RAJIV GANDHI UNIVERSITY OF KNOWLEDGE TECHNOLOGIES

Course Structure

And

Syllabus

For

B.Tech

Chemical Engineering

w.e.f 2011-2012

Rajiv Gandhi University of Knowledge Technologies

Curriculum of Chemical Engineering

1/1 Term (Common to all branches):

Subject No.	Subjects for I term	(L-T)-P	Credits
MA1101	Mathematics - I	3-0	4
PH1101 CY1101	Physics(Chemistry)	3-0	4
HS1101 ME1101	English for Communication(Mechanics)	2-2 / (3-0)	3
EE1101 CS1101	Electrical Technology (Programming & Data struct)	3-0	4
ME1102 CE1101	Intro. To Manufact. Proc & WSP (Engg.Drawing and Graphics)	1-3	3
PH1701 CY1701	Physics Lab (Chemistry Lab)	0-3	2
EE1701 CS1701	Electrical Technology Lab (Programming & Data Struct Lab)	0-3	2
EA1701	Extra Acad Activity(EAA)-1	0-3	P/R
Total load and Credits		**12-14 /13-12**	**22**

Contact hours: 13X2 + 12 = 38 (or 12X2 + 14 = 38)

2/1 Term (Common to all branches):

Subject No.	Subjects for II term	(L-T)-P	Credits
MA1202	Mathematics-2	3-0	4
CY1201 PH1201	Chemistry(Physics)	3-0	4
ME1201 HS1201	Mechanics(English)	(3-0) / 2-2	3
CS1201 EE1201	Programming & Data struct (Electrical Technology)	3-0	4
CE1201 ME1202	Engg.Drawing and Graphics or (Intro. to Manufact. Proc & WSP)	1-3	3
CY1801 PH1801	Chemistry Lab (Physics Lab)	0-3	2
CS1801 EE1801	Programming & Data Struct Lab (Electrical Technology Lab)	0-3	2
EA1801	Extra Acad Activity(EAA)-2	0-3	P/R
Total load and Credits		**13-12 /12-14**	**22**

Contact hours: 13X2 + 12 = 38 (or 12X2 + 14 = 38)

3/1 Term:

Subject No.	Subjects for III term	(L-T)-P	Credits
CS1301	Database Management Systems (DBMS)	5-0	4
HS1302	Managerial Economics	5-0	4
HS1303	Soft Skills	4-3	4
EA1301	Extra Acad Activity(EAA)-3	0-3	P/R
Total load and Credits		**14-6**	**12**

Contact hours: 14X2 + 6 = 34

1/2 Term:

Subject No.	Subject Name	(L+T)-P	Pre Requisites	Credits
CH2001	Fluid Mechanics	3-0	None	4
CH2003	Chemical Process Calculations	3-0	None	4
MA2002	Mathematics – 3 (Numerical Solutions of Ordinary and Partial Differential Equations)	3-0	None	4
CS 2201	Design of Algorithms	3-0	None	4
CH2005	Chemical Engineering Thermodynamics	3-0	None	3
CH2901	Fluid Mechanics Laboratory	0-3	None	2
HS2101	Human values-1	0-3	None	P/R
Total load and Credits		**15-6**		**21**

Contact hours: 15X2 + 6 = 36

2/2 Term:

Subject No.	Subject Name	(L+T)-P	Pre Requisites	Credits
CH2002	Heat Transfer	3-0	CH 2001	4
	Breadth I	3-0		4
MA2004	Mathematics – 4 (Transform Calculus)	3-0	None	4
CH2004	Chemical Technology	3-0	None	4
EC2101	Basic Electronics	3-0	None	4
EC2701	Basic Electronics Laboratory	0-3	None	2
CH2902	Basic Process Simulation Lab	0-3	CH2001, MA2005	2
HS2201	Human values-2	0-3	none	P/R
Total load and Credits		**15-9**		**24**

Contact hours: 15X2 + 9 = 39

3/2 Term:

Subject No.	Subjects	(L-T)-P	Credits
CS2301	Internet Technology	5-0	4
HS_60_	HSS Elective I	5-0	4
BM_60_	Management Elective I	5-0	4
HS2301	Professional development	0-3	P/R
Total load and Credits		**15-3**	**12**

Contact hours = 15x2+3=33

1/3 Term:

Subject No.	Subject Name	(L+T)-P	Pre Requisites	Credits
CH3001	Mass Transfer I	3-0	CH2002	4
CH3003	Mechanical Unit Operations	3-0	None	4
CH3005	Reaction Engineering I	3-0	CH2005	4
CH3007	Instrumentation and Process Control	3-0	None	4
	Breadth II	3-0		3

CH3901	Mechanical Unit Operations and Heat Transfer Laboratory	0-3	None	2
CH3903	Instrumentation and Process Control Lab	0-3	None	2
Total load and Credits		**15-6**		**23**

Contact hours: 15X2 + 6 = 36

2/3 Term:

Subject No.	Subject Name	(L+T)-P	Pre Requisites	Credits
	Breadth III (Environmental Engineering)	3-0		3
CH3002	Mass Transfer II	3-0	CH3001	4
CH3004	Reaction Engineering II	3-0	CH3005	4
CH3006	Process Equipment Design	3-0	CH2902	4
CH3902	Reaction Engineering Laboratory	0-3	None	2
CH3904	Mass Transfer Laboratory	0-3	None	2
CH3906	Process Equipment Design Laboratory	0-3	None	2
Total load and Credits		**12-9**		**21**

Contact hours: 12X2 + 9 = 33

3/3 Term:

Subject No.	Subjects	(L-T)-P	Credits
CH3301	Summer Internship	0-40	8
Total load and Credits		**0-40**	**8**

1/4 Term:

Subject No.	Subject Name	(L+T)-P	Pre Requisites	Credits
CH 4001	Computer Aided Process Synthesis and Design	3-0	MA2005, MA2004 and CH3001	3
CH 4003	Transport Phenomena	3-0	CH2001, CH 2002, CH3001	3/4
	Elective I	3-0		3/4
	Free Elective I	3-0		3
	Breadth IV			3/4
CH4901	Computer Aided Process Design Laboratory	0-3	None	2
CH4501	Project	0-9		6
Total load and Credits		**12-15**		**23-26**

Contact hours: 12X2 + 15 = 39

2/4 Term:

Subject No.	Subject Name	(L+T)-P	Credits
	Elective – II	3-0	4/3
	Elective - III	3-0	4/3
	Elective – IV	3-0	3
	Free Elective II (Management)	3-0	3
CH4502	Project	0-9	6
	Project viva		2
Total load and Credits		**12-9**	**20-22**

Contact hours: 33

Total no of credits =8+12X2+ 21+22x2+23+24x2+(23-26)+(20-22) = 211 - 215

NOTE : L = Lecture T = Tutorial P = Practical

Note: *At least one of the Breadth courses should be related to Environmental Science and Engineering.*

Choice of Electives:
Electives I to IV can be taken from any of the courses being offered from a campus which are expected to be a sub set of the list Electives given here.

Sl.No	Subject No.	Subject Name	L-T-P	Pre Requisites	Credits
1	CH4201	Energy Conservation in Process Industries	3-0	None	3
2	CH4202	Polymer Engineering	3-0	None	3
3	CH4203	Renewable Energy	3-0	None	3
4	CH6201	Optimization Techniques in Process Design	3-0	CH4001, MA 2005	4
5	CH6202	Biochemical Engineering Fundamentals	3-0	None	3
6	CH6203	Process Modeling and Simulation	3-0	CH2902	4
7	CH6204	Advanced Mathematics Techniques in Chemical Engineering	3-0	CH4001	3
8	CH6207	Industrial Pollution Control	3-0	None	3
9	CH6208	Novel separation Processes	3-0	MA 2005	3
10	CH6209	Petroleum Refinery Engineering	3-0	None	3
11	CH6210	Petrochemical Technology	3-0	CH6209	3
12	CH6211	Multiphase Flow	3-0	CH 3001, CH 3002	3
13	CH6212	Fluidization Engineering	3-0	CH 2001	4
14	CH6213	Project Engineering and Management	3-0	None	3
15	CH6214	Hazard Analysis and Risk Management in Chemical Industry	3-0	None	4
16	CH6215	Computational Fluid Dynamics	3-0	CH 2902, CH 4001	3
17	CH6216	Nuclear Technology	3-0	None	4

Requirements for Earning a Minor in Chemical Engineering

The following three theory and one-laboratory courses are compulsory for earning a **Minor** in Chemical Engineering.

Subject No.	Subject Name	Term	(L-T)-P	Credit
CH3001	Mass Transfer Operations I	7	3-0	4
CH3005	Reaction Engineering I	7	3-0	4
CH3004	Transport Phenomena	8	3-0	4
CH4901	Mass Transfer Laboratory	10	3-0	2

Any three of the following courses and one lab are to be taken compulsory for completing the **Minor** requirements in Chemical Engineering.

Subject No.	Subject Name	Term	Pre Requisite	(L-T)-P	Credits
CH2001	Fluid Mechanics	4	None	3-0	4
CH2002	Heat Transfer	5	None	3-0	4
CH2006	Mechanical Operations	5	None	3-0	4
CH3003	Chemical Engineering Thermodynamics	6	None	3-0	4
CH3002	Mass Transfer II	7	CH 3001	3-0	4
CH3007	Instrumentation and Process Control	7	MA2005, MA2004 and CH2001	3-0	4
CH3008	Computer Aided Process Engineering	8	MA2005, MA2004 and CH3001	3-0	3
CH3904	Instrumentation and Process Control Lab	8	None	0-3	2
CH4903	Computer Aided Process Engineering Laboratory	10	None	0-3	2

Syllabus

CH 2001 Fluid Mechanics **(3-0) 4 Credits**

Unit operations and unit processes, unit systems, dimension analysis, basic concepts, nature of fluids, hydrostatic equilibrium, applications of fluid statics. Fluid flow phenomena-Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, Boundary layers.

Basic equation of fluid flow –Mass balance in a flowing fluid; continuity, differential momentum balance; equations of motion, Macroscopic momentum balances, Mechanical energy equations Incompressible Flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction.

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow, Isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow. Flow past immersed bodies, Drag and Drag coefficient, flow through beds of solids, motion of particles through fluids. Fluidization, Conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Expansion of fluidized bed, Applications of fluidization. Continuous fluidization; slurry and pneumatic transport.

Transportation and Metering of fluids- Pipes, fittings and valves, pumps: positive displacement pumps, and centrifugal pumps. Fans, blowers, and compressors, Measurement of flowing fluids-full bore meters, insertion meters.

Text Books:

1. Introduction to Fluid Mechanics by Fox and Mc Donald – 8th Edition.

References:

1. Unit Operations of Chemical Engineering by W.L.McCabe, J.C.Smith & Peter Harriot, McGraw- Hill, 6th Edition, 2001.
2. Transport processes and unit operations by Christie J. Geankoplis, PHI.

CH2003 Chemical Process Calculations **(3-0) 4 Credits**

Basic concepts of Chemical process calculations – Dimensions, units and conversion, concepts on Temperature, Pressure and Concentration.

Material Balances – Introduction, Material Balances with and without chemical reactions, Recycle, Bypass, Purge and Industrial applications.

Energy Balances – Introduction, Energy balances with and without chemical reactions, enthalpy changes.

Basic Chemical Calculations - Ideal gas laws and its application. Dalton law, Raoult's law, Henry's laws, solubility and Distribution coefficient, Heats of Solutions

Humidity charts, their use and saturation.

Text Book:

1. "Basic Principles and Calculations in Chemical Engineering", David M Himmelblau and James B Riggs, 7th Edition, PHI.

References

1. "Chemical process principles Part-I, Material and Energy Balance" by O. A. Hougen, K. M. Watson, John Wiley and Asia Publication.
2. "Stoichiometry" (S.I units): B. I. Bhatt & S. M. Vora, McGraw Hill Ltd, 3rd Edition.

CH 2005 Chemical Engineering Thermodynamics (3-0) 4 Credits

First law of thermodynamics. Volumetric properties and equations of state of pure fluids. Sensible and latent heat effects and heats of reaction. Second law of thermodynamics. Definition of entropy and the third law. Maxwell relations and other relations among properties. Correlations of the thermal and volumetric properties of real fluids. Flow processes. Power cycles. Turbines and jet engines. Refrigeration cycles, heat pumps, and liquefaction of gases.

Text Books:

1. "Introduction to Chemical Engineering Thermodynamics" by J M Smith, H C Van Ness and M M Abbott, 6th Edition, TMH.

CH 2002 Heat Transfer (3-0) 4 Credits

Introduction - Nature of heat flow, conduction, convection, natural and forced convection, radiation. Heat transfer by conduction in Solids Fourier's law , thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres, thermal contact resistance, plane wall: variable conductivity Unsteady state heat conduction Equation for one-dimensional conduction, Semi-infinite solid, finite solid.

Heat Transfer to Fluids without Phase change - Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

Natural convection - Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar flow heat transfer, free convection in enclosed spaces, mixed free & forced convection.

Heat transfer to fluids with phase change - Heat transfer from condensing vapors, heat transfer to boiling liquids.

Heat exchange equipment - General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method). Evaporators - Evaporators, performance of tubular evaporators, capacity and economy, multiple effect evaporators, vapour recompression.

Radiation - Introduction, properties and definitions, black body radiation, real surfaces and the gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation shielding, radiation to semi transparent materials, combined heat transfer by conduction, convection and radiation.

Text Books

1. Transport processes and Unit operations, Christie J. Geankoplis, PHI.

References:

1. "Unit Operations of Chemical Engineering" by W.L.McCabe, J.C.Smith & Peter Harriot, McGraw- Hill, 6th Edition. McGraw-Hill
2. "Process heat transfer" by D. Q. Kern, McGraw-Hill.
3. "Fundamentals of Heat and Mass Transfer" by Frank P. Incropera, David P. De Witt, 5th edition, Wiley International.

CH 2005 Chemical Technology (3-0) 3 Credits

Scope of CPT in process industries, introduction of CPT with reference to Indian resources, industries, trade and export potentials, small scale industries and rural development etc.; preparation of process flow diagrams and process and instrumentation diagrams and major process symbols.

Chlor-Alkali Industries- Phosphorus Industries- Potassium Industries- Nitrogen Industries- Sulphur And Sulphuric Acid- Soap And Detergents- Sugar And Starch Industries- Fermentation Industries- Pulp And Paper Industries- Plastic Industries- Petroleum Processing- Rubber Materials of construction including special materials with reference to the above process industries.

Text Books:

1. Dryden's outlines of Chemical Technology, edited by M.Gopal Rao and M.Sittig, 3rd Edition.

CH 3001 Mass Transfer I (3-0) 4 Credits

Concepts of molecular diffusion and mass transfer coefficients. Molecular Diffusion in Fluids: Molecular Diffusion, Equation of Continuity, binary solutions, Steady State Molecular Diffusion in Fluids at Rest and in Laminar Flow, estimation of diffusivity of gases and liquids. Diffusion in Solids, Fick's Diffusion, Unsteady State Diffusion, types of Solid Diffusion. Mass Transfer Co-efficients and various theories, Heat and Mass Transfer Analogies.

Inter phase Mass Transfer: Concept of Equilibrium, Diffusion between Phases, Material Balances in steady state co-current and counter current stage processes, Stages, Cascades, Kremser – Brown equations.

Equipments for Gas Liquid Operations – their applications, types of packing.

Drying: rate of drying for batch and continuous dryers.

Humidification and Dehumidification: design of cooling towers.

Absorption And Stripping: Absorption equilibrium, ideal and non ideal solutions selection of a solvent for absorption, one component transferred: material balances. Determination of number of Plates, HETP, HTU, NTU determination.

Text books:

1. Separation Process Principles", J Seader and E J Henry.

Reference:

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill..
2. Diffusion: mass transfer in fluid system by E. L. Cussler.
3. Transport processes and unit operations by Christie J. Geankoplis
4. Principles of mass transfer and separation processes, B.K. Dutta, PHI, India

CH 3003 Mechanical Operations (3-0) Credits 4

Introduction to unit operations and their role in Chemical Engineering industries; Types of Mechanical Operations; Characteristics of solid particles: shape- size; sampling techniques; Differential and cumulative screen analysis; particle size distribution; particle size measurement; Surface area measurements; different mean diameters for a mixture of particles-relevant equations and problems.

Principles of size reduction: Specific properties of solids for size reduction; Energy required for size reduction; Crushing and grinding efficiency; Laws of crushing; pulverization and ultrafine grinding; Classification of crushing and grinding equipment- Construction and working principle of mostly used equipments, viz., Jaw crushers, gyratory crushers, hammer mill, crushing rolls, ball mills, and fluid energy mills; open and closed circuit grinding- wet and dry grinding- Grindability index.

Classification of separation methods- solid-solid, solid-gas, solid-liquid - Size separation: screening; industrial screens – grizzly, gyratory and vibratory screens, revolving screens – trommels; capacity and effectiveness of screens; Air separating methods- Gravity settling, cyclone separators, bag filters, electrostatic precipitators, Impingement separators; scrubbers, magnetic separation; froth flotation; mechanical classification and classifiers;

Batch sedimentation- thickeners- Flocculation- centrifugal sedimentation- gravity and centrifugal decanters- coagulation.

Filtration: Classification of filters- description and working of filtration equipment - plate and frame filter press, shell and leaf filters, Rotary drum filter; centrifugal filtration – Top suspended batch centrifuge; Theory of filtration- constant pressure and constant rate filtration; effect of pressure on filtration; filter aids; washing of cakes; Membrane filtration.

Textbooks:

1. Unit Operations of Chemical Engineering by W.L.McCabe, J.C.Smith & Peter Harriot, McGraw- Hill, 6th Edition, 2001.

CH 3005 Reaction Engineering I (3-0) 4 Credits

Introduction - Classification of chemical reactions; single, multiple, elementary and non elementary

homogeneous reactions; order and molecularity; temperature dependency.

Interpretation of Batch reactor data - constant and variable volume batch reactor; reaction rate; rate constant; collection and interpretation of kinetic data; parallel and series reaction; batch, ideal plug flow and CSTR reactor design with and without recycle.

Temperature and Pressure effects for reactions.

Basics of non-ideal flow- E, the age distribution of fluid, the RTD, Conversion in Non-ideal flow reactors, The dispersion model-axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

Text Books

1. "Chemical Reaction Engineering", Wiley Eastern, 3rd ed., Tata McGraw Hill.

Reference:

1. "Elements of Chemical Reaction Engineering" by H S Fogler, 4th Edition, PHI.

CH 3007 Instrumentation and Process Control (3-0) 4 Credits

Instrumentation: Characteristics Of Measurement System- Pressure Measurement- Temperature Measurement - Flow Measurement- Measurement- Instruments For Analysis

Process Control: Introduction to process dynamics and control. Response of First Order Systems. Physical examples of first order systems Response of first order systems in series, Higher order systems: Second order and transportation lag Control systems Controllers and final control elements,

Block diagram of a chemical rector control system, closed loop transfer functions, Transient response of simple control systems, Stability, Root locus, Transient response from root locus, Application of root locus to control systems Introduction to frequency response, Control systems design by frequency response.

Advanced control strategies, Cascade control, Feed forward control, ratio control, Smith predictor, dead time compensation, internal model control. Controller tuning and process identification. Control valves.

Text Books:

1. Patranabis D. – Principles of Industrial Instrumentation – 2nd Edition – Tata McGraw Hill Publishing Company, New Delhi (1999)
2. Industrial instrumentation by Donald P. Eckman, Wiley eastern.
3. Chemical process control by G. Stephanopolous, PHI,1998
4. Process systems analysis and control by D.R. Coughanowr, 2nd ed. Mc Graw Hill
5. Process Control by Wayne Bequette, PHI.

CH 3002 Mass Transfer II (3-0) 4 Credits

Distillation – Flash Distillation, Simple Distillation, Batch distillation with and without reflux, Ponchon - Savarit and McCabe- Thiele analysis of binary distillation.

Adsorption: types and nature of adsorption, isotherm, stage wise and continuous adsorption; fixed, fluidized and moving beds; ion-exchange.

Liquid Extraction: triangular diagram;

Leaching: single and multistage operation, equipment for leaching.

Crystallization: Millers theory, yield calculations, crystallizers. Membrane processes: liquid & gas separation processes, microfiltration, ultra-filtration, nanofiltration, reverse osmosis.

Text books:

1. Separation Process Principles", J Seader and E J Henry.

Reference:

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill..
2. Diffusion: mass transfer in fluid system by E. L. Cussler.
3. Transport processes and unit operations by Christie J. Geankoplis
4. Principles of mass transfer and separation processes, B.K. Dutta, PHI, India

CH 2004 Chemical Reaction Engineering II (3-0) 4 Credits

The tanks in series model- pulse response experiments and the RTD, chemical conversion. Earliness of mixing, segregation and RTD- self-mixing of a single fluid, mixing of two miscible fluids. catalysis and Catalytic reactors- catalysts, steps in a catalytic reactions, synthesizing a rate law, mechanism and rate limiting step.

Heterogeneous reactions -Introduction to Solid catalyzed reactions- The rate equation for Surface Kinetics- Pore diffusion resistance combined with surface kinetics, Porous catalyst particles, Heat effects during reaction, Performance equations for reactors containing porous catalyst particles. Solid catalyzed reactions- Experimental methods for finding rates.

Modeling and Design of Bio reactors and Fluidized Bed Reactors.

Text Books

1. "Chemical Reaction Engineering", Wiley Eastern, 3rd ed., Tata McGraw Hill.

Reference:

1. "Elements of Chemical Reaction Engineering" by H S Fogler, 4th Edition, PHI.

CH 3006 Process Equipment Design (3-0) 4 Credits

Introduction; development of flow diagrams from process description, material and energy balance, sizing of equipment, design preliminaries, design codes, MOC selection procedure, fabrication methods and testing methods.

Stresses in thin and thick walled shells, theories of failure, design of storage vessels. Design of pressure vessels, Design of shell and tube heat exchangers, Design of single effect evaporator, Design of distillation and absorption columns, Design of batch reactor, CSTR and PFR, Optimum pipe diameter.

Text Books:

1. Chemical Engineering: Vol.6, Coulson J.M. and Richardson J.F., Pergamon Press 1983

References:

1. Process Equipment Design, M.V. Joshi
2. Process Equipment Design-Vessel Design: Brownell L.E., Wiley Eastern Ltd.
3. Introduction to Chemical Equipment Design-Mechanical Aspects: Bhattacharya B.C., CBS Publishers.
4. Chemical Engineering Hand Book, Perry, 5th Ed.,

CH 4001 Computer Aided Process Synthesis and Design (3-0) 4 Credits

Review of numerical methods - convergence techniques, solution of linear and non-linear algebraic equations, solution of coupled ordinary differential equations. Importance of VLE/LLE calculations for process simulation.

Algorithms for VLE / LLE calculation methods for non-ideal systems. Modeling / simulation of different process equipment - heat exchangers, furnaces, flash drum, distillation, absorption, other staged / differential contacting processes, reactors etc.

Techniques of process flowsheeting. Commercial steady state process simulators. Simulator components and structures. Use of AI and ANN in process engineering.

CH 4003 Transport Phenomena (3-0) 4 Credits

Viscosity and Mechanism of Momentum Transport-Velocity Distributions in Laminar Flow-Equation of change for Isothermal Systems-Velocity Distributions with more than One independent variable-Interphase

Transport in Isothermal Systems-Thermal Conductivity and Mechanism of Energy Transport-Temperature Distributions in solids and in Laminar Flow-Equations of change for

Non-Isothermal Systems-Temperature Distributions with more than One Independent Variable-Interphase transport in Non-Isothermal Systems-Diffusivity and the mechanism of mass transport-Concentration Distribution in solids and in Laminar Flow-Equation of change for multicomponent systems-Interphase Transport in multicomponent systems.

Text Books:

1. Bird R.B., Stewart W.E. and Light Foot E.N. Transport Phenomena – John Wiley International – 2nd Edition , New York, 2002.
2. Christie J. Geankoplis – Transport Processes and Unit Operations – 3rd Ed., Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

Laboratories

CH 2901 Fluid Mechanics Laboratory (0-3) 2 Credits

1. Bernoulli's apparatus – verification of Bernoulli's Theorem.
2. Loss in pipe lines/equivalent length of different pipe fittings.
3. Fluidized bed.
4. Flow through nozzle/ hook's gauge.
5. Pressure drop using Venturimeter.
6. Calibration of Pitot tube/velocity meter. – Check for the parabolic properties.
7. Calibration of Rotameter.
8. Reynolds Apparatus.
9. Packed Bed.
10. Characteristics of Centrifugal Pump.

CH 2902 Basic Process Simulation Lab (0-3) 2 Credits

Give a basic insight on MATLAB and develop problem solving Techniques of the syllabus covered in mathematics for Numerical Solutions to Ordinary and Partial Differential Equations.
Introduction of ASPEN and Problems on the syllabus covered in Fluid Mechanics, Heat Transfer and Chemical Technology.

CH 3901 Mechanical Unit Operations and Heat Transfer Lab (0-3) 2 Credits

Heat Transfer Laboratory

1. Natural convection apparatus.
2. Forced convection.
3. Thermal conductivity of metal rod.
4. Composite wall apparatus.
5. Shell And Tube Heat Exchanger.
6. Critical heat flux apparatus.
7. Emissivity measurement apparatus
8. Thermal conductivity of liquid

Mechanical Unit Operations Laboratory

1. To determine the drop weight grindability index of Rittenger Number
2. To determine surface area and shape factor of particle by permeability method
3. To see the effect of size of ball in ball mill
4. Sieve Analysis.
5. Froath Floatation.
6. Batch Sedimentation.

CH 3903 Instrumentation and Process Control Laboratory (0-3) 2 Credits

1. Temperature Measurement Apparatus
2. Pneumatic control trainer
3. Control valve characteristics
4. Multi process trainer

5. Temperature control trainer
6. Flapper-Nozzle system
7. Calibration of differential pressure transmitter
8. Calibration of thermocouple and resistance thermometer
9. Study of I/P and P/I converter
10. Pressure control trainer
11. Interacting and Non interacting system
12. Temperature control module
13. Process module

CH 3902 Chemical Reaction Engineering Laboratory (0-3) 2 Credits

1. Packed Bed Reactor
2. Cascade CSTR
3. Isothermal CSTR
4. Isothermal PFR
5. coiled PFR
6. Adiabatic Batch Reactor
7. RTD of packed Bed reactor

CH 3906 Process Equipment Design Laboratory (0-3) 2 Credits

Introduction to various mechanical properties of materials to be used as material of construction, resistance of metals to corrosion under varying conditions of temperature and pressure etc. Application and use of various codes and standards in design.

Design of non-pressure storage vessel, tall vertical vessels, unfired pressure vessels with internal pressure ,Design of unfired pressure vessels with external pressures, end closures, flat plates, domed ends, torispherical, ellipsoidal, hemispherical and conical ends.

Design of Pipe lines; Design and process design of a few equipments like heat exchangers,Evaporators, Distillation columns, Absorbers, Reactors and Dryers .

Mechanical design of selected process equipments such as heat exchangers, Evaporators, Distillation columns, Absorbers, Reactors and Dryers and Crystallizers; Use of softwares for design of equipments.

Text Books:

1. Peters Max. S., Timmerhaus Klaus D.and Ronald E West “Plant Design and Economics for Chemical Engineers”.2003 5th Edition McGraw Hill.
2. Coulson, J. M. and Richardson J. F. “Chemical Engineering”, vol. 6 Pargamon Press. (1989).
3. Brownel and Young, “Process Equipment Design ”.Wiley (1968).

Reference Books:

1. Indian and American Codes Used in Designing of equipments (TEMA and IS Codes)

2. Evans, F. L., “Equipment Design Handbook”, Gulf Publishing Company.(1979).

CH 3904 Mass Transfer Operations Laboratory (0-3) 2 Credits

1. To study the performance of a bench top cooling tower
2. The drying curve of a solid under constant drying conditions
3. Seperation of two miscible liquids in a sieve plate distillation column
4. Liquid liquid equilibria
5. Rate of evaporation and concentration profile
6. packed bed distillation column
7. Simple disillation
8. Steam Distillation.

CH 4901 Computer Aided Process Design Laboratory (0-3) 2 Credits

General Unit operations: Mixer, Flow splitter; Flash column; pipe line and pipe pressure drop; multistage extractor; Decanter; Pump; Single and multistage compressors-Solids handling unit operations: Crusher, Screen, Cyclone, Rotary drum filter, centrifuge, crystallizer -Heat Exchangers: Simple heater, Shell and Tube Heat Exchanger-Distillation Columns: Batch, Binary & multi-component; single and multiple columns; Extractive and azeotropic distillation columns-Absorption Column: Absorption, Stripping-Reactors: Yield based, Stoichiometric and equilibrium reactors: Batch, CSTR, PFR with generalized kinetics

Physical property estimations: Molar volume using equations of state; Fugacity coefficient; Activity coefficient; VLE (K – values); Enthalpy, Free energy; Vapor pressure; Thermal conductivity; Surface tension; Viscosity; Diffusion coefficient- Simulation of a flow sheet: Mass and Energy balances; Handling user specifications on output streams; User specified unit modules-Costing and economic analysis: Project capital cost estimation; Plant operating cost estimation; Profitability analysis

Along with this Students are made to learn with FLUENT also.

Electives

CH 4201 Energy Conservation in Process Industries (3-0) 3 Credits

Concepts of energy accounting, energy auditing and their applications. Energy management principles and their scope. Second law analysis - concepts of energy, entropy generation and lost work. Application of the principle to steady flow process, non-flow process and other irreversible processes involving momentum, heat and mass transfer.

Energy conservation measures through process optimization, product improvement and technology up-gradations - heat pump, co-generation. Pipeline network and heat exchanger network analysis. Principles of thermo-economics and its application.

CH 4202 Polymer Engineering (3-0) 3 Credits

Basic concept of polymer and polymer chemistry. Classification of polymers. Mechanism and kinetics of polymerization. Polymerization reaction engineering: emulsion polymerization, dispersion polymerization etc.

Reactors for polymerization: analysis of polymerization reactions, Reactor design applied to polymer system, Average molecular weight of polymer in different reactor, Control of molecular weight.

Rheology of polymeric system. Unit operations in polymer industries. Polymer processing: moulding, calendaring, extrusion etc.

CH 4203 Renewable Energy (3-0) 3 Credits

Sources Of Energy- Solar Energy- Wind Energy- Hydrogen Energy- Other Sources

Text Books :

1. Sukhatme S.P - Solar Energy - Thermal Collection and Storage - Tata McGraw Hill.

Reference:

1. Rai, G. D. - Non-conventional Energy Sources, Khanna Publishers.
2. El Wakil – Power Plant Technology, Tata McGraw Hill, New York.
3. S. C. Arora and S. Domkundwar – A course in Power Plant Engineering, Dhanpat Rai and Sons, New Delhi,

CH 6201 Optimization Techniques in Process Design (3-0) 4 Credits

Introduction to optimization and its scope in chemical processes. Analytical methods: Objective function, single variable optimization, multivariable optimization without and with constraints.

Linear programming: graphical, algebraic, simplex methods, duality. Numerical search methods: one dimensional search, unrestricted, exhaustive search methods, interpolation methods.

Multidimensional search methods without and with constraints. Variational methods and their applications.

Text Books:

1. Optimization of chemical processes by T.F.Edgar and Himmelblau DM.Mc- Graw. Hill.2001.

CH 6202 Biochemical engineering (3-0) 3 Credits

Introduction to biochemical process industries, industrial alcohols, antibiotics, acids, alcoholic beverages, enzymes, vitamins, single cell protein. Food processing and biological waste treatment. Interaction of chemical engineering principles with biological sciences.

Life processes, unit of living system, microbiology, reaction in living systems, biocatalysts, model reactions. Fermentation mechanisms and kinetics : kinetic models of microbial growth and product formation. Fermenter types; Modeling of batch and continuous fermentor. Bioreactor design, mixing phenomena in bioreactors. Sterilization of media and air, sterilization equipment, batch and continuous sterilize design.

Biochemical product recovery and separation. Membrane separation process: reverse osmosis, dialysis, ultrafiltration; Chromatographic methods: adsorption chromatography, gel filtration, affinity chromatography etc. Electro-kinetic separation: electro-dialysis, electrophoresis. Waste water treatment: activated sludge process, anaerobic digestion, trickling filter.

Text Books:

1. Biochemical engineering fundamentals by J.E.Bailey and D.F.Ollis, 2 ed,1986,McGraw Hill.

CH 6203 Process Modeling and Simulation (3-0) 4 Credits

Introduction and fundamentals of process modeling and simulation; industrial usage of process modeling and simulation; Macroscopic mass, energy and momentum balances; incorporation of fluid thermodynamics, chemical equilibrium, reaction kinetics and feed/ product property estimation in mathematical models.

Simulation of steady state lumped systems including simultaneous solution, modular solution, nested inside-out algorithms, partitioning and tearing with reference to chemical process equipments like reactors; distillation, absorption, extraction columns; evaporators; furnaces; heat exchangers; flash vessels etc. Unsteady state lumped systems and dynamic simulation; Commercial steady state and dynamic simulators; Computer algorithms for numerical solution of steady state and unsteady state models;

Microscopic balances for steady state and dynamic simulation; process modeling with dispersion; axial mixing; micro-mixing; diffusion etc. Computer algorithms for microscopic models; Simulation of process flowsheets and Boolean digraph algorithms; Modeling and simulation of complex industrial systems in petroleum, petrochemicals, polymer, basic chemical industries.

Text Books:

1. Process modeling simulation and control for chemical engineers by W. L. Luyben, McGraw Hill,2nd Edition.

2. Numerical methods in engineering, S.K. Gupta, Tata McGraw Hill.

CH 6204 Advanced Mathematical Techniques in Chemical Engineering (3-0) 3 Credits

Models in chemical engineering; vector and tensor spaces; metric, norm and inner products; orthonormalization; matrices, operators and transformations; eigen values and eigen vectors; Fredholm alternative, Rayleigh quotient and its application to chemical engineering systems; self adjoint and non-self adjoint systems; partial differential equations and their applications in chemical engineering; Strum-Louiville theory; separation of variables and Fourier transformations; application of Greens function for solution of ODE and PDEs in chemical engineering; numerical techniques for solution of ODE and PDEs; linear stability and limit cycles; bifurcation theory; secondary bifurcation and chaos.

Introduction to numerical methods. Linear algebraic equations. Eigen values and eigenvectors of matrices. Nonlinear algebraic equations. Function evaluation and regression techniques. Numerical methods of solving ordinary differential equations - initial and boundary value problems. Numerical solutions of partial differential equations. Basic modeling principles and development of models in chemical engineering. Simulation techniques. Dynamic and steady state simulators.

Text Books:

1. S. Pushpavanam, Mathematical Methods in Chemical Engineering, Printice-Hall of India, New Delhi, 2001.

CH 6207 Industrial Pollution Control (3-0) 3 Credits

Engineering, ethics and environment. Ecological systems and pollution. Fundamental definitions of pollution parameters - air and water quality criteria, Standards and legislation EIA, EIS and EMP. Air and water pollution management through waste minimization.

Industrial air pollution management : air pollution meteorology (Generation, transportation and dispersion of air pollutants). Outlines of industrial air pollution control. Selection, design and performance analysis of air pollution control equipment : gravity settling chambers, air cyclones, ESPs, filters and wet scrubbers.

Industrial water pollution management: Wastewater treatment processes; Pre-treatment, primary and secondary treatment processes. Advanced wastewater treatment processes. Design of sedimentation tanks and biological treatment processes.

Text Books:

1. Environmental pollution and control engineering, Rao C. S. – Wiley Eastern Limited, India..

2. Pollution control in process industries by S.P. Mahajan TMH.,1985.

CH 6208 Novel Separation Processes (3-0) 3 Credits

Rate governed processes: definitions and terminologies; Membrane separation processes,

preparation and characterization of membranes. Principles of reverse osmosis, nanofiltration, ultrafiltration, microfiltration.

Osmotic controlled filtration, gel layer controlled filtration; Detailed design and modeling: film theory, similarity solution, integral method; Design of membrane/process modules; Basic principles and modeling of dialysis;

Electric field enhanced separation processes : zeta potential, electric double layer; Basic modeling of electric field enhanced filtration. Liquid membrane and its modeling. Basic design of gas separation and pervaporation

CH 6209 Petroleum Refinery Engineering (3-0) 3 Credits

Origin of petroleum crude oil. Evaluation of crude oil evaluation and characterization of crude oil : TBP and other distillation tests. Petroleum products, their properties, specification and testing , different properties like flash point, fire point, smoke point, aniline point, carbon residue, kinematic viscosity, pour point, freezing point etc.

Use of crude book data. Petroleum refinery distillation , pre-fractionation and atmospheric distillation of crude. Process design for atmospheric distillation. Stabilization of naphtha. Vacuum distillation of RCO. Reforming of naphtha.

Other secondary processes like Vis-breaking, Furfural/Phenol/NMP extraction, Solvent dewaxing, propane deasphalting. Delayed coking process. FCC unit. Hydrotreatment processes in refining: hydro-desulfurisation, hydrofinishing, Hydrocracking. Production of lube oil base stock, isomerization and alkylation.

Text Books:

1. Petroleum refining Engineering ; WL Nelson Mc Graw Hill company, 4th addition.
2. Modern Petroleum Refining Processes, 4th ed.,, B.K.bhaskara Rao, Oxford & IBH Publishing,2002.

CH 6210 Petrochemical Technology (3-0) 3 Credits

Survey of petrochemical industry; Availability of different feed stocks; Production, purification and separation of feed stocks; Chemicals from methane; Production and utilization of synthesis gas, oxo reactions, etc.; Production of and chemicals from acetylene; Naphtha cracking;

Chemicals from C2, C3, C4 and higher carbon compounds; Polymers properties, production and utilization; Catalytic reforming of naphtha and isolation of aromatics; Chemicals from aromatics; Synthetic fibres, detergents, rubbers and plastics; Petroleum coke;

Elements of design of steam reformer, naphtha cracker, catalytic reformer, etc.

Text Books:

1. B.K. Bhaskar Rao, "A Text on Petrochemicals " 2nd Edition,Khanna publishers, 1996.

CH 6211 Multiphase Flow (3-0) 4 Credits

Fundamental concepts of multiphase : gas - liquid, gas - solid, liquid – liquid and liquid - solid systems. Particle, drop and bubble dynamics. Application of continuity, momentum and energy equations.

Hydrodynamic characteristics : holdup, slip, pressure drop an rise/drop velocities.

Mass and energy transfer with and without simultaneous chemical reactions. Application to trickle beds, bubble and slurry reactors, cyclones, fluidized beds etc.

Text Books:

1. A. Gianetto and P.L. Selveston (Eds.) : `Multiphase Chemical Reactors', Hemisphere Publishing Corporation, N.Y., 1986.
2. G.W. Wallis `One dimensional two - phase flow', McGraw - Hill, N.Y. 1969.

CH 6212 Fluidization Engineering (3-0) 4 Credits

Momentum theorem, equations of change, ideal flow, Euler's equations of motion. Velocity potential, rotational and irrotational flow; Navier-Stokes equation, Poiseuille flow, creep flow and Couette flow. Boundary layer theory: integral momentum analysis. Turbulent boundary layer: turbulence and mixing. Universal velocity profile. Stability analysis of laminar flow, Orr-Sommerfield solution, transition to turbulence, detailed modeling of turbulent flow.

Laminar and turbulent flow of non-Newtonian fluid. Rheological characteristics, consistency measurement, viscometric flow, pipe and annular flow, pipeline design equations.

The phenomena of fluidization and its industrial application. Characteristics of particles. Principle of fluidization and mapping of various regimes. Two phase theory of fluidization. Bubbles in fluidized bed. Entrainment and Elutriation. Fast fluidized bed. Mixing, segregation and gas dispersion.

Heat and mass transfer in fluidized bed. Solid-liquid fluidized bed and three phase fluidized bed. Design of fluidized bed reactors.

Text Books:

1. Fludization Engineering by Kunii and Levenspiel, 2nd Edition.

CH 6212 Project Engineering and Management (3-0) 4 Credits

Origin of chemical project; Feasibility studies; Techno-economic report; Plant location and site selection; Capital cost estimation; Working capital estimation; Profitability indices, Discounted cash flow, Cost-benefit analysis, Sensitivity analysis; Process development, Process Selection, Process Design, Utilities, Scale up; Optimization; Project Construction, Project scheduling, Network analyses; Project report; Plant and Equipment specification.

Text Book:

1. Projects by Prasanna Chandra, 7th Edition, Tata Mc Graw Hill., 2009.

CH 6213 Hazard Analysis and Risk Management in Chemical Industry (3-0) 4 Credits

Process plants : continuous and batch plants. Procedure for systematic study of plants. Plant and equipment start up and shut downs, operations at steady state. Emergency response strategy for plants and equipment. Plant test runs and rating calculations for various equipment.

Plant systems for utilities and auxiliary services. Handling of plant effluent. Safe commissioning of plants. Definition,Aspects of engineering safety; safety systems , General principles of industrial safety, Notified dangerous operation, Chemical hazards. Storage of dangerous materials; vapor cloud explosions; Flammability characteristics of liquids and vapours. control of toxic chemicals; runaway reactions;

Hazards due to fire, explosions, toxicity, relief system; risk and hazard management, emergency shutdown systems; human element in the design of safety, Safety in relation to economic and operational aspects. Engineering control of chemical plant hazards. Industrial plant layout.

HAZAN and HAZOP. Plant and equipment reliability analysis. Case studies plant accidents.

Text Books:

1. P. C. Nicholas, " Safety management practices for hazard waste materials", Dekker,1996.
2. F. P. Lees, "Loss Prevention in Process Industries", Vol.1 and 2, Butterworth, 1983.
3. W. E. Baker, "Explosion Hazards and Evaluation", Elsevier, Amsterdam, 1983.
4. O. P. Kharbanda, and E.A.Stallworthy, "Management of Disasters and How to Prevent Them", Grower, 1986.
5. H.H. Fawcett and W.S. Wood, “Safety and Accident Prevention in Chemical Operations”, 2nd edition John Wiley and sons, New York, 1982.

CH 6214 Computational Fluid Dynamics (3-0) 3 Credits

Basic Concepts of Fluid Flow: Philosophy of computational fluid dynamics, conservation principles of mass, energy, and momentum, simplified flow models such as incompressible, inviscid, potential and creeping flows, classification of flows.

Turbulence and its Modelling: Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model, The k-e model, Reynolds stress equation models, Algebraic stress equation models.

Grid Generation: Structured and unstructured grids, choice of grid, general transformation of equations, some modern developments in grid generation in solving the engineering problems. Finite Difference Method: Discretization of ordinary and partial differential equations, approximation of first, second and mixed derivatives, implementation of boundary conditions, discretization errors, applications to the engineering problems.

Finite Volume Method: Discretisation methods, approximations of surface integrals and volume integrals, interpolation and differentiation practices, implementation of boundary conditions, applications to the engineering problems.

Introduction, one-dimensional steady state diffusion, two-dimensional diffusion problems, three-dimensional diffusion problems. The Finite Volume Method for Unsteady Flows and Implementation of Boundary Conditions: One-dimensional unsteady heat conduction.

Text Books:

1. Anderson Jr J. D., "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill. 1995.
2. Muralidhar K. and Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House. 2003.
3. H. K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics: the finite volume method , Longman scientific & technical publishers, 2007
4. Ferziger J. H. and Peric M., "Computational Methods for Fluid Dynamics", 3rd Ed., Springer. 2002.
5. Ranade V. V, "Computation Flow Modeling for Chemical Reactor Engineering", Academic Press. 2002.

CH 6216 Nuclear Technology **(3-0) 4 Credits**

Course Introduction and overview of Nuclear Engineering, Basic Nuclear Physics and Radiation Interactions Radiation and Biological Effects, Medical Applications, Food Preservation & Agriculture Applications with radiation Other Radioisotope Applications, Tracing, Dating, Sterilization, Radiation Chemistry, Global Energy Supply and Demand Fission Reactors, Safety, Licensing, Fuel Cycle, Advanced Applications of Nuclear Technology, Neutron Radiography, Gemstone Coloring, Nuclear Batteries