode (P+D) control

B. Tech. 6th Semester

CH 321-PROCESS MODELING AND SIMULATION		
Syllabus		
The Role of Analysis: Chemical Engineering Problems, basic concepts analysis: The analysis process, A simple example of estimating an order. Source of the model equation: conservation equations, constitutive equation, control volumes, Dimensional analysis, System of units, Dimensional consistency in mathematical descriptions, Dimensional analysis and constitute relationships, Final observations. Non-reacting Liquid Systems: Introduction, equation of continuity, simple mass balance, application of the model equations, component mass balances. Model behavior: Steady state behavior, Unsteady state behavior, density assumption, Numerical integration methods of ordinary differential equation. Reacting liquid systems: Introduction, basic model equations for a Tank-Type reactor, The reaction rate, The batch reactor, pseudo First-order reactions, Reversible reactions, multiple reactions: consecutive reactions, parallel reactions, complex reactions, constant density assumption, order and stoichiometry. Treatment of Experimental Data: Introduction, criteria for Best Slope-I, Best Slope-II, Best straight line, Physical property correlations, Fitting a quadratic. Simulation examples of gravity fluid flow, heat and mass transfer, monte-carto simulation. Dynamic modeling of simple processes, sequential, simultaneous modular and equation oriented approaches, partitioning and tearing. Computer programming of various iterative convergence methods such as Newton-Raphson, False position, wegstein, Muller methods.		
References		
1.	Process Modelling, Simulation and control for Chemical Engineers	Luyben W.L
2.	Introduction to Chemical Engineering Analysis	Russell T.W.F.
3.	Process plant simulation	Babu, B. V.
4.	Chemical Process Modelling And Computer Simulation	Jana, A. K.

CH 322-TRANSPORT PHENOMENA		
Syllabus		
Similarity in momentum, heat and mass-transport – Newton's laws of viscosity, Fourier's laws of conduction and Fick's laws of diffusion, Flux-transport property relationships, Estimation of transport properties measurement and correlations, velocity distribution in Laminar flow of falling film. Flow over an inclined plane, a circular tube an annulus and between two parallel plates. Shell balance approach for developing equations of change for momentum, heat and mass transport, Equations of change and their approximations for transport in one dimension. Transport equations in turbulent flow and equations for turbulent fluxes. Velocity, temperature and concentration profile for laminar and turbulent flow conditions. Temperature and concentration profiles for conductive and convective transport in solids and fluids. Macroscopic momentum and heat balance equations, Kinetic energy calculation. Constant area and variable area flow problems. Flow through bends. Time determination for emptying of vessels.		
References		
1.	Transport Phenomena	Bird R.B., Stewart W.E. and Lightfoot EW
2.	Transport Phenomena A Unified Approach	Brodkey R S and Hershey
3.	Introduction to Transport Phenomena	Thomson, W.J.
4.	Transport Phenomena Fundamentals	Plawsky J.L.

CH 323-PROCESS EQUIPMENT DESIGN 1		
Syllabus		
Mechanics of materials: Stress, Strain and their relationship. Elastic and plastic deformation, Bending moment, Torsion, creep and fatigue, theories of column; Theories of failures. General design considerations, Design loads, liquid storage tank codes, design of shell, bottom plates, self-supported, and column supported roofs, wind girder, nozzles and other accessories. Unfired pressure vessel, Design of shells under internal and external pressures; Selection and design of flat plate, torispherical, ellipsoidal, and conical closures, compensations of openings. High pressure Vessels designing. Tall vertical & horizontal vessels, Vessel supports; Design of skirt, lug, and saddle supports. Bolted Flanges, Gaskets, Design of non-standard flanges, specifications of standard flanges. Fabrication of equipment; welding, non-destructive tests of welded joints, inspection and testing, vessel lining.		
References		
1.	Process Equipment Design	Joshi, M.V
2.	Process Equipment Design	Brownell, N.E. and Young, H.E.
3.	Introduction of Chemical Equipment Design	Bhattacharya, B.C.
4.	I.S. : 2825-1969- Code for Unfired Pressure Vessels.	

CH 324-CHEMICAL REACTION ENGG. LABORATORY	
Experiments	
1.	To determine velocity rate constant of hydrolysis of ethyl acetate by sodium hydroxide.
2.	To study the rate constant of hydrolysis of an ester-catalyzed by acid.
3.	To study a consecutive reaction system (hydraulic model).
4.	To study a parallel reaction system (hydraulic model).
5.	To study a homogeneous reaction in a semi-batch reactor under isothermal conditions.
6.	Study of non- catalytic homogeneous saponification reaction in CSTR.
7.	To study a non-catalytic homogeneous reaction in a plug flow reactor.
8.	To study the residence time distribution behavior of a back mix reactor.
9.	To study the RTD behavior of a tubular reactor.
10.	To study the RTD behavior of a packed bed reactor.

CH 325-MODELING AND SIMULATION LABORATORY	
Experiments	
1.	Experiments related modelling and simulation with various software like g-Proms, Aspen Plus, etc.

CH 326-MINOR PROJECT AND SEMINAR	
Syllabus	
The Project work will involve experimental work, modeling and simulation.	

Department Electives for 5th and 6th semester

CH 331-BIO CHEMICAL ENGINEERING		
Syllabus		
Introduction To Bioscience: Types of Microorganisms: Structure and function of microbial cells. Fundamentals of microbial growth , batch and continuous culture. Isolation and purification of Enzymes from cells. Assay of Enzymes. Functioning of cells and Fundamental Molecular Biology: Metabolism and bio-energetics, Photosynthesis, carbon metabolism, EMP pathway, tricarbocyclic cycle and electron transport chain, aerobic and anaerobic metabolic pathways. Synthesis and regulation of bimolecular, fundamentals of microbial genetics, role of RNA and DNA. Enzyme Technology and Kinetics: Applications of enzymes in industry and medicine. Immobilization of enzymes, Kinetics of enzyme catalytic reactions involving isolated enzymes, Reversible inhibition. Reactions Catalysed By Enzymes, Reactors, Analysis: Reactor Design and Analysis for soluble enzyme systems. Cofactor regeneration, Membrane reactor . Effect of mass transfer in immobilised enzyme particle systems. Reactors for immobilised enzyme systems. Bio Reactors, Effect of Transport Processes: Introduction to Bioreactor design: Continuously Stirred aerated tank bioreactors. Mixing power correlation .Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption. Multiphase bioreactors and their applications. Downstream processing and product recovery in bioprocesses.		
References		
1.	Biochemical Engineering Fundamentals	J. E. Bailey and D. F. Ollis
2.	Biotechnology	Trevan, Boffey, Goulding and Stanbury
3.	Bio Process Engineering: Basic concepts	M. L. Shuler and F. Kargi
4.	Biochemical Engineering – Principles and Concepts	Inamdar S.T.A

CH 332-BIO CHEMICAL ENGINEERING

Syllabus

Chemistry of Oils, Fats and Fatty Acids : i. Glycerides, ii. Fatty Acids, iii. Non Glyceride Components of Oils & Fats iv. Chemical Reactions of Fats and Fatty Acids, Technology and Production of Oils & Fats, Coconut, cotton seed, peanut, palm, sunflower, sesame, softlower, rice fran, rapeseed and mustard seed, linseed, soyabean, tung, casteroil lard and tallow. Minor Oils: Neem Oil and Salfat. a) Mechanical expression of oils, b) Solvent extraction of oilseed and oil bearing material, c) Fat splitting. Refining and Bleaching : Degumming, alkali refining (batch refining), Miscella refining, refining loses – Bleaching by absorption – continuous bleaching ;Hydrogenation : Mechanism – selectivity as applied to the reaction and catalysis, Hydrogenation in practice (Batch & continuous) preparation of Raney Nickel catalyst, Soap manufacture : Raw materials required, selection of raw materials – full boiled process, Nutritional functions of fats, Testing and important analysis of oils and fats in determining the quality and quantity of oils / fats and oilseed; such as moisture, oil content, F.F.A., protein content, color of the raw / refined oil.

References

1.	Bailey‘s Industrial Oil and Fat Products	Feireidoon Shahidi
2.	Oils & fats Technology	E. Bernardini
3.	Outlines of Paint Technology	W.M.Morgan
4.	Basics of Paint Technology, Part I & II,	V.C.Malshe & Meenal Sikchi.

CH 333-PETROLEUM REFINERY ENGINEERING		
Syllabus		
Primary Processing of Crude Oil, Classification of crude oil, Atmospheric distillation, Vacuum distillation of residue-Products and distillation practice, Secondary Processing of Crude Oil: FCCU, Hydro cracking, Visbreaking, Thermal cracking, Coking, Reforming, Alkylation, Polymerisation and Isomerisation process. Treatment Techniques: Treatment techniques for removal of objectionable gases, Odours, to improve performance, Storage stability, Extraction of aromatics, Olefins and recovery operations from petroleum products.		
References		
1.	Petroleum Refinery Engineering	W.L. Nelson
2.	Modern Petroleum Refining Processes.	B. K. Bhaskara Rao
3.	Modern Petroleum Technology	G. D. Hobson and W. Pohl .
4.	Hand book of Petroleum Refining Processes	R. A. Meyers.

CH 334-FERTILIZER TECHNOLOGY

Syllabus

Introduction: Plant nutrients, different types of fertilizers and their production in India. Nitrogenous Fertilizers: Different feed stocks. Synthesis gas production by steam-naptha reforming and gas purefication. Ammonia synthesis. Urea manufacturing processes. Manufacture of sulphuric acid and ammonium sulphate. Nitric acid and ammonium nitrate manufacture. Phosphatic Fertilizers: Availability and grinding of rock phosphate, manufacturing processes for single and triple super- phosphate and phosphoric acid. Mixed Fertilizers: Availability and manufacture of muriate of potash. Mixed Fertilizers: Mono and di-ammonium phosphate, urea ammonium phosphates, NPK complex fertilizers, granulation techniques. Engineering Problems: Fertilizers storage and handling. Corrosion problems in fertilizers industries. Fertilizer plant effluent treatment and disposal.

References

1.	Chemistry and Technology of Fertilizers	Slack A.V
2.	Chemical Processes Industries	Austin G.T., ―Shreve‘s
3.	Phosphoric Acid, Phosphates and Phosphatic Ferilizers	Waggaman W.H.,
4.	Dryden‘s Outlines of Chemical Technology	Rao M.G. and Sittig M

CH 335-PHARMACEUTICAL TECHNOLOGY

Syllabus

Practice of the following unit operation in pharmaceutical industries: Heat transfer, evaporation, distillation, dry, mixing size reduction, crystallization, filtration, size separation, conveying, humidification, air conditioning and refrigeration, Formulation, development of sterile dosage forms. Production facilities, environmental control and personnel in the production of sterile dosage form, compounding, processing, filtration, sealing, sterilization, packing and labeling of sterile dosage forms. Quality control tests like sterility, pyrogen, clarify, safety and leakage testing, types of tablets. Manufacturing of tablets by wet granulation, dry granulation and direct compression. Tablet processing problems and defects, tablet standardization: hardness, friability, weights variation, disintegration, dissolution and content uniformity tests, Capsules: Hard gelatin capsule, capsule size, formulation and preparation of filled hard gelatin capsules, soft gelatin capsule, soft gel – manufacturing procedures. Quality control of capsule, Cosmetics and Toiletries: Introduction, factors to be considered in the formulation of facial cosmetics, dentifrice‘s, deodorant, antiperspirants, shampoos, hairdressing and hair removers, Pharmaceutical packing: Packing components, types of packing containers and closures, materials used for and their pharmaceutical specification, method of evaluation, stability aspects of packaging materials.

References

1.	The Theory and Practice of Industrial Pharmacy	Leon Lachman, H.A. Lieberman, J.L.K
2.	Unit Process in Pharmacy.	Ganderton
3.	Chemical Engineering in Medicine And Bodogy	D. Hershey
4.	Chemical Engineering in Medicine	Chern. Engg. Prpgrer Syrnp Series

CH 336-CORROSION ENGINEERING

Syllabus

Basic concepts: Definition and importance; Electrochemical nature and forms of corrosion; Corrosion rate and its determination. Electrochemical thermodynamics and kinetics: Electrode potentials; Potential-pH (Pourbiax) diagrams; Reference electrodes and experimental measurements; Faraday‘s laws; Electrochemical polarization; Mixed potential theory; Experimental polarization curves; Instrumentation and experimental procedure. Galvanic and concentration cell corrosion: Basic concepts; Experimental measurements, and determination of rates of galvanic corrosion; Concentration cells, Corrosion measurement through polarization techniques: Tafel extrapolation plots; Polarization resistance method; Instrumental methods and Errors in measurement of polarization resistance; Commercial corrosion probes; Other methods of determining polarization curves. Passivity: Basic concepts of passivity; Properties of passive films; Experimental measurement; Applications of Potentiostatic Anodic Polarization; Anodic protection. Pitting and crevice corrosion: Basic concepts; Mechanisms of pitting and crevice corrosion; Secondary forms of crevice corrosion; Localized pitting, Metallurgical features and corrosion: Inter-granular corrosion; Weldment corrosion; De-alloying and dezincification. Environmental induced cracking: Stress corrosion cracking; Corrosion fatigue cracking; Hydrogen induced cracking; Some case studies; Methods of prevention and testing; Erosion, fretting and Wear, Environmental factors and corrosion: Corrosion in water and Aaqueous Ssolutions; Corrosion in sulphur bearing solutions; Microbiologically induced corrosion; Corrosion in soil; Corrosion of concrete; Corrosion in acidic and alkaline process streams. Atmospheric and elevated temperature corrosion: Atmospheric corrosion and its prevention; Oxidation at elevated temperatures; Alloying; Oxidising environments, Prevention and control of corrosion: Cathodic protection; Coatings and inhibitors; Material selection and design.

References

1.	An Introduction to Corrosion and Corrosion Inhibition	S.N. Banerjee,
2.	An Introduction to Metallic Corrosion and its Prevention	Raj Narayan

CH 337-NOVEL SEPARATION TECHNIQUES

Syllabus

Limitations of common separation techniques – sedimentation, screening, filtration, evaporation, distillation, absorption, liquid-liquid and solid-liquid extraction. Principles of membrane separation process classification, characterization and preparation of membrane, Analysis and modelling of membrane separation, Membrane modules and application. Reverse Osmosis and ultra filtration, membrane characteristics and applications, lon-selective membranes and their application in electrolysis. Per vaporization and gas separation using membranes, Liquid membrane, Industrial applications. Liquid membrane separation, critical extraction, pressure swing adsorption and freeze drying, pervaporation and permeation, nano-separation. Foam and bubble separation, principle, classification, foam and surfactants, Separation techniques, Column Separations. Multi-component separation, Zone melting and Zone refining, electrophoresis, desalting by freezing, centrifugation. Parametric pumping, thermal parametric pumping, batch, continuous pumping, pH-parametric pumping, heatless parametric pumping.

References

1.	Separation Process Principles	Seader J. D. and Henley E. J .
2.	Textbook of Separation Processes	Suresh S, Keshav A
3.	Separation Processes	King C. J.
4.	Water Purification By Ion-exchange	Arden T.V.

CH 338-CERAMIC TECHNOLOGY

Syllabus

Introduction Definition, classification and scope of ceramics, Ceramics verses metals and organics, Historical perspective on the development of ceramics and ceramic industries. Elementary ideas about the raw materials used in pottery, Heavy clayweres, Refractoriers, Glass, Cement, Industries, Raw materials :clays and their classification, Quartz, Polymorphism of quartz, Feldspar and its classification, Talc, Steatite and Mica. Conventional ceramics – Classification, Elementary ideas about whitewares, Cement, Glass, Refractories, Glaze and Enamels their manufacture and applications. Newer ceramics classification and scope of Cermets, Abrasives, Electro ceramics, Bio-ceramics, Space ceramics, Automotive ceramics, Superconducting ceramics, Elementary ideas of their preparation and their applications. Fabrication methods: Classification and scope of various fabrication methods. Brief study of dry semi dry pressing extrusion, Jiggering and jollying, Slip casting HP & HIP, Drying of ceramics, Biscuit firing and glost firing, fast firing technology, action of heat on triaxial body, Elementary ideas of various furnaces used is ceramic industries. Applications of ceramic products in everyday life, in different fields such as Metallurgy, Civil Engineering, Electrical, Electronics, Automobiles, Aerospace and Energy Engineering.

References

1.	Industrial Ceramics	F. Singer and Singer S.S.
2.	Elements of Ceramics	F.H. Norton
3.	Introduction to Ceramics	W.D. Kingery
4.	Ceramic Technology and Processing	Alan G. King, William Andrew

CH 339-ENVIRONMENTAL PROTECTION AND POLLUTION CONTROL		
Syllabus		
Interaction of man and environment, overall picture of environmental pollution, environmental air and water quality criteria, standards and acts, effects of pollution. Air Pollution: dispersion of pollutant in the atmosphere, meteorological factors of air, stability and inversion of atmosphere, control of air pollution, air pollution control equipments. Methods of measuring and sampling of gaseous and particulate pollutants in ambient air and industrial waste gases. Water Pollution: Sources, types of pollutants in liquid wastes of chemical industries, methods for the treatment of liquid wastes to control pollution, selection of pollution control equipment, Methods of sampling of waste water. Odour and its control. Solid Waste Disposal: Characterization of solid wastes, problems of collection and handling, various processing techniques used in solid waste management, solid waste as resource material, Noise pollution: noise control criteria, noise exposure index, Control.		
References		
1.	Environment Pollution Control and Environmental Engg.	C. S .Rao
2.	Environmental Engineering	Peavy and Row
3.	Air Pollution – Engg. Control of Air Pollution Vol IV	A.C. Stern
4.	Environmental Chemistry	J. O .M. Bockris

Open Electives for 5th and 6th semester

CH 351 RISK ANALYSIS AND HAZARD		
Syllabus		
Interaction of man and environment, overall picture of environmental pollution, environmental air and water quality criteria, standards and acts, effects of pollution. Air Pollution: dispersion of pollutant in the atmosphere, meteorological factors of air, stability and inversion of atmosphere, control of air pollution, air pollution control equipments. Methods of measuring and sampling of gaseous and particulate pollutants in ambient air and industrial waste gases. Water Pollution: Sources, types of pollutants in liquid wastes of chemical industries, methods for the treatment of liquid wastes to control pollution, selection of pollution control equipment, Methods of sampling of waste water. Odour and its control. Solid Waste Disposal: Characterization of solid wastes, problems of collection and handling, various processing techniques used in solid waste management, solid waste as resource material, Noise pollution: noise control criteria, noise exposure index, Control.		
References		
1.	Environment Pollution Control and Environmental Engg.	C. S .Rao
2.	Environmental Engineering	Peavy and Row
3.	Air Pollution – Engg. Control of Air Pollution Vol IV	A.C. Stern
4.	Environmental Chemistry	J. O .M. Bockris

CH 352 - ENVIRONMENTAL IMPACT AND ASSESSMENT AND ENVIRONMENTAL AUDIT

Syllabus

Environmental acts - Their need, historical background, national and international acts; Genesis of environmental acts - General procedure followed in changing a bill into an act; implementation of an act using judiciary, executive and legislative powers and their limitations. Main national acts - Environmental protection agency, air act, water act, water and sewerage Board's Factory act, Municipal acts, acts dealing with hazardous and infections wastes. Environmental impact assessment, environmental audit, general procedures followed in preparing reports incorporating EIA ES and EA. Case laws - Principles of case laws, statutory interpretations, site selection, land use planning, town planning act. ISO: 14000 - its need, procedure to be followed to obtain ISO:14000 certification, implications of ISO. Environmental management plan, environment management cells, rehabilitation and remediation, NGOs and their role. Environmental and occupational health, industrial hygiene, risk assessment disaster management plan, epidemiology. Assessment of existing effluent treatment plants, trouble shooting, remedial measures.

References

1.	Handbook of Environmental Impact Assessment, Volume 1 and 2, Blackwell Publishers, UK 2005	Petts, J.
2.	Introduction to Environmental Impact Assessment, London. 2006	Glasson, J. Therivel, R. and Chadwick, A. Routledge
3.	The Theory and the Practice of Environmental Impact Assessment	S. A. Abbasi and N. Ramesh
4.	Complete Guide to ISO 14000, 1996	R. B. Clements. Simon & Schuster,

CH 353 - PETROCHEMICAL TECHNOLOGY		
Syllabus		
Chemicals from methane and synthetic gas: Ammonia, Methanol and Hydrogen Cyanide, Chemicals from olefins: Ethylene derivatives, Propylene derivatives and Butylenes derivatives, Chemical from Aromatics**,** synthetic fibres, Plastics and rubber.		
References		
1.	Petrochemical Process Technology	Mall, I D
2.	Modern Petroleum Refining Processes	Bhaskar Rao
3.	Chemistry & Technology of Petroleum	Speight J.,
4.	Handbook of Petroleum Refining Processing	Robert Mayer,

CH 354 - POLYMER TECHNOLOGY

Syllabus

Polymerization Chemistry: Chain, Step and miscellaneous polymerization reaction and polymerization technique. Polymerization kinetics: Free radical, cationic and polymerization, poly condensation and polymerization. Polymerization Processes : Bulk Solution, emulsion and suspension polymerization, thermoplastic composites, fiber reinforcement fillers, surface treatment reinforced thermoset composites resins, fillers, additives. Polymer reactions: Hydrolysis, acidolysis, hydrogenation, addition and substitution reactions, reactions of various specific groups, cyclyzation and cross linking reactions, reactions leading to graft and block copolymer. Manufacturing processes of important polymer: Plastics – Polyethylene polyvinylchloride & copolymer, polystyrene. Phenol – formaldehyde, epoxides, urethane, teflon, elastomers, robbers, polymeric oils – silicon fibers – cellulosic (Rayon), polyamides (6:6 Nylon), Polyesters (Dacron). Acrylic olefin. Composite materials – Ceramic and other fiber reinforced plastics, polymer degradation – Thermal, Mechanical, Ultrasonic, Photo, High energy radiation, Ecology and environmental aspects of polymer industries. Rheological Sciences, Uncoelastic models – Maxwell.

References

1.	Principles of Polymer Systems	Rodringuez
2.	Textbook of polymer science	Billmayer Jr. Fred W.
3.	Polymer Science & Engineering	David J. Williams
4.	Polymer Processing	Mc. Keley, J.H.

CH 355 - FOOD TECHNOLOGY

Syllabus

Introduction: Current status of the Indian a) agriculture b) Food Industry c) Food processing industry. Basic Food Biochemistry and Microbiology: Food Constituents, Water activity enzymes, Ambient Temperature Processing: Raw material preparation, Size reduction of solid fibrous foods and in liquid foods, Emulsification and Homogenization, Theory and equipment, Mixing and Forming, Extraction and expression, Membrane concentration Fermentation: Theory, Types, Equipment Effect on foods. Heat Processing using Heat or water: Theory, Equipment, Effect on foods, blanching, extrusion, pasteurization, Heat Sterilization, In-container Ultra high temperature (UHT)/aseptic processes. Heat Processing using Hot air: Theory, Equipment, Effect on foods, Dehydration, Baking and Roasting.; Heat Processing using Hot oils: Theory, Equipment, Effect on foods Frying; Heat Processing by direct & radiated energy: Theory, Equipment, Effect on foods Dielectric heating microwave. Processing by removal of heat, Food Preservation & Storage Food contamination Modified Atmosphere Storage (MAS) Hurdle Technology; Post Processing Applications Packaging

References

1.	Preservation of Fruits and Vegetables.	Vijaya khader,
2.	Food Processing and Preservation	Vijaya khader,
3.	(a) Food science, (2nd edition)., (b) Food science & Nutrition.	Srilakshmi. B
4.	Essentials of Food and Nutrition , Vol. I & II.	Swaminathan. M.

B. Tech. 7th Semester

CH 411-PROCESS EQUIPMENTS DESIGN &DRAWING 2		
Syllabus		
Scale up criteria and scale up of process equipment. Process design calculations for heat exchange equipment shell and tube heat exchangers general description, heat transfer coefficients and pressure drop by Kerm's Bells methods rating on existing unit. Design of a new system having one or more units in series single effect evaporation, multiple effect evaporators with boiling point elevation. Process design calculations for mass exchange equipment plate and packed column for distillation and adsorption including column diameter and height. Detailed process and mechanical design, flash drum, Kettle reboiler, condenser, cooling tower & rotary drier.		
References		
1.	Chemical Engineering Vol-1	Coulson J.M. Richardson J.F.
2.	Chemical Engineering Handbook	Perry, Robert H., Green Don W
3.	Applied Process Design in Chemical Petrochemical Plants	E.E. Ludwig
4.	Design of Equilibrium Stages	B.D. Smith

CH 412-PROCESS EQUIPMENTS DESIGN & DRAWING TUTORIAL
Syllabus
Prepare drawing sheet & solve design problems.

CH 413-MAJOR PROJECT AND SEMINAR
Syllabus
The student would be allotted a project in the beginning of the VII semester itself. The project will be based on the industry where he/she has undergone in plant training in industry during summer vacations. He/ She would be expected to submit a detailed plant design report later in the (VIII) semester for the project course (CH-428). In this semester he/she will be assessed for the work that he/she does during the seventh semester under the supervision of a faculty of the department.

CH 414-EDUCATIONAL TOUR AND TRAINING
Syllabus
The students are required to undergo in plant training in some chemical industry for a six weeks period during their summer vacations following VI semester. He/ She is required to collect information‘s relating to process details and other information‘s related to process material, utilities and their properties to prepare a report to be submitted to the department. The student would be assessed in the VII semester through a Viva-voce to be conducted by the teacher in charge training of Chemical Engineering Department.

B. Tech. 8th Semester

CH 421-PROCESS ENGINEERING AND COSTING		
Syllabus		
System and subsystem in process engineering, System analysis, Economic degree of freedom various algorithms, Synthesis of processes, Flow sheeting, Mathematical representation of steady state flow sheet. Equal time value of money, equivalence comparisons, discrete interest and continuous interest, development of its formula, comparison of alternative investment based on capitalized cost. Income, depreciation, taxes, net profit, rate of return, venture profit, payout time break-even point. Time value of money, net present value and venture worth. Capital cost and manufacturing cost estimation methods, Economic analysis and evaluation. Sensitivity & risk analysis, simplifying scale-up cost estimation. Analysis of R&D investment, Technological forecasting for the process industries, Interaction between design and cost equation for optimal design of equipments, Inflation. Energy conservation and environmental control, Experiments.		
References		
1.	Plant Design and Economics for Chemical Engineers	Peters, M.S. and Timmerhaus, K.D
2.	Process Engineering Economics	Schwery H.E.

CH 422-MAJOR PROJECT AND SEMINAR
Syllabus
The student would be allotted a project in the beginning of the VII semester itself. The project will be based on the industry where he/she has undergone in plant training in industry during summer vacations. He/ She would be expected to submit a detailed plant design report later in this semester for the project course). In this semester he/she will be assessed for the work that he/she does during the seventh and eighth semester under the supervision of a faculty of the department.

CH 423-GENERAL PROFICIENCY
Syllabus
General proficiency is meant for developing participation in core/ curricular activities in individual students like sports, NCC, student activities, etc. Students have to undergo a short or long tour and visit the industry of their interest, prepare a write up and present with suitable demonstration. Evaluation will be based on relevant topic student has studied, communication skill and reporting/documenting procedure.

Department Electives for 7th and 8th Semester

CH 431-MULTIPHASE REACTOR DESIGN		
Syllabus		
Introduction: reaction kinetics for multiphase reactions, brief idea of multiphase reactors and design, catalyst deactivation and regeneration, Review of reaction kinetics and reactor design. Industrial reactors: Trickle bed, Bubble column, segmented bed, fluidized bed and slurry reactor, models for analysis gas-liquid, gas-liquid-solid reactions, RTD and macro mixing models, brief description of laboratory reactors, Intrinsic kinetics: catalysis, Langmuir-Hinshelwood models, catalyst pellets, effectiveness factors		
References		
1.	Gas Liquid Reactor Design	Y. T. Shaha
2.	Chemical Reactor Design and Operation	Westerterp K. R., Van Swaaji and Beevackers
3.	Multiphase Chemical Reactor – Theory, Design, Scale-up	Gianetta and Silverton
4.	Heterogeneous Reactions Vol-I and II	Sharma and Doraiswam

CH 432-INDUSTRIAL POLLUTION CONTROL

Syllabus

Stream sanitation. Different equations of self-purification, River standards, Effluent standards, Minimal national standards (MINAS). Sources and effects of various pollutants, Disposal of industrial wastes-on land, in creeks and the sea, in inland streams, into impoundments. Importance of planning location of industries and industrial estates, Common effluent treatment plants, their economics and management. Detailed considerations of wastes from industries such as textile (Cotton, wool, rayon, synthetics), sugar, pulp and paper, distilleries, oil refineries, petrochemicals, pharmaceuticals, dairy, food processing, soaps and detergents, mining, iron and steel, pickling, plating, galvanizing, tanning slaughterhouse, fertilizers, pesticides, dyes and dye intermediates, radioactive wastes. Recovery of hyproducts, reuse of wastewaters with or without treatment.

References

1.	Industrial Pollution Control: Issues and Techniques	Nancy J. Sell
2.	The Complete Guide on Industrial Pollution Control	H. Panda
3.	Pollution Control In Process Industries	S.P. Mahajan
4.	Industrial pollution control handbook, Volume 1	Herbert F. Lund

CH 433-COMPUTER AIDED PROCESS CONTROL & DESIGN		
Syllabus		
programming, Application software: data logging, filtering, digital control: Z-transforms, discrete time dynamic systems, adaptive control, introduction to MIMO control systems. Laboratory exercises.		
References		
1.	Chemical Engineers Handbook	Green DW and Malony, Perrys

CH 434-PROCESS PIPING DESIGN		
Syllabus		
Classification of pipes and tubes, IS & BS codes for pipes used in chemical process industries and utilities. Pipes for Newtonian and non-Newtonian fluids, sudden expansion and contraction effects, Pipe surface roughness effects, pipe bends, Shearing characteristics. Pressure drop for flow Newtonian and non-Newtonian fluids through pipes. Resistance to flow and pressure drop. Effect of Reynolds and apparent Reynolds number. Pipes of circular and non-circular cross section – velocity distribution, average velocity and volumetric rate of flow. Flow through curved pipes (Variable cross sections). Effect of pipe-fittings on pressure losses.Non-Newtonian fluid flow through process pipes, Shear stress, Shear rates behavior, apparent viscosity and its shear dependence, Power law index, Yield Stress in fluids, Time dependant behavior, Thixotropic and rheopetic behavior, mechanical analogues, velocity pressure relationships for fluids, line. Pipe line design and power losses in compressible fluid flow, Multiphase flow, gas-liquid, solid-fluid, flows in vertical and horizontal pipelines, Lockhart Martinelli relations, Flow pattern regimes.		
References		
1.	Chemical Engineering – Vol I ,	Coulson JM and Richardson J.F.
2.	The flow of Complex Mixtures In Pipe	Govier, G.W. and Aziz K
3.	Process Piping Design, , Volume 2,	Rip Weaver

CH 435-FLUIDIZATION ENGG

Syllabus

Introduction: The phenomenon of fluidization; liquid like behaviour of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds. Industrial applications of fluidized beds: Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization. Fluidization and mapping of regimes: Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems; Voidage diagram; Mapping of regimes of fluidization. Bubbles in dense bed: Single rising bubbles; Davidson model for gas flow at bubbles; Evaluation of models for gas flow at bubbles, Bubbling Fluidized beds: Experimental findings; Estimation of bed porosities; Physical models: simple two phase model; K-L model.High velocity Fluidization: Turbulent fluidized bed; Fast fluidization pressure drop in turbulent and fast fluidization. Solids Movement, Mixing, Segregation and staging: Vertical movement of solids; Horizontal movement of solids; Staging of fluidized beds.Gas Dispersion and Gas interchange in Bubbling Beds: Dispersion of gas in beds; Gas interchange between bubble and emulsion; Estimation of gas interchange coefficients. Particle to Gas Mass Transfer: Experimental interpolation of mass transfer coefficients; Heat transfer; Experimental heat transfer from the bubbling bed model.

References

1.	Fluidization Engineering	Kunil, Diazo and Octave Levenspiel
2.	Fluidization	Max Leva
3.	Fluidization Engineering	O. Levenspiel and D. Kunii
4.	Gas-Liquid-Solid Fluidization Engineering	Liang-Shih Fan

CH 436-FUELS AND COMBUSTION

Syllabus

Energy crisis – Present position in India and the world. Origin and Chemical composition, Classification of fuels, Storage and general use of Industrial fuels, Comparison of various types of fuels, Calorific value of a fuel, LCV and HCV, meaning and definition. Determination of HCV and LCV for solid fuels, Bomb calorimeter, Gas calorimeter. Solid fuels: Wood and charcoal, Coals and their characteristics, combustion and availability of coals in India, Coal washing and blending. High and low temperature coal carbonization. Manufacture of coke and recovery of by products. Pulverized coal and its conduction. Liquid fuels: Petroleum, its origin and occurrence. Distillation, products of distillation, their characteristics and uses. Combustion, Chemistry of combustion, combustion calculations pertaining to different fuels and furnaces used in ceramic industries. Theoretical air / fuel ratio, Excess air, Flue gas analysis calculations. Gaseous Fuels: Classification, merits and demerits of the gaseous fuels. N gas, LPG, coal gas, Oil gas, Produces gas, Water gas, Semi-water gas etc., their chemical composition, Manufacture and uses in detail. Nuclear fuels, their scope and classification, Types of nuclear fuels, method of generation of nuclear energy from the sources, etc., Nuclear reactor – classification and types Accessories and their study in detail. Nuclear fuel roads, Moderators, Heavy water etc., Alternate sources of energy, Renewable energy, Hydroelectric, Solar, Geothermal, Tidal, Wind and other types, Bio-gas, Bio-fuels, etc

References

1.	Fuels Technology	Himus
2.	Combustion Engineering and Fuels Technology	Shaha
3.	Principles of Energy conversion	Gulp Jr. A.W.
4.	Energy resources and supply	McMullan, Morgan Murray

CH 437-INDUSTRIAL CATALYSIS

Syllabus

Review of Heterogeneous Catalysis: Role of catalyst components and other constituents, characterization of catalyst and its support. Transport Processes: Analysis of external transport processes in heterogeneous reactions in fixed bed, fluidized bed and slurry reactors. Intrapellet mass transfer, heat transfer, mass transfer with chemical reaction and simultaneous mass and heat transfer with chemical reaction. Catalyst Selectivity: Effect of intrapellet diffusion on selectivity in complex reactions, effect of external mass transfer on selectivity. Catalyst Deactivation: Modes of deactivation – poisoning, fouling and sintering. Determination of deactivation routes, combined effect of deactivation and diffusion on reaction rates, effect of deactivation on selectivity. Reactor Design: Design calculation for ideal catalytic reactor operating at isothermal, adiabatic and non-adiabatic conditions. Deviations from ideal reactor performance. Design of industrial fixed-bed, fluidized bed and slurry reactors. Thermal stability of packed bed and fluidized bed reactors, Overview of various areas of Green chemistry, Successful approaches to Green Chemistry education.

References

1.	Chemical Engineering Kinetics	Smith, J. M
2.	Catalytic Reaction Engineering	Carberry, J. J .
3.	Heterogeneous Catalytic Reactors.	Lee, H. H
4.	Catalytic Reactor Design	Tarhan, M. O .

CH 438-MULTI PHASE FLOW

Syllabus

Introduction to the flow of multiphase mixtures: gas or vapor liquid, liquid-liquid, liquid-solid, gas-solid, solid-liquid-gas and gases carrying solids (pneumatic transport) stratification and dispersion, Flow regimes and flow patterns. Gas (Vapor) and Liquid Flows: Horizontal flow, Vertical flow, pressure, momentum and energy relations, methods of evaluating pressure drop, Lockhard - Martinell, Chisholm correlations, critical flow, non-Newtonian flow. Solid-Gas Flow: Effect of pipeline diameter, inclination, bends, valves and length. Liquid and its physico-chemical properties, rheology, corrosive nature, viscosity, Solid particle size, distribution phase, and density i.e. their factors effecting behavior in a fluid, Concentration of particles and the flow rates of both solids and liquid. Solid-Gas Flow: Horizontal flow, Suspension mechanism, determination of voids, energy requirements for conveying, pressure drop and solid velocities in dilute phase flow, dense phase conveying, vertical transport. Bubble and drop formation: Phase holdups, Interfacial areas, mixing and pressure drops, multiphase (gas liquid solid) operations.

References

1.	The flow of complex mixtures in pipe	Govier, G.W. and Aziz, K
2.	Chemical engineering, Vol I	Coulson JM and Richardson J.F
3.	Multiphase Flow Handbook	Crowe, C.T.
4.	Fundamentals of Multiphase Flow	Brennen, C.E

CH 439-ADVANCED PROCESS OPTIMIZATION

Syllabus

Objective and Formulation of Optimization, Inequality and Equality Constrains in Models Formulation of the Objective Function, Lower and Upper Bounds, Selecting Functions to Fit Empirical Data, Factorial Experimental Designs, Degrees of Freedom, Economic Objective Functions, Measures of Profitability Continuity of Function, NLP Problem Statement, Convexity and Its Applications, Quadratic Approximation, Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function, Optimization of Unconstrained Functions: One-Dimensional Search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods of Unidimensional Search, Unconstrained Multivariable Optimization: Linear Programming (LP) and Applications Geometry of Linear Programs, Basic Linear Programming Definitions and Results, Simplex Algorithm, Barrier Methods, Sensitivity Analysis, Linear Mixed Integer Programs, Application of the EXCEL Solver Spreadsheet for Optimisation, Formulation. Introduction to Non linear Programming with Constraints and Mixed-Integer Programming, Application of Optimisation in Chemical Engineering, Examples of Optimization in Chemical Processes like optimizing recovery of waste heat, Optimal Shell and Tube Heat Exchanger Design, Optimal Design and Operation of binary Distillation Column, Optimal pipe diameter etc.

References

1.	Optimization of Chemical Processes	D M Himmelblau and L S Lasdon
2.	Optimization theory and practice	G. S. Beveridge and R. S. Schechter
3.	Optimization for engineering design: Algorithms and examples	K. Deb
4.	Mixed Integer and Non Linear Optimization	C. A. Floudas, W D Seider, J D Seader and D R Lewin

CH 440- COMPUTATIONAL FLUID DYNAMICS		
Syllabus		
Conservation equations for mass, momentum and energy; Comparison of various numerical techniques for CFD; Review of finite difference and finite element methods; Solution to discretised algebric equation; Finite-volume method for diffusion problems; Finite-volume method for convection and diffusion problems – pressure velocity coupling; Construction of geometry and discreation using Gambit-Fluent's manuals; Commercial CFD solvers; Turbulance modeling; Implementation of boundary conditions; Introduction to multiphase flow; Customizing commercial CFD solver; Unsteady state simulations.		
References		
1.	Computational Fluid Dynamics: The Basics with Application	Anderson, J.D.
2.	Computational Methods for Fluid Dynamics	Ferziger, J.H. and Peric, M
3.	An Introduction to Computational Fluid Dynamics: The Finite Volume Method	H.K. and Malalasekera, W

CH 441-CLEANER TECHNOLOGIES IN CHEMICAL PROCESS INDUSTRIES

Syllabus

Introduction to Cleaner Technology (CT), Technology adoption for Cleaner Production (CP), Cleaner Production: The basis, necessity and potential, C.P. tools, techniques, methodology and applications, Overview of Good House Keeping, Process Modification / Changes, Process Technology Innovations, Equipment Modification, Reuse and Recycle. Principles and Concepts of Green Chemistry, Thermodynamics and Reaction Engineering Principles for C.P., Role of Environmental Biotechnology in C.P.Use of Unit Operations – Adsorption, Absorption and Extraction in C.P. Energy Audit and Energy Conservation, Use of clean fuels inclusive of H2 as a clean fuel of tomorrow, Power Plants, C.P. & C.T. as Remedial Measures for Mitigating Climate Change, Ozone layer depletion and current practices to avoid depletion. Resource recovery / by product recovery from manufacturing process by Cleaner Production Technology (CPT) with special reference to Small Scale Industries. Industrial waste minimization and Waste Minimization Circles, Hazard Prevention by C.P. Technology Alternatives, Designing Cleaner Production – Green Processes, Cleaner Production and Cleaner Technology implementation, Typical case studies.

References

1.	Cleaner Production: Training Resource Package, UNEP IE, Paris, 1996	
2.	Engineers Guide to Cleaner Production Technologies	Paul M. Randall
3.	Green Chemistry : Environmentally Benign Reactions	V. K. Ahluvalia
4.	Chemical Process Safety: Learning from case Histories	R. E. Sanders, Oxford

CH 442-SUSTAINABILITY AND GREEN CHEMISTRY		
Syllabus		
Introduction to Green Chemistry and Sustainability,The Chemistry Behind Green Chemistry: Green Chemistry and Natural Resources: Energy Relationships: Energy sources, Energy conversions and renewable energy, potential of biofuels, Water: Properties, Life in, and Contaminants, Designing an Environmentally Safe Marine Antifoulant,Green Chemistry and Ecology: The Biosphere, The Geosphere, Soil and Food, The Anthrosphere and Industrial Ecology Consumer products, DuPont Petretec Polyester Regeneration Technology.		
References		
1.	Green Chemistry an Introductory Text, Royal Society of Chemistry	Lancaster, M.
2.	Green Chemistry, Theory and Practice	Anastas, P.T.; Warner, J. C.,
3.	Introduction to Green Chemistry	Matlack, A.S.,

CH 443-NANOTECHNOLOGY IN CATALYSIS

Syllabus

Introduction to nanotechnology, definition, history. What makes the nano scale so different from the other length scales by considering the underpinning science (i.e. nano science) and some key examples of nanotechnology. Methods of synthesis of nano materials fabrication-―Top-down‖ vs. ―bottom-up‖ approaches. Equipment and processes needed to fabricate nano devices and structures. Fundamental understanding of catalysis at nano-scale. Wet chemical synthesis, preparation and properties of iron, platinum, gold, cadmium, silver, copper and nickel nano-particles. Synthesis and properties of composite nano-particles and coated nano-particles. Characterization of nano particles by Scanning probe microscopes (Atomic Force Microscopy, Scanning Tunneling Microscopy), Transmission Electron Microscopy, Scanning Electron Microscopy.

References

1.	Nanotechnology: Principles and Practices	S. K. Kulkarni
2.	Nano science and technology: novel structures and phenomena	Tang, Zikang and Sheng, Ping, Taylor and Francis
3.	Nanotechnology: Understanding small systems	B. Rogers, S. Pennathur, J. Adams
4.	Nanotechnology in Catalysis	Pinzhan

Open Electives for 7th and 8th Semesters

CH 451-BIO ENERGY TECHNOLOGY		
Syllabus		
Sources and Classification. Chemical composition, properties of biomass. Energy plantations. Size reduction, Briquetting, Drying, Storage and handling of biomass. Feedstock for biogas, Microbial and biochemical aspects- operating parameters for biogas production. Kinetics and mechanism- High rate digesters for industrial waste water treatment. Thermo chemical conversion of lignocelluloses biomass. Incineration, Processing for liquid fuel production. Pyrolysis -Effect of particle size, temperature, and products obtained. Thermo chemical Principles: Effect of pressure, temperature, steam and oxygen. Fixed and fluidized bed Gasifiers- Partial gasification of biomass by CFB. Combustion of woody biomass-Design of equipment. Cogeneration using bagasse- Case studies: Combustion of rice husk.		
References		
1.	Biotechnology and Alternative Technologies for Utilization of Biomass	Chakraverthy A
2.	Biogas Systems: Principles and Applications	Mital K.M
3.	Biomass Energy Systems	Venkata Ramana P and Srinivas S.N
4.	Gasification Technologies, A Primer for Engineers and Scientists	Rezaiyan. J and N. P. Cheremisinoff

CH 452-SOLID WASTE MANAGEMENT		
Syllabus		
Introduction- Philosophy and organization, Status of solid waste management, Compotation an integrated waste management strategy. Evolution of solid waste management, Legislation and Government agencies, Planning solid waste management progress. Generation of solid waste, Onsite handling, Storage and processing, Transfer and transport, Processing techniques and equipment. Recovery of resources- Conversion, Chemical and Biological methods. Disposal of solid waste- Landfilling, Ocean disposing, Source reduction, Recycling, Composting. Hazardous waste and their management, Process management issues, Planning. Case studies on major industrial solid waste generation units- Coal fired power plant, Textile industry, Brewery, Distillery, Oil refinery, Radioactive generation units.		
References		
1.	Handbook of Solid Waste Management	Frank Krieth
2.	Solid Wastes	Martell
3.	Solid Wastes, George Tchobanuglour	H.Theisen and R.Eliassen.
4.	Solid Waste Management,	Luis F. Diaz, George M. Savage, Linda L. Eggerth, Larry Rosenberg

CH 453-OPTIMIZATION TECHNIQUES

Syllabus

Optimal problem formulation, Single variable optimization algorithms, Multi variable optimization algorithms including simplex search method; Cauchy's steepest descent method; Levenberg Marquardt's method, constrained optimization algorithms including Khun-Tucker conditions, transformation methods; direct search methods; liberalized search techniques; feasible direction method, Specialized algorithms including Integer programming; geometric programming. Nontraditional optimization techniques including simulated annealing, genetic algorithms (GA), introduction to multi objective optimization problems. Application of all the aforesaid techniques with the help of the frequently used benchmark functions for engineering design. ; Scope & Objective: Optimization has become a part of computer aided design activities where the goal is not only to achieve a feasible design but also a design objective. The course provides basic knowledge of deterministic algorithms as well as algorithms which are stochastic in nature with probabilistic transition rules, new methods in computational intelligence or „soft computing" inspired by evolutionary processes in nature, such as genetic algorithms. The course consists of lectures and a project component, which includes both model building and programming. This course also provides an opportunity to get conversant with optimization toolbox of MATLAB by the Mathworks, Inc.

References

1.	Engineering Optimization Theory & Practice,	S. S. Rao,
2.	Multi-Objective Optimization Using Evolutionary Algorithms	K. Deb,
3.	Process Plant Simulation,	B.V. Babu
4.	Optimization of Chemical Processes,	T. F. Edgar, D. M. Himmelblau,

CH 454- ADVANCED ANALYTICAL TECHNIQUES		
Syllabus		
Introduction to spectroscopic methods of analysis, electromagnetic radiation and quantitative spectroscopy, Molecular Spectroscopy, UV, IR, Atomic Spectroscopy: AAS, Electrometric Methods of Analysis, XRD Analsyis, Thermal Methods: DSC, DTA, Chromatographic Methods: GC, HPLC.		
References		
1.	Instrumental methods of analysis	Willard, H.H., Merritt. I.I., Dean J.a., and Settle, F.A
2.	Instrumental Methods of Analysis	Sharma, B.K.,
3.	Absorption spectroscopy of organic molecules	Parikh V.M.,
4.	Fundamentals of Analytical Chemistry	Skoog D.A. and West D.M.,
5.	Fundamentals of molecular spectroscopy.	Banwell, G

CH 455- INDUSTRIAL SAFETY & HAZARD MANAGEMENT

Syllabus

Introduction: Safety program, Engineering ethics, Accident and loss statistics, Acceptable risk, Public perception, Toxicology: How toxicants enter biological organisms, How toxicants are eliminated from biological organisms. Industrial Hygiene: Government regulations, Identification, Evaluation, Control. Fires and Explosions: The fire triangle, Distinction between fire and explosions; Definitions, Flammability characteristics of liquids and vapors, MOC and inerting, ignition energy, Auto ignition, Auto oxidation, Adiabatic compression, Explosions. Designs to prevent fires and explosions: Inerting, Explosion proof equipment and instruments, Ventilations, Sprinkler systems, Introduction to Reliefs: Relief concepts, Definitions, Location of reliefs, Relief types, Data for sizing reliefs, Relief systems. Relief Sizing: Conventional spring operated relief‘s in liquids, Conventional spring operated relief‘s in vapor or gas service, Rupture disc relief‘s in liquid, vapour or gas service. Hazards Identification: Process hazards checklists, Hazard surveys, HAZOP safety reviews.

References

1.	Chemical Process Safety (Fundamentals with applications),	D.A.Crowl & J.F.Louvar
2.	Industrial Hygiene and Chemical safety	
3.	Safety and Accident Prevention in Chemical Operations,	H.H.Fawcett and W.S.Wood
4.	Chemical engineering Vol.6,	Coulson and Richardson‘s