RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, VI-Semester

CM-601 Mass Transfer-II

Course Objective
The objective of this subject is to introduce the undergraduate students with the most important separation equipments in the process industry, and provide proper understanding of unit operations. At the end of study the student will come to know basic operations of cooling towers, dryer, as well as design of a adsorber and calculations involved in liquid-liquid extraction and solid liquid extraction.

Unit I Adsorption: Adsorption theories, types of adsorbent; activate d carbon, silica and molecular sieves. Batch and column, adsorption; Break through curves, Liquid percolation and gas adsorption, calculation.

Unit II Humidification and Dehumidification: Humidification : General Theory, psychometric chart, fundamental concepts in humidification & dehumidification, wet bulb temperature, adiabatic saturation temperature, measurement of humidification calculation of humidification operation, cooling towers and related equipments.

Unit III Drying: Equilibrium mechanism theory of drying, drying rate curve. Batch and continuous drying for tray driers, Drum dryers, spray and tunnel dryers.

Unit IV Leaching and Crystallization: Leaching: solid liquid equilibrium, Equipment, principles of leaching, concurrent and counter current systems and calculation of number of stage required. Crystallization: Factors governing nucleation and crystal growth rates, controlled – growth of crystals, super saturation curve, principle and design of batch and continuous type equipment.

Unit V Liquid –Liquid extraction: Liquid equilibrium & Ponchon – Savarit method, Mc-Cabe-Thiele method, packed & spray column, conjugate curve and tie line data, plait point, ternary liquid – liquid extraction, operation and design of extraction towers analytical & graphical solution of single and multistage operation in extraction, Co-current, counter current and parallel current system.

References:

1. Mc-Cabe, W.L. Smith J.M. – Unit Operation in Chemical Engg.,5th edition Tata McGraw Hill Hogakusha, Tokyo, New Delhi.
2. Coulson J.M. Richardson J.F.-Chemical Engg., Vol 2, Edition-2, Butserworth Heinmann, Oxford, New Delhi.
3. Treybal R.E. – Mass Transfer Operation – 3rd edition, Mc. Graw Hill Book Co. New York.

List of Experiment (Pl. expand it):

1. To study the rate dissolution of a rotating cylinder and then to calculate the mass transfer coefficient.

2. Study of Adsorption in a packed bed for a Solid liquid system, plotting the breakthrough curve of adsorption for a given system

3. To study the performance of forced draft water-cooling tower.

4. To study the drying characteristics of a wet granular material using natural and forced circulation in tray dryer.

5. Studies on solid-liquid extraction column.

6. To study the yield of crystals of a saturated solution using open tank type agitated batch crystallizer.

7. To study the yield of crystals of a saturated solution using Swenson walker crystallizer.

8. To draw the tie lines and plot equilibrium curve for given ternary system.

9. Liquid- Liquid extraction in a packed column for co-current and counter current flow of binary systems.

10. To Study on Liquid-Liquid extraction on a spray Extraction Column.

Note: Each student should perform at least eight experiments from the above list.

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New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, VI-Semester

CM-602 Chemical Reaction Engineering

Course Objective : To apply knowledge from calculus, differential equations, thermodynamics, general chemistry, and material and energy balances to solve reactor design problems, To examine reaction rate data to determine rate laws, and to use them to design chemical reactors, To simulate several types of reactors in order to choose the most appropriate reactor for a given need, To design chemical reactors with associated cooling/heating equipment.

Unit-I Classification of Reactions & Method of Analysis : Reaction rate, Variables affecting the rate, concept of reaction equillibria, order of reaction, theoretical study of reaction rates, collision and activated complex theory, Mechanism of reaction series, Parallel and consecutive reaction, autocatalytic reactions, chain reaction, polymerization reaction. Integral and differential method of analysis, variable volume reactions, total pressure method of kinetic analysis

Unit-II Classification of Reactors & Multiple Reaction : Development of design equations for\batch, semi batch, tubular and stirred tank reactor, Design of Isothermal and non-isothermal batch, CSTR, PFR, reactors. Combination of reactors, Reactors with recycle, yield and selectivity in multiple reactions. Continuous stirred tank and Plug flow reactors uniqueness of steady state in continuous stirred tank reactor, optimum temperature progression, thermal characteristics of reactors.

Unit-III Non ideal Reaction & Heterogeneous Process : RTD dispersion model, Tank and series model, recycle model, segregated flow in mixed models, evaluation of RTD characteristics. Classification of catalysts, General mechanism of catalytic reactions surface area and pore size distribution Rate equation of fluid solid catalytic reactions, Hougen - Watson & Poinule law models, Procurement and analysis of kinetic data, kinetics of catalyst deactivation. Selectivity Reaction and diffusion in porous catalysts, Isothermal and non-isothermal effectiveness factors, Effect of intra-phase transport on yield, selectivity & poisoning, Global
reaction rate.

Unit-IV Design of catalytic reactors : Isothermal & adiabatic fixed bad reactor staged adiabatic reactors, Non isothermal, non adiabatic fixed bed reactors, Fluidized bed reactors, Slurry reactors, Trickle bed reactors.

Unit-V Models and Regime for Fluids : 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 and slow reactions, Aerobic Fermentation, Application to Design Tools for Fast Reactions.

References:

1. Smith J.M; Chemical Engineering Kinetics; Mc Graw Hill.

2. Denbigh & Turner K.G; Chemical Reaction Theory an Introduction; United Press.
3. Copper & Jeffery's GVJ; Chemical Kinetics and Reactor Engineering; Prentice Hall
4. Levenspiel O; Chemical Reaction Engg; Willey Eastern, Singapore.
5. Houghen Watson & Ragatz; Chemical Process Principles Part Iii; Asian Pub-House Mumbai
6. Fogler H.S; Elements of Chemical Reaction Engineering; PHI

List of Experiment (Pl. expand it):

1. To determine velocity rate constant of the hydrolysis of ethyl acetate by sodium hydroxide.
2. To study the rate constant of hydrolysis of an ester-catalyzed by acid.
3. Determine the rate constant and order of reaction between Potassium per sulphate and potassium iodide.
4. To study temperature dependency of rate constant, evaluation of activation energy and verification of Arrhenius law.
5. To study a consecutive reaction system (hydraulic model).
6. To study a parallel reaction system (hydraulic model).
7. To study a homogeneous reaction in a semi-batch reactor under isothermal conditions.
8. Study of non catalytic homogeneous saponification reaction in CSTR.
9. To study a non-catalytic homogeneous reaction in a plug flow reactor.
10. To study the residence time distribution behavior of a back mix reactor.
11. To study the RTD behavior of a tubular reactor.
12. To study the RTD behavior of a packed bed reactor.
13. To study the behavior of a continuous flow reactor system-three reactor in series.
14. To study the kinetics of thermal decomposition of calcium carbonate.
15. To study a homogeneous catalytic reaction in a batch reactor under adiabatic conditions.
16. Study of non catalytic saponification reaction in a tubular flow reactor.

Note: Each student should perform at least eight experiments out of the above list.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, VI-Semester

Departmental Elective CM- 603 (A) Process Equipment Design-I

Course Objective
The objective of this course is to acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. internal and external pressure vessels, tall vessels, high pressure vessels, supports etc.), and different types of equipment testing methods.

Unit I: Mechanics of materials- Stress- Strain relationships of elastic materials subjected to tensile, compressive and shear forces, Elastic and plastic deformation, General design considerations; Design of shell, bottom plates, self supported, and column supported roofs, wind girder, nozzles and other accessories.

Unit II: Unfired pressure vessel- Pressure vessel codes, classification of pressure vessels, Design of cylindrical and spherical shells under internal and external pressures; Selection and design of flat plate, tor-spherical, ellipsoidal, and conical closures, compensations of openings. High pressure Vessels: Stress analysis of thick walled cylindrical shell, Design of monobloc and multiplayer vessels.

Unit III: Tall vertical & horizontal vessels-Pressure, dead weight, wind, earthquake and eccentric loads and induced stresses; combined stresses, Shell design of skirt supported vessels. Vessel supports; Design of skirt, lug, and saddle supports.

Unit IV: Bolted Flanges- Types of Flanges, and selection, Gaskets, Design of non- standard flanges, specifications of standard flanges. Fabrication of Equipment; major fabrication steps; welding, non-destructive tests of welded joints, inspection and testing, vessel lining, materials used in fabrication of some selected chemical industries.

References:
1. Brownell, N.E and Young, H.E; Process Equipment Design; John Wiley
2. Bhattacharya, B.C; Introduction of Chemical Equipment Design; CBS Publishers, Delhi.
3. Perry RH; Hand book of Chemical Engg; Mc Graw Hill Pub
4. I.S.: 2825-1969 – Code For Unfired Pressure Vessels.
5. I.S. 803-1962, Code for Practice for Design, Fabrication and Erection of Vertical and Mild Steel Cylindrical Welded Oil Storage Tanks.
6. Joshi, M.V.; Process Equipment Design.
7. Ludwig EE; Applied Process Design in Chemical and Petrochemical

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New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, VI-Semester

Departmental Elective CM- 603 (B) Polymer Technology

Unit I Polymerization Chemistry:
Chain, step and miscellaneous polymerization reactions and polymerization technique. Polymerization kinetics: Free radical, cationic and anionic polymerization, poly-condensation and polymerization.

Unit-II Polymerization Processes:
Bulk solution, emulsion and suspension polymerization, thermoplastic composites, fiber reinforcement fillers, surface treatment reinforced thermo-set composites resins, fillers, additives.

Unit-III Polymer reactions:
Hydrolysis, acidolysis, aminolysis, hydrogenation, addition and substitution reactions, reactions of various specific groups, cyclization and cross linking reactions, reactions leading to graft and block copolymer

Unit IV Manufacturing processes of important polymers:
Plastics- polyethylene, polypropylene polyvinyl chloride & copolymer, polystyrene; Phenol-formaldehyde, epoxides, urethane, Teflon, elastomers, robbers, polymeric oils - silicon fibers - cellulosic (Rayon), polyamides (6:6 Nylon), Polyesters (Dacron). Acrylic-olefin.

Unit - V 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 Equations, Uni-coelastic models - Maxwell.

References:
1. Rodringuez; Principles of polymer systems; TMH
2. Billmayer Jr, Fred W.; Textbook of polymer science; Wiley tappon
3. David J Williams; Polymer science & engineering; PHI
4. Mc. Keley, JH; Polymer processing; John Wiley

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Chemical Engineering, VI-Semester

Departmental Elective CM- 603 (C) Nano Technology

Unit – I Supramolecular Chemistry:

Definition and examples of the main intermolecular forces and in supramolecular chemistry. Self-assembly process in organic systems. Main supramolecular structures.

Unit- II Physical Chemistry of Nano Materials:

Students will be exposed to the very basics of nanomaterial; A series of nonmaterial that exhibit unique properties will be introduced.

Unit – III Synthesis of Nonmaterial:

Methods of Synthesis of Nonmaterial. Equipment and processes needed to fabricate nano devices and structures such as bio-chips, power devices, and opto-electronic structures. Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches.

Unit IV Biological Nanotechnology:

Biologically- Inspired Nanotechnology, basic biological concepts and principles that may lead to the development of technologies for nano engineering systems. Coverage will be given to how life has evolved sophisticatedly, molecular nano scale engineered devices, and discuss how these nano scale biotechnologies are far more elaborate in their functions than most products made by humans.

Unit – V Nano Instrumentation:

Instrumentation for nano scale Characterization. Instrumentation required for characterization of properties on the nano meter scale. The measurable properties and resolution limits of each technique, with an emphasis on measurements in the nano meter range.

Reference:

1. Supramolecular Chemistry by Jean-Maric Lehn,
2. Supramolecular Chemistry by Jonathan Steel & Jerry Atwood
3. Intermolecular and Surface Forces by Jacob Israelachvili.

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New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, VI-Semester

Open Elective CM- 604 (A) Chemical Process Control

Course Objective

The objective this course enables the students to know about control methods and make the students knowledgeable in various types of measuring instruments used in chemical process industries.

Unit I Construction and characteristics of final control elements such as Proportional, Integral, PD, PID controllers, pneumatic control valve, principles and construction of pneumatic and electronic controllers.

Unit II Process instrumentation diagrams and symbols, process instrumentation for process equipments such as Distillation column Absorption column, Heat Exchanger, Reactors, Evaporators, fluid storage vessels.

Unit III Laplace Transform, Linear open loop system, first order system and their transient response. Dynamic response of a pure capacitive process, Transportation lag, Dynamic response of a first order lag system.

Unit IV Second order system and their transient response. Interacting and non-interacting system. Linear closed loop system, block diagram of closed loop transfer function, controllers, transient response of closed loop system.

Unit V Stability concept, Routh stability criterion, relative stability, Hurwitz stability criterion, Nyquist's stability criterion. Root locus technique, introduction to frequency response, Bode diagram, Bode stability criterion, gain and phase margins, Ziegler Nichols controller setting.

References:
1. Coughnower & Koppel – Process System Analysis and Control- McGraw Hill, New York.
2. D. P. Eckman – Automatics Process Control – McGraw Hill, New York.
3. Peter Harriot – Process Control – McGraw Hill, New York.
4. J. J. Nagrath & M. Gopal; Control System Engineering.

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Chemical Engineering, VI-Semester

Open Elective CM- 604 (B) Process Optimization Techniques

Unit- I Formulation and Optimization:
Formulation of the objective function. Unconstrained single variable optimization: Newton, Quasi-Newton methods, polynomial approximation methods.

Unit-II Unconstrained Optimization:
Unconstrained multivariable optimization: Direct search method, conjugate search method, steepest descent method, conjugate gradient method, Newton's method.

Unit-III Linear Programming:
Linear Programming: Formulation of LP problem, graphical solution of LP problem, simplex method, duality in Linear Programming, two-phase method.

Unit-IV Non linear Programming:
Non linear programming with constraints: Necessary and sufficiency conditions for a local extremum, Quadratic programming, successive quadratic programming, Generalized reduced gradient (GRG) method.

Unit-V Applications:
Applications of optimization in Chemical Engineering.

Suggested Readings:

1. Edgar, T.F., Himmelblau, D. M., Lasdon, L. S., "Optimization of Chemical Process", 2nd ed. McGraw- Hill, 2001.
2. Rao, S. S., "Optimisation Techniques", Wiley Eastern, New Delhi, 1985.
3. Gupta, S. K., "Numerical Methods for Engineers", New Age, 1995.
4. Beveridge, G. S. and Schechter, R. S., "Optimization Theory and Practice", McGraw- Hill, New York,1970.
5. Rekllaitis, G.V., Ravindran, A. and Ragsdell, K. M., "Engineering Optimization- Methods and Applications", John Wiley, New York, 1983

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Chemical Engineering, VI-Semester

Open Elective CM- 604 (C) Fertilizer Technology

Course Objective
To Study of organic process industries involving process technology, raw material availability, production pattern, Engg. problems involving material of construction, Environment pollution, waste utilization and disposal, energy consumption and conservation Equation.

Unit- I Introduction:
Plant nutrients, different types of fertilizers and their production in India. Different feed stocks. Synthesis gas production by steam-naphtha reforming and gas purification. Ammonia synthesis.

Unit- II Nitrogenous Fertilizers:
Urea manufacturing processes. Manufacture of sulphuric acid and ammonium sulphate. Nitric acid and ammonium nitrate manufacture.

Unit – III Phosphate Fertilizers:
Availability and grinding of rock phosphate, manufacturing processes for single and triple super-phosphate and phosphoric acid.

Unit- IV
Mixed Fertilizers:
Availability and manufacture of muriate of potash. Mono and di-ammonium phosphate, urea ammonium phosphates, NPK complex fertilizers, granulation techniques.

Unit-V
Major Engineering Problems:
Fertilizers storage and handling. Corrosion problems in fertilizers industries, Fertilizer plant effluent treatment and disposal.

References:
1. Slack A.V. "Chemistry and Technology of Fertilizers", Wiley interscience Publishers.
2. Waggaman W.H., "Phosphoric Acid, Phosphates and Phosphatic Fertilizers", Hafner Pub.
3. Austin G.T., "Shreve's Chemical Processes Industries", 5th Ed. McGraw Hill.
4. Rao M.G. and Sittig M., "Dryden's Outlines of Chemical Technology", Affiliated East W Press, Delhi.

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Chemical Engineering, VI-Semester

CM-605 Chemical Process Plant Simulation Lab-II

Simulation Study of Various Chemical Process with the help of following Softwares :

1. Introduction to Polymath software: Understanding its function & working.
2. Prodyn: Understanding its functions & working.
3. Practical exercise using MATLAB, CHEMCAD & Prosimulator.

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Chemical Engineering, VI-Semester

CM-606 Chemical Process Control Lab

List of Experiment (Pl. expand it):
1. To study the characteristics of control valves (linear, quick opening, etc)
2. To study the dynamics of liquid level systems of non-interacting and interacting types.
3. To study the response of mercury in glass thermometer with and without a thermowell.
4. To study the characteristics of an electronic PID controller.
5. To study the characteristics of a current to pneumatic converter.
6. To study the effectiveness of computer control of a distillation column.
7. To study the effectiveness of a computer control of a heat exchanger.
8. To study to effectiveness of a computer control of a chemical reactor
9. To study to dynamics of a pressure tanks.
10. To calibrate an air purged liquid level indicator.
Note: Each student should perform at least eight experiments out of the above list.