DEPARTMENT OF CHEMICAL ENGINEERING

Course Book

B.Tech. in Chemical Engineering

(Admission upto 2012-13)

Visvesvaraya National Institute of Technology, Nagpur

April 2014

General Information about the department:

The Chemical Engineering Department at VNIT is one of the youngest and premier engineering department of VNIT Nagpur. It has dynamic and goal oriented group of highly qualified and well experienced faculty with large and modern research and development infrastructure.

Objective of the program:

The Chemical Engineering Program at Visvesvaraya National Institute of Technology produces graduates with a basic understanding of chemical engineering principles along with problem solving, teamwork and communication skills necessary to succeed in diverse careers, including chemical engineering practice and academic research. The Programme has the following educational objectives:

- To prepare students for successful practice in diverse fields of chemical engineering such as pharmaceuticals, chemicals, polymers / advanced materials, energy, biotechnology and environmental engineering and in the fields of societal expectations on time.
- To prepare students for advanced studies in Chemical Engineering and its allied fields.
- To ensure our students are recognized for excellence and leadership and selected for high-ranking industrial, academic, government and other professional positions.
- To develop students' skills and awareness to become socially, ethically and morally responsible individual in all the challenges they take over in our communities and in the field of chemical engineering.

Credit Structure of the program:

The Department offers course at undergraduate level leading to 4 year B.Tech Degree with emphasis on theory and practice of Chemical Engineering to meet the current and future requirements of the country. This is 4 year (8 semester program) , wherein student has to complete certain number of credits as indicated in Table 1. Each subject (or course) has certain number of credits. There are four types of subjects:- Departmental core (DC), Departmental elective (DE), Humanity (HM) and Open course (OC).Core courses are compulsory and some courses from electives are to be taken to complete the required credits.

Table 1. CREDIT REQUIRMENTS FOR B.TECH. CHEMICAL ENGINEERING

Undergraduate Core (UC)		**Undergraduate Elective (UE)**	
Category	**Credit**	**Category**	**Credit**
DC	150	DE	74-92
BS	32	HM	0-6
ES	36	OC	0-12
HU	10	--	--
Total	**228**	**Total**	**92**
Grand Total UC + UE			**320**

The number of credits attached to a subject depends on number of classes in a week. For example a subject with 3-1-0 (L-T-P) means it has 3 lectures, 1 tutorial, and 0 practical in a week. This subject will have eight credits (3X2+1X1+0X1=8). If a student is declared pass in a subject, then he/she gets the credits associated with that subject. Depending on marks scored in a subject, student is given a grade. Each grade has got certain points as follows:

Grades	AA	AB	BB	BC	CC	CD	DD	FF
Grade Points	10	09	08	07	06	05	04	Fail

The performance of a student will be evaluated in terms of two indices, viz. The Semester Grade Point Average (SGPA) which is the grade point average for a semester and Cumulative Grade Point Average (CGPA) which is the grade point average for all the completed semesters at any point in time. SGPA & CGPA are:

$$SGPA = \frac{\sum_{Semester}(Course\ creditsXGrade\ points)_{for\ all\ courses\ except\ audit}}{\sum_{Semester}(Course\ credits)_{for\ all\ courses\ except\ audit}}$$

$$CGPA = \frac{\sum_{All\ Semester}(Course\ creditsXGrade\ points)_{for\ all\ courses\ with\ pass\ grade\ except\ audit}}{\sum_{All\ Semester}(Course\ credits)_{for\ all\ courses\ except\ audit}}$$

Students can Audit a few subjects i.e., they can attend the classes and do home work and give exam also, but they will not get any credit for that subject. Audit subjects are for self enhancement of students.

Details of faculty members of Chemical Engineering Department

S.No	Name	Designation	Qualification	E-mail id
1.	Chaurasia Ashish	Associate Prof.	PhD	Ashishchaurasia1@yahoo.com
2.	Hiwarkar Sonali P.	Assistant Prof.	M.Tech	sonali_hiwarkar@rediffmail.com
3.	Kodape Shyam M.	Assistant Prof.	M.Tech	samkodape@rediffmail.com
4.	Mandavgane Sachin A.	Associate Prof.	Ph.D	mandavgane@gmail.com
5.	Rathod Ajit P.	Assistant Prof.	M.Tech	ajitprathod@gmail.com
6.	Shende Diwakar Z	Assistant Prof.	Ph.D	dzshende@che.vnit.ac.in
7.	Shilapuram Vidyasagar	Assistant Prof.	Ph.D	vidyasagar55@gmail.com
8.	Sonawane Shriram S.	Assistant Prof.	Ph.D	shriramsonawane@gmail.com
9.	Varma Mahesh N.	Assistant Prof.	Ph.D	maheshnvarma@gmail.com
10.	Vijayakumar R P	Assistant Prof.	Ph.D	jbgvijayiitb@gmail.com
11.	Wasewar Kailas	Associate Prof.	Ph.D	k_wasewar@rediffmail.com

Scheme of Instructions for B.Tech. Chemical Engineering

For all the B.Tech. programs, first two semesters are common.The details of these courses are mention in the first year B. Tech Course Book, available at the VNIT website. In the first two semesters, all the B.Tech. students comlete 78 credits from the courses of Basic Sciences (BS), Engineering Sciences (ES), and Humanities (HU).

SCHEME OF INSTRUCTION FOR B. TECH (CHEMICAL ENGINEERING) upto 2013-14

Code	Course	L-T-P	Credits	Code	Course	L-T-P	Credits
III Semester				**IV Semester**			
Core				**Core**			
CML261	Inorganic Chemical Technology	3-0-0	6	CML263	Fluid Mechanics	3-0-0	6
CML262	Chemical Process Calculations	3-0-0	6	CML264	Mechanical Operations	3-0-0	6
CHL261	Physical Chemistry & General Metallurgy	3-0-0	6	CHL214	Organic Chemical Technology	3-0-0	6
CHL263	Organic Chemistry and Synthesis	3-0-0	6	CML265	Chemical Engineering Thermodynamics	3-0-0	6
CHP263	Organic Chemistry and synthesis	0-0-2	2	CHP214	Organic Chemical Technology	0-0-2	2
CHP261	Physical and Inorganic Chemistry	0-0-2	2	CMP264	Fluid Mechanics and Mechanical Operations –I.	0-0-2	2
Electives (pick any)				**Electives (pick any)**			
CML474	Plant Utility	3-0-0	6	CML299	Introduction to computing software for chemical engineering	3-0-0	6
MAL205	Num. Methods & Prob. Theory	3-0-0	6	CML467	Materials in chemical Industries	3-0-0	6
V Semester				**VI Semester**			
Core				**Core**			
CML361	Mass Transfer – I	3-0-0	6	CML368	Chemical Reaction Engineering	3-0-0	6
CML363	Chemical Process Equipment Design	3-0-0	6	CML366	Mass Transfer – II	3-0-0	6
CML362	Heat Transfer – I	3-0-0	6	CML466	Chemical Plant Design	3-0-0	6
CMP364	Chemical Engineering Design and Drawing –I	0-0-2	2	CML367	Heat Transfer – II	3-0-0	6
CMP365	Fluid Mechanics &Mechanical Operation –II	0-0-2	2	CML371	Chemical Process Modelling and Simulation	3-0-0	6
				CMP366	Mass Transfer	0-0-2	2
				CMP367	Heat Transfer	0-0-2	2
				CMP371	Chemical Process Modeling and simulation	0-0-2	2
Electives (pick any)				**Electives (pick any)**			
CHL369	Green Chemistry and Engineering	3-0-0	6	CML374	Optimization Techniques	3-0-0	6
CML370	Environmental Engineering (Civil)	3-0-0	6	CHL336	Polymer Engineering	3-0-0	6

CMP370	Environmental Engineering (Civil)	0-0-2	2	CML468	Ore and Mineral Processing	3-0-0	6
CML375	Analytical Methods for Chemical Analysis	3-0-0	6				
VII Semester				**VIII Semester**			
Core				**Core**			
CML461	Transport Phenomena	3-0-0	6	CMD453	Seminar and Group Discussion Program		2
CML462	Chemical Reaction Engineering – II	3-0-0	6	CMD452	Project Phase-II		8
CML463	Process Control and Instrumentation	3-0-0	6				
CMP462	Chemical Reaction Engineering	0-0-2	2				
CMP463	Process Control and Instrumentation	0-0-2	2				
CMP464	Chemical Engineering Design &Drawing –II	0-0-2	2				
CMD451	Project Phase-I		4				
Electives (pick any)				**Electives (pick any)**			
CML620	Membrane Technology	3-0-0	6	CML374	Optimization Techniques	3-0-0	6
CML480	CFD for Chemical Engineers	3-0-0	6	CML471	Biotechnology and Bio chemical Engineering	3-0-0	6
CML374	Petroleum Refinery Engineering	3-0-0	6	CML472	Advance Separation Process	3-0-0	6
CML375	Analytical Methods for Chemical Analysis	3-0-0	6	CML473	Safety and Risk Analysis	3-0-0	6
				CML621	Nanotechnology	3-0-0	6
				CHL336	Polymer Engineering	3-0-0	6
				CML491	Project Planning and Management	3-0-0	6

Detailed Syllabus

CML 261 - Inorganic Chemical Technology [(3-0-0); credits:6]

Syllabus: Industrial gases: CO, CO_2, H_2, O_2, N_2, SO_2, C_2H_2, Helium and Nitrogen oxide. Industrial acids: 25% & 65% oleums, Liq. Sulphur Trioxide, Liq. Sulphur dioxide manufacture. Sulphuric acid, Nitric acid, Hydrochloric acid and Phosphoric acid. Miscealleanous Chemicals industries: Alum [ferric & Non-ferric], sugar, carbon-disulphide.

Industrial carbon: Activated carbon, lamp carbon, carbon black, graphite, industrial diamond, and Inorganic pigments: Study of pigments and dyes.

Waste Energy Recovery. Co-generation of power and Application to Chemical Industry for reducing cost of production.

Marine Chemicals: Salt from seawater. By-products of salt industry e.g. Bromine and Iodine.

Nuclear Industries: Nuclear Reactors, Feed materials, Uranium and Nuclear Reactors. Reprocessing of Nuclear materials, protection from radioactivity – measures.

Chlor – alkali industries: Soda Ash, Bicarbonates, Miscellaneous alkalis, Chlorine, Caustic Soda, Bleaching powder, Hypochlorites and chlorites, Eletrolytic MnO_2, Aluminium metal.
Electrolytic and Electrochemical Industries: Chlorates, Per-chlorates, Primary and Scecondary cells. Artificial abrasives, Calcium carbides, Silicides and Nitrides.
Fertilisers: Ammonia, Nitrogenous fertilizers, Phosphatic fertilizers, Potassic fertilizers, Compound and Complex fertilizers, miscellaneous fertilizers.
Glass - Chemistry of glass making and manufacturing process, Composition of different types of glass special glass lining to vessels, Protective Refractory Linings for Chemical Plants.

TEXT BOOK:

1. Ahluwalia V.K. and Kidwai M, "New Trends in Green Chemistry", Anamaya Publishers, New Delhi.

REFERENCES:

1. Dryden C.E, "Outlines of Chemical Technology", East West Press, 1973
2. Kirk – Othmer, "Encyclopedia of Chemical Technology", John-wiley & Science.
3. Shreve R.N and Brink J.M, "Chemical Process Industries", McGraw Hill Co.New York, 1977
4. Soni P.L. and Kalyal, "Textbook of Inorganic Chemistry", S. Chand & Co.New Delhi.

CML262 Chemical Process Calculations [(3-0-0); credits:6]

Syllabus: Fundamental concepts, gas relationship, molarity, molality, normality, partial pressure, pure component volume and the related calculations.
Humidity and saturation and their applications fundamental concepts of material balance. Material balance in various unit processes and unit operations. Material balance with chemical reactions
Energy balance related to various process equipments.Calculation of standard heat of reaction from heat of formation and heat of combustion, thermo chemistry, energy balance in various unit operations, heat of solutions, heat of neutralization etc.
Fuels and combustion calculation, proximate and ultimate analysis, adiabatic reaction temperature, air to fuel ratio, complex processes calculation.

TEXT BOOK:

1. Hougen O.A. and Watson K.M. "Chemical Process Principles, Port-I Material and Energy Balance", John Willey, New York 1947.

REFERENCES

1. Vora S.M. and Bhut B.I., "Industrial Stoichiometry", Tata McGraw Hill, New Delhi.
2. Himmelblau D.M., "Basic Principles and Calculations in Chemical Engineering", 6th Edition, Prentice Hall of India Ltd.
3. Williams E.T. and Johnson R.G.; "Stoichiometry for Chemical Engineers", McGraw – Hill, New York 1958.

CML263 Fluid Mechanics [(3-0-0); credits:6]

Syllabus: Properties of Fluid: Pressure, density, specific weight, viscosity, dynamic and kinemetic viscosity, Newton's law of viscosity and its applications.
Fluid Statics: Pascal's Law and Hydrostatic equation, absolute and gauge pressures - pressure measurements by manometers and pressure gauges.– Forces on plane and curved surfaces
Fluid kinetics: Description of Fluid flow, Lagrangian and Eulerian approach One dimensional flow approximation, Types of fluid Flows: Steady and unsteady, Uniform and non-uniform, control volume concept, Reynolds transport theorem, Continuity equation, Velocity and acceleration of fluid particle, stream line, streak line, path line, velocity potential function,
Fluid Dynamics: Momentum theorem and its application. Euler's equation, Bernoulli's equation for incompressible fluid flow, Engineering applications of energy equation,
Pitot – static probe, Current meters,Venturimeter, Orificemeter, Rotameter, Nozzlemeter, Notches & weirs.
Flow Through Pipes: Critical Reynold's number, velocity distribution in pipes, friction factor, Moody's chart, Laminar flow through pipe, Hagen-Poiseulli's equation, Turbulent flow through pipe, Hydraulic

gradient line and Total energy line. Minor head losses in pipes. Pipe Networking Transmission of power through pipe.
Flow Over Immersed Bodies: Drag and lift, Types of drag force, Drag on sphere, Cylinder and airfoil; Circulation and Lift on a cylinder and airfoil; Magnus effect
Boundary Layer Theory: Development of Boundary layer over flat plate and pipe, boundary layer thickness
Pumps: definition and classifications - Centrifugal pump: classifications, working principles, , specific speed, efficiency and performance curves - Reciprocating pump: classification, working principles, indicator diagram, work saved by air vessels and performance curves - cavitations in pumps - rotary pumps: working principles of gear and vane pumps.

TEXT BOOKS:

1. Gupta Santosh & Gupta Vijay, "Fluid Mechanics and its applications", New Age International Publishers.

REFERENCES

1. Munson BR, Young D F and Okiishi T H , "Fundamentals of Fluid Mechnics", 5th Edition, John Wiley & Sons
2. Badger W.L. and Banchero J.T. "Introduction of Chemical Engineering", McGraw Hill 1995.
3. Bansal R.K.; "Fluid Mechanics", Khanna Publication.
4. Coulson J.M. and Richardson J.F.,Backhurst J.R. and Harker J.H.; "Chemical Engineering, Vol. I & II", Publishers: Butterworth - Heinmann, 2001-2002.
5. Ghosal S.K., Sanyal S.K. and Dutta S.; "Introduction to Chemical Engineering", Tata McGraw Hill Book Co.
6. Kapoor B.; "Fluid Mechanics", New Age International, New Delhi.
7. McCabe W.L. Smith J.C. and Harriot P.; "Unit Operations of Chemical Engineering", McGraw Hill, 6th Edition 2001.

CML264- Mechanical Operation [(3-0-0); credits:6]

Syllabus: Properties and characterization of particulate solids, surface area distribution of powders, size reduction and separation, crushing, grinding equipments and their characteristics, open and close circuit grinding.
Screen analysis, mechanical classifiers classification. Principles of filtration and theory, filtration equipments and their characteristics, pressure and vacuum filters, compressible and non compressible cake and their effect on filtration rate, centrifugal separation equipments and their principles of operation as well as the characteristics, optimum filtration cycle, membrane filtration.
Motion of particles through fluid, drag coefficient, free settling and hindered settling, gravity settlers, sedimentation theory and principle of operation. Batch and continuous thickeners as well as the design procedures, sedimenting centrifuges.
Agitation and mixing of solids and liquids fundamentals, mixing and agitation equipments and their operational characteristics, power consumption in mixing and agitation, different types of agitators and their selection criteria.
Storage and conveying of solids, bins, hoppers, silos and their operational characteristics, Loading and unloading of solids, different types of conveyors and elevators for solid materials.
Dust collectors, cyclone separators, electrostatic precipitators, bag filters, operational characteristics of these and other similar dust separators.

TEXT BOOKS:

1. Chattopadhyay O.P., "Unit Operations of Chemical Engineering, Vol. 1 & 2", Khanna Publications, New Delhi, 1996.

REFERENCES

1. Coulson J. M. and Richardson J.F; "Chemical Engineering Vol. 1& 2" , Butter worth – Heinemann Ltd. 2001-2002.
2. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations of Chemical Engineering", McGraw Hill, New York 2001.

3. Ghosal S.K., Sanyal S.K. and S. Dutta; ITata, "Introduction to Chemical Engineering", McGraw Hill Book Co.
4. Lowrison G.C.; "Crushing and Grinding", Butterworth & Co. Ltd. 1974, London.

CHP262 Organic Chemical Technology [(0-0-2); credits:2]

Syllabus: Fundamentals of organic chemical synthesis, oxidation and reduction reactions, liquid and vapour phase oxidation, kinetics and thermochemistry of such reactions, methods of reduction.

Amination and Amminolysis general principles, physical and chemical factors affecting these processes, various amination and amminolysis reactions and the kinetics and thermodynamic study of these reactions.

Alkylation reactions, alkylating agents, parameters involved in control of these reactions, sulfation and sulfonation reactions, parameters affecting these processes.

Hydrogenation reactions, kinetics and thermodynamics of such reactions, industrial hydrogenation processes, hydrogenation of unsaturated fatty oils, synthesis of methanol etc., halogenation reactions.

Manufacturing processes for industrially important organic chemicals.

Introduction to Polymerization, polymerization processes, polymerization techniques, copolymerization, manufacturing processes for various industrially important polymers.

TEXT BOOKS:

1. Doraiswamy L.K., "Organic Synthesis Engineering", Academic Press, New York

REFERENCES

1. Dryden C.E., Rao M.G. and Sltting .M. East, "Outlines of Chemical Technology", West Press New Delhi.
2. Groggins P. H., "Units Processes In Organic Synthesis", Tata McGraw Hills Book Co.

CML265 Chemical Engineering Thermodynamics [(3-0-0); credits:6]

Syllabus: Laws of thermodynamics for closed and open system, concepts of entropy, entropy changes, reversible and irreversible processes, equilibrium concept, Maxwell's relations, P-V-T behaviour of pure substances, Heat of reaction and effect of temperature on heat of reaction.

Thermodynamic properties of fluids, their calculations using equations of state, partial molar quantities, fugacity, chemical potential, activity coefficients, free energy estimation, Gibb's Duhem Theorem.

Vapour-liquid, vapour–solid and liquid–liquid phase equilibrium for ideal and non ideal systems, Criteria for chemical reaction equilibrium flow of compressible fluids in pipes and nozzles.

Refrigeration cycle, carnot refrigerator, gas and vapour compression refrigeration, choice of refrigerants, absorption refrigeration, heat pumps, compressors, single stage and multistage, expansion engines, liquification processes.

TEXT BOOK:

1. Bett K.E., Rowlinson J.S. and Saville G. "Thermodynamics for Chemical Engineers",. MIT Press America.

REFERENCES:

1. Dadge B.F., "Chemical Engineering Thermodynamics", McGraw Hill Co. 1944, New York.
2. Smith J.M., "Introduction to Chemical Engineering Thermodynamics", McGraw Hill, 2005.
3. Narayan K.V., "A text book of chemical engineering thermodynamics", PHI, 2001
4. Rastogi R.P. and Mishra R.R., "An introduction to Chemical Engineering", Vikas Publishing House Pvt.Ltd, New Delhi.
5. Rao Y.V.C., "Chemical Engineering Thermo dynamics", University press (INDIA) Ltd.

CMP264- Fluid Mechanics and Mechanical Operation Lab-I [(0-0-2); credits:2]

Syllabus:

1) Study of varation of Orifice coefficient with Reynold number (C_d Vs N_{Re}).
2) Determination of sedimentation rate and design of thickener.
3) Evaluation of agitation performance.
4) Determination of Coefficient of discharge of Venturimeter.

5) Determination of Coefficient of discharge of Rotameter.
6) Determination of Coefficient of discharge of Orfice meter.
7) Determination of Coefficient of discharge of Notched Weir.
8) Performance evaluation of Centrifugal pump and Reciprocating pump.
9) Hydrodynamic studies in a packed bed.

TEXT BOOKS:

1. Chattopadhyay O.P., "Unit Operations of Chemical Engineering, Vol. 1 & 2", Khanna Publications, New Delhi, 1996.

REFERENCES

1. Coulson J. M. and Richardson J.F; "Chemical Engineering Vol. 1& 2", Butter worth – Heinemann Ltd. 2001-2002.
2. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations of Chemical Engineering", McGraw Hill, New York 2001.

CML361- Mass Transfer – I [(3-0-0); credits:6]

Syllabus: Introduction to mass transfer operations, Diffusion in gases and liquids, steady state and unsteady state operations, diffusion mass transfer, individual and overall mass transfer coefficients concept.

Theories of mass transfer, analogies and Interphase mass transfer process; simultaneous heat and mass transfer processes.

Drying: Constant rate and falling rate periods, equilibrium moisture contents, drying equipments, rotary dryers, drum dryers, vacuum dryers, Spray dryer, fluidized bed dryers, dryer calculations and dryer selection criteria.

Crystallization: Theory of Crystallization, saturation, supersaturation, nucleation and crystal growth, various equipments for crystallization, their operational and design characteristics.

Adsorption: Adsorption isotherms, adsorption agents, equipments for adsorption, pressure swing adsorption technology, adsorption phenomena,

Humidification and dehumidification, equipment's operational characteristics, design procedures and selection criteria along with mass transfer calculations, Types of cooling towers, cooling tower operational characteristics.

TEXT BOOKS:

1. Treybal R.E. "Mass Transfer Operations", McGraw Hill Book Co., New York 1980

REFERENCES

1. Coulson J.M. and Richardson J.F., "Chemical Engineering Vol. I, II & III", Pergamon Press, New York 1977
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill Book Co.
3. McCabe W.L. and Smith J.C. & Harriot, "Unit Operations of Chemical Engineering", McGraw Hill Book Co., New York 1980
4. Lyderson A.L., "Mass Transfer in Engineering Practice", John Wiley Co. (1983)
5. Chattopadyay P., "Unit Operations of Chemical Engineering, Vol. 1 & 2", Khanna Publishers, New Delhi
6. Suryanarayana A., "Mass Transfer" , New Age International, New Delhi.

CML362- Heat Transfer- I [(3-0-0); credits:6]

Syllabus: Basic modes of heat transfer, conduction, convection and radiation, Heat conduction equation at steady state, heat conduction in slabs, cylinders, spheres, heat generation inside solids, unsteady state heat conduction, Biot number, Fourier number, Heisler charts.

Types of thermal insulation, critical thickness and optimum thickness of insulation, extended surfaces, fin performance evaluation, effectiveness of fins.

Free and forced convection inside and outside the tubes as well as over the plates, individual and overall heat transfer coefficients. Heat transfer in laminar flow and turbulent flow, dimensionless numbers in heat

transfer, expressions for calculating individual and overall heat transfer coefficients. Heat transfer coefficients in natural convection and its applications.
Condensation and Boiling: Condensation over flat plate, condensation inside and outside the tubes in horizontal, vertical and inclined position, film condensation, drop wise condensing. Estimation of film coefficient of heat transfer for condensing vapours turbulence in condensing film. Heat Transfer to boiling liquids, pool boiling and forced convection boiling, boiling curve and its characteristics.
Radiation heat transfer, laws of radiation, concepts of black body, gray body, green house effect, emissive power, heat flux by radiation, view factors, radiation shield, luminous and non luminous gases.
Heat Transfer fluids: Steam, organic thermic-fluids such as Downtherm and others, molten metals, molten salts, flue gases, calculation of heat transfer coefficients for the heating fluids and their selection criteria.

TEXT BOOKS:

1. Coulson J.M., Richardson J.R., "Chemical Engineering, Vol. I", Butterworth Heinemann, New Delhi.

REFERENCES

1. Hollman J.P, "Heat Transfer", McGraw Hill, 1993.
2. Kern D.Q, "Process Heat Transfer", Tata McGraw Hill Book Co., New Delhi, 1990.
3. McAdams W.H, "Heat Transmission", McGraw Hill Book Co. New York, 1954.
4. Eckert E.R.G. and Drake R.M, "Heat Transfer and Mass Transfer", McGraw Hill Education.
5. Sukhatme S.P, "Text Book on Heat Transfer", Orient Longman Pvt. Ltd.
6. Kumar D.S., "Process Heat Transfer", S.K.Kataria & Sons Publishers,New Delhi.
7. Kothandaram C.P., Subramanyan S., "Heat Transfer and Mass Transfer", Databook, Wiley eastern Ltd., (1989).
8. Dawande S.D, "Principles of Heat and Mass Transfer", Central Techno Publications, Nagpur.
9. Arora S.C, "Heat Transfer and Mass Transfer", Khanna Published, New Delhi.

CML363- Chemical Process Equipment Design [(3-0-0); credits:6]

Syllabus: Importance of chemical process equipment design, design procedure for pressure vessels subjected to internal pressure, external pressure and combined loading, closures for pressure vessels, optimum proportions of pressure vessels, optimum sizing of vessels.
Design of pressure vessels subjected to high pressure, monoblock construction, shrink fit construction.
Design of supports, flanges, nozzles for vessels, Design of jackets, coils for pressure vessels, design of agitation system, type of agitators, estimation of power requirement for mixing and agitation.
Mechanical design of storage tanks, for volatile and non-volatile liquids roof and bottom design, optimum proportions of storage tank, storage tanks for solids and its design procedure.
Fundamentals of pipeline design, optimum diameter of pipelines, supporting structure for pipelines, pipeline design for liquids and gases, steam and thermic fluids, materials of construction for pipelines.
Construction materials for process equipments, polymeric materials, coating and protective linings, corrosion mechanism and its prevention, cathodic and anodic protection techniques, testing of welded joints.

TEXT BOOKS:

1. Dawande S.D., "Process Design of Equipments", Central Tecno Publication, Nagpur.

REFERENCES

1. Joshi M.V., Mahajan V.V., "Process Equipment Design", MacMillan India Ltd.
2. Bett K.E., Rowlinson & Saville G, "Thermodynamics for chemical Engineering", MIT Press America
3. Walas. S, "Chemical Process Equipment Design", Oxford, Butterworth Heinemann (1990).
4. Brownell L.E. and Young E.H., "Process Equipment Design", John Wiley ,New York

CMP364-Chemical Engineering Design and Drawing Lab-I [(0-0-2); credits:2]

Syllabus: Symbols used in Drawing, Design and Drawing of various chemical equipments and accessories like storage tank, Jacketed vessel, reaction vessel, hanges coil, gasket, pressure vessel, supports, Agitator, etc.

Minimum 10-12 Imperial size sheets (A-1) covering the above syllabus should be drawn out of which 1/3rd should be drawn using computer software like AutoCAD.

TEXT BOOKS:

1. Joshi M.V., Mahajan V.V., "Process Equipment Design", MacMillan India Ltd

REFERENCES

1. Khurmi R.S ,Gupta J.M., "A text book of machine design", S.Chand &Company Ltd, NewDelhi.
2. Dawande S.D., "Process Design of Equipments", Central Techno Publication, Nagpur.

CMP365-Fluid Mechanics and Mechanical Operation Lab-II [(0-0-2); credits:2]

Syllabus:

1) To verify the laws of crushing using size reduction equipment like rolls, vibrating mills, jaw crusher.
2) To find the effectiveness of hand screening for size seperation sample by a given screen.
3) To determine the time of grinding in a ball mill for producing a product with 80% passing a given screen.
4) To determine the specific cake resistance, filter medium resistance of a slurry in plate and frame filter and leaf filter.
5) Tutor on refrigeration.
6) Determination of Specific Surface area of screen.
7) Hydrodynamics studies in Fluidized bed. Friction factor Vs Reynolds number (f Vs N_{Re}) and friction factor in coils.

TEXT BOOKS:

1. Gupta Santosh & Gupta Vijay, "Fluid Mechanics and its applications", New Age International Publishers.

REFERENCES

1. Badger W.L. and Banchero J.T.; "Introduction of Chemical Engineering", McGraw Hill 1995.
2. Bansal R.K., "Fluid Mechanics", Khanna Publication.
3. Coulson J.M. and Richardson J.F.; Backhurst J.R. and Harker J.H., "Chemical Engineering, Vol. I & II", Butterworth- Heinmann, 2001-2002.

CML366- Mass Transfer – II [(3-0-0); credits:6]

Syllabus: Distillation: Vapour – liquid equilibria, Raoult's law, X-Y and H-X-Y diagrams, differential distillation and equilibrium distillation, steam distillation, azeotropic distillation, extractive distillation.

Fractionation, binary distillation, plate and packed columns for distillation, analytical and graphical methods for estimation of number of stages required in distillation column, minimum reflux ratio, optimum reflux ratio, number of stages at optimum reflux, murphree plate efficiency and overall plate efficiency, effect of feed conditions on number of plates for separation.

Concept of HETP, HTU, NTU in distillation, plate and packed columns, packings for packed columns, pressure drop in plate and packed columns, bubble cap, sieve tray, valve tray plate columns.

Absorption Equilibrium relationships, two film theory, penetration theory, surface renewal rate theory, concept of driving force and mass transfer coefficient, plate column and packed columns for absorption, selection of solvent for absorption and absorbers design procedures.

Liquid – Liquid Extraction fundamentals, selection of solvent for extraction, estimation of mass transfer coefficients, triangular diagram representation, equipments for liquid – liquid extraction, plate and packed columns, spray columns, rotary disc contactors, design procedures and equipment selection criteria. Single stage, multistage operations etc.

Solid – Liquid Extraction fundamentals, Solvent selection, equilibrium relationship, triangular diagram representation, single stage, multistage concurrent and counter current operation, equipments for solid – liquid extraction, their design procedure and selection criteria.

TEXT BOOKS:

1. Treybal R.E., "Mass Transfer Operations", McGraw Hill Book Co., New York 1980

REFERENCES

1. Coulson J.M. and Richardson J.F., "Chemical Engineering Vol. I, II & III", Pergamon Press, New York 1977
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill Book Co.
3. McCabe W.L. and Smith J.C. & Harriot, "Unit Operations of Chemical Engineering", McGraw Hill Book Co., New York 1980
4. Lyderson A.L. "Mass Transfer in Engineering Practice", John Wiley Co. (1983)
5. Brown G.G., "Unit Operations", John Wiley & Sons, New York
6. Chattopadyay P. "Unit Operations of Chemical Engineering, Vol. 1 & 2", Khanna Publishers, New Delhi
7. Suryanarayana A. "Mass Transfer", New Age International, New Delhi

CML367- Heat Transfer-II [(3-0-0); credits:6]

Syllabus: Classification of heat exchangers, recuperative, regenerative and direct contact type, double pipe heat exchangers, co-current counter, current flow arrangement, overall heat transfer coefficient.

Fixed tube sheet, floated head and U–tube shell and tube heat exchangers, their design procedures, number of passes in heat exchangers, fouling of heat exchangers, baffles in heat exchangers, selection of heating and cooling media for heat exchangers, Troubleshooting of shell and tube heat exchangers, thermal stresses and vibrations in shell and tube heat exchangers.

Plate heat exchangers, design procedure, advantages over shell and tube heat exchangers, spiral plate heat exchangers, helical coil heat exchangers.

Heat Regenerators, fixed and fluidized bed, Evaporators types and their operational characteristics. Single stage and multistage evaporation system, Steam economy, boiling point rise of solution and its effect on evaporation system, rising film and falling film evaporators.

Effectiveness of heat exchanges, NTU method. Heat Transfer in jacketed vessels, boilers, furnaces and reactors, reboilers, heat transfer in agitated vessels with and without coils, Heat transfer in packed and fluidized beds.

TEXT BOOKS:

1. Coulson J.M., Richardson J.R., "Chemical Engineering, Vol. I", Butterworth Heinemann, New Delhi.

REFERENCES

1. Kern D.Q, "Process Heat Transfer", Tata McGraw Hill Book Co., New Delhi, 1990.
2. McAdams W.H, "Heat Transmission", McGraw Hill Book Co. New York, 1954
3. Sukhatme S.P, "Text Book on Heat Transfer", Orient Longman Pvt. Ltd.
4. Kothandaram C.P., Subramanyan S. "Heat Transfer and Mass Transfer", Databook, Wiley eastern Ltd., (1989).

CML368-Chemical Reaction Engineering- I [(3-0-0); credits:6]

Syllabus: Introduction to Chemical Reaction Engineering:

What is chemical reaction engineering?, Role of Chemical Reaction Engineering in Process Industry, Classification of reaction based on various terms, Reaction rate, Chemical kinetics, Variables affecting rate of reaction, Speed of reactions, Problems.

Kinetics of Homogeneous Reactions:

Concentration dependent term and temperature dependent terms of rate equation, Single and multiple reactions, Elementary and non-elementary reactions, Molecularity and order of reaction, Rate constant, Representation of reaction rate, Kinetic models, Temperature dependency from Arrhenius' law, thermodynamics, various theories, Activation energy, Problems.

Interpretation of Batch Reactor Data:

Constant volume batch reactor, Variable volume batch reactor, Integral method and differential method of analysis of kinetic data, other methods of analysis of kinetic data, Temperature and reaction rate, Problems.
Introduction To Reactor Design:
Types of reactors, PFR, CSTR etc., Material & energy balances single ideal reactor, Space-time and space-velocity, Holding time, Introduction of non-ideal flow, Problems
Ideal Reactors for a Single Reaction:
Ideal Batch Reactor, Steady State Mixed Flow Reactor, Steady State Plug Flow Reactor, Problems
Design for Single Reactions:
Size comparison of single reactors, General graphical comparison, Multiple reactor system, Recycle reactor, Autocatalytic reactions, Problems.
Design for Parallel Reactions:
Introduction to design of parallel reactions, Qualitative and Quantitative discussion on product distribution, Contacting patterns, Reactor Size and arrangement, Selectivity, Yield, Problems.
Potpourri of Multiple Reactions:
Reversible first order reaction, First order followed by zero order reaction, Zero order followed by first order reaction, Successive reversible reactions of different orders, reversible reactions, Irreversible series-parallel reactions, Graphical representation, Denbigh reactions and their special cases, Problems.
Temperature and Pressure Effects:
Single and multiple reactions, Heats of reaction from thermodynamics, Equilibrium constant, Temperature, Graphical design procedure, Optimum Temperature Progression, Heat Effects, Adiabatic and non-adiabatic operations, Problems.

TEXT BOOKS:

1. Octave Levenspiel, "Chemical Reaction Engineering", John Wiley & Sons, Singapore, 1998 3rd Edition.

REFERENCES

1. Fogler H.S., "Elements of Chemical Reaction Engineering", Prentice-Hall, NJ, 2006, 4th Edition.
2. G. F. Froment and K. B. Bischoff, "Chemical Reactor Analysis", John Wiley & Sons, Singapore, 1990 2nd Edition.
3. Smith J. M., "Chemical Engineering Kinetics", McGraw Hill, N Y, 1981, 3rd Edition.

CMP366- Mass Transfer Laboratory [(0-0-2); credits:2]

Syllabus:

1. To determine the Mass Transfer coefficient for Absorption of CO_2 in NaOH solution in packed Column.
2. Study of adsorption of acetic acid on activated charcoal [To verify adsorption isotherms].
3. To determine the number of Heat Transfer Units (HTU) & height equivalent to Theoretical plate (HETP) of Packed distillation column.
4. To study the drying characteristics curve under constant drying condition in rotary vacuum or tray dryer.
5. Diffusion (Liquid – Liquid) –To calculate the diffusion coefficient of vapour in still Air.
6. To study the characteristics of Boiling point diagram.
7. To study the characteristics Cooling Tower experiment.
8. Experiments on Differential Distillation.
9. To determine rate of distillation by Steam Distillation.
10. Performance evaluation of fluid bed dryer.
11. Study of factors affecting rate of Evaporation :-

i) Effect of Surface Area.
ii) Effect of Temperature.

12. Solid liquid extraction
13. Liquid – Liquid Extraction– To determine Overall efficiency for a three stage counter-current and cross current system.
14. Diffusion (Liquid–Air):- To find the diffusion coefficient of vapour in still air.

15. Experiments on Fractional Crystallization.
16. Spray Column Dryer:- To study the Design and operating Principles of Spray Dryer.
17. Plate Column Distillation :- to study the Performance of a rectification column.
18. Determination of Rate of drying, Free moisture content and bound moisture content.

TEXT BOOKS:

1. Treybal R.E., "Mass Transfer Operations", McGraw Hill Book Co., New York 1980.

REFERENCES

1. Coulson J.M. and Richardson J.F., "Chemical Engineering Vol. I, II & III", Pergamon Press, New York 1977
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill Book Co.
3. McCabe W.L. and Smith J.C. & Harriot, "Unit Operations of Chemical Engineering", McGraw Hill Book Co., New York 1980
4. Lyderson A.L., "Mass Transfer in Engineering Practice", John Wiley Co. (1983)
5. Brown G.G., "Unit Operations", John Wiley & Sons, New York
6. Chattopadyay P., "Unit Operations of Chemical Engineering, Vol. 1 & 2", Khanna Publishers, New Delhi
7. Suryanarayana A. "Mass Transfer", New Age International, New Delhi

CMP367- Heat Transfer Laboratory [(0-0-2); credits:2]

Syllabus:

1) Determination of Cp of Ebonite in Infinite Cylinder.
2) Determination of Thermal Conductivity of a metal rod at different temperatures using Fourier equation.
3) Determination of Heat Transfer Coefficient in Enameled Vessel.
4) Determination of Heat Transfer Coefficient in Jacketed Kettle and natural convention with or without stirring.
5) Determination of Overall Heat Transfer in Shell and Tube Heat Exchanger.
6) Determination of Overall heat transfer coefficient in film condensation and Drop wise condensation.
7) Determination of Overall heat transfer coefficient in a CSTR.
8) Determination of heat transfer coefficient in steam – air heat exchanger / hot oil.
9) Evaluation of Wilson Plot.
10) Verification of Nusselt Equation.
11) Determination of Stefan Boltzmann constant using (dT/ dθ) from temperature Vs Time plot.
12) Determination of Emissivity of a given plate at various temperatures.
13) Determination of Overall heat transfer coefficient for Concentric Tube heat Exchanger.
14) Determination of heat transfer coefficient in a Finned tube heat Exchanger.
15) Study of temperature distribution along the length of a pin-fin under natural and forced convention conditions.
16) To study single / Double / Triple effect evaporators and find its steam Economy.

TEXT BOOKS:

1. Coulson J.M., Richardson J.R. "Chemical Engineering, Vol. I", Butterworth Heinemann, New Delhi.

REFERENCES

2. Kern D.Q, "Process Heat Transfer", Tata McGraw Hill Book Co., New Delhi, 1990.

CML371- Chemical Process Modeling and Simulation [(3-0-0); credits:6]

Syllabus: Introduction to Process Modeling and Simulation. Fundamentals: Uses of Mathematical Models, Scope of coverage, principles of formulation Fundamental laws: Continuity, energy, equation of motion, transport equations, equation of state, chemical kinetics and problems related to this. Examples of mathematical models of chemical engineering, systems: Series of Isothermal, Constant-Holdup CSTRs,CSTRs With Variable Hold-ups,Two Heated Tanks,Gas-Phase, Pressurized CSTR, Nonisothermal

CSTR,Single-Component Vaporizer,Multicomponent Flash Drum,Batch Reactor,Reactor With Mass Transfer Ideal Binary Distillation Column,Multicomponent Nonideal Distillation Column,Batch Distillation With Hold-up,pH Systems,steady state modeling of Solvent Extraction,two state extraction,models in heat transfer operation, Models in reaction kinetics schemes for various reaction schemes: Series parallel, combination, etc.

TEXT BOOKS:

1. William L. Luyben, "Process Modeling, Simulation An Control For Chemical Engineers", McGraw-Hill Publishing Company

REFERENCES:

1. B.V.Babu, *"Process Plant Simulation"*, Oxford
2. V.G.Jenson,and G.V.Jefree, "Mathematical methods in Chemical Engineering", Academic Press

CMP371- Chemical Process Modeling and Simulation Lab [(0-0-2); credits:2]

Syllabus: The following experiments have to be conducted using any one software Polymath/C / C++/ Fortran/Aspen Hysys/Unisim (Any 08 out of 14 listed below).

1. Gravity Flow tank.
2. Three CSTR's in series – open loop.
3. Three CSTR's in series – closed loop.
4. Non-isothermal CSTR.
1. Complex reaction scheme (Batch Reactor)
2. Second order complex batch reactor
3. Series parallel reaction scheme
4. Semi-batch reactor model
5. Complex reaction model
6. Parallel second order reaction scheme
7. Reversible and irreversible 1^{st} order reactions
8. 2^{nd} order series reactions
9. Complex set of series parallel reactions

TEXT BOOKS:

1. William L. Luyben, "process modeling, simulation an control for chemical engineers", McGraw-Hill Publishing Company

REFERENCES

1. A.Kayode Coker, "Modeling of Chemical Kinetics and Reator Design", Gulf Professional Pubilshing
2. B.V.Babu, *"Process Plant Simulation"*, Oxford
3. V.G.Jenson,and G.V.Jefree, "Mathematical methods in Chemical Engineering", Academic Press

CML461- Transport Phenomena [(3-0-0); credits:6]

Syllabus: Definition of transport properties, their measurement and estimation, velocity distribution in laminar and turbulent flow, shell momentum balances, flow of non-Newtonian fluids, development of boundary layer, flow over flat plates, and velocity profiles.

One-dimensional equation of motion and continuity, Euler and Navier–stokes equation, dimensional analysis of equation change.

Shell balance approach for developing equations for momentum, heat and mass transport, Temperature distribution in solids and fluids in laminar flow, development of thermal boundary layer.

Concentration distribution in solids and in fluids in laminar flow, equations of change for multi component systems.

Similarity between heat, momentum and mass transport and mass transport and various analogies. Application of heat, momentum and mass transport concepts to various to various disciplines of engineering and technology.

TEXT BOOKS:

1. Bird R.B., Stewart W.E., Lightfoot E.N, "Transport Phenomena", John Wiley & Sons, Singapore, 1960 & 2002.

REFERENCES

1. Thomson, W.J. "Introduction to Transport Phenomena", Pearson Education Asia, Singapore, 2000.
2. Brodkey R.S. and Hershey H.C, Transport Phenomena: A Unified Approach, McGraw-Hill, New York,1988.
3. Plawsky J.L, "Transport Phenomena Fundamentals", Marcel Dekker, New York, 2001.
4. Slattery J.C., Sagis L., Oh E-S. "Interfacial Transport Phenomena", Springer, New York, 2007.

CML462- Chemical Reaction Engineering – II [(3-0-0); credits:6]

Syllabus: Overview of Chemical Reaction Engineering: Summary of Chemical Reaction Engineering-I, Choosing the right kind of reactor, Problems. Flow Pattern, Contacting, and Non-Ideal Flow: Non ideal flow in reactors, RTD of fluid in reactors, Age distribution, F curve, C curve and E curve, Compartment model, Dispersion model, Tank in Series model, Problems.

Introduction to Heterogeneous Reactions: Examples of heterogeneous reactions, contacting pattern and flow modeling, Problems. Solid Catalysed Reactions:

Introduction and Spectrum of kinetic regimes, Surface kinetics and rate equation, pore diffusion, porous catalyst, Heat effects, Performance Equation, Experimental methods and rate equation, Controlling Resistance, Product distribution in multiple reactions, Problems.

Introduction to Catalyst and Catalytic Reactors: Typical Catalysts, Catalyst Characterizations, Catalyst Deactivation and Regeneration, Packed bed reactor, Fixed Bed, Fluid Bed, Trickle bed, Slurry Reactors etc., Problems.

Kinetics and Design of Fluid- Fluid Reactions: The rate equation, Kinetic regimes for mass transfer and reaction, Fast reaction, Intermediate reaction, Slow Reactions, Factors to select the contactor, Straight mass transfer, Various cases of mass transfer with chemical reaction, reaction kinetics, Problems.

Kinetics and Design of Fluid- Particle Reactions: Various models for fluid-solid reactions, Shrinking core model, Rate of reaction, Reaction/Mass transfer Control, Rate controlling steps, plug flow and mixed flow of solids, Problems.

TEXT BOOKS:

1. Octave Levenspiel, "Chemical Reaction Engineering", John Wiley & Sons, Singapore, 1998 3rd Edition.

REFERENCES:

1. Fogler H.S., "Elements of Chemical Reaction Engineering", Prentice-Hall, NJ, 2006, 4th Edition.
2. G. F. Froment and K. B. Bischoff, "Chemical Reactor Analysis", John Wiley & Sons, Singapore, 1990 2nd Edition.
3. Smith J. M., "Chemical Engineering Kinetics", McGraw Hill, N Y, 1981, 3rd Edition.

CML463- Process Control and Instrumentation [(3-0-0); credits:6]

Syllabus: Importance, aims and objectives of process control, introduction to system dynamics, concept of dynamic response, first order, second order interacting and non interacting systems, concepts of transfer function, time constant, process gain, overshoot, decay ratio, dead time. Introduction to set point, disturbance, closed loop and open loop control, feedback and feed forward configurations, dynamics of feedback control system. Types of controllers, P, PI and PID controllers, controller gain, stability analysis, Routh stability criteria. Design of controllers using open loop response, Zigeler – Nichols controller settings, Bode and Nyquist stability criteria. Control valve and choice of controller settings. Basic design of pneumatic controllers, electric / electronic controllers, discontinuous control modes – two position, classical and modern control actions. Process instruments used for measurement of pressure, temperature, liquid level, flow rate and compositions, pressure gauge, strain gauge, McLeod gauge, vacuum measurement, transducers, transmitters, digital signal processing. Introduction to set point, error, accuracy, sensitivity,

Application of control systems to chemical process equipments such as chemical reactors, heat exchangers, distillation columns, boilers etc.

TEXT BOOKS:

1. Stephanopoulos G., "Chemical Process Control, An Introduction to Theory and Practice", Prentice Hall of India Ltd., Englewood Cliffs, New Jersey.

REFERENCES

1. Babatunde A., Ogunnaike & Ray W.H., "Process Dynamics, Modeling and Control", Oxford Press, New York, (1994)
2. Coughnowr D.R., "Process Systems Analysis and Control", McGraw Hill Book Co.
3. Radhakrishnan V.R., "Instrumentation and Control for the Chemical, Mineral and Metallurgical Processes", Allied Publishers Ltd., New Delh
4. Perry R.H., "Chemical Engineer's Handbook",
5. Harriot P. "Process Control", McGraw Hill, New Delhi, 1984.
6. Smith Carlos A. & Corrieio A.B., "Principles and Practice of Automatic Process Control", John Wiley & Sons, New York.

CMP462- Chemical Reaction Engineering Lab [(0-0-2); credits:2]

Syllabus:

1) To determine the reaction rate constant {k} for given reaction. (CSTR / BATCH / SEMIBATCH / PFR)
2) To determine the effect of temperature on reaction rate constant. (CSTR / BATCH /SEMIBATCH / PFR)
3) To determine the activation energy {E} for the given reaction. (CSTR / BATCH / SEMIBATCH / PFR)

4) To draw C [t], E [t] & F [t] curve and to calculate the mean residence time {tm} variance { ó2} and skew ness { S3} for plug flow reactor.
5) To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance { ó2} and skew ness { S3} for packed Bed reactor.
6) To study the cascaded CSTR
7) To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance { ó2} and skew ness {S3} for Annular reactor.
8) To study the kinetic in tubular flow reactor [coiled tube] for the given reaction.

TEXT BOOKS:

1. Octave Levenspiel, "Chemical Reaction Engineering", John Wiley & Sons, Singapore, 1998 3rd Edition.

REFERENCES

1. Fogler H.S., "Elements of Chemical Reaction Engineering", Prentice-Hall, NJ, 2006, 4th Edition.
2. G. F. Froment and K. B. Bischoff, "Chemical Reactor Analysis", John Wiley & Sons, Singapore, 1990 2nd Edition.
3. Smith J. M., "Chemical Engineering Kinetics", McGraw Hill, N Y, 1981, 3rd Edition.
4. Inamdar S.T.A. "Biochemical Engineering – Principles and Concepts", Prentice-Hall of India, New Delhi,2007.
5. Shuler M.L., Kargi F., "Bioprocess Engineering – Basic Concept", Prentice-Hall of India, New Delhi, 2006.

CML463- Process Control & Instrumentation Lab [(0-0-2); credits:2]

Syllabus:

1) Study of first order system & determination of time constant for a first order system.

2) Study of second order interacting and non interacting system &determination of time constant, overshoot and decay ratio.
3) Study of Gain of a proportional controller.
4) Study of Process simulation .
5) Study of P–I Controller.
6) Study of P-I-D Controller.
7) Study of Proportional Controller.
8) Calibration & determination of time lag of various first and second order instruments.
9) Set point setting and study of operation of a system & set point setting.
10) Study of Safety valve actuating system.
11) PC based control of any of the equipment ex. Heat Exchanger, Distillation column etc.
12) Flow control study using P, P-I, P-I-D, controllers.

REFERENCES

1.Stephanopoulos G., "Chemical Process Control, An Introduction to Theory and Practice", Prentice Hall of India Ltd., Englewood Cliffs, New Jersey.
2. Babatunde A., Ogunnaike & Ray W.H., "Process Dynamics, Modeling and Control", Oxford Press, New York, (1994)
3. Coughnowr D.R., "Process Systems Analysis and Control", McGraw Hill Book Co.

CMP464-Chemical Engineering. Design and Drawing Lab-II [(0-0-2); credits:2]

Syllabus: Design and drawing of chemical equipments like, Heat exchanger, distillation column, evaporator, cyclone seperator, autoclave, Dryer, Pump, etc.

Preparation of working drawing part list & assembly drawings of plant layouts and piping drawing, device drawing.

Minimum 10-12 Imperial size sheets (A-1) covering the above syllabus should be drawn out of which $1/3^{rd}$ should be drawn using computer software like AutoCAD.

TEXT BOOKS:

1. Joshi M.V., Mahajan V.V, "Process Equipment Design", Macmillan India Ltd

REFERENCES

1. Khurmi R.S ,Gupta J.M. "A Text Book Of Machine Design", S.Chand &Company Ltd, New Delhi.
2. Dawande S.D., "Process Design of Equipments", Central Tecno Publication, Nagpur.

CML466- Chemical Plant Design [(3-0-0); credits:6]

Syllabus: Introduction to various codes used in chemical industries and their application, fundamentals of process flow sheet design.

Process design calculations for heat exchange equipments such as shell and tube H.E., plate heat exchangers, single stage and multistage evaporators.

Process design calculations for mass transfer equipments such as tray towers, packed towers for distillation sieve tray design and layout, hydraulic design, packed column internals, permissible pressure drop limits, design calculations for absorbers.

Process design calculations for dryers, crystallizers, reactors with examples.

Economic evaluation of process equipments, project cost estimation, measures of economic performance, depreciation, break even analysis, minimum cost analysis, profitability analysis.

Safety in chemical plant design, safety codes, handling of hazardous chemicals, safety factors and parameters in design of process equipments.

Pressure relieving devices, plume analysis, centrifugal pump troubleshooting, installation, regular checks, and selection criteria, risk analysis of process equipments.

TEXT BOOKS:

1. Dawande S.D., "Process Design of Equipments", Central Techno Pub., Nagpur (2007).

REFERNCES

1. Perry R.H. and Green D.W. "Perry's Chemical Engineering Handbook", McGraw Hill Book Co
2. Timmerhaus P., "Plant Design and Economics for Chemical Engineers", McGraw Hill Book Co
3. Chandalia S.B. , "Handbook of Chemical Process Development", Multi-tech. Publishing Co. Mumbai, (2002).

CHL369-Green Chemistry and Engineering [(3-0-0); credits:6]

Syllabus: Introduction to environmental issues- Air, Water, Land, Biodiversity, Solid waste, Air quality issues – NO_x, HCs and VOCs. Ground level ozone, Pb, particulates, SO_x, NO_x and acid deposition; Water Quality issues Ecology; Waste flows – sources, trends, preventive environmental management, (PEM). Global environmental and energy issues, Global warming, Ozone depletion.

Environmental Laws and Regulations – Indian rules and regulations; Indian scenario vis-à-vis global scenario paradigm shift from end – of – pipe to front - end pollution prevention and waste minimization.

Green Chemistry - Green Chemistry principles and methodologies – alternative feedstocks, green solvents, synthesis pathways, inherently safer chemistry; Environmental ethics – roles and responsibilities of chemical engineers for chemical process safety and environmental protection, Industrial ecology.

Evaluation and Improvement of Environmental Performance of Chemical Processes - Evaluation of environmental fate, estimation of ecosystem risks, classification of environmental risks. Evaluation of exposures–workplace characterization, exposure pathways, monitoring worker exposure, Designing safer chemicals; Design for environment (DFE), Life cycle assessment.

Evaluation of environmental performance during process synthesis –Environmental performance tools – Economic criteria, environmental criteria, Threshold limit values (TLVs), permissible exposure limits (PELs), and Recommended exposure limits (REL s), Toxicity weighting; evaluating alternative synthetic pathways; Environmental release assessment. Release quantification methods and modeled release assessments. Integrated with Hazard and Operability (HAZOP) analysis.

Green Engineering: Principles of green engineering, pollution prevention for chemical reactors; pollution prevention in storage tanks and fugitive emission; pollution prevention assessment. Assessment of environmental performance, Concepts of sustainability and sustainable processes.

Flowsheet Analysis for Pollution Prevention and evaluation of Environmental performance of a flow sheet: Process and energy integration; optimizing strategies for segregation, mixing and recycling of streams; Evaluation of environmental performance of a flow sheet – Fugacity capacity, intermedia transport, reaction loss processes, Metrics for environmental risk evaluation of process design with respect to environment.

TEXT BOOKS:

1. Ahluwalia V.K. and Kidwai M., "New Trends in Green Chemistry", Anamaya Publishers, New Delhi

REFERENCES

1. Anastas P.T. and Williamson T.C. Green Chemistry, "Frontiers in Benign Chemical Synthesis and Processes", Oxford University Press (1998)
2. David T. Allen & David R Shonnard, "Green Engineering: Environmentally Conscious Design of Chemical Process", Prentice Hall PTR.
3. Lancaster M (Mike), "Green Chemistry: An Introductory Text", Royal Society of Chemistry, 2002.

CML380- Industrial Waste Treatment (IWT) [(3-0-0); credits:6]

Syllabus: Nature and characteristics of industrial wastes; Sources and types of wastes: solid, liquid, and gaseous wastes; Pre-treatment of Industrial wastes, unit operations and unit processes. Sampling Techniques.

Methods for Treating industrial waste gases or air discharges- physical method, chemical method, combined method, biological method.

Solid and Hazardous wastes: definitions, concepts. Incineration, recycling, composting, landfill, On-Site Monitoring and Analysis of Industrial Pollutants.

Waste water treatment-physical, chemical and biological method.
Recent trends in Industrial waste treatment. Application of Biotechnology for Industrial Waste Treatment.
Case Studies:- Example (Treatment of Pharmaceutical Wastes, Treatment Refinery Wastes, Treatment of Textile Wastes, Treatment of Pulp and Paper Mill Wastes, Treatment of Dairy Processing Wastewaters, Treatment of Pesticide Industry Wastes, Food Waste Treatment, Treatment of Rubber Industry Wastes, Treatment of Tannery Industry Wastes and Radioactive waste etc.).

TEXT BOOKS:

1. Nemerow N.L, "Industrial Waste Treatment", Butterworth-Heinemann.

REFERNCES

1. S.P.Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill
2. Frank Woodard, "Industrial Waste Treatment Handbook", Butterworth-Heinemann
3. Freeman H. M., "Environmntal pollution control engineering", McGraw Hill

CMP380- Industrial Waste Treatment Laboratory [(0-0-2); credits:2]

Syllabus:

1. Determination of BOD in the given waste water sample
2. Determination of Dissolved oxygen in the given waste water sample
3. Determination of COD in the given waste water sample
4. Determination of solid content in the given waste water sample
5. Estimation of chloride in a sample (by Moher's Method)
6. Determination of hardness of water by complexometric titration method
7. Determination of acidity/alkalinity of given waste water sample
8. Standard plate count test, bacteriological study.
9. To study water quality test.
10. To study the waste water treatment by Adsorption.
11. To study the waste treatment using membrane separation.
12. To study the monitoring of NOx,SOx,Particulate matter in the ambient air .
13. To study the analysis of physical parameter (moisture content,bulk density ,sp. Gravity etc.) of solid waste.

TEXT BOOKS:

1. Nemerow N.L, "Industrial Waste Treatment", Butterworth-Heinemann.

REFERENCES

1. S.P.Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill
2. Frank Woodard, "Industrial Waste Treatment Handbook", Butterworth-Heinemann
3. Freeman H. M., "Environmntal pollution control engineering", McGraw Hill
4. C.S.Rao, "Environmntal pollution control engineering", New Age International
5. R. S. Ramalho, "Introduction to Wastewater Treatment Processes", Academic Press,California

CMP-421- Nanocomposite technology Lab [(0-0-2); credits:2]

Syllabus:

1. To find glass transition temperature using DSC
2. To find M.P. of Composites using DSC
3. To find Degradation temperature of Composites using TGA
4. To find Rheological behavior of nanofluids of TiO2 Water/EG/Parafine Rheometer
5. To find Tan Delta of Composites Rheometer
6. To find Young's modulus of composites DMA
7. To find Storage modulus of composites DMA
8. To analyze relaxation modulus vs. decay time effect of samples nanomemrane/composites DMA
9. To find effects of thermal aging on melt properties of composites Rheometer
10. Estimation of Polymer Lifetime by TGA Decomposition Kinetics

TEXT BOOKS:

1. Guozhong Cap, Ying Wang, "Nanostructures and Nanomaterials(synthesis properties and applications)", World Scientific.

REFERENCES

1. Jurgen Schulte, "Nanotechnology (strategies, industry trends and applications0", Willey.
2. S.Reich, C.Thomsen, J.Maultzsch, "Carbon Nanotubes (Basic concept and physical property)", Wiley-VCH
3. Yuri G. Yanovsky "Polymer Rheology theory and practice", Chapman and Hall.
4. Gerhard Wilde, "Nanostructured Materials", Elsevier.

CML481- Instrumental Analytical Techniques [(3-0-0); credits:6]

Syllabus:

An introduction to analytical chemistry: choice of analytical methodology, sampling, sample preparation, chemical analysis, tools for quantitative chemical analysis, quality assurance.

Extraction methods such as liquid-liquid extraction, solid phase extraction, super-critical fluid extraction and accelerated solvent extraction. Cleanup and fractionation methods.

Introduction to Chromatography, high-pressure liquid chromatography (HPLC), gas chromatography (GC) and other chromatographic methods. Detector types with focus on mass spectrometry and hyphenated techniques such as GC-MS and LC-MS.

Introduction to spectroscopic methods (UV-VIS, IR, X-ray, atomic absorption spectroscopy (AAS) and inductive coupled plasma mass spectrometry).

Introduction to data processing, errors in chemical analyses, statistical analyses (including chemometrics) and data presentation. Method development, evaluation, validation and QA/QC measures. Uncertainty analysis.

TEXT BOOKS:

1. Harris, D.C., "Quantitative Chemical Analysis", W.H.Freeman and company.

REFERNCES

1. Bruno, T.J, and Svoronos, P. D. N., "Handbook of Basic Tables for Chemical Analysis", CRC Press
2. McNair, H. M. and Miller, J. M., "Basic Gas Chromatography", Willy and Sons, Inc
3. Palvia D. L., Lampman G. M., Kriz G. S. and Vyvyan J. R., "Introduction to Spectroscopy", Brooks/Cole
4. Snyder L. R, and Krikland J. J., "Introduction to Modern Liquid Chromatography", A Wiley Inetrscience Publication
5. Skoog D. A., West D. M., Holler F. J. and Crouch S. R., "Fundamentals of Analytical Chemistry", Brooks/Cole
6. Gary. D. Christian, "Analytical Chemistry", John Willy and Sons, Inc
7. Willard, H.M., Merit L.L., "Instrumental Methods of Analysis", CBS publishing and Distrubution

CML333- Polymer Processing [(3-0-0); credits:6]

Syllabus: Introduction: Comparison of thermoplastics and thermoset plastics; Thermoset plastics - Types of resins, Interpenetrating Polymer Networks (IPN); Thermoplastics - Types of aliphatic and aromatic thermo plastics, copolymers, Blends and alloys; Liquid crystal plastics; cellular plastics; oriented plastic materials.

Processing: Basics of process design, Classification & general aspects of processes - molding & forming operations, Post die processing; Decoration of plastics - Printing, Vacuum Metalizing, In-mold decoration. Additives & Compounding - Different types of additives, Batch mixers, continuous mixers, Dispersive and distributive mixing, Characterization of mixed state.

Fundamentals on Viscous & Viscoelastic behavior of polymer melt, Rheological measurements and Polymer processability. Non isothermal aspects - Temperature effect on rheological properties, Crystallization, Morphology & Orientation, plastic memory, Molecular weight effects on processing and properties.

Properties & Testing of plastics: Basic concepts of testing, National & International standards, Test specimen preparation, Pre conditioning & Test atmosphere.

Identification of plastics by simple test - Visual examination, Density, Melting point, Solubility test, Flame test, Chemical tests.
Effect of shape & structure on material properties, Long - term & short - term mechanical properties, crazing, Permeability & barrier properties, Environmental-stress cracking, Melt flow index, Heat deflection temperature, Vicat softening temperature, Glass transition temperature, thermal conductivity, Co-efficient of thermal expansion, Shrinkage, Thermal stability, Flammability.
Waste management & Recycling: Plastics waste and the associated problems, Integrated waste management - source reduction, recycling & sustainability correlation, energy recovering process. Environmental issues, policies and legislation in India.

TEXT BOOKS:

1. Gruenwald G, "Plastics - How Structure Determines Properties", Hanser Publishers, 1993

REFERNCES

1. Baird D. G. and Collias D. I., "Polymer Processing Principles and Design", Butterworth-Heinemann, 1995
2. Vishu Shah, "Hand Book of Plastics Testing Technology", John Wiley & Sons Inc. New York
3. J.S.Anand, K.Ramamurthy, K.Palanivelu, "How to identify Plastics by Simple Methods". CIPET, Chennai
4. Anthony L. Andrady (Ed.), "Plastics and the Environment", Wiley Interscience, New York

CML299- Introduction to computing softwares for chemical engineering [(3-0-0); credits:6]

Syllabus:

Introduction to Softwares- Documentation; Development Environment; Desktop Tools, Other development environment tools.
Manipulating Matrices-Matrices and Magic squares, Expressions, Working with Matrices, More about Matrices and Arrays, Controlling commnad window input and output; Graphics-Basic plotting, Editing plots, Mesh and surface plots, Printing and Handling the Graphics.
Programming with MATLAB-Flow control, Other data structures, Scripts and Functions.
Examples of Chemical engineering solved problems using MATLAB-Equations of state, Vapour liquid equilibrium, Chemical reaction equilibria, Reaction-kinetic system, Transport processes, etc.

TEXT BOOKS:

1. Andrew Knight, "Basics of MATLAB and Beyond", Chapman & Hall/CRC press LLC., 2000

REFERENCES

1. Rudra Pratap, "Getting Started with MATLAB7: A Quick Introduction for Scientists and Engineers", Oxford University Press, Newdelhi, India
2. W. Fred Ramirez, "Computational Methods in Process Simulation", Elsevier Science & Technology Books

CML370- Environmental Engineering [(3-0-0); credits:6]

Syllabus: Man and environment, biogeochemical cycles, Biosphere and ecosystem, Forest Nutrient cycles and the parameters responsible for the disturbance of these cycles.
Mobile and stationary sources of air pollutants, air pollution, behaviour of pollutants and atmospheric chemical reactions, air pollution control processes, atmospheric dispersion of pollutants, models for dispersion, limitations of models, effective stack height concept, gas sampling and analysis.
CO, CO_2, H_2S, SO_x, NO_x emissions and their control, desulphurization. Sources of water and pollutants, classification and characterization of solid, liquid and gaseous waste, measurement of levels of pollution such as DO, BOD, COD, TOC, ThOD, soluble and suspended volatile solids, Water quality and discharge standards.
Unit operations such as screening, coagulation, flocculation, filtration, clarification, solvent extraction.
Chemical treatment of waste material, oxidation, chlorination, Ozonation, incineration etc. Biological Treatment, biochemical kinetics, microbial kinetics, microbial growth.

Aerobic and anaerobic waste treatment, activated sludge process, aerated lagoons, anaerobic digesters, Biogas & trickling filters & its utilization. Solid Waste & its disposal pyrolysis (Incineration, Composing and filling etc.).

Measuring environmental impacts, life cycle analysis, legislation controlling discharges, optimal degree of abatement, and policies for regulation of environmental impacts.

TEXT BOOKS:

1. Mahajan S.P. "Pollution Control in Process Industries", Tata McGraw Hill Book Co.

REFERENCES

1. Pandey G.N. and Camey G.C., "Environmental Engineering", Tata – McGraw Hill Book Co., New Delhi (1989)
2. David L; Weber W.J. "Environmental Engineering Handbook, Physico – Chemical Processes for Water Quality Control", Lewis Publishers.
3. Sincero A., "Environmental Engineering, A Design Approach", Prentice – Hall of India, New Delhi (1996)

CMP370- Environmental Engineering Laboratory [(0-0-2); credits:2]

Syllabus:

1. Collection of particulate matter using Air sampler.
2. Determination of NO_x and SO_x and CO.
3. Determination of relative humidity of atmosphere.
4. Determination of dissolve oxygen and carbon dioxide.
5. Estimation of B.O.D.
6. Determination of physical properties of water

a) Density b) pH

c) Surface tension d) turbidity e) conductance.

7. Chromatographic Separation of compounds.
8. Determination of Cu, Ni, and Co in solution by spectrophotometry.
9. Determination of available chlorine/ free chlorine/Chloride in given water samples.
10. N.P.K. content estimation of soil.
11. Semi-micro determination of nitrogen, sulphur, and halogens.
12. Study of Solvent - Extraction technique for metal ion determinations.

REFERENCES

1. David L; Weber W.J. "Environmental Engineering Handbook, Physico-Chemical Processes for Water Quality Control", Lewis Publishers.
2. Rao M.N. and Dutta A.K., "Waste Water Treatment", Oxford & IBH Publishing Co. Pvt. Ltd.
3. Pandey G.N. and Camey G.C., "Environmental Engineering", Tata – McGraw Hill Book Co., New Delhi (1989)

CML372- Pulp and Paper Technology [(3-0-0); credits:6]

Syllabus: Introduction, raw materials for paper making, structure, physical, chemical properties, morphology, reaction of cellulose with different chemicals

Aqueous pulping systems, commercial pulping process, variables associated with raw materials and pulping process, optimization of process parameters, materials and energy balance calculations

Pulp washing, screening, recovery of spent chemicals involving multiple effect evaporators, cascade evaporators, incineration, recaustising and calcinations

Pulp bleaching and stock preparation, internal sizing, filling and loading, colouring, wet end strength additives, surface sizing.

Sheet forming process, Fourdnui and cylinder mould machine, drainage characteristics, water marking, head box, slice, wire, couch, pressing of sheet for water removal.

Paper drying, drying characteristics, heat and mass transfer aspects, ventilation, dryer performance calculations, air-drying, radiant drying.

TEXT BOOKS:

1. Casey J P, Ed., Wiley Interscience, "Pulp and Paper: Chemistry and Chemical Technology Vol I to IV", New York,

REFERENCES

1. MacDonald R G, "Pulp and Paper Manufacture Vol I to III", 2nd Ed., McGraw Hill, New York.
2. Britt K W, "Handbook of Pulp and Paper Technology", Reinhold Publishing Corporation, New York.
3. Kocurek, "Pulp and Paper Manufacture" , Tappi Publication.
4. Mark, "Handbook of Physical and Mechanical testing of Paper and Board, Vol.I & II", Dekker Publication.

CHL 336- Polymer Engineering [(3-0-0); credits:6]

Syllabus: Introduction to Polymeric Materials : Structure of polymers - Linear, branched, cross linked, classification of polymers.

Polymerisation Types and Techniques: Distinctive features of addition and condensation polymerisation, Mechanisms of addition polymerisation, radical, Ionic, Co-ordination, Copolymerisation. Block & graft copolymers. Chemistry of thermoplastic and thermosetting polymers, Solid State polymerisation. Advanced polymerization techniques using Ziegler-Natta catalysts, metallocenes etc. Bulk, solution, suspension and emulsion polymerization technique. Polymer Processing: Analysis of polymer processing. rheology of polymers, flow in tubes, calendaring, extrusion, injection modeling, fiber spinning, and coating.

Polymer Structure – Property - Relationships: Effect of chemical composition on various properties of Polymer, Mechanical properties: Stress-strain in polymers, elasticity, tensile strength;Transition Properties : Glass transition (Tg), melt transition (Tm);Electrical Properties : Dielectric constant, power factor, dissipation factor; Optical Properties: Chemical Properties : Cohesive energy, solubility parameter, Polymer toxicity; Physical properties of polymers and adhesives. Phenolic, Epoxy and Polyurethane structural adhesives.

Engineering and Speciality Polymers: Polyolefins; Polyamide; Biopolymer : Insulating Polymers; Polymer blend and alloys; Inorganic polymers; Conducting polymers.

Polymer Composite: Fundamentals of polymer composites, Different type of Polymer Composites, Different reinforcement and matrices, fiber and polymer matrix properties, interfacial adhesion, and manufacturing.

TEXT BOOKS:

1. BillMeyer F. W., "Textbook of polymer science",3rd edition, John Wiley & Sons

REFERENCES

1. Gowarikar V.R. and Viswanathan N.V., Jayadav Sreedhar , "Polymer Science", Wiley Eastern Limited.
2. Askeland W.D., "The Science & Engg. of Materials", Academic Press.
3. Bueche F., "Physical properties of polymers", Wiley, New york, 1962.
4. Clegg D.W., "Structure & Properties of Polymers", Elseveir Publication,2005.
5. Fried J. R., "Polymer Science & Technology", 3rd edition, Interscience, New York.
6. Ku C.C.& Liepins R., "Electrical Properties of Polymers" Hanser Publications, Munich,1987.
7. Seanor, D.A., "Electrical properties of polymers", Acadamic press, Newyork, 1982.

CML374- Petroleum Refining Engineering [(3-0-0); credits:6]

Syllabus: Fundamental principles of origin and occurrence of petroleum crude and its exploration, Composition of petroleum, classification and physical properties, Evaluation of crude oil and petroleum products, status of petroleum refining in India, future refining trends.

Crude oil Distillation Process, Pretreatment of crude, atmospheric and vacuum distillation process,

Secondary conversion processes: Thermal and catalytic cracking, Catalytic reforming, Pyrolysis,

Heavy Residue Upgradation Technologies: Hydrocracking, Hydrotreating, visbreaking and coking, alkylation, Isomerisation, dehydrogenation processes, polymerization.

Lubricating oil, grease and Bitumen: Dewaxing and deoiling, deasphalting, lube hydrofinishing, bitumen air blowing, Sweetening and Desulphurization, Hydrodesulphurisation of petroleum products.
Refinery products, refinery gas utilization: LPG, propylene and hydrogen recovery,
Reformulated Gasoline: Present and future requirements.

TEXT BOOKS:

1. Bhaskara Rao B.K., "Modern Petroleum Refining Processes" Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

REFERENCES

1) 2. Nelson W.L., "Petroleum Refining Engineering", Applied Science Publication
2) Noel H.M., "Petroleum Refining Manual", Publisher Reinhdd Pub. Corp., New York
3) Ram Prasad, "Petroleum Refining Technology", Khanna Publishers

CML465- Chemical Informatics [(3-0-0); credits:6]

Syllabus: Cheminformatics introduction: Indroduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and structure Elucidation.
Representation of molecules and Chemical Reactions: Nomenclature; Different types of notations; SMILES coding; Matrix Representations; Structure of Molfilles and Sdfiles; Libraries and tookits; Different electronics effects; reaction classification.
Representing 2D and 3D structures I. Kinds of 2D structures representation; atom lookup and connection tables; graph theory; SMILES; SD files; representation nuances; descriptors.
Database Design and their Management: Database concepts. Structured Query language. Design of Chemical databases, Data Abstraction; Data Models; Instances and Schemes; E-R Model – Entity and entity sets; Relations and relationship sets; E-R diagrams, Reducing E-R Diagram to tables, Network Data Model: Basic concepts, Hierarchical data Model: Basic concepts, Metadatabases, Indexing and Hashing, Text Databases, Introduction to Distributed Database Processing, Data Security. Intefacing programs with databases.
Calculation of physical and chemical data, molecular mechanics, Descriptors for chemical compounds, Methods for data analysis, Artificial intelligence systems in Chemical Engineering, Chemical Markup Language (CML).
Prediction of physical and chemical properties, Structure– Spectra correlations, Chemical reactions and synthesis design, Drug design, elements of bioinformatics and genomics.
Introduction to computational fluid mechanics, Applications of CFD in modeling flow through porous media and through capillaries, Modeling flow through the human circulatory systems, Drug delivery.

TEXT BOOKS

1. Andrew Bender, Jonathan M Goodman, "Cheminformatics", Oxford University Press-2007

REFERENCES:

1. Gasteiger J. and Engel T., "Chemoinformatics", A Text Book, Wiley VCH.
2. Stuart Schreiber, Tarun M. Kapoor, "Chemical Biology: From Small Molecules to Systems Biology and Drug Design Chemical Release 2001."

CML467- Materials in Chemical Industries [(3-0-0); credits:6]

Syllabus: Introduction : Introduction to materials and their principle properties, Simple stresses and strains, Concept of stress, strain, shear stress, shear strain, Hook's law, Elastic limit, stress-strain curve for mild steel and elastomeric materials, factor of safety, Poisson's ratio, Strain energy
Basic principles in their selection for fabrication and erection of chemical plant:Testing of materials, destructive and nondestructive tests, structure of atom and chemical bonds, crystal structures and their influence on material properties, Deformation and slip processes.
Special diffusion process : Aluminizing, Electroplating-hard chrome & nickel plating - Hard dip coating, Cladding - Physical and chemical vapor deposition - Metal spraying , Plastics and rubber coating ,Conversion coating , Coating of tools ,TiC, TiN, Alumina and diamond coating of tools ,Selection of coating of tools , Selection of coating for wear and corrosion resistance.

Metals and their alloys: Iron–carbon diagram, Ferrous and nonferrous alloys, Fe-C diagram, mild steel, special steels, stainless steels, brasses, brasses, aluminum alloys and titanium alloys, high and low temperature material, insulation, refractories.
Selection of the steel, Heat treatment of steel, Proper design for proper heat treatment , Critical temperature and heating - Annealing- Spheroidzing- normalizing , hardening -Isothermal transformations , TTT diagram - tempering - austempering - martempering and ausforming. Heat treatment of corrosion - resistance steels.
Harden ability and its testing, Hard material alloys, Types of structure and their specific volume.
Effect of temperature on mechanical properties various methods of improving the strength for service conditions.
Effect of alloying elements on properties of steel. Alloys of copper, aluminium, magnesium, nickel and zinc,compositions and their uses
Corrosion and its control : Different types of corrosion: chemical, biochemical, and electrochemical; Internal and external factors affecting corrosion of chemical equipments.
Corrosion factors, inhibition, prevention, control and testing, Corrosion behaviour of metals and alloys. Forming processes and corrosion. Fracture in Ductile and Brittle materials, creep, mechanisms of creep and methods to reduce creeping in materials, creep rate and relations. Fatigue-mechanism- methods to improve fatigue resistance in materials. Composite materials, types, stress-strain relations in composite materials, applications.
Polymers, natural & synthetic: Selection of polymeric materials for equipment linings, fiber reinforced plastic, application of special polymers like Nylon 66, Teflon in engineering
Elastomers and plastomers, molecular structure and properties of polymers
Ceramic and glasses: Crystalline and non-crystalline ceramics, silicates, refractories, clays, cements, glass vitreous silica, and borosilicate, Ceramic.

TEXT BOOKS:

1. James F. Shacketford, "Introduction to material science", McMillan publishing company, NewYork ISBN 1990.

REFERENCES

1. Jestrazebaski D.Z., "Properties of Engg. Materials", Toppers.Co. Ltd.
2. Khurmi R.S. and Gupta J.K.,A S.. "text book of machine design"; Chand publication
3. Manas Chand ,; Mcmillan , "Science of Engineering Materials Vol.1 &2", Co. of India Ltd.

CML468- Mineral and Ore Processing [(3-0-0); credits:6]

Mineralogy: Studies of important metallic and non metallic minerals, their characteristics, origin etc. application of non metallic minerals. Sea as a source of minerals. Status of mineral beneficiation industry in India. Study of some representative beneficiation practices with flow sheets. Sampling methodology and equipments.
Comminution: Primary, secondary and special crushers and their performances. Cylindrical and cylindro-conical ball mills, Rod mills, Tube / Pot mills and their performances, capacities, reduction ratios etc. Dry and Wet Grinding. Open and closed circuit grinding. Work Index calculations. Interlocking and liberation of minerals.
Screening: Sizing and Classification: Standard screening tests and graphical representations of the results. Particle size distribution, Sorting, Sizingand Pneumatic classifiers and their performances. Thickeners, Hydrocyclones etc. Theory and practice of sedimentation and filtration. Working of Rotary vacuum filters.
Gravity Concentration Techniques: Principles of Jigging, Tabling and Heavy Media Separation. Processes with equipments used, important controlling factors in operation and application. Beneficiation practice for arsenopyrite containing scheelite.
Froth Flotation: Natural and Artificial Floatability of minerals. Frothers, Collectors, Depressants, Activators / Deactivators, PH Modifiers, etc. Flotation machines. Study of representative sulphide and non sulphide minerals and non metallic ores. Multistage flotation and Column Flotation.
Electrostatic and Magnetic Separation: Principles of Electrostatic and Magnetic Separation (Dry and Wet type). Separation units used in practices and examples in the industries. Calculation of Recovery and ratio of concentration and Mass balance calculations in ore dressing. Industrial set up of Ore Dressing plant.

TEXT BOOKS:
1. Gaudin A.M.,"Elements of Mineral Dressing", , Publisher New York Edition2nd Edition

REFERENCES
1. Pryor E.J; "Mineral Processing",Publisher Kluwar Academic Publishers Edition3rd Edition
2. Rutley F., "Elements of Mineralogy" ,Publisher Thomas Murray & Co., London
3. Robert H. & Locke, Richards C.E., "A Text Book of Ore Dressing" ,Publisher McGraw Hill Co.

CML469- Technology of Paints, Pigments and Powder Coatings [(3-0-0); credits:6]

Syllabus: Historic development of paint industry, paint components and their roles, classification of paints, organic file formers, chemistry of film formers, water thinabble coatings

Drying and semidrying oils like linseed, tung, castor, soyabean oil, their occurrence, compositions and properties. Drying index and its significance, Modification of oils for surface coatings like malenised, styrenated and vinylated oils.

Classification of resins, natural resins like rosin, shellac, cashew nut shell liquid and synthetic resins like phenolics, epoxy, polyester, polyurethane & acrylic resin.

Paint machineries like ball mill, attritor, dynomill, triple roll mill, edge runner, sand mill, working mechanism and selection of machinery for a particular end use.

Principles of formulations of various types of paints like primer, synthetic enamels, wall finishes, wood finishes, computerized colour matching system, testing and analysis of paints, paint film defects and their remedies.

Industrial paints like stoving paints, acrylic paints, bicycle paint, marine paints, acid & alkali resisting paints, automotive paints, method of applications, powder coating, compositions, applications and comparison with normal liquid paints.

Pigment classification, properties, industrial pigments like Titanium dioxide, zinc sulphide lithophone, chrome pigments, red oxide pigment, black pigment, organic pigment, tonners and speciality pigment.

TEXT BOOKS:
1. W M Morgans, "Outline of Paint Technology", CBS Pub, New Delhi

REFERENCES:
1. Zeno Wieks Jr, Frank Jones, S Peter Peppar, "Organic Coating Science and Technology Vol I & II", Wiley Interscince Pub, New York, 1992
2. R Lambourene, Ellis Horwoor Ltd, "Paint and Surface Coating", John Wilet & Sons, New York, 1987

CML470-Computer Aided Design [(3-0-0); credits:6]

Syllabus: Elements of digital computer architecture, computer logic, central processing unit, main memory, Input / Output devices, operation systems – Software languages hierarchy, Assembly language and high level languages - graphic software, language selection, programmed development. Physical properties evaluation, Thermodynamic properties of gases and binary mixtures, methods of calculations, Vapor-liquid equilibrium data for ideal and non-ideal mixtures. Bubble points and dew points, flash distillation calculation. Equipment design. Development of software for the following systems: Heat exchange systems. Double pipe and shell & tube exchangers – Pumps, pipings and pressure drop calculations. Equipment design like evaporator, single and multiple effects, Distillation systems, crystallizer, Absorber and stripper – Liquid – Liquid extraction. Process dynamic simulation - Distillation column, Reactors, Absorbers, evaporators and crystallizers. Introduction to simulation packages like GPSS, CSMP.

TEXT BOOKS:
1. Afgan N.H. and Schlunder, C.V. "Heat Exchangers-design and theory" , Scripta Book, Washington, 1974.

REFERENCES
1) Bhattacharya and Narayanan, "Computer aided design of Chemical Process equipments" , New Central Book Agency,Calcutta (1992)

2) Crowe C.M. et. al., "Chemical plant simulation-An Introduction to Computer aide steady-state process analysi", Prentice Hall, 1971
3) Franks R.G.E., "Modeling and simulation in Chemical Engineering", Wiley Inter Science, 1972.
4) Groover M.P., Timmers E.W., "Computer Aided Design and Manufacturing", Prentice Hall of India Pvt. Ltd., New Delhi, 1985
5) Henley E.J., and Rusen F.M., "Material and Energy Balance Computations", John Wiley, New York, 1969.
6) Holland C.D., "Fundamentals and modeling of simulation process", Prentice Hall (1975).
7) Leeshey M.E, "Computer aided process plant design", Gulf Publishing Co.
8) Myers, A.L. and Seeden, W.D., "Introduction to Chemical Engineering and Computer Calculations", Prentice Hall, 1976.
9) Nashelsky L., "Introduction to Digital Technology", John Wiley and Sons, New York, 1983.
10) Prausnitz, S., "Computer calculations in Multi Component vapor liquid equilibria" Prentice Hall, 1980.
11) Smith B.D., "Design of Equilibrium Stage Processes", McGraw Hill Book Co. New York.

CML471- Biotechnology and Biochemical Engineering [(3-0-0); credits:6]

Syllabus: Types of micro organisms, structure and function of microbial cells, batch and continuous culture, microbial growth kinetics, enzymes from cells, their function and immobilized kinetics, kinetics of microbial growth.

Enzyme technology and kinetics, enzyme catalysis, enzyme applications in industries and medicines, metabolism and bioenergetics, photosynthesis, synthesis and regulation of bimolecular, fundamentals of microgenetics, role of DNA and RNA.

Control of metabolic processes, stoichiometry and yield coefficients from Redox reactions.

Reactions catalyzed by enzymes, types of reactors such as CFSTR, Plug flow.

Introduction to Bioreactor design, scale up of bioreactions and bioreactors, volumetric mass transfer rate of oxygen from air bubbles, respiratory model for mycellial pallet, mechanical mixing, aeration, power consumption, heat transfer in bio reactor.

Sterilization techniques, media and air sterilization, death rate of micro organisms.

Introduction to fermentor design, design of fermentors with modified organisms.

Bioreactor modeling and simulation. Design for bioproducts, applications in biochemical and biomedical engineering.

Downstream processing in biochemical industries: such as separation processes for bulk chemicals unit operations such as Ultra filtration, Aqueous two phase extraction.

TEXT BOOKS:

1. Michael L.Shuler And Fikret Kargi, "Bioprocess Engineering : Basic Concepts", Prentice-hall India Learning private limited

REFERENCES

1. Berry D.R , Russel I., Stewart G.G., "Yeast Biotechnology", Allen and Unwin Publishers, London, (1987).
2. Deswal S., Deswal A., "Basics of Biotechnology", Dhanpat Rai & Co., New Delhi.
3. Syed Tanveer Ahmed Inamdar, "Biochemical engineering: Principles and Concepts", Prentice-hall India Learning private limited
4. Bailey J.E. & Ollis D.F. "Biochemical Engineering Fundamentals" McGraw Hill Book Co. N.Y.(1986).

CML472- Advanced Separation Process [(3-0-0); credits:6]

Syllabus: Overview of Separation Processes:

Introduction / Revision of various Conventional Separation Processes and their applications, advantages, and disadvantages, Need of advance Separation processes, types, Problems.

Reactive Separations:

Introduction, Concept of reactive separations, types of reactive separations, reactive distillation, membrane based reactive separations, reactive extraction, reactive adsorption, reactive absorption, reactive crystallization, applications, design aspects, scope for future, Problems.

Hybrid Separations:

Introduction, Concept of hybrid separations, types of hybrid separations, networking or combination of various separation processes, applications, design aspects, scope for future, Problems.

Membrane Separations:

Introduction, type of membrane separations, membrane, membrane materials, ultrafiltration, microfiltration, nanofiltration, reverse osmosis, pervaporation, type of membrane modules, membrane fouling, concentration polarization, various mathematical models for membrane processes, application, design considerations, Problems.

Supercritical Fluid Extraction:

Introduction, Concept of super critical extraction, factors affecting supercritical extraction, properties of supercritical fluid, applications, design considerations, Problems.

Multi-component Distillation:

Introduction, need of multi-component distillation, methods of multi-component distillation, design methods of multi-components distillation Problems.

Chromatographic Separation:

Introduction, Principles, Classifications, High performance liquid chromatography, ion exchange chromatography, affinity chromatography, reversed phase chromatography, gas chromatography, application, Problems.

Bio-separation Processes:

Introduction, overview of bioseparations, cell disruption, filtration, centrifugation, adsorption, extraction, membrane separation, precipitation, chromatographic separation, Applications, Problems.

Electro-kinetic Separation:

Introduction, Various methods, Electrophoresis, Capillary electrophoresis, Isoelectric focusing, Esotachophoresis, Electro-floatation, Applications, Problem.

TEXT BOOKS:

1. Seader J. D., Henley E. J., "Separation Process Principles", Wiley, 2001, 2nd Edition

REFERENCES

1. Richardson J. F., Harker J. H., "Chemical Engineering" Vol. 2, Elsevier, 2002, 5th Edition.
2. Mukhopadhyay M., "Natural Extract using Supercritical CO_2," CRC Press, 2000, 1st Edition.
3. Nath K., "Membrane Separation Processes", Prentice Hall of India, 2008, 1st Edition.
4. Sivasankar B., "Bio-separations: Principles and Techniques", Prentice Hall of India, 2005, 1st Edition.
5. International Research Papers

CMP 472- Separation Process Laboratory [(0-0-2); credits:2]

Syllabus:

1. Study of Membrane Bioreactor
2. Study of Pervaporation (1)
3. Study of pervaporation (2)
4. Study of fermentor : Ethanol production
5. Study of fermentor: Carboxylic acid production
6. Study of Reactive Extraction (1)
7. Study of Reactive Extraction (2)
8. Study of Supercritical Extraction (Design)
9. Study of Multi-component Distillation (Design)
10. Study of hybrid separation (Design)
11. Study of Membrane Filtration (Design)

TEXT BOOKS:

1. Seader J. D., Henley E. J., "Separation Process Principles" Wiley, 2001, 2nd Edition

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REFERENCES

1. Richardson J. F., Harker J. H., "Chemical Engineering" Vol. 2, Elsevier, 2002, 5th Edition.
2. Mukhopadhyay M., "Natural Extract using Supercritical CO_2," CRC Press, 2000, 1st Edition.
3. Nath K., "Membrane Separation Processes", Prentice Hall of India, 2008, 1st Edition.
4. Sivasankar B., "Bio-separations: Principles and Techniques", Prentice Hall of India, 2005, 1st Edition.
5. International Research Papers

CML473- Safety And Risk Analysis [(3-0-0); credits:6]

Syllabus: Introduction to process plant safety, handling of hazardous chemicals, Lower flammability limit (LFL), UFL, LEL, UEL, TLV, electrostatic hazards, Hazard code and explosive limit, TWA, Ceiling level, Safety in handling of gases, liquids and solids,

Flammable liquid hazards, fire and explosion index, fire ball hazards, oil spillage hazards, Bleveuvce, pool fires, jet fires, radiation hazards.

Explosion, emergency and disasters in chemical process plants, onsite and offsite emergency plan, Fire detectors, smoke detectors.

Safely audit of chemical process plants, HAZOP studies, fault tree and event tree analysis.

Resources for combating fires, dry chemical powders, fire fighting foam, fixed and portable fire extinguishers, FMEA.

Risk analysis of chemical processes, risk management, risk identification, personnel training, risk to environment.

OSHA standards, importance of plant layout in safety, importance of site selection, personnel safety, role of human error in losses. Case studies of fires, explosions, disasters in chemical process plants.

TEXT BOOKS:

1. Daniel A. Crowl and Joseph F. Louvar, "Chemical Process Safety: Fundamentals with Applications" Prentice Hall International Sereis

REFERENCES

1) Greene R. "Safe and Efficient Plant Operation and Maintenance", McGraw Hill Book Co., New York.
2) Dixit, "Safety Evaluation of Environmental Chemicals", PHI.
3) Dekkar Marcel, "Safety Management and Practices for Hazardous Units", McGraw Hill Book Co., New York, 1995
4) Saxena, "Safety and Good House Keeping", National Productivity Council, New Delhi (1976)
5) Wells G.L., "Safety in Process Plant Design", George Godwin Ltd., (1980).

CML475- New and Renewable Energy Sources [(3-0-0); credits:6]

Syllabus: Introduction : Energy scene of supply and demand in India and the world, Energy consumption in various sectors, potential of non-conventional energy resources,energy needs and energy supply, sources, contribution of non-conventional energy.

Solar Energy : Solar radiation and its measurement, characteristics and estimation, limitations in the applications of Solar Energy, Collectors: flat plate and concentrating types, their comparative study; design and material selection, efficiency, selective paints and surfaces. Solar water heater, applications of Solar Energy for heating, drying, water desalination, solar concentrators, photovoltaic power generation using silicon cells. Thermal storages, Solar ponds, Solar pumps, Solar power, Solar cookers etc. Direct conversion of solar energy to electricity and its various uses, materials, limitations and costs.

Bio- Fuels : Photosynthesis and generation of bio-gas, digesters and their design, selection of material; feed to digester, pyrolytic gasification, production of hydrogen, algae production and their uses.

Wind Energy : Principle of energy from wind, availability, site selection, different types of wind turbines, design criteria and material selection, economics.

Geo-Thermal Energy : Geo-technical wells and other resources dry rock and hot aquifer analysis , harnessing geothermal energy resources Tidal Energy : Its meaning, causes of tides and their energy

potential, enhancement of tides, limitations, different methods of using tidal power. Principles of ocean thermal energy conversion (OTEC) analysis and sizing of heat exchangers for OTEC.
Ocean Thermal Energy : Principle of utilization and its limitations, description of few systems.
Other Non-conventional Energy Sources ,fluidized bed combustion, heat from waste and other sources.
Energy Conservation : Principles of energy conservation. Familiarization with the different energy conservation appliances and practices, improved cooking stoves, benefits of improved cooking stoves over the traditional cooking stoves. Scope of energy conservation in the domestic, commercial and agricultural sector.

TEXT BOOKS:

1. Kothari D.P., "Renewable Energy Sources and Emeriging Technologies",PHI,2008

REFERENCES:-

1) Khan B.H., "Non-Conventional Energy Sources",2nd edition, McGraw-Hill,2009
2) Solanki C.S., "Renewable Energy Technologies",PHI,2009
3) Rai G.D, "Solar Energy Utilization" , Khanna Publishers, Delhi.
4) Rai G.D, "Non-Conventional Energy Sources", Khanna Publishers, Delhi.
5) Twiddle J., Weir T., "Renewable Energy Resources", Cambridge University Press, 1986.
6) Veziroglu, N., "Alternative Energy Sources", Volume 5 & 6, McGraw-Hill, 1978

CML476- Surface Coating Engineering [(3-0-0); credits:6]

Syllabus: Preparation of Pigments: White Pigments . Red pigments; orange and yellow pigments; green, blue and black pigments.
Drying Oils and Driers; Solvents and Plasticisers: Resins, gums; waxes and bitumens, varnishes and lacquers; paints and enamels; cellulose ester products;synthetic resins and finishers; paint chemistry.
Paints plant; varnish plant; manufacture operation; factory cost accounting; research, development and control; fire protection; safety and health.

TEXT BOOKS:

1. Tracton A. A., "Coatings Materials and Surface Coatings", CRC Press, 2007

REFERENCES:

1. Bieleman J., "Additives for Coatings", John Wiley & Sons, 2008.
2. Schweitzer P. A., "Paint and Coatings", CRC Press, 2005.

CML477- Corrosion Engineering [(3-0-0); credits:6]

Syllabus: Thermodynamics and Kinetics of electrochemical corrosion:
Enabling theory for corrosion, thermodynamics aspectrs of corrosion reactions, anerset equation. Basic wet corrosion cell, electrode potential, potential- ph diagram, kinetics of corrosion reactions, Butler-Volmer equation, polarization, mixed potential theory, passivity, immunity.
Types of corrosion – recognition and mechanisms:
Uniform corrosion, galvanic corrosion, pitting, dealloying, crevice corrosion, intergranular corrosion, filiform corrosion, impingement attack, cavitations, fretting corrosion cracking process.
Corrosion measurements:
Methods of measurement s of corrosion based kn study of various ASTM standards for corrosion – Weight , electrochemical, electrical, thickness.
Corrosion protection and surface engineering :
Principles of different methods of corrosion protection and surface treatment, chemical and clectrochemical surface treatments if metals.
Protective coatings like plating, pvd, cvd,thermal spray, hot dip, applicastion of inhi9bitors, and electrochemical methods for corrosion protection.
Other Corrosion Environment and Materials Selection: selection of corrosion resistant materials for use in acids, alkalies, atmosphere, soils, seawater, freshwater, etc.

TEXT BOOKS:

1. Butlar G. and Ison' H C. K "Corrosion and its Prevention in Waters", Leonard Hill- London (1966).

REFERENCES:

2. Rajgopalan, K.S., "Corrosion and its Prevention", Chemical Engineering Education Development Centre, I.IT. Madras (1975).
3. Uhlig H. H, "Corrosion and Corrosion control", John Wiley and sons (1971).

CML478-Piping Engineering [(3-0-0); credits:6]

Syllabus:

Pipe Routing & Drafting: Piping Symbols, Flow Diagrams, Piping Isometrics, General Arrangement Drawings Sections and Elevation, Detail Drawings, Plot Plans, 3D Representations. Piping System Components: Piping Layout, Piping Fittings - elbows, tees, reducers, end caps, Stub Ins, Flanges, Gaskets, Selection & Application of Valves, Pipe Racks, Pipe Supports, Anchors, & Guides, Thermal Insulation. Valves, Flanges & Gaskets Special piping components: Construction working and selection of various components such as steam traps, strainers, sight glass, level gage, expansion bellows, flame arresters, inline mixers and static mixtures.

Valves and other piping components: Functions of valves and their selection, valve materials and, material of construction for the following type: Gate, globe, Needle, piston, Butterflies, plug. Diaphragm, pinch, foot and float valves, Application of various valves and their operational characteristics relevant to piping engineering.

Process equipment : Reactors, Towers, Exchangers, Pressure Vessels, Drums, Furnaces, Process Liquid Storage Tanks, Mechanical equipment - Pumps, Compressors, Turbines Process & Instrumentation Diagrams (P&ID s) / Process Flow Diagrams: Purpose of P& ID s, Stages of Development of P & ID s, Symbolism & Conventions, Process & Instrument Drawings, Process Equipment Relationships, Process Industry Practices.Codes, Specifications, Abbreviations, Piping Abbreviations, Specification ClassesEquipment Layout. Pipe Wall Thickness Calculations, Maximum Allowable Operating Pressure (MAOP), Design Conditions, Design Pressure, Design Temperature.

Selection of various piping materials such as Ferrous, non-ferrous and non-metallic,

Piping fabrication, Precautions, Welder's qualification, Preparations of pipe edges.

Designation of coated electrodes, Requirements of weld tests, Hot bending and cold bending operations, Fabrication specifications.

Standard Piping Details: Underground Piping Systems, Pipe Rack Spacing, Pipe Flexibility, Heat Expansion, Anchors, Shoes, Guides, Field Supports, Dummy Supports, Hanger Rods, Spring Hangers.

TEXT BOOKS:

1. Deutsch D. J., Process piping systems, Chemical engineering magazine. Mc - Graw hill.

REFERENCES:

1. Littleton C.T., "Industrial piping", Mc-Graw hill
2. McAllister E.W. "Pipeline Rules of Thumb Handbook", Gulf Publication, 1979
3. Mcketta J. J., "Piping Design Handbook", Gulf Publications, 1992.
4. Rase H. F., "Piping design for process plants", John Wiley
5. Watters G.Z., "Analysis and Control of Unsteady Flow in Pipelines", Butterworth, 1986.

CML - Entrepreneurship Development [(3-0-0); credits:6]

Syllabus: Entrepreneur - Traits of Entrepreneurs - Types of Entrepreneurs - Intrepreneur Diffenernce between Entrepreneur and Intrapreneur - Entrepreneurship in Economic Growth, Factors affecting Entrepreneurical Growth. Motivation : Major motives influencing Entrepreneur- Achivement Motivation Training, Self Rating, Business game, Thematic Apperception Test - Stress Management. Entrepreneurship Development Programs - Need, objectives. Business : Small Enterprises-definition, Classification - Characteristics, ownership structure-Project Formulation – Steps involved in setting up a Business - Identifying, Selecting a good business opportunity Market survey and Research, Techno economic Feasibility Assessment - Preliminary Project Report-Project Appraisal-Sources of information-Classification of needs and Agencies. Financing & Accounting : Need-Sources of Finance, Term Loans, Capital structure, Financial Institutions, Management of working capital,Costing Break Even Analysis, Network analysis Techniques of PERT/CPM - Taxation - Income Tax, Excise Duty - Sales Tax. Support To Entrepreneurs :

Institutional Support to Entrepreneurs-Sickness in small Business - Concept, Magnitude, Causes and Consequences, Corrective measures - Government Policy for small Scale Enterprise - Growth strategies in small Industry - Expansion, Diversification, Joint venture, Merger, sub-contracting.

TEXT BOOKS:

1. Dr Sharma D. D., "Total Quality Management" Sultan Chand and Sons, New Delhi.

REFERENCES

2. Gupta C. B. and Srinivasan P., "Entrepreneurship Development", Sultan Chand and Sons, New Delhi
3. Khanna S.S, "Entrepreneurial Development", S.Chand & Co. Ltd NewDelhi, 1999.
4. Philip Kotler, "Marketing Management", Prentice Hall of India, New Delhi
5. Rathore B.S. and Dr. Saini J. S, "A Handbook of Entreprenuership", Aapga Publications, Panchkula (Haryana).

CML491-Project Planning and Management [(3-0-0); credits:6]

Syllabus:

Management Science: Management, its growth, concepts of administration and management of organization. Definition of management, functions, authority and responsibility. Unity of command and direction Decision making in management by objectives.

Personnel Management: Manpower planning, sources of recruitment, selection and training of staff. Job evaluation, merit rating, performance appraisal, wage administration and system, of wage payment, incentive, motivations, industrial fatigue, Trade unions – industrial relations.

Basic considerations: Basic considerations in Chemical Engineering Plant Design. Project identification, preliminary teachno-economic feasibility. Process design aspects-process selection, factors affecting. Importance of laboratory development, pilot plant, scale-up methods, safety factor's, flow diagrams.

Selection of process equipments-standard Vs special equipments, materials of construction of process equipment, selection Criteria, specification sheets

Process auxiliaries - piping design, layout, process control and instrumentation

Process utilities-process water, boiler feed water, wastes treatment & disposal, Oil heating system, chilling plant, compressed air vacuum.

Plant location and layout principles, factors affecting, use of scale methods, case studies.

Preliminary analysis of balance sheet: Statement of income and expenditure. Introduction to ratio analysis, various ratios i.e. current ratio, returns on investment, earning per share, debt. Equity. Cost estimation-factors involved in project cost estimation, total capital investment, fixed capital and working capital, Methods if estimation of investment. Cost index and scaling for equipment cost. Estimation of total product cost-factors involved. Interest-types & calculations.

Financial Management of Project: Capital structure analysis. Debt equity ratio, fixed capital, working capital, cost of finance, interest calculations.Prime cost, overhead cost, allocation of overheads, MODVAT. Methods of raising finance i.e. shares, debentures and financial institutions.

Depreciation: Concept of depreciation, various methods of - determination of depreciation problems related to above method's, obsolesce. Need for expansion and diversification, concept of marginal additional investment. Estimation of investment 6/10 factor rule. Introduction to taxes, sales tax, excise and octri, insurance etc.

Inventory control, scheduling a project using CPM/PERT. Project management. Optimum conditions-optimum production rates in plant operations, optimum conditions in cyclic operations. Design reports.

TEXTBOOKS:

1. Mantel, Samuel, Meredith and others, "Project Management: Core Text Book", Wiley India Pvt. Ltd., 1st Edition, 2006.

REFERENCES:

1. S. Choudhary, "Project Management", McGraw Hill India

CML492- Energy Management [(3-0-0); credits:6]

Syllabus: Energy auditing: Methodology, analysis of past data, measurements of various parameters, portable and on line instruments.
Energy economics: Payback period, Rate of Return, life cycle costing.
Steam Systems: Boiler-efficiency testing, excess air control, Steam distribution and use, steam traps, condensate recovery, flash steam utilization.
Electrical systems: Demand control, power factor correction, load scheduling/shifting. Motor drives – motor efficiency testing, energy efficient motors, and motor speed control.
Lighting: Conservation in Pumps, Fans (flow control), Compressed Air Systems, Refrigeration and conditioning systems, Waste heat recovery, heat pipes.
TEXT BOOKS
1.Murphy W.R., McKay G.A, "Energy Management", Murphy Butterworth-Heinemann Ltd., 2001.

REFERENCES
1.Turner W.C, "Energy Management Handbook", Fairmont Press, Lilburn, Georgia, 1993.

MAL266- Engineering Drawing and Graphics [(3-0-0); credits:6]
Syllabus: ISI Conventions.(ISI No. 696 – 1960) Covering the standard practice in Machine Drawing and also use of I.S.I. specifications for limits & fits (ISI No. 919 – 1960).
Preparation of free hand proportionate dimensioned sketches & conventions of various elements such as screw threads, fastener (nuts, bolts, studs, locking arrangement, foundation bolts etc.) Rivets and riveted joins, welded joints.
Exercises in converting pictorial & isometric views into orthographic projection, sectioned views. Preparation of details & assembly drawings of simple machine parts such as keys, cotters, pin, pulleys, cottered joints & knuckle joints Bearing, shaft couplings. Various flanges & pipe connections. A valve, cocks, traps. Fixed and flexible joints, Expansion joints.
Minimum 10-12 Imperial size sheets (A-1) covering the above syllabus should be drawn out of which $1/3^{rd}$ should be drawn using computer software likes AutoCAD
TEXT BOOKS:
1. Bhatt N.D.; "Elementary Engineering Drawing", Charotar Publishing House.

REFERENCES

1. Mathur M.L. and Vaishwanar R.S.; "Engineering Drawing and Graphics", Jain Brothers, New Delhi – 1993.
2. Narayana K.L. and Kannaiah P, "Engineering Graphics", Tata McGraw Hill Co. Ltd., 2000.
3. Neumann W. M. and Sproul R.F, "Principles of Computer Graphic", McGraw Hill 1989.

CMP 267- Computer Programming and Applications [(3-0-0); credits:6]
Syllabus: (Introductory Lectures followed by Practicals):
Concept of Algorithm: Termination and correctness, Algorithms to programs; Specification, stepwise refinement technique, problem solving using Pascal
Computer Architecture: ALU, CPU, I/O devices, system softwares, operating systems, compilers, multiuser environments.
Computer programming and numerical methods, computer-programming languages, C & C^{++} programs for matrix operations, programs for estimating roots of polynomials.
Programs for numerical integration, Trapezoidal and simphsons rules, regression analysis, programs for solution of ordinary differential equations, programs for interpolation and extrapolations.
TEXT BOOKS:
1. Adams J.M., "Computers Application Implications" John. Wiley Co. (1975).
REFERENCES
1) Saran S., Swami P.K, Singh, K.K. Shah I.M. and Lal D.;, "Computer Programming and Numerical Methods", Metropolitan Book Corp. Ltd., New Delhi
2) Syal I.C. and Gupta S.P, "Computer Programming and Engineering Analysis", A.H. Wheeler Co.

MAL275- Numerical and Statistical Methods [(3-0-0); credits:6]

Syllabus: Approximations and errors in computation and their evaluation, rounding – off and truncation; absolute, relative and percentage errors. Solution of non-linear algebraic and transcendental equations, Bisection, false position, Newton–Raphson, Iterative methods and generalized Newton's method for multiple roots.

Newton – Raphson, Iterative, false-position and bisection methods; generalized Newton's for multiple roots. Solutions of linear simultaneous equations by Gauss elimination, Gauss-Jordan, Crout's triangularization, Jacobi and Gauss-Seidel methods, Cubic spline and Gaussian quadrature formula.

Numerical solutions of ODE by Taylor series, Euler's modified method, Runge-Kutta method, Milne's method and their applications. Approximation of derivative (Ordinary & Partial), Boundary value problems by finite difference methods.

Random variable, distribution function of continuous and discrete random variables, mathematical expectation, generating function, Moments, Skewness and Krtosis.

Special probability distributions – Binomial, Poisson's, Normal, Chi-square, t distribution, and F-distributions, confidence intervals for mean and variance.

Tests of hypothesis and significance, tests involving normal distribution, t- distribution chi-square distribution and F distribution.

Correlation and regression: simple and multiple correlation and applications related to Engg. Prblems.

TEXT BOOKS:

1. Grewal B.S.;, "Higher Engineering Mathematics" Khanna Publication – 2004

REFERENCES

1) Gupta S.C. and Kapoor V.K.;, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, Educational Publisher, New Delhi.
2) Sastry S.S, , "Introductory Methods of Numerical Analysis", Prentics – Hall of India Pvt. Ltd., New Delhi – 1995.
3) Spiegel M.R.; "Probability and Statistics", Tata McGraw Hill Book.

CML480-Membrane Technology [(3-0-0); credits:6]

Syllabus: Principles, characteristic, and classification of membrane separation processes; Membrane materials, structures, and preparation techniques; Membrane modules; Plant configurations. Membrane characterization: Pore size and pore distribution; Bubble point test; Challenge test; Factors affecting retentivity, concentration polarization, gel polarization, fouling, cleaning and regeneration of membranes. Mechanisms of separation: Porous membranes, dense membranes, and liquid membranes. Membrane separation models: Irreversible thermodynamics; Capillary flow theory; Solution diffusion model; Viscous flow models; Models for separation of gas (vapour) mixtures; Science and technology of microfiltration, reverse osmosis, ultrafiltration, nanofiltration, dialysis and electrodialysis, pervaporation, liquid membrane permeation, gas permeation. Membrane reactors: Polymeric, ceramic, metal and bio-membrane.

TEXT BOOKS:

1. Mulder M., "Basic Principles of Membrane Technology", Kluwer Academic Publishers, Dordrecht,1991

REFERENCES

1) Baker R.W., "Membrane Technology and Applications", 2nd Edition, John Wiley & Sons., Chichester, England ,2004
2) Nath K "Membrane Separation Process" Prentice-Hall of India Private Ltd , New Delhi 2008
3) J.D.Seader, Ernest J. Henley, D. Keith Roper, "Separation Process Principles:Chemical and Biochemical Operations", Third edition, Wiley 2010.
4) Geankoplis C. J., "Transport Processes And Separation Process principles" 4th Edition Prentice-Hall of India Private Ltd , New Delhi

CML….- Reliability Engineering [(3-0-0); credits:6]

Syllabus: Introduction to probability: review of sets, events, definitions, finite sample spaces and enumeration, conditional probability, partitions theorem, total probability theorem, Bayes' theorem
Reliability Engineering Introduction: concept, terms, definitions, applications, history
Failure distribution: Reliability function, MTF, HRF, bathtub curve, conditional reliability
Constant failure rate model: exponential function, failure modes, applications, two-parameter exponential distribution, Poisson process
Time dependent failure models: Weibull distribution, normal distribution, lognormal distribution
Reliability of systems: serial, parallel configuration, SSF, minimal cuts, minimal paths, common-mode failures, three state devices
State dependent systems: Markov analysis, load sharing systems, standby systems, degraded systems, three state devices
Physical reliability models: covariate, static, dynamic models, physics of failure models
Design for reliability: specification and system measurements, reliability allocation, design methods, failure analysis, system safety and fault tree analysis
Maintainability: analysis of downtime, repair time distribution, stochastic point processes, system repair time, reliability under preventive maintenance
Availability: concepts and definitions, models, system availability, design analysis
Data collection and empirical methods Identifying failure and repair distribution

TEXT BOOKS:

1. Hines W. W., Montgomery D. C., Goldsman D. M., Borror C. M., "Probability and Statistics in Engineering" John Wiley and Sons (Asia) Pte Ltd., Singapore.

REFERENCES

1. Ebeling C. E. "Introduction to Reliability and Maintainability Engineering", Tata McGraw-Hill, New York

CML 619 Computational Methods in Chemical Engineering [(3-0-0); credits:6]

Syllabus: This course focuses on the use of modern computational and mathematical techniques in chemical engineering. Starting from a discussion of linear systems as the basic computational unit in scientific computing, methods for solving sets of nonlinear algebraic equations, ordinary differential equations, and differential-algebraic (DAE) systems are presented. The finite difference and finite element techniques are presented for converting the partial differential equations obtained from transport phenomena to DAE systems. The use of these techniques will be demonstrated in the MATLAB® computing environment.
Application of root finding techniques to chemical engineering problems. Linear/nonlinear simultaneous equation modeling of chemical engineering phenomenon and solving by linear system by Gaussian, Gauss-Jordan, Jacobi and Gauss –Seidel methods Jacobi methods
Finite difference solution for the second order ordinary differential equations. Finite difference solution for one dimensional heat equation (both implicit and explicit) use of computer for solving the numerical.

TEXT BOOKS:

1.Steven C. Chapra &Raymond P Canale, "Numerical Methods for Engineers", 4th Edition, Tata McGraw Hill, New Delhi.

REFERENCES

1. Santosh Gupta, "Numerical Methods for Engineers", New Age Internationa Publishers.New Delhi

CML480- CFD for Chemical Engineers [(3-0-0); credits:6]

Syllabus: Introduction to CFD:
Overview of CFD, Basic transport equations, Application of CFD, Mathematical description of physical phenomena, Problems.
Discretization methods:
Nature of numerical methods, Methods of deriving the discretization equations, Control volume formulation, Discretization 1-D steady state and unsteady state conduction equations, Various methods, 2-D and 3-D

equations, Over-relaxation, Under-relaxation, Discretization of convection and diffusion terms, Upwind Scheme, Exact solution, Exponential scheme, Hybrid scheme, Power law scheme, other schemes, discretization of 2-D and 3-D equations, Generalized equation, False diffusion, Problems.

Calculation of the Flow Field:

Difficulties related pressure gradient term and continuity equation, Staggered grid, Momentum equation, Pressure and velocity correction, Pressure correction equations, SIMPLE, SIMPLER and other algorithms, Problems.

Turbulence Modeling:

Introduction to turbulence, Mean flow equations, Nature of turbulence, Classification, Zero order equation models, One equation models, Two-equation models, Turbulent stress models, Advanced and other models., Problems.

Reactive Flow Modeling:

Physical processes in the conservation equations, feedback and interaction mechanisms, complications of multiphase flow, representation, resolution and grids, Problems.

CFD Case Studies:

Introduction to various CFD softwares and in-house CFD codes; CFD case studies: Design of stirred tank reactor, jet mixed tanks, bubble column, fluidized bed, submerged jets, flow in curved pipe, turbulent flow and heat transfer in finned tubes, melting around a vertical pipe, transient combined mixed convection and radiation from vertical aluminium fin, heat transfer in rotary kiln reactors, heat transfer in metal and alloy solidification, membrane reactors etc.

TEXT BOOKS:

1. H. K. Versteeg and W. Malalasekera, "An introduction to CFD", Longman Scientific and Technical, 1st edition, 1995.

REFERENCE BOOKS

2. E. S. Oran and J. P. Boris, Numerical Simulation of Reactive Flow, Cambridge University Press, 2nd edition, 2001.

3.J. H. Ferriger, M. Peric, Springer, Computational methods for fluid dynamics1st edition, 1996.

4. S. V. Patankar,Numerical heat transfer and fluid flow, Mc Graw-Hill Book Company, 1st Edition, 1980.

5. W. Rodi, Turbulence models and their applications – a state of the art review, IAHR – AIRH Monograph series,3rd Edition, 1993.

6. P. S. Ghoshdastidar, Computer simulation of flow and heat transfer, Tata McGraw-Hill Publishing, 1st edition, 1998.

7. K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publications, 2nd Edition, 2003.