Curriculum Undergraduate Programme

B TECH CHEMICAL ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY

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PREFACE

With rapidly changing industrial scene and technological advances that have taken place in the field of Chemical Engineering (CH) has been revolutionalized. This needs upgradation and updating the existing academic programmes, so that trained human resources are competent to meet requirements of today's industries. Accordingly the Department of Chemical Engineering has come forward to restructure the academic programmes stipulated under the credit based system.

We have tried our best to prepare a Model Curriculum and syllabi for four year under graduate programme in Chemical Engineering. The exercise was handicapped with the following difficulties:

i) It is interdisciplinary in character involving considerable inputs from other disciplines.
ii) It depends on advances in science, technology and materials
iii) Its differential status at the National and International level

It is really challenging to evolve a common programme for this discipline that meets the need of national and international industries and research establishments. However, with the rich experience of successful experimentation with above idea for over forty years, the task of development of a model curriculum could be possible.

The suggested curriculum is based on philosophy presented by the Dean (Academic Programmes) during the Senate meeting of the institute. It possesses the following features:

i) The suggested curriculum is in conformity with IIT/AICTE norms with emphasis on analysis and design of industrial processes required to work in control environment.
ii) The graduates turned out have to be acceptable by national and international industry and academic /research establishments.
iii) The programme has to be forward looking in context of the rapid changing scenario of science and technology which provides a proper balance in teaching of basic sciences, social sciences and management, engineering sciences and technical arts, technologies and their applications.
iv) Core subjects have been selected to cover all those, which are essential in training of CH graduates.
v) The curriculum presents flexibility so that new programmes started with reasonable sources can be managed with a scope of further updating as the resource position improves.

The above features have been achieved by offering a number of electives courses both departmental and open in nature.

I take this opportunity to express my deep appreciation to members of the Senate for their valuable suggestions and critical comments in finalizing the curriculum and Professor Moin Uddin, Director, NIT Jalandhar for his initiative and direction. It is hoped that the curriculum complied in form of the booklet will be of immense help to the students and the faculty in smooth running the under graduate programme in Chemical Engineering. I thank all the members of Board of Studies in Chemical Engineering for their help and cooperation rendered in bringing out this booklet in time.

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Dr B R Ambedkar National Institute of Technology
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क्त ठ ट ।डठम्क्ड्ढ ।ट छ ।ज्प्ब्छ ।स् प्छैज्प्ज्न्ज्म् व्थ् ज्म्ब्भ्छव्स्व्ळल्ए श्र ।स्।छक्भ्।ट
ठ ।ब्भ्म्स्व् व्थ् ज्म्ब्भ्छव्स्व्ळल् ;ठण् ज्म्ब्भ् ब्भ्म्डप्ब्।स् म्छळप्छम्म्त्प्छळद्ध

TEACHING SCHEME

1ST SEMESTER

GROUP-A

Sr. No	Course Code	Name	L	T	P	Contact Hours	Credit
1.	MA-101	Mathematics-I	3	1	0	4	4
2.	PH-101	Physics	3	1	0	4	4
3.	IC/EC-101	Electrical Sciences	3	1	0	4	4
4.	CS-101	Computer Programming	2	0	0	2	2
5.	BT-101	Introduction to Bio Sciences	3	0	0	3	3
6.	HM-101	Psychology of Human Behaviour	2	0	0	2	2
7.	PH-102	Physics Lab	0	0	2	2	1
8.	ME-101	Engineering Graphics	1	0	4	5	3
9.	IC/EC-102	Electrical Science lab	0	0	2	2	1
10.	CS-102	Computer Programming Lab	0	0	2	2	1
		Total	17	03	10	30	25

GROUP-B

Sr. No	Course Code	Name	L	T	P	Contact Hours	Credit
1.	MA-101	Mathematics-I	3	1	0	4	4
2.	CH-101	Chemistry	3	1	0	4	4
3.	ME-102	Elements of Mechanical Engg.	3	1	0	4	4
4.	HM-102	English Communication	3	0	0	3	3
5.	CE-101	Environmental Science & Tech.	2	0	0	2	2
6.	HM-103	Introduction to Management	2	0	0	2	2
7.	IN-101	Manufacturing Process	1	0	4	5	3
8.	ME-103	Mechanical Engineering Lab	0	0	2	2	1
9.	HM-104	English Communication Lab	0	0	2	2	1
10.	CH-102	Chemistry Lab	0	0	2	2	1
		Total	17	03	10	30	25

2ND SEMESTER

GROUP-A

Sr. No	Course Code	Name	L	T	P	Contact Hours	Credit
1.	MA-102	Mathematics-II	3	1	0	4	4
2.	CH-101	Chemistry	3	1	0	4	4
3.	ME-102	Elements of Mechanical Engg.	3	1	0	4	4
4.	HM-102	English Communication	3	0	0	3	3
5.	CE-101	Environmental Science & Tech.	2	0	0	2	2
6.	HM-103	Introduction to Management	2	0	0	2	2
7.	IN-101	Manufacturing Process	1	0	4	5	3
8.	ME-103	Mechanical Engineering Lab	0	0	2	2	1
9.	HM-104	English Communication Lab	0	0	2	2	1
10.	CH-102	Chemistry Lab	0	0	2	2	1
		Total	17	03	10	30	25

GROUP-B

Sr. No	Course Code	Name	L	T	P	Contact Hours	Credit
1.	MA-102	Mathematics-II	3	1	0	4	4
2.	PH-101	Physics	3	1	0	4	4
3.	IC/EC-101	Electrical Sciences	3	1	0	4	4
4.	CS-101	Computer Programming	2	0	0	2	2
5.	BT-101	Introduction to Bio Sciences	3	0	0	3	3
6.	HM-101	Psychology of Human Behaviour	2	0	0	2	2
7.	PH-102	Physics Lab	0	0	2	2	1
8.	ME-101	Engineering Graphics	1	0	4	5	3
9.	IC/EC-102	Electrical Science lab	0	0	2	2	1
10.	CS-102	Computer Programming Lab	0	0	2	2	1
		Total	17	03	10	30	25

3rd सेमेस्टर

S No	Course code	Course Title	Periods			Credits	Contact Hours	Pre requisite	Cat	AICTE Parameters
			L	T	P					
1	CH 201	Fluid Flow	3	0	0	3	3		DC	DC
2	CH 203	Chemical Process Calculations	3	1	0	4	4		DC	DC
3	CH 205	Mechanical Operations	3	1	0	4	4		DC	DC
4	CH 207	Chemical Technology-I	3	0	0	3	3		DC	DC
5	MA 202	Numerical Methods	3	1	0	4	4	Math I & II	ID	BS
6	CY 661	Nano-materials, Nano-Science and Nanotechnology	3	1	0	4	4		ID	ESTA
7	CH 211	Fluid Flow Laboratory	0	0	2	1	2		DC	DC
8	CH 215	Mechanical Operations Laboratory	0	0	2	1	2		DC	DC
		Total	**18**	**4**	**4**	**24**	**26**			

4th सेमेस्टर

S No	Course code	Course Title	Periods			Credits	Contact Hours	Pre requisite	Cat	AICTE Parameters
			L	T	P					
1	CH 202	Heat Transfer	3	1	0	4	4	Fluid Flow	DC	DC
2	CH 204	Chemical Engineering Thermodynamics	3	0	0	3	3		DC	DC
3	CH 206	Chemical Technology-II	3	0	0	3	3		DC	DC
4	CH 208	Energy Technology	3	0	0	3	3		DC	DC
5	PH 204	Material Science and Engineering	3	0	0	3	3		ID	ESTA
6	CS 207	Object Oriented Programming	3	0	0	3	3		ID	ESTA
7	CH 212	Chemical Technology Laboratory	0	0	2	1	2		DC	DC
8	PH 224	Material Science and Engineering Laboratory	0	0	2	1	2		ID	ESTA
9	CS 217	Object Oriented Programming Laboratory	0	0	2	1	2		ID	ESTA
		Total	**18**	**2**	**4**	**22**	**24**			

5वां सेमेस्टर

S No	Course code	Course Title	Periods			Credits	Contact Hours	Pre requisite	Cat	AICTE Parameters
			L	T	P					
1.	CH 301	Mass Transfer-I	3	1	0	4	4		DC	DC
2.	CH 303	Chemical Reaction Engineering - I	3	1	0	4	4		DC	DC
3.	CH 305	Petroleum Refining Engineering	3	1	0	4	4		DC	DC
4.	CH 307	Industrial Instrumentation	3	0	0	3	3		DC	DC
5.	CH 3XX	Departmental Elective I	3	0	0	3	3		DE	DC
6.	ID	Interdisciplinary Course (Open Elective)	3	0	0	3	3		ID	IE
7.	CH 311	Heat Transfer Laboratory	0	0	2	1	2		DC	DC
8.	CH 313	Energy Technology Laboratory	0	0	2	1	2		DC	DC
9.	CH 315	Process Plant Design-1	0	0	2	1	2		DC	DC
		Total	**18**	**3**	**6**	**24**	**27**			

6वां सेमेस्टर

S No	Course code	Course Title	Periods			Credits	Contact Hours	Pre requisite	Cat	AICTE Parameters
			L	T	P					
1.	CH 302	Process System Analysis & Control	3	1	0	4	4		DC	DC
2.	CH 304	Mass Transfer II	3	1	0	4	4	CH 301	DC	DC
3.	CH 306	Chemical Reaction Engineering - II	3	1	0	4	4	CH 303	DC	DC
4.	CH 3XX	Departmental Elective II	3	0	0	3	3		DE	DC
5.	CH 3XX	Departmental Elective III	3	0	0	3	3		DE	DC
6.	ID	Interdisciplinary Course (Open Elective)	3	0	0	3	3		ID	IE
7.	CH 312	Mass Transfer Laboratory	0	0	2	1	2		DC	DC
8.	CH 314	Chemical Process Control and Reaction Engineering Laboratory	0	0	2	1	2		DC	DC
		Total	**18**	**3**	**4**	**23**	**25**			

7ज्ञ सेमेस्टर

S No	Course code	Course Title	Periods			Credits	Contact Hours	Pre requ is-ite	Cat	AICTE Parameters
			L	T	P					
1.	CH 401	Transport Phenomena	3	0	0	3	3		DC	DC
2.	CH 403	Environmental Pollution Control Engineering	3	0	0	3	3		DC	DC
3.	CH 405	Safety in Chemical Plants	3	0	0	3	3		DC	DC
4.	CH 4XX	Departmental Elective IV	3	0	0	3	3		DE	DC
5.	CH 4XX	Departmental Elective V	3	0	0	3	3		DE	DC
6.	ID	Interdisciplinary Course (Open Elective)	3	0	0	3	3		IE	IE
7.	CH 411	Computational Techniques in Chemical Engineering Laboratory	0	0	2	1	3		DC	DC
8.	CH 413	Process Plant Design II	0	0	2	1	2		DC	DC
9.	CH 415	Industrial Practical Training	0	0	0	4	2		--	DC
10.	CH 400	Project (Phase-1)	0	0	-	2	-		DC	DC
		Total	**18**	**0**	**4**	**26**	**26**			

8ज्ञ सेमेस्टर

S No	Course code	Course Title	Periods			Credits	Contact Hours	Pre requisite	Cat	AICTE Parameters
			L	T	P					
1.	CH 402	Process Economics and Management	3	0	0	3	3		DC	HSS
2.	CH 404	Process Modeling and Simulation	3	0	0	3	3		DC	DC
3.	CH 4XX	Departmental Elective VI	3	0	0	3	3		DE	DC
4.	CH 4XX	Departmental Elective VII	3	0	0	3	3		DE	DC
5.	ID	Interdisciplinary Course (Open Elective)	3	0	0	3	3		IE	IE
6.	CH 412	Environmental Pollution Control Laboratory	0	0	2	1	2		DC	DC
7.	CH 414	Process Modeling and Simulation Laboratory	0	0	2	1	2		DC	DC
8.	CH 400	Project (Phase –II)	0	0	-	4	-		DC	DC
		Total	**15**	**0**	**4**	**21**	**19**			

List of Departmental Electives

Vth Semester

S.NO	Course No	Course title	Periods		
			L	T	P
1	CH 321	Polymer Science and Engineering	3	0	0
2	CH 323	Oil Technology	3	0	0
3	CH 325	Rubber and Plastic Technology	3	0	0

VIth Semester

1	CH 322	Petroleum Recovery Technology	3	0	0
2	CH 324	Natural Gas Engineering	3	0	0
3	CH 326	Petrochemical Technology	3	0	0
4	CH 328	Membrane Separation Processes	3	0	0
5	CH 330	Plant Utilities	3	0	0

VIIth Semester

1	CH 421	Energy Management and Audit	3	0	0
2	CH 423	New and Renewable Energy Sources	3	0	0
3	CH 425	Instrumental Methods of Analysis	3	0	0
4	CH 427	Leather Technology	3	0	0
5	CH 429	Fertilizer Technology	3	0	0

VIIIth Semester

1	CH 422	Environmental Management in Process Industries	3	0	0
2	CH 424	Environment Impact Assessment	3	0	0
3	CH 426	Industrial Rheology	3	0	0
4	CH 428	Introduction to Multiphase Flow	3	0	0
5	CH 430	Paint Technology	3	0	0

Interdisciplinary Courses (Open Electives)

S.NO	Course No	Course title	Periods		
			L	T	P
1	CH 001	Fluid and Particle Mechanics	3	1	0
2	CH 002	Heat and Mass Transfer	3	1	0
3	CH 003	Environmental Management in Process Industries	3	0	0
4	CH 004	Hydrocarbon Engineering	3	0	0
5	CH 005	Industrial Safety	3	0	0

DEPARTMENT OF CHEMICAL ENGINEERING

Syllabus of Third Semester

CH-201 Fluid Flow [3 0 0 3]

Introduction, Ideal and real fluids, Extensive and Intensive Properties, Specific Weight, Mass density and Specific gravity, Viscosity, Surface Tension and Capillarity, Evaporability and Vapor pressure, Newtonian & Non Newtonian fluids.

Fluids Static-Pressure, Hydrostatics law, Pascal's Law, Different types of manometer, Continuous gravity Decanter, Centrifugal decanter and other pre- measuring equipments, Determination of meta centric height.

Fluids Kinematics and Dynamics - Classification of fluid flows, streamline, streak line, and Path lines, Flow rate & continuity equation, Bernoulli's Theorem, Kinetic energy correction factor and momentum correction factor in Bernoulli's equation.

Laminar Viscous Flow and Flow measurement devices- flow regimes and Reynolds numbers, Laminar flow in circular pipes (Hagen Poiseuille Law), Venturimeter, Orifice Meter.

Hydraulic pumps- Pump Classification & Applications, Centrifugal pumps verses Reciprocating pumps, pump losses and Efficiencies, Multistage pumps, Work and power Input, Cavitation and maximum Suction lift, specific and minimum speed.

Flow around Immersed Bodies- drag force, lift and drag coefficients, drag on Flat Plate, Circular Cylinder and Sphere.

Books Recommended:

1. Smith J C, McCabe W L and Harriot P H, "Unit Operations of Chemical Engineering", McGraw Hill (2001).
2. Kumar D S, "Fluid Mechanics & Fluid pwer engineering",S K Kataria & Sons (2004)
3. Timoshenko S P and Young D H "Engineering Mechanics", by McGraw Hill (1937).
4. Modi P N and & Seth S M, "Hydraulics and Fluid Mechanics", Delhi Standard Publishers Distributors (2002)
5. Perry's, "Handbook of Chemical Engineering", 7th Ed, McGraw Hill (1997).
6. Brown G G "Unit Operations" 1st ed. , CBS Publisher (2004)

CH-203 Chemical Process Calculations [3 1 0 4]

Introduction to Chemical Engineering Calculations: Units and dimensions, mole concept, conventions in methods of analysis and measurement, basis, temperature, pressure, the chemical equations and stoichiometry, limiting and excess reactant, conversion and yield.

Material Balance: Material balance, program of analysis of material balance problems, solving material balance problems that do not involve chemical reactions, solving material balances problems involving chemical reactions, multiple subsystems, recycle, bypass, and purge calculations.

Gases Vapors, Liquids and Solids: Ideal gas law calculations, real gas relationships, vapor pressure and liquids, saturation, partial saturation and humidity.

Energy Balances: Concepts and units, calculation of enthalpy changes, application of the general energy balance without reactions occurring energy balances that account for chemical reaction,

reversible processes and the mechanical energy balances, heats of solution and mixing, psychometric charts and their use.

Books Recommended

1. Himmelblau D M, "Basic Principles and Calculations in Chemical Engineering," Prentice Hall (1998).
2. Haugen O A, Watson K M and Ragatz R A, "Chemical Process Principles (Part-I): Material and Energy Balances", Asia Publishing House (1995).
3. Bhatt B I and Vora S M, " Industrial Stoiciometry": Tata McGraw Hill Publishing, New Delhi (1987).
4. Reklaitis G V, "Introduction to material and energy balances" Wiley, New York (1983)
5. Felder R M and Rousseau R W, "Elementary principles of Chemical Processes" Wiley, New York 2nd Edition (1986)

CH-205 Mechanical Operations [3 1 0 4]

Size Reduction : Particle size and shape, particle mass, size and shape distributions, measurement and analysis, concept of average diameter ,size reduction , crushing, grinding and law of grindings.
Screening : Screening equipment ,capacity and effectiveness of screen, effect of mesh size on capacity of screen.
Settling : Flow around a single particle, drag force and drag coefficient, settling velocity of particles in a fluid, hindered and free settling of particles, thickening gravity separation
Filtration : Classification of filters, various types of cake filters ,principle of cake filtration ,clarification filters, liquid clarification, centrifugal settling process.
Agitation & Mixing: Agitation of liquids, axial flow impellers, radial flow impellers, velocity and power consumption of agitated vessels, blending & mixing.
Fluidization : Packed beds, bed porosity, flow though a bed of particles, fluidization & fluidized bed, conditions for fluidization minimum velocity, types of fluidization.
Solid Handling : Flow of solid by gravity, transport of solids by screw / belt conveyers, cyclones, bag filters, electrostatic precipitators, particulate collection system.

Books Recommended

1. Smith J C, Mccabe W L and Harriot P H, "Unit Operations of Chemical Engineering", McGraw Hill (2001).
2. Bhattacharya B C and Narayanan C M "Mechanical Operation for Chemical Engineers"
3. Perry's, "Handbook of Chemical Engineering", 7th Ed, McGraw Hill (1997).
4. Brown G G "Unit Operations" 1st ed. , CBS Publisher (2004)
5. Richardson and Coulson "Chemical Engineering Vol II",5 th ed., Butterworth – Heinemann (2003).

CH- 207 Chemical Technology - 1 [3 0 0 3]

Soaps and Detergents: Raw materials and Reaction Chemistry, Continuous process for manufacture of fatty acids, soaps and glycerine, Classification of detergents, Builders and additives, Manufacture of detergents like alkyl benzene sulphonate ,Sodium alkane sulphonate.
Cane Sugar: Cane production and varieties, manufacturing equipment and technology, cane sugar refining, bagasse utilization, energy requirements and conservation, environmental considerations.

Polymers: Nomenclature of polymers and their classification, Modes of polymerization i.e addition, condensation, step growth and chain growth polymerization , Methods of polymerization. Selected industrial polymerization, including plastics, synthetic fibers, synthetic and natural rubbers.

Agricultural Residue Utilization: Availability and Characteristics, energetic and energy contents, modes of energy recovery, gasification, pyrolysis, deoxygenation, chemicals from agricultural residues.

Oils and Fats: Status and scope: Major oil seeds production in India; expression, solvent extraction, energy and solvent requirements, minor oil seeds and other oil bearing materials, Hydrogenation of oils.

Books Recommended

1. Dryden C E, "Outlines of Chemical Technology", East –West Press Pvt. Ltd., New Delhi, 2nd Edition (1973)
2. Austin G T, "Shreve's Chemical Process Industries", McGraw Hill Book Company, New Delhi 5th Edition (1986)
3. Chemical Engineering Education Development Centre– "Chemical Technology I, II, III, IV, Manual of Chemical Technology, Indian Institute of Technology, Madras".
4. Shukla S D and Pandey G N, "A text book of Chemical Technology Vol I", Vikas Publishing House Pvt. Ltd., New Delhi
5. Shukla S D and Pandey G N, "A text book of Chemical Technology Vol II", Vikas Publishing House Pvt. Ltd., New Delhi

MA-201 Mathematics- III [3 1 0 4]

Roots of algebraic and transcendental equations, Bisection method, Regula – Falsi method, Newton –Raphson method, Bairstow's method and Graeffe's root squaring method.

Solution of simultaneous algebraic equations, matrix inversion and eigen-value problems, triangularisation method, Jacobi's and Gauss-Siedel iteration method, partition method for matrix inversion, power method for largest eigen-value and Jacobi's method for finding all eigen-values.

Finite differences, interpolation and numerical differentiation, forward, backward and central differences, Newton's forward, backward and divided difference interpolation formulas, Lagrange's interpolation formula, Stirling's and Bessel's central difference interpolation formulas, numerical differentiation using Newton's forward and backward difference formulas and numerical differentiation using Stirling's and Bessel's central difference interpolation formulas.

Numerical integration, Trapezoidal rule, Simpson's one-third rule and numerical double integration using Trapezoidal rule and Simpson's one-third rule.

Taylor's series method, Euler's and modified Euler's methods, Runge-Kutta fourth order methods for ordinary differential equations, simultaneous first order differential equations and second order differential equations.

Boundary value problems, finite difference methods for boundary value problems.

Partial differential equations, finite difference methods for elliptic, parabolic and hyperbolic equations.

Books Recommended

1. S S Sastry, Introductionary Methods of Numerical Analysis, 3rd Edition, Prentice Hall of India Pvt.Ltd., New India -1999

2. S C Chapra and R P Canale, Numerical Methods for Engineers, 2nd Edition, McGraw Hill Book Company, Singapore 1990.
3. Grewal, B S, "Numerical Methods", Khanna Publishers ,Delhi.

CY-661 Nanomaterials, Nanoscience and Nanotechnology [3 1 0 4]

Introduction :Terminologies, History & Scope
Characterization & Fabrication: Contemporary Characterization Methods, top down & Bottom up Fabrication, Solution based Synthesis of Nanoparticles, Vapour Phase Synthesis & Synthesis with framework, Nanolithography, Dip Pen Lithography.
Artificially Layered Materials: Quantum Well, Quantum Dots, Super lattices & Layered Structures.
Self Assembly: Supramolecular & dimension Control in Nanostructure, thermodynamics and coded self assembly.
Biomaterials:DNA & Nanomaterials, Bioanocomposites, Biometrics, molecular motor.
Nanoelectronics and Molecular Computing: Molecular wires, Nonowires, Nanotubes, Molecular switch, Molecular logic gates and molecular storage devices, DNA Computing Quantum Computing.
Books Recommended

1. Introduction to Nanotechnology, C P Poole & F J Owens, Wiley, 2003.
2. Understanding Nanotechnology, Scientific American 2002.
3. Nanotechnology, M Ratner & D Ratner, Prentice Hall 2003.
4. Nanotechnology, M Wildon, K Kannagara G Smith, M Simmons & B Raguse, CRC Press Boca Raton 2002.

CH-211 Fluid Flow Laboratory [0 0 2 1]

1. To find coefficient of friction in pipes of different materials.
2. To verify Bernaulli's equation using hydraulic bench.
3. To find losses due to sudden expansion and sudden contraction in pipes.
4. To calculate Reynold's number for laminar and turbulent flow.
5. To calculate metacentric height.
6. To determine volumetric and mass flow rates through the Venturi meter.
7. To determine volumetric and mass flow rates using orifice meter.
8. To determine the efficiency of a pump.
9. To calibrate and to find mass flow rate through Rotameter.

CH-215 Mechanical Operations Laboratory [0 0 2 1]

1. Determination of power consumption and study of agitation and mixing characteristic of a fluid.
2. Determination of drag coefficient from the plot of drag coefficient Vs modified Reynolds No.
3. To determine pressure drop through a packed bed: To plot the graph between modified Reynolds no. Vs modified friction factor and verify Ergun Equation in packed column.
4. To find out the collection efficiency of a cyclone separator.
5. Determination of screening efficiency in a vibrating screen.
6. Plate and frame filter press: determination of cake resistance and filter medium resistance.
7. Determination of specific cake resistance in constant pressure vacuum filtrations
8. To study filtration characteristics of a leaf filter.

9. To study the flow through a helical coil.
10. To study the crushing efficiency of a roll crusher.
11. To study flow through an orifice.

Syllabus of Fourth Semester

CH-202 Heat Transfer [3 1 0 4]

Conduction: Basic law of heat conduction – Fourier's law, thermal conductivity, its dependence on temperature, steady state heat conduction through a composite solid and its electric analogue, steady state heat conduction through cylinders, spheres and variable area of solids, different insulating materials and their applications for process equipment and pipelines, Fourier's law in three dimensions, lumped capacity method of unsteady state conduction.

Convection: Convection heat transfer and the concept of heat transfer coefficient, individual and overall heat transfer coefficient, heat transfer between fluids separated by plane wall, heat transfer between fluids separated by cylindrical wall (pipes), critical/ optimum insulation thickness, heat transfer through extended surfaces.

Forced Convection: Over a flat plate, thermal boundary layer, dimensionless groups and dimensional analysis, Buckingham Pi-theorem, heat transfer correlations- internal and external flows, laminar and turbulent flows,

Free convection: Heat transfer correlations for free convection, free convection from flat surfaces, free convection from a cylinder.

Heat Transfer with phase change: Boiling phenomena and analysis of boiling curve, correlation for nucleate boiling, critical heat flux, condensation phenomena, film condensation on a vertical surface (Nusselt equation, effect of non-condensable gases, drop wise condensation.

Radiation: Basic principle of radiation from a surface, blackbody radiation, Planck's law, Wein's displacement law, the Stefan Boltzmann law, Kirchoff's law, gray body, radiation exchange between black bodies & gray bodies.

Evaporation: Types of evaporators, single and multiple effect evaporators, capacity and economy, boiling point elevation.

Books recommended

1. Holman J P, "Heat Transfer", McGraw Hill Book Co. (1992).
2. Incropera F P and DeWitt D P, "Introduction to Heat Transfer," 2nd Ed John Wiley New York (1996).
3. Geankopolis C J, "Transport Processes and Separation Process Principles", Prentice Hall of India, 4th Edition, Eastern Economy Edition (2004)
4. Kern D Q, "Process Heat Transfer", McGraw Hill Book Co. (1997).
5. Coulson J M and Richardson J F, "Chemical Engineering" Volume 1, Pergamon Press (1999).

CH-204 Chemical Engineering Thermodynamics [3 0 0 3]

Review of First ,Second and Third Law of Thermodynamics : First law of Thermodynamics , Thermodynamics state and state functions , enthalpy, the steady state steady flow process, equilibrium, phase rule, reversible processes , Second law of thermodynamics, Heat engines, Entropy, Entropy changes of an ideal gas,

Third law of thermodynamics.

Volumetric properties of pure fluids :PVT behaviour for an ideal gas, Virial equation of state,Applications of Virial equations, Cubic equation of state, Generalized correlations, Acentric factors.

Heat Effects : Sensible Heat Effects , Internal Energy of ideal gases, Latent heat of pure substances , Standard heat of reaction, formation , combustion, Heat of reaction at higher temperature, Heat effects of Industrial reactions.
Thermodynamic Properties of fluid: Maxwell relations, Residual properties, two phase system, Thermodynamic diagram
Equilibrium and Stability: Criteria of equilibrium, Chemical Potential, Application of equilibrium criteria, Clausius clapeyon equation.
Phase Equilibria: Fugacity, Determining of fugacity of pure substances, Fugacity in mixture, Ideal solution, Excess properties, and Liquid phase properties from VLE data, Activity coefficients, and coefficient equations.
Chemical Reaction Equilibria: Reaction ordinate for single & multiple reactions , condition of equilibrium for a chemical reactions, Standard states and G, Temperature dependence of the equilibrium constant , Estimation of equilibrium rate constant , Homogeneous gas phase reactions, Heterogeneous chemical equilibrium.

Books Recommended

1. Smith J M, Van Ness H C, Abbott M M, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill (TMH Edition), 6th ed (2003).
2. Rao Y V C, "Chemical Engineering Thermodynamics", First Edition, Universities Press (India) Ltd., Hyderabad (1997).
3. Kyle B G, "Chemical and Process Thermodynamics", Third Edition, Prentice Hall PTR, Upper Saddle River, New Jersy (1999).
4. Denbigh K G, "Principles of Chemical Equilibrium", Cambridge University Press, 4th ed. (1981).
5. Keeneth S Pitzer, "Thermodynamics", McGraw Hill, 3rd ed.

CH - 206 Chemical Technology -II [3 0 0 3]

Soda Ash: Manufacturing,solvay and modified solvay process, materials of construction environmental considerations and corrosion problems
Chlor Alkali Industry: Electrochemistry of brine electrolysis, current efficiency, energy efficiency, diaphragm cells, mercury cells, mercury pollution and control, membrane cells, caustic soda, chlorine, hydrochloric acid; corrosion problems and materials of construction.
Regenerated Cellulose: Growth of industry, raw materials, Pre-treatment, pulping, manufacture of paper, recovery of chemicals, environmental considerations, viscose rayon.
Fertilizers: Status of industry, grading and classification of fertilizers, raw materials, hydrogen production, synthesis of ammonia based fertilizers, manufacture of phosphatic fertilizers and phosphoric acid, potash fertilizers, N-P-K values. Corrosion problems and materials of construction.
Cement and Glass.
Sulphuric Acid.

Books Recommended

1. Dryden C E, "Outlines of Chemical Technology", East –West Press Pvt. Ltd., New Delhi, 2nd Edition (1973
2. Austin G T, "Shreve's Chemical Process Industries", McGraw Hill Book Company, New Delhi 5th Edition (1986)

3. Chemical Engineering Education Development Centre– "Chemical Technology I, II, III , IV , Manual of Chemical Technology, Indian Institute of Technology , Madras".
4. Shukla S D and Pandey G N, "A text book of Chemical Technology Vol I", Vikas Publishing House Pvt. Ltd., New Delhi
5. Shukla S D and Pandey G N, "A text book of Chemical Technology Vol lI", Vikas Publishing House Pvt. Ltd., New Delhi

CH- 208 Energy Technology [3 0 0 3]

Solid Fuels: Principle Solid Fuels – Coal, origin, composition & classification of coal, Properties of coal, terms used in analysis of coal, classification of Indian coals, petrology of coal
Coal Preparation: Dry and Wet processes, storage of coal. Coal carbonisation : mechanism of carbonisation , high temperature and low temperature carbonization briquetting, gasification of coal, Lurgi process, Winkler process , Kopper –Totzek process , liquefaction of solid fuels.
Liquid Fuels: Petroleum and related products,origin, occurrence and reserves, nature of petroleum crudes, classification and characteristics of petroleum, Refining Unit Process: Cracking, Thermal Cracking ,Catalytic cracking , Hydrocracking, Reforming Thermal and Catalytic Reforming, Alkylation, Polymerization Isomerization, petroleum products :naphtha, motor gasoline, aviation gasoline , kerosene , diesel oil, gas oil , fuel oil , lubricants , petroleum waxes,petroleum coke.
Gaseous Fuels: Classification, Wobbe Index natural gas, methane from coal mines, producer, water, carbureted water gas, coal, blast furnace, refinery gases, LPG.
Combustion: General Principles of combustion, stoichiometry & heat balance calculations, coal burning equipments, stokers, pulverized fuel burners gas and oil burners, fluidized bed combustion.
Alternate Energy Systems: Solar Energy – Photovoltaic cells, solar collectors. Nuclear energy: nuclear reactions, fuel materials, moderators and structural materials, reactors, wind energy, tidal energy, and geothermal energy.
Furnaces: General classification and description of different types of furnaces.

Books Recommended

1. Brame J S and King J C, "Fuels- Solid, Liquid and Gaseous" , St. Martin Press
2. Sarkar S, "Fuels and combustion", Longman publishers India Ltd.., IInd Edition
3. Haslam R T and Russel R P, "Fuels and their combustion" , McGraw Hill
4. Gupta O P, "Elements of Fuels, Furnaces and Refractories", Khanna Publishers
5. Griswold J, "Fuels combustion and furnaces", McGraw Hill

PH-204 Material Science and Engineering [3 0 0 3]

Structure of crystalline Solids: Crystal structures and crystal system, reciprocal lattice, miller indices, closed packed structures, determination of crystal structures.
Imperfections in solid: Point imperfections and their equilibrium concentration, Edge and screw dislocations; burgers vector and the dislocations; burgers vector and the dislocation leap, stress fields and energies of dislocations, dislocations forces, dislocation sources; Multiplication of dislocations.
Diffusion in Solid: Fick's law of diffusion, solution to fick's second law, applications based on second law solution, the kirkendall effect, the atomic model of diffusion.

Mechanical properties: The elastic properties, model of elastic Behaviour, platic deformation tensile stress-strain curve, shear strength of perfect and real crystals, mechanical failure, fatigue and fracture, creeps: mechanism of creep, Characterization of creep curves.
Electrical properties : Classical and quantum theory of free electronics; relaxtion time, collision time and mean free path, density of energy states and Fermi energy, Electorn motion under periodic potential , Origin of energy bands in solids, classification of material on the basis of band gap, effective mass, intrinsic and extrinsic semi- conductors, hall effect and its applications.
Dielectric properties: Mechanism of polarization, concept of polarizability and internal fields, Dielectrics in alternating fields; frequency of dependence of polarizability.
Magnetic properties : Magnetic moments and its origin, dia- and para- magnetism, ferro and ferri- magnetism, soft and hard magnetic materials , ferrites , Application of magnetic materials.
Super conductivity: Properties of superconductors. London equations, quantum explanation of super conductivity, flux quantization, application of super conductors.

Books Recommended

1. William D. Callister, Jr. "Materials Science and Engineering" John Wiley and Sons, Inc. New York , 1997
2. Dekker A.J. , "Solid State Physics" Macmillan, India Limited , Madra, 1991.
3. Azaroff. L.V " Introduction to Solid", Tata Mc Graw Hill , New Delhi, 1992
4. RaghvanV. " Material Science and Engineering ", Prentice Hall of India, New Delhi, 1998
5. Kittal "Solid State Physics" Wiley Eastern Limited, New Delhi, 1987

CS-207 Object Oriented Programming [3 0 0 3]

Object oriented thinking: Need for oop paradigm, A way of viewing world – Agents, responsibility, messages, methods, classes and instances, class hierarchies (Inheritance), method binding, overriding and exceptions, summary of oop concepts, coping with complexity, abstraction mechanisms.
Java Basics: History of Java, Java buzzwords, data types, variables, scope and life time of variables, arrays, operators, expressions, control statements, type conversion and costing, simple java program, classes and objects – concepts of classes, objects, constructors, methods, access control, this keyword, garbage collection, overloading methods and constructors, parameter passing, recursion, string handling.
Inheritance: Hierarchical abstractions, Base class object, subclass, subtype, substitutability, forms of inheritance- specialization, specification, construction, extension, limitation, combination, benefits of inheritance, costs of inheritance. Member access rules, super uses, using final with inheritance, polymorphism- method overriding, abstract classes.
Packages and Interfaces: Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, differences between classes and interfaces, defining an interface, implementing interface, applying interfaces, variables in interface and extending interfaces. Exploring packages – Java.io, java.util.
Exception handling and multithreading: Concepts of exception handling, benefits of exception handling, Termination or resumptive models, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes. Differences between multi threading and multitasking, thread life cycle, creating threads, synchronizing threads, daemon threads, thread groups.

Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes, inner classes.The AWT class hierarchy, user interface components- labels, button, canvas, scrollbars, text components, check box, check box groups, choices, lists panels – scrollpane, dialogs, menubar, graphics, layout manager – layout manager types – boarder, grid, flow, card and grib bag.
Applets: Concepts of Applets, differences between applets and applications, life cycle of an applet, types of applets, creating applets, passing parameters to applets.
Swing: Introduction, limitations of AWT, MVC architecture, components, containers, exploring swing-JApplet, JFrame and JComponent, Icons and Labels, text fields, buttons – The JButton class, Check boxes, Radio buttons, Combo boxes, Tabbed Panes, Scroll Panes, Trees, and Tables.
Networking: Basics of network programming, addresses, ports, sockets, simple client server program, multiple clients, Java .net package Packages – java.util,

Books Recommended

1. An Introduction to programming and OO design using Java, J.Nino and F.A. Hosch, John wiley & sons.
2. An Introduction to OOP, second edition, T. Budd, pearson education.
3. Introduction to Java programming 6th edition, Y. Daniel Liang, pearson education.
4. An introduction to Java programming and object oriented application development, R.A. Johnson-Thomson.
5. Core Java 2, Vol 1, Fundamentals, Cay.S.Horstmann and Gary Cornell, seventh Edition, Pearson Education.

CH-212 Chemical Technology Laboratory [0 0 2 1]

1. To determine the acid value of a vegetable oil and lubricating oil.
2. To determine the saponification value of vegetable oil
3. To estimate the given reducing sugar
4. To estimate the given non reducing sugar
5. To study loss on Heating of Tar and Bitumen
6. To determine the sediment in Crude Petroleum and Fuel oils
7. To determine the viscosity of a given sample by Redwood Apparatus
9 To standardize the given Fehling's solution.
10. To study the given polymerization reaction
11. To determine the viscosity of a given sample by U-tube viscometer

PH -224 Material Science and Engineering Laboratory [0 0 2 1]

1. To determine the resistivity of a semiconductor by four –probe method.
2. To estimate the band gap energy of seminconductor .
3. To determine the Hall coefficient of a semiconductor and hence to estimate the charge carrier concentration
4. To calibrate an electromagnet
5. To determine the magnetic susceptibility of paramagnetic salt by Guoy's balance method.
6. To find energy loss due to hysteresis for the material of given metal ring using a C.R.O
7. To investigate creep of a copper wire at room temperature.

8. To find young's modulus, modulus of rigidity and Poisson's ratio for the material of a given wire by Searle's method.
9. To study the elastic behaviour of solid using composite Piezo- electro oscillator
10. To study cooling curve a binary alloy
11. To test the given cement sample using autocalve
12. To determine the permittivity of a given material using parallel capacitor
13. To verify Richerdson's equation of thermionic emission
14. To study the magnetization and de-magnetization behaviour of ferromagnetic rod by magnetometer method.

CS-217 Object Oriented Programming Laboratory [0 0 2 1]

Objectives:

To make the student learn a object oriented way of solving problems.
To teach the student to write programs in Java to solve the problems

1 Write a Java program that prints all real solutions to the quadratic equation ax2 + bx + c = 0. Read in a, b, c and use the quadratic formula. If the discriminant b2 -4ac is negative, display a message stating that there are no real solutions.

2 The Fibonacci sequence is defined by the following rule:
The fist two values in the sequence are 1 and 1. Every subsequent value is the sum of the two values preceding it. Write a Java program that uses both recursive and non recursive functions to print the nth value in the Fibonacci sequence.

3 Write a Java program that prompts the user for an integer and then prints out all prime numbers up to that integer.
a) Write a Java program to multiply two given matrices.
b) Write a Java Program that reads a line of integers, and then displays each integer, and the sum of all the integers (Use StringTokenizer class of java.util)

4 Write a Java program that checks whether a given string is a palindrome or not. Ex: MADAM is a palindrome.
a) Write a Java program for sorting a given list of names in ascending order.
b) Write a Java program to make frequency count of words in a given text.

5 Write a Java program that reads a file name from the user, then displays information about whether the file exists, whether the file is readable, whether the file is writable, the type of file and the length of the file in bytes.
a) Write a Java program that reads a file and displays the file on the screen, with a line number before each line.
b) Write a Java program that displays the number of characters, lines and words in a text file.

6 Write a Java program that:
Implements stack ADT.
Converts infix expression into Postfix form
Evaluates the postfix expression

7 Develop an applet that displays a simple message.
a) Develop an applet that receives an integer in one text field, and computes its factorial Value and returns it in another text field, when the button named "Compute" is clicked.

8 Write a Java program that works as a simple calculator. Use a grid layout to arrange buttons for the digits and for the +, -,*, % operations. Add a text field to display the result.

9 Write a Java program for handling mouse events.

a) Write a Java program that creates three threads. First thread displays “Good Morning” every one second, the second thread displays “Hello” every two seconds and the third thread displays “Welcome” every three seconds.

b) Write a Java program that correctly implements producer consumer problem using the concept of inter thread communication.

10 Write a program that creates a user interface to perform integer divisions. The user enters two numbers in the textfields, Num1 and Num2. The division of Num1 and Num2 is displayed in the Result field when the Divide button is clicked. If Num1 or Num2 were not an integer, the program would throw a NumberFormatException. If Num2 were Zero, the program would throw an ArithmeticException Display the exception in a message dialog box.

11 Write a Java program that implements a simple client/server application. The client sends data to a server. The server receives the data, uses it to produce a result, and then sends the result back to the client. The client displays the result on the console. For ex: The data sent from the client is the radius of a circle, and the result produced by the server is the area of the circle. (Use java.net)

12 Write a java program that simulates a traffic light. The program lets the user select one of three lights: red, yellow, or green. When a radio button is selected, the light is turned on, and only one light can be on at a time No light is on when the program starts.

b) Write a Java program that allows the user to draw lines, rectangles and ovals.

13 Write a java program to create an abstract class named Shape that contains an empty method named number Of Sides ( ).Provide three classes named Trapezoid, Triangle and Hexagon such that each one of the classes extends the class Shape. Each one of the classes contains only the method number Of Sides ( ) that shows the number of sides in the given geometrical figures.

b) Suppose that a table named Table.txt is stored in a text file. The first line in the file is the header, and the remaining lines correspond to rows in the table. The elements are seperated by commas. Write a java program to display the table using Table component.

Syllabus of V Semester

CH- 301 Mass Transfer-I [3 1 0 4]

Mass Transfer Operations: Classification of mass transfer operation, choice of separation methods.

Diffusion in Mass Transfer: Steady state molecular diffusion in fluids at rest and in laminar flow, molecular diffusion in gases, molecular diffusion in liquids, diffusivity in liquids and gases, momentum and heat transfer in laminar flow.

Mass Transfer Coefficient:Local and overall mass transfer coefficient, heat and mass transfer analogy, eddy diffusivities, film theory, penetration theory, surface renewal theories, combination film theory and surface stretch theory.

Interphase Mass Transfer: Equilibrium, local two phase mass transfer coefficients, Local overall Mass Transfer coefficients, material balance for co current & counter current processes, cascades and concept of Ideal stage and stage efficiencies, continuous contact equipments.

Gas Absorption: Choice of solvent, Estimation of number of ideal stages – Graphical and Analytical methods, Minimum solvent flow rate, Significance of absorption factor, number of transfer units and height of a transfer unit (NTU & HTU) concepts, packed column for absorption, rate of absorption, height of column based on condition in gas film and liquid film, height based on overall coefficients, equipment for gas absorption

Drying: Equilibrium in drying, batch drying and rate of batch drying, time of drying, Through circulations drying & continuous drying, batch & continuous drying equipments.

Books Recommended

1. Geankopolis C J, "Transport Processes and Separation Process Principles", Prentice Hall of India, 4th Edition, Eastern Economy Edition (2004)
2. Treybal R E , "Mass Transfer Operations" 3rd ed. , McGraw Hill (1980)
3. McCabe W L and Smith J C "Unit Operations of Chemical Engineering", McGraw Hill (2001).
4. Coulson J M and Richardson J F "Chemical Engineering , Vol. 2, 5", McGraw Hill (1999)
5. Walter L, Badger & Julius T.Banchero "Introduction to Chemical Engineering", McGraw Hill (1997)

CH- 303 Chemical Reaction Engineering - I [3 1 0 4]

Introduction: Kinetics of homogeneous chemical and biochemical reactions, single and multiple reactions, order & molecularity, rate constant, elementary and non elementary reactions, temperature dependent term of rate equation,

Interpretation of Batch Reactor: Constant volume batch reactor, integral method of analysis of data, series and parallel reactions, reversible reactions, Variable volume batch reactor, Differential methods of analysis, Temperature and reactions rate.

Introduction to Reactor Design: Ideal batch reactor, mixed flow reactor, plug flow reactor, holding and space time, design for single reactions, size comparison (analytical and graphical method, plug flow reactors in series & parallel, mixed reactor in series , recycle reactors.

Design for Multiple Reactions: Reactions in parallel and series in C.S.T.R, reactions in parallel and series in Plug flow reactor, yield & selectivity.
Temperature and Pressure Effect: General design procedure, optimum temperature progression, adiabatic operation, non adiabatic operation, semi batch reactors.
Non Catalytic Fluid Solid Reactions: Selection of model, unreacted core model for spherical particles, diffusion through gas film control, diffusion through ash layer control, chemical reaction control, Design.

Books Recommended

1. Levenspiel O, "Chemical Reaction Engineering", 3rd Ed, John Wiley & Sons, Singapore (1999).
2. Fogler H Scott, "Elements of Chemical Reaction Engineering", 3rd ed, Prentice Hall Inc. (1999).
3. Smith J M, "Chemical Engineering Kinetics", McGraw Hill, 3rd ed. (1981).
4. Hill, C G, "Chemical Engineering Kinetics and Reactor Design", John Wiley (1977).
5. Coulson J M and Richardson J F, "Chemical Engineering Volume 3", Pergamon Press (1999**).**

CH- 305 Petroleum Refining Engineering [3 1 0 4]

Introduction to petroleum industry. World petroleum resources, petroleum industries in India.
Scope and Purpose of Refining: Global and Indian refining scenario, Petroleum refining industry in India practice and prospects, An overview of the entire spectrum of the refinery products, refinery configuration development, Physio chemical characteristics of Petroleum and Petroleum products
Refinery Distillation Processes: Desalting and Stabilization of crude, Process description of typical simple distillation, Fractional distillation, crude oil distillation, vacuum distillation etc, Degree of separation (5-95 gap) and degree of difficulty of separation (Δ t 50), Packie charts, ASTM, TBP and EFV Distillation.
Fuel Refining: Cracking, coking, reforming, alkylation, isomerisation, polymerization, sweetening, visbreaking.
Lube Refining: Solvent extraction, dewaxing, propane deasphalting.
Wax Refining: Deoiling of crude wax, crystallization, catalytic, sweating microcrystalline and petroleum wax applications.
Hydro processing: Hydro cracking, hydro treating, hydro finishing.
Refinery Feedstock: Nature and effect of different types of refinery feedstock and their impurities on refinery configuration and operation.
Refinery Gas Processing: Process description of typical light ends unit, acid gas removal using gas treating processes.
Two Phase oil and gas separation equipment : Types, their description , vessel sizing . Theory of separation and separator design.
Three phase Oil gas and water separators : Types of separators, their description. Various control and vessel internals, theory and sizing of three phase separator . LACT units.
Safety and pollution considerations in refineries. Treatment methods, Sweetening, hydrodesulphurization, smoke point improvement.

Books Recommended

1. Nelson W L, "Petroleum Refinery Engineering", Mc Graw Hill Book Co. 1985)

2. Watkins R N, “Petroleum Refinery Distillation”, Gulf Publishing Co.
3. Gary J H and Handework G E, “Petroleum Refining Technology and Economics”, Marcel Dekker, Inc. (2001).
4. Jones D S J, “Elements of Petroleum processing”, John Wiley & Sons (1995)
5. Waquier J P, “Petroleum Refining” Vol. I & II Editions, Technip (1995)
6. Guthre, V.B., "Petroleum Products", Hand-Book McGraw Hill.

CH-307 Industrial Instrumentation [3 0 0 3]

General principles of measurement.
Static and dynamic characteristics of instruments.
Temperature Measurement: Thermocouples, resistance thermometers, thermistors, optical and radiation pyrometers.
Pressure Measurement: Use of manometers, Bourdon gauge, bellows type gauge, measurement of vacuum and pressure transducers.
Flow Measurement: use of obstruction type meters. Variable area meters. Pressure probes, positive displacement type meters.
Liquid level Measurement: Direct and differential method, measurement in open and pressure vessels, measurement of liquid.
Measurement of Viscosity, Conductivity, Humidity and pH.
Measurement of nuclear radiation. Instrument for gas analysis, gas chromatography, mass spectroscopy.
Industrial weighing and feeding systems.
Process instrumentation, recording instruments, indicating and signalling instruments, transmission of instrument reading, control centre, instrumentation diagram, instrumentation in modern plant.

Books Recommended

1. Eckman D P, “Industrial Instrumentation”, Wiley Eastern Ltd (1975).
2. Kerk F W, Rimboi W, and Tarapore R, “Instrumentation”, Wiley and Sons (1983).
3. Considine D N, “Process Instruments and Controls Handbook”, McGraw Hill (2001).
4. Andrew W G,” Applied instrumentation in the Process Industries Vols I,II,III” Gulf Publishing Company (1987).
5. Instrument Society of America Instrumentation in the chemical and petrochemical Industries Vol 8 (1984).

CH-311 Heat Transfer Laboratory [0 0 2 1]

1. Determination of emmissivity of the given test plate
2. Determination of thermal conductivity of the given liquid
3. Determination of thermal conductivity of insulating powder
4. Determination of heat transfer coefficient by forced convection
5. Determination of heat transfer coefficient for pin fin by natural convection
6. Determination of heat transfer coefficient for pin fin by forced convection
7. Determination of overall heat transfer for parallel flow in double pipe heat exchange
8. Determination of overall heat transfer coefficient for counter flow in double pipe heat exchanger
9. To conduct test on heat pipe and comparison of the temperature distribution

10. Determination of heat transfer coefficient in shell & tube heat exchanger
11. Determination of overall heat transfer coefficient in an open pan evaporator
12. Determination of heat transfer coefficient by dropwise and filmwise condensation

CH-313 Energy Technology Laboratory [0 0 2 1]

1. To determine the flash point of a given sample
2. To determine the Smoke Point of a given sample
3. To study the Distillation of Petroleum Products
4. To determine the calorific value of a fuel using Peroxide Bomb Calorimeter
5. To estimate the moisture content in the given coal sample
6. To determine the Cloud Point and Pour Point of a given sample
7. To study the burning properties of the given sample
8. To determine the Melting Point of Petroleum wax

CH-315 Process Plant Design-1 [0 0 2 1]

Introduction: Introduction to principles involved in the design and construction of plant.
Design preliminaries: Design codes, pressure, temperature, factor of safety, corrosion allowance, weld joint efficiency factor, design loadings, Poisson's ratio, dilation of pressure vessels, criteria of failure, material of construction.
Storage tanks: Introduction to Indian standards for storage tanks and their use to design cylindrical and spherical vessels under internal pressure, fixed roof and open roof tanks.
Mechanical design: Mechanical design of tall vessels for distillation and absorption columns.
Design of supports: Design of supports for vertical and horizontal vessels.

Books Recommended

1. Bhattacharya B C, "Chemical Equipment Design", CBS Publisher (1985).
2. Sinnott R K, Coulson & Richardson, "Chemical Engineering (Vol.6)", 2nd Ed, Butterworth Heinemann, Oxford (1998).
3. Ludwig E E, "Applied Process Design for Chemical and Petrochemical Plants (Vol. 1, 2 and 3)", 3rd Ed., Gulf Publishing Company, Houston (1995).
4. Perry's, "Handbook of Chemical Engineering", 7th Ed, McGraw Hill (1997).
5. Ulrich, G D, "A Guide to Chemical Engineering Process Design and Economics", John Wiley (1984).

Syllabus of VI Semester

CH-302 Process System Analysis & Control [3 1 0 4]

Introduction

Laplace Transform: Transforms of simple function, Transforms of Derivative, Initial value theorem and Final value theorem, Transform of Integral

Response of First order system: Mercury thermometer & its transfer function, Forcing functions, Liquid Level System, Liquid Level Process with constant flow out let, Linearization, Mixing tank & R.C. Circuit

Response of First order system in series: Non interacting System, Interacting System

Higher order System: Transfer function of second order system, under damped System, Impulse function, Sinusoidal function, Transportation lag

Control System: Components of control system, block diagram, Negative and Positive feed back, Servo problem and Regulation Problem, Development of Block diagram

Controllers and final control element: Control Valve, Proportional controller, Integral & Derivative controller, Comparison.

Closed Loop Transfer functions: Determination of transfer function

Transient response of control system: Proportional control for set point change, Proportional control for load change, Proportional Integral control for load change, Proportional Integral Control for set point change

Stability: Concept of stability, Stability Criteria, Routh test for stability

Introduction to frequency response: Bode diagram for first order, Bode diagram for proportional, Integral and derivative control, Second order system

Control System Design by frequency response: Bode stability criteria, Gain and phase Margin, Ziegler Nichols Controller settings,

Introduction to State-Space Methods: State Variables, State space description, selection of state variables.

Books Recommended

1. Coughanower D R, “Process System Analysis and Control”, McGraw Hill, 2nd ed. (1991)
2. Seborg, Edgar, and Mellichamp, “Process Dynamics & Control”, John Wiley 2nd. Ed. (2004)
3. Harriot, “ Process Control”, Tata Mcgraw Hill (2000)
4. Stephanopoulos,” Chemical Process Control - An Introduction To Theory & Practice”, Ist Ed., Prentice Hall of India Private Limited (2003).
5. Luyben W L, “Essentials Of Process Control” McGraw Hill (1997).

CH-304 Mass Transfer –II [3 1 0 4]

Mass Transfer equilibria for vapour - liquid, liquid – liquid, solid - liquid and solid- gas systems

Distillation : Raoult’s Law and Dalton’s law, partial vaporisation and partial condensation, relative volatility, differential distillation & flash distillation, steam distillation, Lewis Sorel and McCabe –Thiele methods & numerical, Ponchon Savarit method, Underwood and Fenske equations, total reflux , minimum and optimum reflux ratios, multiple feeds and side streams

Liquid – Liquid Extraction: Ternary phase diagrams & choice of solvent, single stage and multistage cross current, co-current and counter current extraction operation for immiscible and miscible solvents, related numerical problems, continuos contact extractors.
Leaching: Mass transfer in leaching, equipment for leaching, single stage and multistage cross current, co-current and counter current leaching operations, related numerical problems
Adsorption: Introduction and the nature of adsorbent, adsorption equilibria, the Langmuir isotherm , BET isotherm and Gibbs isotherm, potential theory and adsorption equipments.
Crystallization: Formation of nuclei, nuclei growth and properties of crystals, effect of impurities on crystals formation, effect of temperature on solubility, caking of crystals, yield of crystals, crystallisers, related numerical problems

Books Recommended

1. Geankopolis C J, "Transport Processes and Separation Process Principles", Prentice Hall of India, 4th Edition, Eastern Economy Edition (2004)
2. Treybal R E , "Mass Transfer Operations" 3rd ed. , McGraw Hill (1980)
3. McCabe W L and Smith J C "Unit Operations of Chemical Engineering", McGraw Hill (2001).
4. Coulson J M and Richardson J F "Chemical Engineering , Vol. 2, 5", McGraw Hill (1999)
5. Walter L, Badger & Julius T.Banchero "Introduction to Chemical Engineering", McGraw Hill (1997).

CH-306 Chemical Reaction Engineering – II [3 1 0 4]

Non Ideal Flow: Non ideal flow patterns, E,F &C Curve, Mean residence time, Models for non ideal flow, N Tanks in series model, conversion in a reactor using RTD data .Heterogeneous Process: Global rates of reaction, Types of Heterogeneous reactions Catalysis, The nature of catalytic reactions, Mechanism of catalytic reactions. Physical Adsorption and Chemisorption : Physical adsorption and Chemisorption, Adsorption isotherms, Assumptions,Rates of adsorption isotherm, problems.
Solid Catalysts: Determination of surface area, Void volume and solid density, Pore volume distribution, Theories of heterogeneous catalysis, Classification of catalysts, catalyst preparation, Promoter and inhibitors, Catalysts Deactivation
Rate Equations for Fluid solid catalytic reactions: Rates of Adsorption, Surface reaction, Desorption , Rate limiting step, Power Law, Langmuir Hishelwood rate, Eley Rideal mechanism , Packed bed reactor and fluidized bed reactor, Numerical Problems
Intra Pellet Mass Transfer : Gaseous diffusion in single cylindrical pore, Different modes of diffusion: Bulk diffusion, Knudsen diffusion and surface diffusion, Diffusion in Liquids, Diffusion in Porous Catalyst, Concepts of effective thermal conductivity and effective diffusivity, Effectiveness factors
Reactors: Fixed Bed Catalytic Reactor, Single and multibed adiabatic reactors, Multitubular fixed bed reactor
Introduction to Fluid Reactions: Kinetic Regimes for Mass Transfer and Reaction, Film Conversion parameter, Clues to the kinetic Regime from solubility data, Clues to the Kinetic Regime from equipment, Applications to design

Books Recommended

1. Levenspiel O, "Chemical Reaction Engineering", 3rd Ed, John Wiley & Sons, Singapore (1999).
2. Fogler H Scott, "Elements of Chemical Reaction Engineering", 3rd Ed, Prentice Hall Inc. (1999).
3. Smith J M, "Chemical Engineering Kinetics" , McGraw Hill , 3rd ed. (1981).
4. Hill, C G, "Chemical Engineering Kinetics and Reactor Design", John Wiley (1977).
5. Coulson J M and Richardson J F, "Chemical Engineering Volume 3", Pergamon Press (1999).

CH-312 Mass Transfer Laboratory [0 0 2 1]

1. To plot the ternary phase diagram for acetic-acid – water Toluene
2. To draw the tie line and to determine plait point for ternary system
3. To determine the diffusivity of acetone in air
4. To study the drying characteristics of the given wet material (Natural Convection)
5. To determine the Mass Transfer Coefficient for vaporization of naphthalene in air
6. To verify Rayleigh's Equation for Batch distillation
7. To find HETP and HTU for packed distillation column
8. To purify turpentine oil having high boiling point using steam distillation
9. To determine VLE data for methanol –water and to compare it with literature data
10. To determine the mass transfer coefficient by carrying out liquid-liquid extraction in a packed column using acetic acid- toluene-water system
11. To study the drying characteristics of the given wet material (forced convection)
12. To study the process of crystallization in an agitated batch crystallizer and to plot a graph between weight of crystals Vs temp.
13. To find out mass transfer coefficient in a drop wise liquid –liquid extraction.

CH-314 Chemical Process Control and Reaction Engineering Laboratory [0 0 2 1]

1. Determination of rate constant for saponification reaction in a batch reactor
2. Determination of porosity and sphericity of the given catalyst.
3. Study of RTD in a Packed bed reactor
4. Study of RTD in a Trickle bed reactor
5. To study the adsorption of acetic acid on charcoal and prove the validity of Freundlich and Langmuir adsorption isotherm
6. To study the adsorption of oxalic acid on charcoal and prove the validity of Freundlich and Langmuir adsorption isotherm
7. Determination the time constant of a given Mercury Thermometer.
8. Determination of time constant in a liquid level tank
9. Determination of time constant in a heated tank
10. To study the effect of proportional controller in a liquid level tank
11. To study the effect of proportional Integral controller in a liquid level tank
12. To study the effect of proportional – Integral and derivative controller in a liquid level tank.

Syllabus of VII Semester

CH-401 Transport Phenomena [3 0 0 3]

Summary of vector and tensor Notation: Vector operations from a geometrical view point. Vector operation from an analytical view point, the vector differential operations, second order tensors, vector and tensor components in curvilinear coordinates, differential operations in curvilinear coordinates.

Momentum Transport: Viscosity and the mechanism of momentum transport, Newton's law of viscosity, non- Newtonian fluids, pressure and temperature dependence of viscosity, theory of viscosity of gases at low density, theory of viscosity of liquids.

Velocity Distributions in Laminar Flow: Shell momentum balances: boundary conditions, flow of a falling film, flow through a circular tube, flow through an annulus, adjacent flow of two immiscible fluids.

The Equations of Change for Isothermal Systems: To equation of continuity, the equation of motion, the equation of mechanical energy.

Thermal Conductivity and the Mechanism of Energy Transport: Fourier's Law of heat conduction, temperature and pressure dependence of thermal conductivity in gases and liquids, theory of thermal conductivity of gases at low density, theory of thermal conductivity of liquids, thermal conductivity of solids.

Temperature Distributions in solids and in Laminar Flow: Shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a chemical heat source, heat conduction through composite walls: Addition of Resistance, Forced Convection, Free Convection.

The Equations of change for Nonisothermal systems: The equations of energy, the energy equation in curvilinear coordinates, the equations of motion for forced and free convection in nonisothermal flow, summary of the equations of change, use of equation of change to set up steady – state heat transfer problems.

Diffusivity and the Mechanism of Mass Transport: Definition of concentrations, velocities and mass fluxes, fick's law of diffusion, theory of ordinary diffusion in gases at low density, theory of ordinary diffusion in liquids.

Concentration Distributions in Solid and in Laminar Flow: Shell mass balances: boundary conditions, diffusion through a stagnant gas film, diffusion with heterogeneous chemical reaction, diffusion with homogeneous chemical reaction, diffusion into a falling liquid film l forced – convection mass transfer,

Analogies between Heat, mass and momentum and transfers

Books Recommended

1. Bird R B, Stewart W E and Light fort R N, "Transport Phenomena", John Wiley and Sons (2002).
2. Welty J R , Wilson R E and Wicks C E , "Fundamentals of Momentum , Heat and Mass Transfer",4th ed,John Wiley and Sons (2001).
3. John C Slattery, "Momentum, Energy and Mass transfer in continua", McGraw Hill, Co. (1972).

4. Bennet C U and Myers J E, " Momentum, Heat and Mass Transfer" Tata McGraw Hill Publishing Co. (1975)
5. Robert S Brodkey and Harry C Hersing, "Transport Phenomena a Unified approach" McGraw Hill Book Co. (1988).

CH-403 Environmental Pollution Control Engineering [3 0 0 3]

Types of Pollution

Air Pollution, Water Pollution, Noise Pollution, Soil Pollution, Marine Pollution, Land and Agriculture Pollution, Thermal Pollution, Biomedical and Radioactive Pollution

Legislation for Biodiversity Protection

Environmental Laws, Acts, Rules and Regulations, National Conservation Strategy and Policy Statement on Environment and Development, Policy Statement for Abatement of Pollution

Current Environmental Issues

Global Warming and Greenhouse Effect, Global Ozone Problem, Acid Rain, Global Carbon Dioxide Rise and Impact, Vehicular Pollution, Environmental Toxicology, Environmental Degradation, Energy Management, Remote Sensing, Natural Disaster, Environmental Biotechnology

Air Pollution Control Engineering

Introduction, Definition, Sources, Characteristics and Perspective of Air Pollutants, Effects of Air Pollution on Biodiversity, Economic Effects of Air Pollution, Air Quality and Emission Standards, Engineering Systems of Control of Air Pollution by Equipment and by Process Changes

Water Pollution Control Engineering

Introduction, Definition, Sources, Characteristics and Perspective of Water and Wastewater Pollutants, Effects of Water Pollution on Biodiversity, Economic Effects of Water Pollution, Water Quality and Emission Standards, Physical, Chemical and Biological Parameters, Engineering Systems of Control of Water and Wastewater Pollution by Primary, Secondary and Advance Treatment

Solid Waste Management

Introduction, Definition, Sources, Characteristics and Perspective of Solid Waste, Generation, Separation, Handling, Storage and Transportation of Solid Waste, Chemical and Biological Treatment of Solid Waste

Books Recommended

1. Rao M. N. and Rao H. V. N., "Air Pollution", Tata McGraw Hill Publishing Company Ltd., (2005).
2. Peavy H. S., Rowe D. R. and Tchobanoglous G., "Environmental Engineering", McGraw Hill Book Company, International Edition (1985).
3. Metcalf and Eddy, Inc., "Wastewater Engineering-Treatment and Reuse", Tata McGraw Hill Publishing Company Ltd., Fourth Edition (2004).
4. Rittmann B. E. and McCarty P. L., "Environmental Biotechnology: Principles and Application", McGraw Hill International Editions, First Edition (2001).
5. Garg S. K., Garg R. and Garg R., "Ecological and Environmental Studies", Khanna Publishers, First Edition (2006).

CH-405 Safety in Chemical Plants [3 0 0 3]

Introduction: Concept of Loss prevention, acceptable risks, accident and loss statistics, nature of accident process, inherent safety.
Toxicology: Dose vs response, toxicants entry route, models for dose and response curves, TLV and PEL
Industrial Hygiene: Identification, Material safety data sheets, Industrial hygiene evaluation, and control
Basics of Fires and Explosion: Fire triangle, definitions, flammability characteristics of liquid and vapors, LOC and inerting, types of explosions
Designs for fire prevention:
Hazard identification: Hazard survey, checklist, HAZOP, safety reviews, what if analysis
Risk Assessment: probability theory, event tree, fault tree, QRA and LOPA, Dow's fire and explosion index, Mond index, Dow's Chemical release model
Accident Investigations:
Case Histories
Bhopal gas tragedy, flixborough disaster, Pasadena accident, IOCL disaster

Recommended Books

1. Crowl D A, Louvar J F, " Chemical Process Safety Fundamentals with applications", 2nd Prentice Hall, NJ (2002).
2. Coulson J M and Richardson J F , "Chemical Engineering",2nd , Vol 6, Pergamon, press (1999).
3. Dow Chemical Company, Dow's Chemical Exposure Index Guide, 1993, New York
4. Lees F P , Loss prevention in process Industries, 2nd ed, Butterworth, London, (1996)
5. Wells G L, Safety in process Plant Design, George godwin ltd., New York, (1980)

CH-411 Computational Techniques in Chemical Engineering Laboratory [0 0 2 1]

1. Estimation of Molar Volume and Compressibility Factor from Van Der Waals
2. Estimation of Molar Volume and Compressibility Factor from Redlich-Kwong
3. Fitting Polynomials and Correlation Equations to Vapor Pressure Data.
4. Fitting Parameters in the Monod Equation for a Batch Culture
5. Estimation of Vapor Pressure Correlation by Clapeyron and Antoine Equations
6. Gas Volume Calculations Using Various Equations of State
7. Estimation of specific volume of a non-ideal gas following Van der Waals equation by solving non-linear equation using Newton Raphson Method.
8. Bubble Point Calculation for an Ideal Binary Mixture
9. Dew Point Calculation for an Ideal Binary Mixture
10. Estimation of Adiabatic Flame Temperature in Combustion
11. Estimation of Antoine Equation Parameters Using Nonlinear Regression
12. Calculations involving Flash Evaporation of an Ideal Multicomponent Mixture
13. Solution of simultaneous material balance equations using Gauss Jordan elimination method
14. To study the transient behaviour of Continuous stirred tank reactor.
15. Numerical integration over batch reactor to find time using Simpson's rule/ trapezoidal rule

CH-413 Process Plant Design-II [0 0 2 1]

Heat exchangers: Classification of shell and tube heat exchanger, material of construction, cleaning of heat exchangers, heat transfer fluid, agitated vessels, description of shell, tubes, bonnet and channel, pass partition plate, nozzle, baffles, tie rods, baffle spacers, flanges, gaskets and expansion joints. Design of heat exchangers: Energy balance, heat duty consideration and process design of double pipe and shell and tube heat exchangers. Mass Transfer Equipments: Types of mass transfer equipments, packed and tray type towers.
Tray Hydraulics: Bubble cap columns, perforated plate columns and packed towers
Process Design: Process design of tray and packed towers.

Books Recommended

1. Kern D Q, "Process Heat Transfer", McGraw Hill (2001)
2. Perry's, "Handbook of Chemical Engineering" McGraw Hill, 7th Ed (1997).
3. Coulson J M and Richardson R E, "Chemical Engineering" Vol 2 and 6, Pergamon Press (1998).
4. Van Winkle M, "Distillation", Ist Ed. , McGraw Hill Company, New York (1967).
5. Ludwig E E, "Applied Process Design for Chemical and Petrochemical Plants (Vol. 1,2 and 3)", 3rd Ed., Gulf Publishing Company, Houston (1995)

CH-415 Industrial Practical Training [0 0 0 4]

Each student is required to undergo compulsory 6-8 months practical training in reputed industry/ CSIR Laboratory or any institute of National Importance including National Institute of Technology, Jalandhar etc as approved by the Department.

CH-400 Project (Phase –I) [0 0 4 2]

Every student will be required to submit a project report in a typed form, on a topic selected by the student, but specifically approved by the faculty member, who will guide the student or on a topic to be assigned by one or more faculty members.
The project work on the topic will consist of either some investigational work, computer simulation or design problem or experimental set up of some development work of or prototype equipment. Every student will be orally examined in the topic incorporated in the project and in the project and in the related area of specialization.
The student will be required to submit three copies of his/her project report to the department office for record. One copies each for the department library, participating faculty and students own copy.

Syllabus of VIII Semester

CH-402 Process Economics and Management [3 0 0 3]

Cost Estimation: Factors affecting investment & production costs, Capital investments (Fixed and working capital), Types of capital cost estimates, Cost Indexes, Estimating equipment costs by scaling 6/10 Factor Rule, Purchase Equipment Installation , Insulation costs, Instrumentation & Control, Piping , Electrical Installation , Service facilities, Land, Engineering . & Supervision , Start –up expenses. Methods of Estimating Capital Investment, Estimation of total product cost, Different costs involved in the total product for a typical Chemical Process plant.

Interest & Investment Costs: Types of interest (simple & compound interest), Nominal & Effective Rates of interest, Continuous interest, Present worth & discounts, perpetuities, capitalized costs, Interest & Investment costs.Taxes & Insurance: Types of taxes, Property taxes, excise taxes, income taxes, Types of Insurance & Legal Responsibility.

Depreciation: Purpose of Depreciation as cost, Types of Depreciation, Depletion, Service life., Salvage value, Present value, Methods of Determining Depreciation , Straight- line method, Declining Balance Method, Sum of the years Digits method, Sinking Fund Method, Single Unit & Group Depreciation.

Profitability, Alternative Investments & Replacement: Profitability standards, Mathematical methods of profitability evaluation: Rate of return on investment, Discounted cash flow method, Net Present worth, Capitalised costs, pay out period. Determination of Acceptable investment, Alternatives when an investment must be made, Alternative analysis by method of return on incremental investment, Alternative analysis incorporating minimum return as a cost, Replacements, Balance sheets & Income statement.

Optimum Design: General procedure for Determining optimum conditions, Procedure with one variable, Procedure with Two or More variables, Break even chart for production schedule and its significance for optimum analysis. Examples of optimum design in a Chemical Process Plant.

Books Recommended

1. Peters, M S & Timmerhaus K D,"Plant Design and Economics for Chemical Engineers", McGraw Hill , New York , 4th Edition (2003)
2. Ulrich , G D,"A Guide to Chemical Engineering Process Design and Economics", John Wiley (1984)
3. Guthrie K M, " Process Plant Estimation, Evaluation and Control", Craftsman Solano Beach, California (1974)
4. Douglas, " Conceptual Design of Chemical Processes", McGraw Hill (1998)
5. Valle Riestra , "Project Evaluation in Chemical Process Industries", McGraw Hill

CH-404 Process Modeling and Simulation [3 0 0 3]

Introduction: Definition of mathematical model, lumped parameter models, distributed parameter models, uses of mathematical models, scope of coverage, principles of formulation.

Fundamental laws: Continuity equations, energy equations, equation of motion, equations of state, equilibrium, chemical kinetics.

Mathematical Models for Chemical Engineering Systems: Series of isothermal constant holdup CSTRs, CSTRs with variable holdups, Two heated tanks, Non-isothermal CSTR, Single component vaporizer, Batch reactor,Ideal binary distillation column, Batch distillation with holdup, pH

systems, Lumped parameter model of gas absorber, Model foe heat exchanger, Model for interacting & non-intracting tanks, Model for biochemical reaction.
Simulation: Meaning of simulation, Simulation examples of isothermal CSTR, non-isothermal CSTR. Batch reactor.

Books recommended

1. Luyben W L, "Process Modeling Simulation and Control for Chemical Engineers", international ed. McGraw Hill (1990).
2. Rose L M, " The Application of Mathematical Modelling to Process Development and Design", First Ed. Applied Science Publisher Limited., London (1974).
3. Bequette , " Process Dynamics- Modelling, Analysis and Simulation", PHI International (2003).
4. Rase H F, "Chemical Reactor Design for Process Plants, Vol II: Case Studies and Design Data", 1st Ed., John Wiley and Sons, New York (1997)
5. Denn M Morton, "Process Modelling", First Ed. Longman Publisher (1986).

CH-412 Environmental Pollution Control laboratory [0 0 2 1]

To carry out following experiments in the laboratory:

1. To determine the Total Solids of a given sample.
2. To find out Total Dissolved Solids of a given sample.
3. To find out Fixed and Volatile solids of the given sample.
4. To determine Acidity of the given sample.
5. To determine the Alkalinity of the given sample.
6. To determine the Total Hardness of the given sample.
7. To find out amount of Sulphates in a given sample.
8. To estimate the content of Chlorides in the given water sample
9. To find the quantity of the Dissolved Oxygen present in the given sample
10. To determine the BOD of a given wastewater sample.
11. To determine the COD of a given wastewater sample.

CH-414 Process Modelling and Simulation Laboratory [0 0 2 1]

1. Modeling and Simulation of Isothermal CSTR.
2. Modeling and Simulation of non-isothermal CSTR.
3. Modeling and Simulation of isothermal batch reactor.
4. Modeling and Simulation of non-isothermal batch reactor.
5. Modeling and Simulation of distillation column.
6. Modeling and Simulation of heat exchanger.
7. Modeling and Simulation of cyclone separator
8. Modeling and Simulation of CSTRs in series

CH-400 Project (Phase –II) [0 0 8 4]

Every student will be required to submit a project report in a typed form, on a topic selected by the student, but specifically approved by the faculty member, who will guide the student or on a topic to be assigned by one or more faculty members.

The project work on the topic will consist of either some investigational work, computer simulation or design problem or experimental set up of some development work of or prototype equipment. Every student will be orally examined in the topic incorporated in the project and in the project and in the related area of specialization.

The student will be required to submit three copies of his/her project report to the department office for record. One copy each for the department library, participating faculty and students own copy.

Syllabus of Electives

Electives for Fifth Semester

CH-321 Polymer Science and Engineering [3 0 0 3]

Introduction: Concepts and classification of polymers Functionality , Glass transition temperature, Addition, condensation , step- growth and chain –growth polymerization
Molecular weight estimation: Average molecular weight – Number and weight average, Sedimentation and viscosity average molecular weights, Molecular weight and degree of polymerization, Significance of molecular weight.
Polymerization Processes: Bulk, solution, emulsion and suspension polymerization, Comparison of polymerization processes.
Polymerization Kinetics: Chemistry of step reaction polymerization, Mechanism and kinetics of polycondensation reactions and free- radical chain polymerization.
Synthetic Fibres: Types of Fibres, Spinning Techniques, Manufacturing Technology and Applications of different types of fibres: cellulosic fibres, polyamides, acrylics, vinyls and vinylidines, fluorocarbons.
Plastics: Manufacturing Technology and applications of different types of plastics: Polyester, polyethylene, Phenolics, Rubbers, structure, properties and preparation natural rubber synthetic rubbers: SBR, rubber compounding and reclaiming..

Books Recommended:

1. Gowariker V R , Viswanathan N V and Sreedhar J "Polymer Science" New Age International Publishers (1996)
2. Billmeyer F W "Text Book of Polymer Science" Wiley Tappers (1994)
3. Ghosh P, "Polymer Science and Technology of plastics and rubber" Tata McGraw Hill (2001).
4. Gupta R K and Anil Kumar, " Fundamentals of Polymer Engineering", 2nd Ed., Marcel Dekkar (2003)
5. Fried J R "Polymer Science and Technology" PHI

CH- 323 Oil Technology [3 0 0 3]

Introduction: General survey of oils and oil based industries sources of oils and fats, their classification,
General properties of oils: Properties and utilization, composition of glycerides, non-glyceride components, fatty acids, waxes.
Methods of introduction of oils and fats: extraction solvents and extraction rendering, Refining and hydrogenation of oils, Vanspati, margerin shorteming.
Essentials of oil: Soaps raw materials and methods of manufactures, introduction to synthetic detergents. Fat splitting, fractionation of fatty acids and recovery of glycerin. Essential oils and cosmetics.

Books Recommended:

1. Payne H F , Organic coating technology Vol. I & II , Wiley, New York, (1954)
2. Morgans H M , Outlines of Paint technology, 3e, CBS, New Delhi, (2001)

3. Joseph Bijos , Good Painting Practices, Wiley, New York, (1967)
4. Gerhard Buchbauer, Handbook of Essential Oils: Science, Technology, and Applications, CRC, Austria, (2009)

CH-325 Rubber & Plastic Technology [3 0 0 3]

Rubber & elastomers, natual & synthetic chlorinated, oxygenated, cycle rubber, Runa S. Buna N, Butyl rubber, neoprene, thiokols, polyisoprene rubber, polyurethane, Fillers, saccelerators, activators, antioxidants & other additives, mastication & compounding, vulcanization theory & technology, Latex testing, formulation, fabrication, rubbers of commercial importance.
Introduction to Plastics, Polythene, LDPE, Poly Propylene, Copolymers of ethylene, polystyreme, acrylic plastics, Polyvinyl acetate, PVC, Polytetrafluoro ethylene (PTFE), Polymidesm, Polyesters, Polyurethanes, Polycarbonates, cellulose plastics, phenolic resins, Plastic material processing technology; mouldings, extrusion, injection, blow & compression moulding, vaccum forming, compounding, designing with plastics, plastics of commercial importance.

Books Recommended:

1. Gowariker V R , Viswanathan N V and Sreedhar J "Polymer Science" New Age International Publishers (1996)
2. Billmeyer F W "Text Book of Polymer Science" Wiley Tappers (1994)
3. Ghosh P, "Polymer Science and Technology of plastics and rubber" Tata McGraw Hill (2001).
4. Gupta R K and Anil Kumar, " Fundamentals of Polymer Engineering", 2nd Ed., Marcel Dekkar (2003)
5. Fried J R "Polymer Science and Technology" PHI

Electives for Sixth Semester

CH-322 Petroleum Recovery Technology [3 0 0 3]

Petroleum as a resource material: Physical and chemical characteristics of crude oil, origin of oil, source rock and maturation.
Migration of oil-mechanism pattern and barriers, Reservoir rocks and cap rocks, Entrapment of oil-types and mechanism
Reservoir Rock Properties: Porosity, permeability, Effective and relative permeability, wettability, capillary pressure characteristics.
Flow of fluids through porous media: Darcy's law, single and multiphase flow.
Reservoir flow through porous media, drive mechanism, Introduction to enhanced oil recovery methods.
Drilling: Introduction to on-shore and offshore drilling operations, drilling accessories rig components, drilling fluid circulation system.
Production: Production equipment, Introduction to work over and well stimulation method. Two phase oil and gas separation equipment, Types, their description, vessel internal sizing. Theory of separation., Three phase oil- Gas and water separators- type of separators their description, various control and vessel internals. LACT Units.
Storage and handling of Petroleum fluids: Different types of tanks for storage of oil and LPG

Books Recommended :

1. Berger B D, Anderson K E, “Modern Petroleum” Pennwell books
2. Bradley H B, “Petroleum Engineering Handbook”, SPE
3. Cole F W, Reservoir Engineering manual
4. Carl Gatlin , “Petroleum Engineering Drilling and Well Completions” Prentice Hall .
5. Mc Cray and Cole , “ Oil Well Drilling Technology” Oklahoma Press .

CH-324 Natural Gas Engineering [3 0 0 3]

Gas from condensate and oilfields. Scope of Natural gas industry. Basic thermodynamic and system energy concepts in Natural Gas Engineering.

Review of physical and chemical properties of natural gas and associate hydrocarbons. Phase behaviour studies of two phase hydrocarbon systems, equations of states, multiple flashes. Water-hydrocarbon system. Vapour liquid equilibria.

Flow of fluids. Compression calculations. Heat Transfer and Mass Transfer principles and applications in Natural Gas Engineering.

Gas flow measurement. Process control and instrumentation in natural gas processing plants.

Natural Gas Processing. Field separation and oil absorption process. Refrigeration and low temperature processing. Liquification process. Dehydration of Natural Gas sweetening of Natural gas and sulphur recovery, Processing for LPG, LNG, CNG system.

Transmission of Natural Gas. Specifications. Utilization of Natural Gas. Underground storage and conservation of Natural Gas.

Unconventional Gas: Coal Bed Methane, Natural Gas Hydrate.

Conversion of gas to liquid.

Economic consideration for development of gas fields.

Books Recommended :

1. Kumar S, “Gas Production Engineering”, Gulf Publishing Co. (1987)
2. Beggs H D, “Gas Production Operations”, OGCI Publication (1984).
3. Ikoku C K, “Natural Gas Engineering” – John Wiley (1984).
4. Alexandre R, “Natural Gas : Production, Processing and Transport” – Hyperion Books (1995).
5. Donald L Katz, “Hand Book of Natural Gas Engineering” Mc Graw Hill

CH-326 Petrochemical Technology [3 0 0 3]

Petrochemical-an overview: Growth of global and Indian petrochemicals industries. Definition of Petrochemicals, History of Petrochemicals Industry, Development of Petrochemicals Industry in India, Economics of Petrochemicals Industry, general cost considerations,indigenous technology V/S foreign know-how. Sources of petrochemicals - Natural gas and petroleum, classification of petrochemicals.

Chemicals from methanol and synthesis gas: Oxo-products, methanol, formaldehyde, carbon - di - sulphide , Hydrogen cyanide.

Chemicals from ethane, ethylene and acetylene: synthetic ethanol.aldehyde, acetaldehyde, acetic acid, vinyl acetate, butraldehyde and ethyl hexanol and DOP; ethylene oxide, ethylene glycol, acrylonitrile, ethanol, amines, ethyl chloride, ethylene di chloride

Chemicals from propane and propylene: iso propanol, acetone, glycerol, propylene oxide, propylene glycols, isoprene, cumene.
Chemicals from butanes, butane pentanes and pentanes: butadiene, butone, epoxides,butanol amines, butyl acetate, methyl-ethyl ketone
Chemicals from aromatics: mono chloro and di-chloro benzene, BHC nitro benzene, do-decyl benzene, benzoic acid, nitro toluene, pthalic anhydride, iso pthalic acid, terethalic acid and di methyl terepthalate, maelic anhydride, adipic acid, hexa methylene di amine
Future of petro chemicals: integrated petro chemical complex, energy crisis in petro chemical industries, natural gas as petro chemical feed stock, import of heavy feed stocks on petro chemicals, ecology and energy crisis. Coal as an alternative to oil, energy crisis and industrial fuel, synthetic fuels, trends in petro chemical industries.

Books Recommended :

1. B.K Bhaskar Rao, " A textbook on petro chemicals" 2nd , Khanna publisher (1996)
2. Ram Prasad , " petroleum refining technology" khanna publisher
3. Maiti Sukumar, "Introduction to Petrochemicals" Oxford and IBH publishing Co. (1992)
4. Chauvels A and Lefebvre G, "Petrochemical process" Vol.4

CH-328 Membrane Separation processes [3 0 0 3]

Introduction: Definition of membrane and membrane process, Commercial membrane separation processes, new membrane separation process under development
Reverse Osmosis: Introduction and definition, theory and design, different membrane modules, selected applications and economics.
Ultra filtration: Introduction and definition, theory and design, membrane module and process configuration, applications and economics.
Micro filtration: Introduction and definition, theory of cross flow filtration, dead end micro filtration, applications and economics.
Emulsion liquid membranes: Introduction and definition, theory and design,
selected applications and economics
Dialysis, Electodialysis, Pervaporation, Gas permeation: Brief introduction and applications**.**

Books Recommended:

1. Wilson & Sirkar, Membrane Handbook, Mc grawhill, London, (2001).
2. Nune and Peinemann, Membrane Technology in chemical industries, Wiley, New York, (2000).
3. Cheryan Munir, Ultra filtration Handbook, Technomic, New York, (1985)
4. Noble and Stern, Membrane separation and technology, principles and applications, Elsevier, (1995)
5. Baker R W, Membrane technology and applications, Wiley**,** New York, (2000).

CH-330 Plant Utilities [3 0 0 3]

Steam:- Boilers- classification , various types, construction, boiler mountings & accessories, properties of steam-tables, Mollier Diagram.
Power Generation: Internal Combustion Engines- classification, two- stroke, four stroke petrol & diesel engine, valve timing diagram,carburetor, Combustion Phenomena .
Refrigeration: Air refrigeration cycles, vapour compression cycle, P-H diagram, liquefactions processes .
Compressed Air and Vacuum: Use of compressed air. Classification of compressors. reciprocating compressors-mechanical details, single stage and two stage reciprocating compressor , inter cooler, minimum work input in multistage.
Centrifugal compressor- velocity diagram for centrifugal compressors, dimensional parameters, slip factor , impeller blade shapes, losses in axial flow compressors.
Fuel: Natural gas, liquid petroleum fuels, coal & coke .
Waste Disposal: Plant sewer system and waste disposal.

Books Recommended:

1. Yadav B, "Thermodynamics & Heat Engines", Central Publishing House, Allahabad (2000).
2. Vasandani, "Treatise on Heat Engines", New Delhi (2000)
3. Lyle O, "The efficient use of steam",Her Majesty's Stationary Ofiice,London (1974).
4. Baasal W D, " Preliminary Chemical Engineering Plant Design" New York, (1989).
5. Dodge B F, "Chemical Engineering Thermodynamics", McGraw Hill, (1967).

Electives for Seventh Semester

CH-421 Energy Management and Audit [3 0 0 3]

Energy Scenario: Commercial and Non-Commercial Energy, Primary Energy Resources, Commercial Energy Production, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment: Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Energy Conservation Act-2001 and its Features. Kyoto Protocol. Global warming.
Energy Management & Audit: Definition, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.
Energy Action Planning: Key elements, Force field analysis, Energy policy purpose, perspective, Contents, Formulation, Ratification, Organizing - location of energy management, Top management support, Managerial function, Roles and responsibilities of energy manager, Accountability.
Motivating-motivation of employees: Information system designing barriers, Strategies; Marketing and communicating-training and planning.
Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques- Simple pay back period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs.

Project Management: Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification.
Energy Monitoring and Targeting: Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques -energy consumption,
Production, Cumulative sum of differences (CUSUM).

Books Recommended:

1. Capehart, Barney L., Wayne C. Turner and William J. Kennedy, "Guide to Energy Management" , Third Edition, Fairmont Press, Atlanta, GA, 2000;
2. Albert Thumann and D. Paul Mehta "Handbook of Energy Engineering", by. 4th ed. Lilburn, GA: Fairmont Press; 1997
3. Loftness, Robert L. "Energy Handbook." 2d ed. New York: Van Nostrand Reinhold Co., 1984.
4. Turner W. "Energy Management Handbook", Ed., John Wiley &. Sons, New York, 1982
5. Lapedes, DN " Encyclopedia of Energy", McGraw-Hill, New York, (1976)

CH- 423 New and Renewable Energy Sources [3 0 0 3]

Introduction: Global and Indian scenario, sources, Energy conservation, types of NCES with applications
Solar Energy: Role and development of new renewable energy sources, instruments for measuring solar radiations, solar radiation data, Flat plat and concentrating collectors, classification of concentrating collectors, advanced collectors, different methods of solar energy storage, solar ponds, solar applications: Solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.
Geothermal Energy: Resources, types of wells, methods of harnessing the energy
Wind Energy: Sources and potentials, horizontal and vertical axis, wind mills, wind regime analysis and evaluation of wind mills.
Biomass and Biofuels: Recycling of agricultural waste, anaerobic/aerobic digestion, and types of biogas digesters, gas yield, and combustion characteristics of bio gas, design of biogas system for heating, lighting and running IC engines. Introduction to Biofuels such as biodiesel, ethanol, biobutanol etc. and their production and present status.
Ocean Energy: OTEC, settling of OTEC plants, thermodynamic cycles
Tidal Energy: Potential and conversion technique, mini hydel power plants and their economics

Books Recommended:

1. Rai G D, "Non-conventional energy sources"
2. Kumar Ramesh and Narosa, "Renewable Energy Technologies"
3. Ashok V Desai, "Non-convetional energy", Wiley Eastern
4. Sukahme, "Solar energy"
5. K. Mittal and Wheeler, "Non-conventional energy system"

CH-425 Instrumental Methods of Analysis [3 0 0 3]

Atomic Absorption Spectroscopy: General principles, instrumental set up and analytical procedures and applications.

Flame photometry: Principles of flame photometry, type of instruments, experimental technique, applications.
Thermo-Analytical method: Theory, instrumental requirements and methodology for thermogravimetric analysis (TG), differential thermal analysis (DTA) and differential scanning calorimetry (DSC), applications.
Chromatographic Methods: Classification of chromatographic methods according to separation and development procedure, instrumentation and applications.
Solvent Extraction: Distribution law, techniques for solvent extraction and application.
Turbidimetry: Principles of turbidimetry, instrumental set up and applications.
Polarography and Amperometric Titrations: General principles and instrumental set up and application.
Electrochemical Techniques: Conductometry, pH metry, cyclic voltametry.
Data Analysis: Uncertainties, Errors, calibrations, Mean, Standard Deviation, Least square fit.

Books Recommended

1. Willard, Merritt, Dean and Settle, Instrumental Methods of Analysis, CBS Publisher and Distributors., 1986
2. Khopkar S M Basic Concepts of Analytical Chemistry, Wiley Eastern.
3. J Haines, Blackie, Thermal methods of Analysis, Principles, Application and Problems, Academic and Professional, 1994.
4. A Braithwaite and F J Smith , Chromatographic Methods, , 5th edn. Blackie Academic and Professional, London, 1996.
5. Skoog, Holder, Nieman, Principles of Instrumental Analysis, Fifth edition, Thomson Books, 1998.

CH 427: Leather Technology [3 0 0 3]

Leather Manufacture: Introduction to the manufacture of leather from different hides and skins. Chemistry and Mechanisms of various Pre-tanning, Tanning and Post tanning and Finishing processes.
Tannages: Principles involved in Inorganic and Organic tanning.
Leather Auxiliaries: Introduction to the Auxiliaries used during Leather processing.
Leather Machinery: Study of various types of Leather, Footwear, Garment and Leather Goods Machinery.
Footwear: Anatomy of Human Foot, Foot Comfort and Foot care, Footwear Materials, Footwear Manufacture, Final Inspection and Packages.
Leather Garments and Goods: Classification of Leather Garments and Goods, Material Selection, Designing and Styling, Pattern Production.
CAD of Leather Products: Introduction to general CAD, Design methods using CAD for leather products. Grading of patterns for footwear and garments, International Fashion Trends, Colour Characteristics, Decorative Styling Techniques

Books Recommended:

1. Thornton J H, “Textbook of Footwear Manufacture”, Heywood, London, 1964.
2. Harvey A J, “Footwear Materials and Process Technology”, Lasra Publications, New Zealand.

3. Training in Tanning Techniques and Leather Goods Manufacture – Course Material", Central Leather Research Institute Publication, Chennai, 1990.
4. Radhakrishnan P and Kothandaraman C P, "Computer Graphics and Design".
5. "American Shoe Making", Shoe Trades Publishing Co., Cambridge, USA.

CH- 429 Fertilizer Technology [3 0 0 3]

Elements required for plants growth, Classification of fertilizers, Compound, Complex & bulk blended fertilizers. N-P-K values & calculations.
Nitrogenous Fertilizers: Manufacturing Processes for Ammonia, Effects of various factors on the process. Manufacture of ammonium sulphate, ammonium chloride, Ammonium phosphate, Ammonium nitrate, nitric acid, Urea etc.
Economics & other strategies, Material of construction & corrosion problem.
Phosphatic fertilizers: Calculation of percentage tricalcium phosphate of lime in phosphatic rock. Manufacture of triple super phosphate & single super phosphate, Nitrophosphate, Sodium phosphate, phosphoric acid & other phosphatic fertilizers.
Potash Fertilizers: Manufacture of potash fertilizers like potassium sulphate, potassium chloride etc.

Books Recommended

1. Dryden C E, "Outlines of Chemical Technology", East –West Press Pvt. Ltd., New Delhi, 2nd Edition (1973)
2. Austin G T, "Shreve's Chemical Process Industries", McGraw Hill Book Company, New Delhi 5th Edition (1986)
3. Chemical Engineering Education Development Centre– "Chemical Technology I, II, III , IV , Manual of Chemical Technology, Indian Institute of Technology , Madras".
4. Shukla S D and Pandey G N, "A text book of Chemical Technology Vol I", Vikas Publishing House Pvt. Ltd., New Delhi
5. Shukla S D and Pandey G N, "A text book of Chemical Technology Vol lI", Vikas Publishing House Pvt. Ltd., New Delhi

Elective for Eighth Semester

CH-422 Environmental Management in Process Industries [3 0 0 3]

Introduction, Process and Waste Characteristics, Pollution Control in Process and Waste Management according to the environment standards specific to the following types of Industries:

Chemical Process and Allied Industries

Pesticides Industry, Paint Industry, Pharmaceutical Industry, Fertilizer Industry, Sugar and Distillery Industry, Acids and Explosives Industry, Petroleum Refinery and Petrochemical Industry, Dyes and Dye-intermediate Industry, Pulp and Paper Industry, Leather Industry

Food Processing and Allied Industries

Dairy Industry, Poultry Industry, Edible Oil Industry

Textile and Allied Industries

Textile Industry, Man-made Fibre and Rayon Industry, Jute Processing Industry

Metallurgical and Mining Industries

Iron and Steel Industry, Aluminium Industry, Copper Industry, Foundry Industry, Coal Mining Industry, Lead and Zinc Mining Industry

Cement and Allied Industries
Cement Industry, Ceramic Industry, Lime and Brick Kiln
Mechanical, Electrical, Electronics and Allied Industries
Metal Fabricating Industry, Electroplating Industry, Printing Industry, Electrical and Electronics Industry, Aerospace Industry

Books Recommended

1. Dryden C. E., "Outlines of Chemical Technology", East-West Press Pvt. Ltd., Second Edition (1973).
2. Austin G. T., "Shreve's Chemical Process Industries", McGraw Hill Book Company, Fifth Edition (1986).
3. Bhatia S. C., "Handbook of Industrial Pollution and Control", CBS Publishers and Distributors, Volume I and II, First Edition (2002).
4. Sell N. J., "Industrial Pollution Control-Issues and Techniques", Van Nostrand Reinhold Publication, Second Edition.
5. Hocking M. B., "Handbook of Chemical Technology and Pollution Control", Academic Press, Third Edition (2005).

CH-424 Environment Impact Assessment [3 0 0 3]

Study of Ecology and Ecosystem
Ecology and Environment, Biosphere as an Ecosystem, Functions of an Ecosystem, Habitats of Biological Species, Ecological Succession, Food-chains and Food-webs, The Bio-geo-chemical Cycles of Elements and Minerals
Biodiversity and its Conservation
Introduction to Biodiversity, Components of Biodiversity, Importance of Biodiversity, Threats to Biodiversity, Factors causing Loss of Biodiversity, Endangered and Endemic Fauna and Flora of India, *In situ* and *Ex situ* Techniques for Conservation of Biodiversity
Environment and Human Population
Global Population, Population Growth and Population Explosions, Environment and Human Health, Environment and Human Rights, Value based Environmental Education, Environmental Movements
Environment Impact Assessment (EIA)
Concept of EIA, Origin of EIA, Procedure of EIA, Evaluation Methodology for EIA, Scope Studies, Preparation and Review of Environment Impact Statement (EIS)**,** Introduction of Life Cycle Assessment, Environmental Parameters in LCA, Concept of Environmental Audit**,** Necessity and Importance of EA, Audit Procedures
Environmental Management System (EMS)
Introduction, Terminology and Certification, Environmental Standards, the International Standard Organization (ISO), the ISO 9000 and the ISO 14000 Family of Standards, Guides and Technical Reports, ISO 14001 Certification as a Tool for Sustainable Development
Case Studies
Discussion and analysis of various Case studies of environmental engineering projects

Books Recommended

1. Anjaneyulu Y., "Environment Impact Assessment Methodologies", B S Publications (2002).

2. Canter L. W., Environment Impact Assessment", McGraw Hill, Second Edition (2005).
3. Garg S. K., Garg R. and Garg R., "Ecological and Environmental Studies", Khanna Publishers, First Edition (2006).
4. Santra S. C., "Environmental Science", New Central Book Agency (P) Ltd., Second Edition (2006).
5. Uberoi N. K., "Environmental Management", Excel Books, Second Edition (2006).

CH-426 Industrial Rheology [3 0 0 3]

Introduction: Introduction to non Newtonian and non Newtonian fluid behavior, time independent fluid behavior, time dependent fluid behavior (thixotropy and rheopexy), visco elastic fluids, dimensional considerations.
Rheometry for Non Newtonian Fluids: Capillary viscometers, rotational viscometers, normal stress measurements,
Flow in pipes and in conduits of non circular cross section: Fluid flow in laminar flow in circular tubes, power law fluids, bingham plastic, yield pseudo plastic fluids, generalized Reynolds no for time independent fluids, laminar flow in two infinite parallel plates, laminar flow in concentric annulus.
Heat Transfer Characteristics of non Newtonian fluids in pipes: Laminar flow in circular tubes, full developed heat transfer to power law fluids in laminar flow
Momentum heat and Mass transfer in boundary layers
Liquid mixing

Books Recommended

1. Chabra and Richardson, Non Newtonian fluids in Process Industries, Butterworth, Melbourne, (1999)
2. Bird, Stewart W E and Light fort, "Transport Phenomena", John Wiley and Sons (2002).
3. Welty J R , Wilson R E and Wicks C E , "Fundamentals of Momentum , Heat and Mass Transfer",4th ed, John Wiley and Sons (2001).
4. Tanners R I, "Rheology: An Historical perspective", Elsevier, Amsterdam (1998).
5. Skelland, A H P, Non Newtonian flow and heat transfer, Wiley, New York (1967)

CH-428 Introduction to Multiphase Flow [3 0 0 3]

Flow past immersed bodies: Drag and drag coefficients, flow through beds of solids, motion of particles through fluids, fluidization, types of fluidization and applications.
Two-phase flow: Two–phase flow through pipes. Lockhart-Martinelli parameters and their application in analysis of two-phase flows.
Interaction of fluids: Mixing of a single fluid; degree of segregation, early and late mixing of fluids, models for partial segregation, mixing of two miscible fluids. Gas-liquid flow phenomenon, Types of regimes formation – trickle, pulse, bubble, dispersed bubble, spray regime etc.
Types of Multiphase-Reactors: Various types of multiphase reactors. eg. Packed bed, packed-bubble column, trickle bed reactor, three phase fluidized bed reactor, slurry bubble column, stirred tank reactor. Characteristics of above mentioned reactors such as; fluid flow phenomena and flow

regimes, flow charts/ correlations, pressure drop, liquid hold up etc. Reactors involving Newtonian and non-Newtonian fluids.

RTD in Multiphase Flow systems: Non Ideal Flow: Residence time distribution of fluid in vessel, E, F & C Curve, Mean and variance, the Dirac delta function, residence time, linear and non-linear processes, models for non ideal flow, dispersion model, N tanks in series model, model for small deviations from plug flow and long tails, conversion in a reactor using RTD data, diagnosing ills of operating multiphase reactors, models for multiphase reactors. Two parameter model; PD model; three parameter models; PE Model.

Books Recommended

1. Levenspiel O, "Chemical Reaction Engineering", 3rd Ed , John Wiley & Sons, Singapore (1999).
2. Fogler H Scott, "Elements of Chemical Reaction Engineering", 3rd ed, Prentice Hall Inc. (1999).
3. Shah Y.T., "Gas-Liquid-Solid Reactor Design", McGraw Hill Int. New York, 1979.
4. Westerterp K.R., van Swaaij W.P.M., and Beenackers A.A.C.M., "Chemical Reactor Design and Operation", John Wiley & Sons, 1993.
5. Doraiswamy L.K., and Sharma M.M., "Heterogeneous Reactions: Volume 2 Fluid-Fluid-Solid Reaction", John Wiley & Sons, 1984, Singapore

CH-430 Paint Technology [3 0 0 3]

Introduction: History and development of paint industry, paint its definition, function and classification.

Raw Materials: Raw material for industry, drying oils, bodied oils natural and synthetic resins, pigments and extenders.

Paint Auxiliaries: Auxiliaries like driers, plasticsers, softeners, dispersing and flatting agents varnishes and lacquers,

Manufacturing of paints: formulation and manufacturing of paints, machinery used in paint manufactures, methods of application, applications of industrial and architectural finishes. . Common defects in paint and varnishes.

Books Recommended

1. Payne H F , Organic coating technology Vol. I & II , Wiley, New York, (1954)
2. Morgans H M , Outlines of Paint technology, 3e, CBS, New Delhi, (2001)
3. Joseph Bijos , Good Painting Practices, Wiley, New York, (1967)
4. Bentley and Turner, Introduction to Paint Chemistry and principles of paint technology, fourth Edition, CRC publisher, Austria, (1997)

Syllabus of Interdisciplinary Electives (Open Electives)

CH 001 Fluid and Particle Mechanics [3 1 0 4]

Introduction to Fluid flow: Ideal and real fluids, Extensive and Intensive properties, viscosity, surface tension, capillarity, evaporability, vapour pressure, Newtonian and Non Newtonian fluids.
Fluid Statistics: Hydro statistics law, Pascal's law, Different types of Manometer, centrifugal decanter
Fluids Kinematics and Dynamics: Classification of fluid flow, streamline, streakline, pathlines, flow rate and continuity equation, Bernaulli's theorem and its application, kinetic energy and momentum correction factor in Bernaulli's equation, concept of friction law in fluid flow, various pumps.
Laminar Viscous flow and flow measurement devices: Reynolds numbers, Hagen Poiseuille Law, Venturi meter, Orifice meter. Size Reduction: Particle size and shape, particle mass, size and shape distributions, measurement and analysis, concept of average diameter, size reduction, crushing, grinding and law of grindings.
Screening: Equipment, capacity and effectiveness of screen, effect of mesh size on capacity of screen.
Settling: Flow around a single particle, drag force and drag coefficient, settling velocity of particles in a fluid, hindered and free settling of particles, thickening gravity separation
Separation of solid from liquid: Classification of filters, various types of cake filters, principle of cake filtration, clarification filters, liquid clarification, centrifugal settling process.
Agitation & Mixing: Agitation of liquids, axial flow impellers, radial flow impellers, velocity and power consumption of agitated vessels, blending & mixing.
Fluidization: Packed beds, bed porosity, flow though a bed of particles, fluidization & fluidized bed, conditions for fluidization minimum velocity, types of fluidization.

Books Recommended

1. Smith J C, Mccabe W L and Harriot P H, *"Unit Operations of Chemical Engineering"*, McGraw Hill, 7th edition, (2005).
2. Richardson and Coulson *"Chemical Engineering Vol II", 5th ed.*, Butterworth – Heinemann (2003).
3. Perry's, "*Handbook of Chemical Engineering*", 7th Ed, McGraw Hill (1997).

CH 002 Heat and Mass Transfer [3 1 0 4]

Conduction: Fourier's law, steady state heat conduction through a composite solid, cylinders, spheres, different insulating materials for process equipment
Convection: Convection, individual and overall heat transfer coefficient, heat transfer between fluids separated by plane wall and by cylindrical wall (pipes), critical/ optimum insulation thickness, concepts of heat exchanger.
Heat Transfer with phase change: Boiling phenomena, correlation for nucleate boiling, critical heat flux, condensation phenomena, film condensation on a vertical surface.
Radiation: Blackbody radiation, Planck's law, Wein's displacement law, the Stefan Boltzmann law, Kirchoff's law.
Evaporation: Single and multiple effect evaporators, capacity and economy, boiling point elevation.

Mass Transfer Coefficient: Local and overall mass transfer coefficient, local two phase mass transfer coefficients, Local overall Mass Transfer coefficients.
Gas Absorption: Choice of solvent, number of ideal stages, height of column, equipment for gas absorption
Drying: Equilibrium in drying, rate of batch drying, time of drying, drying equipments.
Distillation : Raoult's Law and Dalton's law, partial vaporisation condensation, relative volatility, differential & flash distillation, steam distillation, total reflux , minimum and optimum reflux ratios, Lewis Sorel and MaCabe –Thiele methods, Ponchon Savarit method
Liquid – Liquid Extraction: Ternary phase diagrams & choice of solvent, single stage and multistage cross current, co-current and counter current extraction operation
Adsorption: Introduction and the nature of adsorbent, adsorption equilibria, the Langmuir isotherm, BET isotherm and Gibbs isotherm, adsorption equipments.
Crystallization: Formation and properties of crystals, crystallisers

Books Recommended

1. Smith J C, Mccabe W L and Harriot P H, "*Unit Operations of Chemical Engineering"*, McGraw Hill, 7th edition, (2005).
2. Richardson and Coulson *"Chemical Engineering Vol II", 5th ed.,* Butterworth – Heinemann (2003).
3. Perry's, "*Handbook of Chemical Engineering*", 7th Ed, McGraw Hill (1997).
4. Geankopolis C J, "*Transport Processes and Separation Process Principles*", Prentice Hall of India, 4th Edition, Eastern Economy Edition (2004)
5. Treybal R E , "Mass Transfer Operations" 3rd ed. , McGraw Hill (1980)

CH - 003 Environmental Management in Process Industries [3 0 0 3]

Introduction, Processes and Waste Characteristics, Pollution Control in Processes and Waste Management according to the environment standards specific to the following types of Industries:
Chemical Process and Allied Industries
Pesticides Industry, Paint Industry, Pharmaceutical Industry, Fertilizer Industry, Sugar and Distillery Industry, Acids and Explosives Industry, Petroleum Refinery and Petrochemical Industry, Dyes and Dye-intermediate Industry, Pulp and Paper Industry, Leather Industry
Food Processing and Allied Industries
Dairy Industry, Poultry Industry, Edible Oil Industry
Textile and Allied Industries
Textile Industry, Man-made Fibre and Rayon Industry, Jute Processing Industry
Metallurgical and Mining Industries
Iron and Steel Industry, Aluminium Industry, Copper Industry, Foundry Industry, Coal Mining Industry, Lead and Zinc Mining Industry
Cement and Allied Industries
Cement Industry, Ceramic Industry, Lime and Brick Kiln
Mechanical, Electrical, Electronics and Allied Industries
Metal Fabricating Industry, Electroplating Industry, Printing Industry, Electrical and Electronics Industry, Aerospace Industry

Books Recommended:

1. Dryden C. E., “Outlines of Chemical Technology”, East-West Press Pvt. Ltd., Second Edition (1973).
2. Austin G. T., “Shreve’s Chemical Process Industries”, McGraw Hill Book Company, Fifth Edition (1986).
3. Bhatia S. C., “Handbook of Industrial Pollution and Control”, CBS Publishers and Distributors, Volume I and II, First Edition (2002).
4. Sell N. J., “Industrial Pollution Control - Issues and Techniques”, Van Nostrand Reinhold Publication, Second Edition.
5. Hocking M. B., “Handbook of Chemical Technology and Pollution Control”, Academic Press, Third Edition (2005).

CH - 004 Hydrocarbon Engineering [3 0 0 3]

Role of oil and gas in world economy: Importance of oil and gas in the world economy, oil and gas reserves, supply and demand, Specific features of oil and gas industries.
Introduction origin of oil and its recovery: Origin and occurrence of crude oil, physical and chemical properties of oil, entrapment of oil: types and mechanism, Exploration methods, oil recovery methods, world petroleum reserves, Drilling, Production equipments.
Natural gas from condensate and oil fields, thermodynamic and energy change, Review of physical and chemical properties of NG and associate hydrocarbons.
Flow of fluids: Gas handling facilities, flow of fluids. Compression of gasses, application of heat and mass transfer principles and application in natural gas energy system, Transmission of Ng in pipelines, LPG technique, its production and distribution.
Natural Gas processing: Purifications, refrigeration and low temperature processing, liquefaction process, LNG, NGL recovery, Sweetening of NG, sulfur recovery.
Storage and handling: Storage, tanks, underground storage and conservation of NG and oil
Economic consideration for development of gas fields.

Books Recommended

1. Carroll John, “Gas hydrates: A guide for engineers”, Elsevier USA (2003)
2. Kandiyoti.R, Herod and Bartle K, “Solid Fuels and Heavy Hydrocarbon Liquids: Thermal Characterization and analysis”,Elsevier (2006)
3. S.Kumar, “Gas production engineering”,Gulf Publishing Co. (1987)
4. Ikoku C K, “Natural gas engineering”,John Wiley (1984)
5. Beggs D H, “Gas production operations”,OGCI Publication (1984)

CH - 005 Industrial Safety [3 0 0 3]

Introduction: Concept of Loss prevention, acceptable risks, accident and loss statistics, nature of accident process, inherent safety.
Toxicology: Dose vs response, toxicants entry route, models for dose and response curves, TLV and PEL
Industrial Hygiene: Identification, Material safety data sheets, Industrial hygiene evaluation, and control
Basics of Fires and Explosion: Fire triangle, definitions, flammability characteristics of liquid and vapors, LOC and inerting, types of explosions

Designs for fire prevention:
Hazard identification: Hazard survey, checklist, HAZOP, safety reviews, what if analysis
Risk Assessment: probability theory, event tree, fault tree, QRA and LOPA, Dow's fire and explosion index, Mond index, Dow's Chemical release model
Accident Investigations:
Case Histories
Bhopal gas tragedy, flixborough disaster, Pasadena accident, IOCL disaster

Books Recommended

1. Crowl D A, Louvar J F, " Chemical Process Safety Fundamentals with applications", 2nd Prentice Hall, NJ (2002).
2. Coulson J M and Richardson J F , "Chemical Engineering",2nd , Vol 6, Pergamon, press (1999).
3. Dow Chemical Company, Dow's Chemical Exposure Index Guide, 1993, New York