BIRLA INSTITUTE OF TECHNOLOGY
MESRA RANCHI
DEPARTMENT OF CHEMICAL AND POLYMER ENGINEERING

ME (CHEMICAL ENGINEERING)

COURSE STRUCTURE AND SYLLABUS

Number of seats: 18
Eligibility : BE/B.Tech in Chemical Engineering, Polymer Engg, Metallurgical & Materials Engineering, BioTechnology, Food & Biochemical Engineering and Chemical Technology.

BIRLA INSTITUTE OF TECHNOLOGY
MESRA RANCHI
DEPARTMENT OF CHEMICAL AND POLYMER ENGINEERING

ME (CHEMICAL ENGINEERING)

COURSE STRUCTURE

	Course No	Subjects	L	T	P	CP	Prerequisite
		1st Sem					
	MCL1001	Advanced Transport Phenomena-1	3	0	0	3	
	MCL1003	Advanced Mathematical Techniques in Chemical Engineering	3	0	0	3	
	MCL1005	Advanced Reaction Engineering	3	1	0	4	
		Breadth paper (management Paper)	3	0	0	3	
		Elective – I	3	0	0	3	
		Laboratories					
	MCL1002	Process Equipment Design	0	0	3	2	
	MCL1004	Computational Laboratory	0	0	3	2	
		2nd Sem					
	MCL2001	Advanced Transport Phenomena-II	3	0	0	3	
	MCL2003	Advanced Process modelling simulation and optimization	3	1	0	4	
		Elective - II	3	0	0	3	
		Elective - III	3	0	0	3	
		Breadth Paper (IT paper)	3	0	0	3	
		Laboratories					
	MCL2002	Computer Aided Process Engineering	0	0	3	2	
	MCL2004	Chemical Engineering Research Laboratory	0	0	3	2	
		3rd Sem					
	MCL3002	Thesis (Part – I)	0	0	0	15	
		4th Sem					
	MCL3002	Thesis (Part – II)	0	0	0	20	
			Total			**75**	

ELECTIVE SUBJECTS

Elective – I

MCL1007 Petroleum Refinery Engineering

MCL1009 Materials Science and Engineering

MCL1011 Energy Resources and Conservation

MCL1013 Biochemical Engineering

MCL1015 Advanced Thermodynamics

MCL1017 Polymer Technology

MCL1019Instrumental Analysis

MCL1021 Computational Methods in Chemical Engineering

Elective – II

MCL2005 Advanced Process Dynamics and Control

MCL2007 Petrochemical Technology

MCL2009Mineral Beneficiation

MCL2011Catalysis and adsorbents

MCL2013 Rubber Technology

MCL2015 Coal and Coal chemicals Technology

MCL2017 Pollution Control Technology

Elective – III

MCL2019 Process Modeling & Simulation

MCL2021Principles of Polymer Processing

MCL2023Colloid and Interfacial Engineering

MCL2025Computational Fluid Dynamics

MCL2027Advanced Separation Processes

MCL2029Composite Material

MCL2031Petroleum Reservoir Engineering

MCL2033Food Science and Technology

MCL2035Combustion Engineering

MCL 2037 Advances in NanoTechnology

SYLLABUS

MCL1001 Advanced Transport Phenomena - I

Module 1

Vectors & Tensors:

Geometric representation of vectors; Einstein summation convention; Basic review of vector algebra; Representation using Kronecker delta and alternating unit tensor; Review of vector calculus. Tensors: dyadic products with another tensor, vector etc; tensor operations required for stress analysis. (5)

Module 2

Transport by molecular motion: Newton‘s law and viscosity, Fourier‘s law of Heat conduction. Fick‘s law of Diffusion. (5)

Module 3

Kinematics: Motion, streamlines, pathlines and streaklines,Governing equations of fluid mechanics. Introduction: Equation of continuity, equation of motion, Euler equation, Bernoulli equation, Momentum boundary layer theory (Laminar boundary theory & turbulent boundary layer theory), dimensionless number and its significance. (5)

Module 4

Navier-stokes equation, creeping flow around a solid sphere, expression for total drag, Turbulent flow: Transition to turbulence, Prandtl’ mixing length, Turbulence models. Boundary layer on immersed bodies, two dimensional boundary layer equation, laminar boundary layer on flat plate (Blasius exact solution), Von-Karmann’s integral momentum equation, boundary layer separation flow and pressure drag, Flow of compressible fluids, thermodynamic considerations, continuity and momentum equation for one dimensional compressible flow, one dimensional normal shock, flow through fluidized beds. Navier-Stokes equation and various approaches of simulation (stream velocity, primitive variable). (5)

Module 5

Non-Newtonian Fluids: Classification of fluid behavior, Laminar flow(Fluid with a yield stress) Laminar flow in cylindrical tubes, Laminar flow between parallel plates, Laminar flow in annuli(Newtonian fluids Bingham Plastic Fluids), Laminar flow(fluids without a yield stress), Power law fluids. (5)

Module 6

Modes of heat transfer; concepts of (a) thermal conductivity – constant and temperature dependent, (b) thermal diffusivity and (c) heat transfer coefficient. Fourier’s law of heat conduction. (5)

Module7

Shell energy balance and boundary conditions – Heat conduction with electrical, nuclear, viscous and chemical heat source, Heat conduction through composite walls, Heat conduction in fins. Free convection – flow between two vertical walls. (5)

References:

(1) "The Flow of Complex Mixtures in Pipes" by Govier and Aziz.
(2) "Non Newtonian Flow and Heat Transfer" by A. H. P. Skelland
(3) "Chemical Engineering" by Coulson and Richardson, Volume I
(4) R.W. Fox, A.T. Mc Donald, P.J. Pritchard, Introduction to Fluid Mechanics, Willey, 6th edition.
(5) J.G. Knudsen and D.L. Katz, Fluid Dynamics and Heat Transfer, McGraw Hill, New York, 1958.
(6) R.B. Bird, W.E. Stewart, and E.N. Lightfoot, Transport Phenomena, Second edition, John Wiley and Sons, 2002.

MCL1003 Advanced Mathematical Techniques in Chemical Engineering

Module 1

Introduction of vector space, Metric, Norm, Inner Product space, completeness of space. Vectors: Linear combination of vectors, dependent/independent vectors; Orthogonal and orthonormal vectors; Gram-Schmidt orthogonalization; Examples. (5)

Module 2

Contraction Mapping: Definition; Applications in Chemical Engineering with examples. Matrix, determinants and properties. (5)

Module 3

Eigenvalue Problem: Various theorems, Solution of a set of algebraic equations, Solution of a set of ordinary differential equations, Solution of a set of non-homogeneous first order ordinary differential equations (IVPs). Applications of eigenvalue problems: Stability analysis, Bifurcation theory. (5)

Module 4

Partial Differential equations: Classification of equations, Boundary conditions, Principle of Linear superposition. (5)

Module 5

Special ODEs and Adjoint operators: Properties of adjoint operator, Theorem for eigenvalues and eigenfunctions. (5)

Module 6

Solution of linear, homogeneous PDEs by separation of variables: Cartesian coordinate system & different classes of PDEs, Cylindrical coordinate system, Spherical Coordinate system. (5)

Module 7

Solution of non-homogeneous PDEs by Green's theorem, Solution of PDEs by Similarity solution method, Solution of PDEs by Integral method, Solution of PDEs by Laplace transformation, Solution of PDEs by Fourier transformation. (5)

Books Suggested

1. Mathematical Methods in Chemical Engineering by S. Pushpavanam, Prentice Hall of India.
2. Applied Mathematics and Modeling for Chemical Engineers by R. G. Rice & D. D. Do, Wiley.
3. Mathematical Method in Chemical Engineering by A. Varma & M. Morbidelli, Oxford University Press.

MCL1005 Advanced Reaction Engineering

Module 1

Basics - mass and energy balance equations for reactors, Kinetics - rate law, theories of rate constants, determination of kinetics from experimental data, multiple reaction kinetics . (5)

Module 2

Kinetics of different reaction: biochemical reactions (Michaelis–Menten kinetics, Monod model kinetics), polymerization reactions kinetics. (5)

Module 3

Design of biochemical reactor, polymerization reactor. (5)

Module 4

Other reactor types - Semi-batch, Packed Bed, Fluidized Bed, Membrane, Slurry, Trickle Bed. Gas-Liquid reactions/reactors - Fundamentals. (5)

Module 5

Non-ideal reactor models- Flow, Reaction and Dispersion, Numerical solutions to flows with dispersion and reaction, Modelling real reactors with combinations of ideal reactors. (5)

Module 6

Gas-Solid reactions/reactors –Catalytic and Non-Catalytic Reaction fundamentals Concepts of catalysis- Kinetics, Deactivation, Effectiveness factor, Diffusion effects, External resistance to mass transfer, Shrinking core model. (5)

Module 7

Chemical Reaction Equilibria: Criterion of chemical reaction equilibrium, Application of Equilibrium Criteria to Chemical Reactions, the standard Gibbs Energy Change and the Equilibrium Constant, Effect of Temperature on the Equilibrium Constant, Evaluation and Relation of Equilibrium Constants, Equilibrium Conversions for single Reactions, Phase Rule and Duhem's Theorem for Reacting Systems. (5)

Suggested Books

1. Elements of chemical reaction engineering, H.S. Fogler
2. Chemical Reactor Analysis and Design, G. F. Froment and K. B. Bischoff
3. Chemical Engineering Kinetics, J. M. Smith
4. Heterogeneous Catalysis in Industrial Practice, Satterfield, C. N.,

MCL2001 Advanced Transport Phenomena - II

Module 1

Equation of energy (general convection-diffusion equation) – rectangular coordinate system. Use of the Energy equation - Unsteady state conduction in finite and semi-infinite slabs. Concept of thermal boundary layer vis-a-vis hydrodynamic boundary layer – effect of Prandtl number on thermal boundary layer thickness. Dimensional analysis of equation of Energy. (5)

Module 2

Radiation-Direct radiation between black bodies and non blackbodies at different temperature. (5)

Module 3

Concentrations, Velocities and Mass and Molar fluxes. Concept of Mass diffusivity and Mass transfer coefficient. Fick's law of diffusion.
Shell mass balance and boundary conditions – Diffusion through stagnant gas film, Diffusion in a falling film, Diffusion with heterogeneous chemical reaction, Simultaneous mass and heat transfer problem. (5)

Module 4

Equations of Continuity for binary mixture, simplification of general equation for special cases. Dimensional analysis of the equations of Continuity – role of Schmidt number. (5)

Module 5

Generalized Transport Equation:
General Advection-Diffusion equation - conservation equations (Motion, Energy and Species concentration) in terms of general variable (Φ) and diffusivity. Concept of coupled equations. (5)

Module 6

Flow of multiphase mixtures: Two phase gas vapor liquid flow, horizontal and vertical flows of gas liquids, liquid, gas – solid mixtures, slip and hold up effects, phase separation and settling behavior, pressure, momentum and energy relations, practical methods for evaluating pressure drop. (5)

Module 7

Motion in the fluidized bed: conditions for fluidization, behavior of the fluidized bed, minimum fluidization velocity, different types of fluidization, particulate fluidization, bubbling

fluidization, semi fluidization, mixing and segregation in fluidized bed, application of fluidization. (5)

Suggested Books

1. Advanced Heat and Mass Transfer, A. Faghri, Y. Zhang, J. Howell
2. Process Heat Transfer: Kern D.Q., McGraw Hill.
3. Unit Operations of Chemical Engineering: McCabe, W.L., Smith, J.C., Harriot, P.,McGraw Hill, 1993.
4. Kothandaraman, C.P. and S. Subramanyan, Heat and Mass Transfer Data Book. New Age International
5. Mass Transfer Operations: Treybal R.E., Mc Graw Hill, 1981
6. Chemical Engineering, vol. 1, Coulson & Richardson, Butterworth Heinemann

7. R.B. Bird, W.E. Stewart, and E.N. Lightfoot, Transport Phenomena, Second edition, John Wiley and Sons, 2002.

MCL 2003 Advanced Process Modeling, Simulation and Optimization

Module 1

Mathematical Model: Introduction and Necessity Definition of modelling and simulation - validation with experiments, benchmarking; Need of models – predictive capability, trend analysis; Micro, meso and macroscale models - concept of multiple scales using crystallizer as an example, deterministic and stochastic descriptions Experimentation, empiricism, data correlation and mathematical modeling using examples. (5)

Module 2

Examples from Crystallization of solid, Coagulation, Coalescence and breakage of drops, Grinding, Microbial population dynamics, Reaction in a porous particle etc. (5)

Module 3

Monte Carlo methods – Basics of random no. and probability distributions Poisson process, Birth-death process, Solution of Laplace's diffusion eqn. Time and event driven simulation methods, Interval of quiescence Lattice simulation – examples from particle deposition, catalyst sintering etc. (5)

Module 4

Optimization basics and convexity, Multidimensional constrained optimization Gradient Secant and Newton methods . Karsh-Kuhn-Tucker optimality conditions. (5)

Module 5

Linear programming Simplex method, Nonlinear programming Sequential quadratic programming (SQP). (5)

Module 6

Generalized reduced gradient method (GRG) and penalty function methods, mixed integer linear programming (MLP) mixed integer nonlinear programming(MNLP) evolutionary optimization techniques. (5)

Module 7

Genetic Algorithm, Simulated Annealing part swarm optimization, differential evolution, self organizing migrating algorithm, and scatter search. (5)

Course Text References:

1. T.F. Edgar and D. M. Himmelblau, Optimization of Chemical Processes 2nd Edition, McGraw Hill International Editions, Chemical Engineering Series, 2001.
2. Floudas, C.A., Nonlinear and Mixed Integer Optimization: Fundamentals and Applications, Oxford University Press, New York 1995.
3. G.V, Reklatis, A. Ravindran and K.M.Ragsdell, Engineering Optimizaiton – Methods and Applications
4. S. S. Rao, Engineering Optimization, Theory and Practice 4th Ed, John Wiley and sons 2009
5. L.T.Biegler, I,E, Grossmann, and A. W. Westergerg, systematic Methods of Chemical Process Design, Prentice Hall International Series, 1997

ELECTIVE – I

MCL 1007 Petroleum Refinery Engineering

Module 1

Characterization of crude oil and refinery products : crude distillation process atmospheric distillation unit (ADU) vacuum distillation unit (VDU). (5)

Module 2

Thermal and catalytic cracking, Catalytic reforming, Hydrotreating, and Hydrocracking. (5)

Module 3

Light end processes: alkylation, isomerization and polymjerization. (5)

Module 4

Heavy end processes : coking, visbreaking, deasphalting and dewaxing; Lube oil base stock (LOBS) production. (5)

Module 5

Introduction to refinery Process Design : Refinery stream property estimation, refinery mass balance, design of oil-water separators, Design of light end units – Fenske Underwood and Gilliand method. (5)

Module 6

Design of refinery absorbers and strippers. (5)

Module 7

Design of crude and vacuum distillation units, design of refinery heat exchanger networks Design of FCC units. (5)

Book:

1. J. H.Gary and G.E. Handwerk, Petroleum Refining Technology and Economics 4th Ed. Marcel Dekker, 2001
2. D.S.J. Jones and P.R. Pujado Handbook of Petroleum Proessing, Springer, 2006
3. C.S.Hsu and P.R. Robinson, Practical Advances in Petroleu Processing, Springer, 2006
4. J.G. Speight and NB. Ozum, Petroleum Refining Process, Marcel Dekker, 2002.

MCL 1009 MATERIALS SCIENCE AND ENGINEERING

MODULE I

Introductory concept: Crystal structures, Space lattice, Symmetry elements, Unit cells, Crystal systems, Packing factors, Miller indices, Single crystals, Polycrystalline materials, X-ray diffraction & Bragg's law, Laue method, Power Method. (5)

MODULE II

Types of imperfections, Point defects. Dislocations: Edge dislocation & Screw dislocation, Burger's vector, Concepts of dislocation density, Surface defects, Volume defects, vibrational defects. Phase Equilibria, Microstructural changes during cooling, The Lever rule and its applications, Gibbs phase rule. Glass transition. (5)

MODULE III

Free electron theory of metals, Band theory of solids, Intrinsic, Extrinsic & compound semiconductor, conductivity, mobility, Temperature dependence of conductivity & carrier concentration. Superconductors: elementary introduction, High TC superconductors. Dia, Para and Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Influence of temperature, Magnetic domains & hysteresis, Magnetic materials, Magnetic storage devices, Memory materials. Ferro-electricity, Piezo electricity, Ferro and piezo electric materials.

Electrical, thermal, magnetic and optical properties of materials. (5)

MODULE IV

Processing and application of metals and alloys

Engineering stress, Engineering strain, stress-strain behaviour, Elastic deformation. Atomic view of elasticity, Anelasticity, Slip, Slip systems, Resolved shear stress, Plastic deformation of single and polycrystalline materials, Strain hardening. Recovery, Recrystallization, Cold working & Hot working. Grain Growth, Introduction to Fracture, Fatigue and Creep. (5)

MODULE V

Processing and applications of ceramics, polymers and composites. (5)

MODULE VI

Common Refractory: Materials, Portland cement composition and its grades. Glasses: Types of glasses, Glass ceramics. Optical Fibre. Smart polymers for electrical and electronic applications,

Conducting polymers. Composites: Fibre reinforced composites, Whiskers, Various fibre reinforced composites. (5)

MODULE VII

Advanced materials, corrosion and degradation of materials. Basic concepts of nanotechnology, Nanomaterials: Fabrications & Applications. Selection of materials: economic, environmental and social issues. (5)

BOOKS:

1. W.D. Callister (Jr) Material Sciene can Engineering, An introduction, John Wiley and Sons, 2003
2. V. Raghavan, Materials Science and Engineerig: A first Course, PHI Learning, New Delhi 2009
3. Y.W.Chung, Introductionm to Materials Science and Engineering, CRC Press, Boca Raton, 2006
4. W.F. Smith, Materials Sciene and Engineering, Tata McGraw-Hill, New Delhi 2008
5. G. S. Upadhyaya and A. Upadhyaya, Materials Science and Engineering, New Delhi 2005.
6. The Structure and Properties of Materials, Vol. –I,
7. Physical Properties of Materials, M. C. Lovell, A. J. Avery, M. W. Vernon, ELBS.

MCL 1011 Energy Resources & Conservation

Module I

Introduction major sources of energy: renewable and nonrenewable, primary and secondary energy souces, energy scenario, prospects/need of alternate energy sources, conventional and nonconcentional energy sources. (5)

Module II

Power Plant Engineering – Steam cycle, combined cycle Power Generation, Steam generators, fuels for steam generation. (5)

Module III

Hydroelectric power plants, Nuclear Plant technology, Diesel and gas turbine power plant. (5)

Module IV

Solar energy – Solar thermal, solar photovoltaic
Wind energy, geothermal, tidal. (5)

Module VI

Energy from Biomass – Biodiesel, bioethanol, Biogas, Incineration. (5)

Module VII

Energy recovery –Heat exchanger network, Waste heat boiler, Low grade fuels- reacto off-gassesliquid and solid waste, heat pumps.
Process integration and Pinch Technology – two stream four stream problem, Heat exchanger network design for maximum energy recovery, minimum numbr of exchangers etc. (5)

Books:

1. S. Sarkar, Fuel and combustion, Orient Longman 2nd Ed 1990
2. P. K.Nag, Poewrt Plant Engineering, TATA McGraw Hill – 2002
3. B. H.Khan, Non-conventional energy resources, McGraw Hill, New Delhi
4. C.S. Solanki, Renewable energy Technology, Prentice Hall Publicaiton, 2008
5. S.P.Sukhatme, Solar Energy, Tata Mcraw Hill, New Delhi, 1996
6. W.C. Turner, Energy Management hand book, Wiley Press, 1981
7. R.K.Sinnott, Chemical Engineering Design, Elsevier, 2008

MCL 1013 Biochemical Engineering

Module I

Basics of Biology; Overview of Biotechnology; Diversity in Microbial Cells, Cell Constituents, Chemicals for Life. (5)

Module II

Kinetics of Enzyme Catalysis. (5)

Module III

Immobilized Enzymes: effects of intra and inter-phase mass transfer on enzyme kinetics. (5)

Module IV

Major Metabolic Pathways: Bioenergetics, Glucose Metabolism, Biosynthesis. (5)

Module V

Microbial Growth: Continuum and Stochastic Models.

Design, Analysis and Stability of Bioreactors. (5)

Module VI

Kinetics of Receptor-Ligand Binding Receptor-mediated Endocytosis Multiple Interacting Microbial Population: Prey-Predator Models. (5)

Module VII

Bio-product Recovery & Bio-separations; Manufacture of Biochemical Products. (5)

Books

1. Biochemical Engineering Fundamentals by J. E. Bailey & D. F. Ollis, McGraw Hill Book Company, 1986.
2. Biochemical Engineering by H. W. Blanch & D. S. Clark, Marcel Dekker, Inc., 1997.
3. Bioprocess Engineering (Basic Concepts) by M. L. Shuler & F. Kargi, Prentice Hall of India, 2003
4. Transport Phenomena in Biological Systems by G. A. Truskey, F. Yuan, D. F. Katz, Pearson Prentice Hall, 2004.

MCL1015 Advanced Thermodynamics

Module 1

Review of Basic Postulates, Maxwell's relations, Legendre Transformation, Pure Component properties. (5)

Module 2

Theory of corresponding states, real fluids Equilibrium, Phase Rule, Single component phase diagrams. (5)

Module 3

Introduction to Multicomponent Multiphase equilibrium, introduction to Classical Mechanics, quantum Mechanics, Canonical Ensemble, Microcanonical Ensemble, Grand Canonical Ensemble, Boltzmann, Fermi-dirac and Bose Einstein Statistics,Fluctuations, Monoatomic and Diatomic Gases. (5)

Module 4

Introduction to Classical Statistical Mechanics, phase space, liouville equation, Crystals, Intermolecular forces and potential energy functions, imperfect Monoatomic Gases, Molecular theory of corresponding states. (5)

Module 5

Introduction to Molecular Simulations, Mixtures, partial molar properties, Gibbs Duhems equations, fugacity and activity coefficients, Ideal and Non-ideal solutions. (5)

Module 6

Molecular theories of activity coefficients, lattice models, multiphase Multicomponent phase

Equilibrium.VLE/SLE/LLE/VLLE. (5)

Module 7

Chemical Equilibrium and Combined phase and reaction equilibria. (5)

Course Text References:

1. McQuarrie D.A, Statistical Mechanics, Viva Books Private Limited, 2003.
2. Hill Terrel, An Introduction to Statistical Thermodynamics, Dover, 1960.
3. Allen MP, Tildesley DJ, Computer simulation of liquids, Oxford, 1989.
4. Callen, HB. Thermodynamics and an Introduction to Thermodstatics, 2nd Edition, John Wiley and Sons, 1985.
5. Prausnitz, J.M., Lichtenthaler R.M. and Azevedo, E.G., Molecular thermodynamics of fluid-phase Equilibria (3rd edition), Prentice Hall Inc., New Jersey,1996.
6. J.M. Smith. H.C.Van Ness and M.M.Abott. "Introduction to Chemical Engineering Thermodynamics:. McGraw Hill International edition (5th ed.). 1996

MCL1017 POLYMER TECHNOLOGY

MODULE-1
Additives for Plastics: mechanism of action, method of incorporation of: fillers, plasticizer, stabilizer & flame retarder, cross linking agents, blowing agents, antistatic agents (6)

MODULE- II
Manufacturing process with emphasis on flow sheet & process alternatives, processing application, major engineering problems & economics, manufacturers in India of the following polymers: PE and PP (7)

MODULE- III
Manufacturing process with emphasis on flow sheet & process alternatives, processing application, major engineering problems & economics, manufacturers in India of the following polymers: PS and PVC (6)

MODULE- IV
High performance thermoplastics: Polyacetal, Polyamides, Polycarbonate, Polysulfone, PPO,
Polyesters (USP,fibre forming,film-forming). (5)

MODULE-V
Thermosets: Phenolic resins, aminoplasts, alkyl, & aryl epoxies, polyurethanes, silicones, Polyester (5)

MODULE- VI
Functional polymers: Photo responsive polymers, Ion conducting polymers, polymers, Water soluble polymers, biodegradable polymers, liquid crystal polymers, Magnetic polymers, (3)

MODULE- VII
Plastics in automobile industries, biomedical application, electronic application, cable application, plastics in agriculture application, space and defence application, polymer in building construction, photographic application. (3)

Text Books:
1. Plastics materials: Brydson J.A., 3rd Edn., Butter worth, Woburn 1975
2. Plastics Engineering Hand Book: Frados J. Society of plastic & Industruy. Inc. 4th Edn., Van Nostrand, N.Y. 1976
3. Shreve‘s chemical process Industries, George T. Sustin, Mc Grow Hill.
4. Unit process in Organic synthesis, Groggins, P.H. Mc Grow Hill.
5. Hand Book of Plastic Testing Technology, Vishu Shah, Wiley Inter Science.

MCL 1019 INSTRUMENTAL ANALYSIS

Module 1:- Basic principles of IR and FTIR, UV-Visible, Mass spectroscopy. (4)

Module 2: The NMR phenomena, Instrumentation, Spin-lattice relaxation, Chemical shift, intermolecular spin-spin coupling, Dipolar line broadening. Broad line spectra, Magic angle spinning (MAS), spin-spin interaction. Analysis of spectra - structural investigation (stereoregularity, chain branching, etc.), Crystallinity. Electron spin resonance spectroscopy. (5)

Module 3: Light Scattering, Dynamic Light Scattering and Static Light Scattering**,** Raman Spectroscopy. (3)

Module 4: Light microscopy - optical system of microscope, Birefringence, Hot stage Microscopy. Electron microscopy – TEM, SEM, Principle, Instrument, Specimen preparations, applications. Energy Dispersive Spectroscopy (EDS), Application of Scanning transmission Electron Microscopy, Auger Electron spectroscopy(AES). Electron scanning chemical analysis (ESCA). (8)

Module 5 :- Xray Diffraction Methods : Classification of Crystal systems, Symmetry elements, point Group and Space Group, Principle of X Ray Scattering and Diffraction, Interplaner Spacing Bragg's Law and Laue Conditions. Instrumentation, Application of WAXS and SAXS. Degree of Crystallinity (Ruland's method), Crystallite size analysis, Orientation (Pole Figures), residual stress. Application for determination of crystallinity, and residual stresses. Single Crystal X Ray analysis. (8)

Module 6:- Thermal analysis: Principle, Instrument, and application - Differential Scanning Calorimetry(DSC), Differential thermal analysis (DTA), Thermogravimetric analysis (TGA), Dynamic mechanical thermal analysis (DMTA). (6)

Module 7:-Chromatography: Principles and Applications of High Performance Liquid Chromatograpy and High Performance Thin Layer Chromatography, Gas Chromatography, Affinity Chromatography, Pyrolysis Gas Chromatography (6)

BOOKS:

1. Organic spectroscopy for chemical Analysis,
2. Instrumental analysis, Skoog
3. G. Bodor, "Structural investigation of polymers", ELLIS HORWOOD,1991.
4. T.,A.,Ossald and G.,Menges, "Materials Science of Polymers for Engineers", Carl Hanser Verlag Publishers, 1996.

MCL 1021 COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING

Module 1

Errors and error control; Interpolation and optimization. (5)

Module 2

Linear algebraic equations; Matrix inversion and matrix eigenvalues estimation. (5)

Module 3

Solution of non-linear algebraic equations; Newton Raphson technique and homotopy; Numerical integration. (5)

Module 4

Ordinary differential equations; Runge Kutta Techniques; Predictor corrector methods. (5)

Module 5

solution of partial differential equations; implicit and explicit techniques. (5)

Module 6

Finite volume and finite element methods; Differential algebraic equations. (5)

Module 7

Introduction to equation solving software like MATLAB, DSSL, LSODE etc. (5)

Course Text References:

1. R. Schilling and S. L. Harris, Applied numerical methods for engineers, Brroks and Cole, 1999.
2. W. H. Press, S. K Teukolsky, W.T. Wetterling and B. P. Flannery, Numerical Recipes in C and C++, Cambridge University Press, 2002
3. Constantinides, Applied numerical methods with Personal Computers, McGraw Hill, 1987.
4. Carnahan, H. A. Luther and J. O. Wiles, Applied numerical methods, Wiley, 1969
5. R. W. Hornbeck, Numerical methods, Prentice Hall, 1975.
6. S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, 1989.
7. J. N. Reddy, An Introduction to the Finite Element Methods, McGraw-Hill Inc., 1993
8. Patankar S. V., Numerical heat transfer and fluid flow, Hampshire Taylor and Francis Group, New York 1980

Elective- II

MCL 2005 Advanced Process dynamics and Control

Module I
Discrete time systems, analog to digital and digital to analog conversion, sampling of continuous time signal. (5)

Module II
Conversion of discrete time to continuous time signal with zero and first holds. (5)

Module III
z transform stability analysis of discrete time systems. (5)

Module IV
Design of digital controller, Digital PID controller, Dahlin's algorithm, dead beat controller, pole-placement and ringing. (5)

Module V
State-space representation of systems, discretization of state space model, transfer function of state space and state space to transfer function models. (5)

Module VI
Stability analysis of state space models. Lyapunov stability criteria, controllability and observability canonical forms, state observers. (5)

Module VII
Design of state space model based controller, model predictive controller, internal model controller. (5)

Books:

1. G. stephanopoulosm Chemical Process control; An introduction to Theory and Practie, Prentice-Hall India 2003.
2. W.L.Luyben, Process Modelling Simulaiton and Control for Chemical Engineers, McGraw-hill 1990.
3. B.Oggunnaike and W.H.Ray, Process Dynamics, Modelling and control, Oxford University Press 1995
4. K.Ogala, Modern Control Engineering, Pretice Hall of India, New Delhi 2003
5. N/W. Bequette, Process Control: Modellling Design and Simulaiton, Prentice Hall of India, New Delhi 2003
6. K.Astrom and B. Wittemark, computer controlled Systems, System and Design, Prentice Hall of India New Delhi, 1994
7. D.E. Se;bong, T.F.Edgar and D. a. Mellichamp, process Dynamics and control, John Wily & Sons Inc, 2003.
8. W.L.luyben, Process Modelling Simulaiton and control for chemical Engineers, McGrawHill, 1990.

MCL 2007 Petrochemical Technology

Module 1

Petrochemical feed stock Manufacture of acetic anhydride, acetonje, acetic acid, adipic acid and aniline. (5)

Module 2

Manufacture of benzene toulune and xylene(BTX). (5)

Module 3

Manufacture of benzoic acid, benzyl chloride, butl acedate, carbon tentrachloride, chlorobenzene ethyl acetate. (5)

Module 4

Manufacture of maleic anhydride, methyl ethyl ketone, phthalic anhydride. (5)

Module 5

Manufacture of polyvinyl chloride, polyethylene, propylene and vinyl acetate. (5)

Module 6

Transportation of petrochemical products. (5)

Module 7

Health and safety ion petrochemical industries. (5)

Books

1. M. Wells Hand book of Petrochemicals and Processes, 2nd Ed, Ashgate Publishing Co 1999
2. S. Matar, Chemistry of Petrochemical Processes, 2nd Ed Gulf Publishing Company, 20000
3. P. Wiseman, Petrochemicals, John Wiley & Sons, 1986
4. R. Meyers, Hand Book of Petrochemicals Production Processes, McGraw Hill, 2005.

MCL2009 Mineral Beneficiation

Module I

Introduction to Mineral Processing, scope and importance; Basic unit operations, relative merits and demerits of processing of ores, definition ore, mineral, gangue, concentrate, tailing, yield, recovery and ratio of concentration. (5)

Module II

Comminution in Mineral Industries, Principles, Machinerie for crushering and grinding, Engineering challenges. Screening in Mineral Industrial practices. Screen efficiency. (5)

Module II

Classification: Movements of solids in fluid. Hindered settling, free settling, equal settling particles. Reynolds number and its importance. Types of classifiers, their principles and operations. Concentration operations: Types of different gravity concentration units, Their features, applications and relative merits and demerits. (5)

Module III

Flotation: Fundamental and practice of flotation, types of reagents and their importance. Critical pH curves. Flotation circuits. Mass balance. Magnetic and electro-static separation. Principles and applications. (5)

Module IV

Dense media Separation. Magnetic and Electrostatic separation

Dewatering: Thickening, filtration and drying: Principles and practices. (5)

Module V

Coal Beneficiation: Review Coal formation, Coal geology, coal characterization, Coal analysis, types of coals, Necessity, scope and application of coal preparation, Mining methods and their effects on size, quality and washability characteristics of coal. Selection, testing and utilisation of coking and non-coking coals. (5)

Module VI

Gravity separation process for coarse coal: Jigging principle, types of jigs used in washeries, their control arrangements; Heavy media separation, media requirement and recovery systems. Different types of bath – their merits, demerits and application. Heavy media cyclones – operating principles, performance operation of spirals and tables, their comparative performance, Evaluation of performance : partition curve, misplacement, Meyers curve. (5)

Module VII

Fine coal cleaning : froth flotation, oil agglomeration, water only cyclones and their application, preparation of noncoking coal, modern developments in processes and units. Coal preparation economics:Reference to Indian coal mining industries. (5)

Books

Mineral Processing Technology, by B. A. Wills

MCL 2011 CATALYSIS AND ADSORBENTS

MODULE 1
Fundamentals of catalysis and adsorption; types of catalysts and adsorbents. (5)

MODULE 2
Preparation methods: Conventional and novel. (5)

MODULE 3
Surface area and porosity. (5)

MODULE 4
Bulk and surface characterizations, diffusion in porous material. (5)

MODULE 5
Kinetics and mechanisms, Transport effect: deactivation. (5)

MODULE 6

Major applications in chemical industry. (5)

MODULE 7
Recent developments in catalysts and adsorption. (5)

Books:

1. J.M.Smith, Chemical Engineering Kinetics, McGraw-Hill Book Company, 1981
2. D.M.Ruthven, Principles of adsoroption and adsoption processes, John Wiley & Sons 1984
3. R. T. Yang, Adsor;bent: Fundamentals and aApplicaitons Wiley Interscience 2003
4. K.P. deJong, Synthesis of solid catalysts, Wiley – VCH 2009
5. H. S. Fogler, Elements of chemical reaction engineering, Prentice Hall of India 1999
6. C.H.Bartholomew and R.J. Farrauto, Fundamentals of Industrial catalytic Processes, Wiley VCH 2006
7. J. M.Thomas, and W.J. Thomas, Principles and Practivce of Heterogeneous Catalysis, Wiley – VCH, 1996R.T. Yang Gas separation by adsorption Processes, World Scientific Pubvkishing Company 1997
8. G. E, H Knozinger and J. Weikamp, Handbook of Heterogeneous Catalysis, Vol 1-2, Wiley VCH 1997.

MCL 2013 Rubber Technology

Module 1: Natural rubber - Chemical structure, auto oxidation and other reactions, blending with other polymers, compoundin (5)

Module 2: Chemistry and technology of synthetic rubbers –NR, SBR, nitrile, polybutadiene, polychloroprene, EPDM, Butyl rubber, hlorosulfonated polyethylene. (5)

Module 3: Theory of rubber elasticity, linear viscoelasticity of rubber, theory of reinforcement and crosslinking- mechanism and practice of sulfur vulcanization and nonsulfur, vulcanization (peroxide, metaloxides and other special curing systems)ilicone rubber, thermoplastic elastomers. (8)

Module 4: Rubber Additives:fillers,accelerators,activators,antioxidants, antiozonants, peptizers, processing aids (5)

Module 5: Rubber Processing Compounding Milling, Mixing, Extrusion, Calendering, Moulding.

Module 6: Tyre technology-mixing, reinforcement,classification, Reverse engineering in rubber technology,Industrial safety & hazards,Hose technology, Conveyer belt (5)

Module 7: Manufacturing of Dipped goods from latex, latex foam, Latex thread, latex treated coir.Rubber coated fabrics, Rubber footwear technology. Using textile, leather, PVC. (7)

Books:

1. Rubber Technology and Manufacture : Blow C.M. 2nd Edn. Numbers Butterworth London, 1982.
2. Dr. Werner Hoffmann. Rubber Technology Handbook, Hanser Publication, NY, 1996.
3. Rubber Technology, Morton, M., N.Y. Vannostrand Reinhold Company, 1973, IInd Ed.
4. Polymer Physics , Rubinstein,M, Colby R.H. Oxford University press , 2003.

MCL 2015 Coal and Coal chemicals Technology

Module I

Review Coal formation, Coal geology, coal characterization, Coal analysis, types of coals, Coal Family – Properties – Calorific Values – ROM, DMMF, DAG AND Bone Dry Basis – Ranking – Bulk & Apparent Density – Storage – Washability – Coking & Caking Coals. (5)

Module II

Coal Beneficiation: Necessity, scope and application of coal preparation, (Mining methods and their effects on size, quality and washability characteristics of coal.) Selection, testing and utilisation of coking and non-coking coals.Gravity separation process for coarse coal: Jigging principle, types of jigs used in washeries, their control arrangements; Heavy media separation, media requirement and recovery systems. Different types of bath – their merits, demerits and application. Heavy media cyclones – operating principles, performance operation of spirals and tables, their comparative performance, Evaluation of performance : partition curve, misplacement, Meyers curve. (5)

Module III

Fine coal cleaning : froth flotation, oil agglomeration, water only cyclones and their application, preparation of noncoking coal, modern developments in processes and units. Coal preparation economics:Reference to Indian coal mining industries. (5)

Module IV

Coal Bed Methane& Coal Mine Methane, Potential & unitization of CBM/CMM in India. (5)

Module V

Production of fuel gases from coal, Producer gas, Water gas, Gasification of Coal, Coal Properties and suitable gasifer for Indian Coals. (5)

Module VI

Destructive Distillation of Coal, Coking of coal; Coke manufacturing in Coke Ovens; Production of Coke Oven Gas, Processing & Recovery of primary coal chemicals; Production of Syngas from coke oven gas for recovery of chemicals. (5)

Module VII

Coke Oven Light oil as sours of chemicals; Distillation of Coal Tar to Chemicals Hydrogenaton of Coal, Coal to synthetic liquid fuel. (5)

BOOKS:

1. Mineral Processing Technology, by B. A. Wills
2. Johson Dr. James Lee : Kinetics of Coal Gasification;- Jhon willey & Sons, New York
3. Chemicals from Coal Carbonisation Products – TIFAC, January,1994
4. Coal Chemicals – published by Allied Publishers Ltd, 1996
5. Coal, Coke and Chemicals; By Philip J. Wilson and Jospeh H. Wells Mac Graw Hill Books
6. Chemistry of Coal Utilization, By H.H. Lowry; Jhon willey & Sons.
7. Fundamental of Coal bed Methane Reservoir engineering , by JhonSeidle
8. Applied Coal Petrology: The Role of Petrology in Coal Utilization By Isabel Suárez Ruiz, John C. Crelling
9. Gasification, Second Edition by Christopher Higman,Maarten van der Burgt

MCL2017 POLLUTION CONTROL TECHNOLOGY

Module 1

Types of environments and their pollutants. Classification of pollutants. Legislative aspects including water act. 1974, Air Act 1981 and efflument standards. Air pollution: Sources and effects of different air pollutants, Sampling and analysis of air pollutants. (5)

Module 2

Design and working principle of Air pollution control equipments: gravitational settling chambers, Cyclone Separator, Baghouse, ESP, Venturi Scrubber, fabric filter. Selection criteria of particulate collector. Dispersion of air pollutants and solutions to the atmospheric dispersion equation. (5)

Module 3

Control of gaseous emission with special reference to Sulphur dioxide, Nitrogen oxide, carbon monoxide and hydrocarbons. Design of gaseous emission controlling equipments: Gas absorption, Adsorption, burners etc. (5)

Module 4

Water pollution: Sources, sampling. Classification of water pollutants & their effect. BOD, COD, SS, TS, TDS etc. Primary Treatment- Design of Sedimentation tank, Floatation (5)

Module 5

Biological Treatment of wastewater: Design of activated sludge treatment system, trickling filter. Facultative ponds, aerobic and anaerobic ponds, etc. Advanced Treatment: microstraining, coagulation and filtration, sonoluminiscence, adsorption, Ion exchange, solvent extraction, stripping, Membrane Separation techniques – ultrfiltration, Reverse osmosis, electrodialysis etc. (8)

Module 6

Solid waste management, Sources and classification, public health aspects, Methods of collection and disposal methods: open dumping, landfill, incineration, composting, vermiculture; Solid waste management using bioremediation for specific pollutants like chromium. Mercury, ammonia / urea, phenolic sludge. Incinerator Design. (5)

Module 7

Pollution control in selected process industries – fertilizer industries, petroleum refineries and petrochemical units, pulp and paper industries, Tanning industries, Sugar industries, Dairy, Alcohol industries, Electroplating and metal finishing industries, Radioactive wastes, ranking of wastewater treatment alternatives. (7)

Text Books / References:

1. Environmental Pollution Control Engineering – C S Rao, New age
2. Pollution Control in process industries – S.P.Mahajan
3. Introduction to Environmental Engineering – Connwell & Devis. TMH.
4. Wastewater treatment for pollution control – S.J.Arceivala, TMH
5. Air Pollution – Rao,
6.Wastewater Engg. – Metcalf & Eddy, TMH
7. Standard Methods APHA /AWWA

Elective – III

MCL2019 Process Modeling & Simulation

Module - I

Mathematical Model: Introduction and Necessity Definition of modelling and simulation - validation with experiments, benchmarking; Need of models – predictive capability, trend analysis; Micro, meso and macroscale models - concept of multiple scales using crystallizer as an example, deterministic and stochastic descriptions Experimentation, empiricism, data correlation and mathematical modeling using examples. (5)

Module - II

Model Development Principles: Synthesis of sub-models, Hypothesis, Dimensional Analysis, Scaling Classification of Models: Deterministic and Stochastic – Macroscopic diffusion equation, Random walkLumped and Distributed Parameter - Stirred tank and plug flow models Linear and non-linear – Pendulum dynamics, Population biology. (5)

Module - III

Modeling of Simple Processes: Stirred tank models – Single and multi-particle dissolution and growth in stirred tanks. Disperse systems – heat and mass transfer and chemical reaction between continuous and dispersed particle phases Slurry reactor, Emulsion liquid membrane etc. Continuity, momentum, mass and energy balance equations: Introduction and meaning of the terms – no derivation. Simplification of these equations to model special cases Plug flow models – Differential balance, Homogeneous and heterogeneous treatment, Catalytic and non-catalytic reactions (isothermal, adiabatic, non-isothermal and non-adiabatic etc.) (5)

Module - IV

Specialized Modeling and Simulation Techniques: Population Balance models – Fundamentals, Derivation of mass balance and number balance equations. (5)

Module - V

Examples from Crystallization of solid, Coagulation, Coalescence and breakage of drops, Grinding, Microbial population dynamics, Reaction in a porous particle etc. (5)

Module - VI

Monte Carlo methods – Basics of random no. and probability distributions Poisson process, Birth-death process, Solution of Laplace's diffusion eqn. Time and event driven simulation

methods, Interval of quiescence Lattice simulation – examples from particle deposition, catalyst sintering etc. (5)

Module - VII

Fractal models – Definition, Diffusion and reaction limited growth, Aggregate structure. Solution and Analysis of Results: Parameter estimation, Moments, Phase-plane, Time series. (5)

Course Text References:

1. Aris, R., Mathematical Modeling Techniques: A Chemical Engineer's Perspective, Academic Press, 1999.
2. Randolph, A. D., Larson, M. A., Theory of Particulate Processes, Academic Press, 1988.
3. Aris, R., Mathematical Modelling Techniques, Dover, 1994.

MCL 2021 Principles of Polymer Processing

MODULE- I

Rheology of Polymer melts: Viscosity models, Dependence of viscosity on Temperature, Pressure, molecular weight. Viscous dissipation. Extensional viscosity, **Visco elasticity of Polymers.** Linear Viscoelastic models, Model to molecule analogy, Boltzmann stress superposition Principles. Relaxation Spectrum Dynamic Response. Experimental Techniques to determine Transition and Relaxation in Amorphous Polymers. Time Temperature Superposition. (5)

MODULE – II: Diffusivity, Solubility and Permeability in Polymer Systems. Characterization of Mixing process. (5)

Module III : Extrusion hardware: Extruder and Post Extrusion machineries. heet, pipe, blown film,compounding, Designing of dies. (5)

Module IV: Process analysis: Solids conveying, plasticating, melt conveying (Newtonian/Non Newtonian), Power consumption, Optimal, Design. Flow through dies. Extrudate Swell. Instabilities - shark skin, melt fracture. Polymer degradation. (5)

Module V: Process analysis for post die processing Fire processing, Film casting and stretching, film blowing. (5)

Module VI: General systems and simulation of Injection Moulding Mould filling simulation. Newtonian fluid into disc cavity, runner, cavity combination. (5)

Module VII: Hardware and simulation of following moudling/forming process Blow moulding, thermoforming, rotomoulding. (5)

Text Books:

1. Polymer Processing Principles and Design, D. G. Baird and D. Collias, John Wiley and Sons.
2. Polymer Extrusion, Chris Rauwendaal, Hanser, 1994.
3. Plastics Product Design and Process Engineering, H. Belofsky, Hanser, 1995.
4. Blow Moulding Handbook, Rosato, D.V. and Rosato D.V., Hanser, 1989.
5. Principles of Polymer Processing, Tadmor, Z and Gogos, C.G., John Wiley and Sons,1982
6. Plastic Extrusion Technology, Hensen, Henser, 1997.
7. Plastics Engineering, Crawford, R.J., Pergammon Press.
8. Fundamentals of Polymer Processing, Middleman, Mc Graw Hill, 1979.
9. Rotational MouldingTechnology, Roy Crawford and J.L.Throne, William Andrew publishing, 2002
10. Thermoforming, J.L.Throne,Hanser, 1987

MCL2023 Colloid and Interfacial Engg

Module 1: Introduction to colloidal material, surface properties, origin of charge on colloidal particles, preparation & characterization of colloidal particles. [5]

Module 2: Surfactants type (Anionic, cationic, Zwitterionic, Gemini and non-ionic). Theory of surfactants. CMC. Kraft temperature. Phase behavior of cone surfactant systems, surfactant geometry, bilayers, vesicles and liquid crystals, and packing. Emulsions, Microemulsions & Gels. [5]

Module 3: Intermolecular Forces, Van-der-waals forces (Kessom, Debye, and London Interactions). Potential energy curve, Brownian motion and Brownian Flocculation. [5]

Module 4: Surface and interfacial Tension. Surface free energy , Surface tension for curved interfaces, Surface excess and Gibbs adsorption isotherm. Measurement of Surface tension, Interfacial Tension, Contact angle. [5]

Module 5: Contact angle, Wetting Young-Laplace equation, Dynamic properties of interfaces . Surface viscosity, Kelvin equation. [5]

Module 6: Electrical phenomena at interfaces(Electronic kinetic phenomena, Electric double layer, short range forces). DLVO theory, capillary hydrostatics. Zeta potential, Electro osmosis phenomena, Streaming potential, Electro viscous flows. [5]

Module 7: Applications in detergents, personal-care products, pharmaceuticals, nanotechnology and food, textile, paint and petroleum industries. [5]

Books:

1) A.W. Adamson and A.P Gast, Physical Chemistry of surfaces, Wiley Interscience , NY 1997 and surface.

2) P.C Hiemen and R.Rajgopalam, Principle of colloid and surface Chemistry NY Marcel Dekker, 1997.

3) D.J.Shaw, Colloid and surface chemistry, Butterworth Heineman, Oxford,1992

4) Pallab Ghosh, Colloid and Interface Science,

5) J. Israelachvili, Intermolecular and Surface Forces, Academic Press, New York 1992

6) R.J. Hunter, Foundations of Colloid Science, Oxford University Press, New York, 2005

MCL 2025 Computational Fluid Dynamics

Module 1:

Introduction : Transport equations, Analytical and numerical solute of transport equations, Review of linear solvers. (5)

Module 2:

Analogical behavior of momentum, mass and energy transport. (5)

Module 3:

Partial differential equations : Types of PDE. Boundary conditions. Solution of PDE. (5)

Module 4:

Finite difference, finite element and finite volume schemes: Grid generation and discretization; accuracy, consistency, stability and convergence. (5)

Module 5:

explicit and implicit formulation; solution of Navier –Stokes equation with various approach of simulation staggered grid and collocated grid solution. (5)

Module 6:

solution of convective-diffusion equation; solution of chemical engineering problems. (5)

Module 7:

Introduction to multiphase turbulence modeling. (5)

Books:

1. S.V.Patankar, Numerical heat transfer and fluid foow, Taylor and Francis, 2004
2. T. J.Chung, computational Fluid Dynamics, Cambridge University Press, 2003
3. P.S.Ghosdastidar, Computer simulation of flow and heat transfer, Tata , McGraw Hill, 1998.
4. W. E. Schiesser and C. A., Silebi, Computational Transport Phenomena, Cambridge University Press, 1997
5. S.K.Gupta Numerical methods for engineers, New Age Intl, 2001

MCL 2027 Advanced Separation Processes

Module - 1
Multi Component Distillation , Selection of operating pressure, Equilibrium for Multi component System, Methods for Multi Component Distillation, Design of Batch Distillation for Multi component with Rectification with constant reflux & constant over head component. (5)

Module 2 : Continuous distillation of multi component system, Energy Conservation in Distillation column, Advance topics in distillation. Distillation Curve Maps, Extractive Distillation, Salt Distillation, Pressure Swing Distillation, Homogeneous Azeotropic Distillation, Heterogeneous Azeotropic Distillation, Reactive Distillation, Supercritical Fluid Extraction. (5)

Module 3: Modeling and simulation of absorption and leaching processes. Diffusion in non-ideal system and development of generalized Maxwell-Stefan formulation, Study of Generalized Fick's law, Estimation of binary and multicomponent Diffusion Coefficients, Study of interphase mass and energy transfer. (5)

Module 4 : Membrane Separation Techniques:
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. (5)

Module 5 : Advances in Absorption - Criteria for selection of packed tower, tray tower, Spray chamber, Venturi Scrubber etc. Design of Falling Film Absorption, Design of Spray Chamber , Design of Venturi Scrubber, Advantage of Falling Film Absorber. (5)

Module 6: Degree of Freedom for Different Equipments, such as distillation column, reactor, heat exchanger, pump etc. (5)

Module 7: Super heated steam Drying, Introduction, Numericals. (5)

Text Books:
1. Introduction to Process Engineering and design by S.B.Thakore & B.I. Bhatt
2. Chemical Engineering Handbook 7th edition by R.H.Perry & Green D.
3. Mass Transfer Operation 3rd Edition by R.E.Treybal
4. B.D. Smith, Design of Equilibrium Staged Processes, McGraw Hill.
5. Van Winkle , Distillation, McGraw Hill.

MCL 2029 COMPOSITE MATERIALS

MODULE 1:

Definition,classification and components of composite-ceramic composite, metal composite, polymer composite, concept on macro, micro and nanocomposite. (5)

MODULE 2:

Theory of reinforcement, concept of microfibrill, effect of orientation, adhesion, lamination theory. (5)

MODULE 3:

Matrix for composite:Ceramic-Silicon,Graphite,Metal-Aluminum, Metal alloy,Polymer-thermoplastic and thermoset matrix- PP,PBT,PC.ABS, Nylon, Phenolics, Epoxy,Polyester. (5)

MODULE 4:

Reinforcement for composite-Particulate-silica, carbon, titania, talc, zirconia,Continuous-Natural-Jute, Sisal, Coir, Cotton,Synthetic-Carbon, glass, Boron, Alumina, nylon, PE, Polyester. (5)

MODULE 5:

Design concept, product management and quality control, environmental effects & effect of defect on the performance of composites. (5)

MODULE 6:

Composite fabrication, limitation and advantage of filament winding, pultrusion,vacuum bag, pressure bag, hand layup, spray up, compression moulding, injection moulding, polymer foam. (5)

MODULE 7:

Characterization of composites- ASTM standards for testing composite -flexural, tensile, impact, thermal, morphological and electrical properties-application of composites. (5)

Books:

1.R.M. Jones, Mechanics of Composites Materials,2nd edition.Taylor and Francis 2010

2. F.L.Mathews and R.D. Rawlings, composite materials: Engineering and Science, CRC Press Woodhead, 1999

3. B.D. Agarwal and J.D. Broulman, Analysis and Performance of fibre Composites, John Wiley and Sons.New York,1990

4. P.K.Mallik, Fibre Reinforced Composites: materials, manufacturing and design, 2nd Edn.Marcel and Dekker,New York,1993

5. K.K.Arthur, Mechanics of Composites,CRC Press, 1997

6. P.K.Mallik,Composite Engineering Hand Book, 2nd Edn,Marcel and Dekker,New York,1997

MCL 2031 PETROLEUM RESERVOIR ENGINEERING

Module 1

Petrophysical properties of Reservoir Rock Properties: Porosity, permeability, fluid saturation, effective and relative permeability, wettability and capillary pressure. 5

Module 2

Reservoir Fluids: Reservoir fluid characteristics, reservoir fluid sampling, PVT properties determination, different correlations and laboratory measurements. Phase behavior of hydrocarbon system. 5

Module 3

Flow of Fluids through Porous Media: Darcy's law, single and multiphase flow, linear, radial& spherical flow, steady state & unsteady state flow, flow through fractures, GOR, WOR equations. 5

Module 4

Reservoir Pressure Measurements and Significance: Techniques of pressuremeasurement. Reservoir Drives: Reservoir drive mechanics, Drive indices and recovery factors. 5

Module 5

Reserve estimation: Estimation of petroleum reserve, resource & reserve concept, latest SPE/ WPC/ IS classification, volumetric material balance. Generalized MBE & Gas MBE. 5

Module 6

Production behavior of gas, gas condensate and oil reservoirs. Rock and fluid compressibility effect. Water influx in reservoir, Performance prediction of depletion, gas cap, water and combination drive, reservoir pressure maintenance. 5

Module 7

Displacement process, Immiscible, Buckeley&Leverett treatment of fractional flow & frontal advance equations. Water flood performance. 5

Books:

1. R.E.Terry M. Hawkins and NB.C.Craft, Applied Petroleum Reservoir Engineering, Prentice Hall 1991
2. L.P; Dake, Fundamentals of Reservoir Engineering, Elsevier 1983
3. T. Ahmed and P; McKinney, Advanced Reservoir Engineering, Elsevier, 2004
4. D.L. Katzz and R.L.Lee, Natural Gas Engineering, McGraw Hill 1990

MCL 2033 FOOD SCIENCE AND TECHNOLOGY

Module 1: Food quality characteristics; Composition and nutritive value of common foods, Structure, properties and metabolic function of food constituents viz. water, carbohydrates, lipids, proteins, enzymes, vitamins, minerals, pigments, colours and flavouring substances; Undesirable constituents in foods; Changes in food constituents during processing and storage. (5)

Module 2: Food Microbiology: Microbial groupings and identification; Nutrient requirements for bacterial culture; Growth and inactivation kinetics; Harmful and beneficial effects of microbes, microbes in food industry; Food spoilage, poisoning and intoxication . (5)

Module 3: Unit operations in Food industries : Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration Size reduction and screening of solids, mixing and emulsification, filtration and membrane separation, centrifugation, crystallization, extraction. (5)

Module 4
Food canning technology: Fundamentals of food canning technology. Heat sterilization of canned food, containers - metal, glass and flexible packaging. Canning procedures for fruits, vegetables, meats, poultry, marine products. (5)

Module 5
Baking Roasting Frying. Applications. Equipment. Engineering problems. (5)

Module 6
Low Temperature and Non Thermal Processing of foods : Applications. Equipment. Engineering problems. Dairy Processing Technology. (5)

Module 7
Post harvest Technology for cereals, pulses and oil seeds. Food Laws and Standards : good packaging Quality control in food industry. (5)

BOOKS:
1. R.P.Singh and D.R.Heldman, Introduction to Food Engineering, II Edition, Academic Press, 1993
2. E. L.Watson and J.C.Harper, Elements of Food Engineering, II Edition, Van Nostrand Reinhold Co., 1987.
3. R.Macral, R.K.Robinson and M.J.Sadler (Editors),Encyclopaedia of Food Science, Technology and Nutrition, 8 volumes, Academic Press, 1993.
4. McKenna,Engineering and Food 2 Volumes, Elsevier Applied Science Publication, 1984.
5. T.Kadiya (Editor),Food Packaging, Academic Press Inc., 1990. Bourivert, Food Microbiology; IV Edition, 1986.
6. R.T. Toledo, "Fundamentals of Food Process Engineering", AVI Publishing Co., 1980.
7. R. Angold,G.Beech and J.Taggart, " Food Biotechnology", Cambridge University Press, 1989.
8. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology", AVI Publishing Co., 1978.
9. J. G. Bernnan, J. R. Butters, N. D. Cowell and A.E.V.Lilley, "Food Engineering Operations", 2nd Edn., Applied Science, 1976

MCL 2035 Combustion Engineering

ModuleI

Fuels Types And Characteristics Of Fuels-Determination Of Properties Of Fuels-Fuels Analysis-Proximate And Ultimate Analysis-Moisture Determination-Calorific Value-Gross & Net Calorific Values Calorimetry Dulong's Formula For Cv Estimation-Flue Gas Analysis Orsat Apparatus-Fuel & Ash Storage & Handling Spontaneous Ignition Temperatures. (5)

Module 2

Solid fuels Types Coal Family Properties Calorific Values ROM, DMMF, DAG AND Bone Dry Basis Ranking Bulk & Apparent Density Storage Washability Coking & Caking Coals – Renewable Solid Fuels Biomass Wood Waste Agro Fuels Manufactured Solid Fuels. Liquid Fuels Types Sources Petroleum Fractions-Classification Refining Properties Of Liquid Fuels Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number Etc, Alcohols Tar Sand Oil–Liquefaction Of Solid Fuels. (5)

Module 3

Classification Composition & Properties Estimation Of Calorific Value Gas Calorimeter. Rich & Lean Gas Wobbe Index Natural Gas Dry & Wet Natural Gas Stripped NG Foul & Sweet NG LPG CNG Methane Producer Gas Gasifiers Water Gas Town Gas Coal Gasification Gasification Efficiency Non Thermal Route Biogas Digesters Reactions Viability Economics. (5)

Module 4

Stoichiometry Mass Basis & Volume Basis Excess Air Calculation Fuel & Flue Gas Compositions Calculations Rapid Methods Combustion Processes Stationary Flame Combustion Explosive Combustion. Mechanism Of Combustion – Ignition & Ignition Energy Spontaneous Combustion- Flame Propagation Solid, Liquid & Gaseous Fuels Combustion Flame Temperature Theoretical, Adiabatic & Actual Ignition Limits Limits Of Inflammability. (5)

Module 5

Coal Burning Equipments Types Pulverized Coal Firing Fluidized Bed Firing Fixed Bed & Recycled Bed Cyclone Firing Spreader Stokers Vibrating Grate Stokers Sprinkler Stokers, Traveling Grate Stokers. Oil Burners Vaporizing Burners Air Aspiration Gas Burners Burners Classification According To Flame Structures Factors Affecting Burners & Combustion. (5)

References

1.Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Logman,latest Edition
2.Bhatt,Vora Stoichiometry,2nd Edition, tata Mcgraw Hill, 1984
3.Blokh AG, Heat Transfer in Steam Boiler Furance, Hemisphere Publishing Corpn,1988
4.Civil Davies, Calculations in Furance Technology, Pergamon Press,Oxford,1966
5.Sharma SP,Mohan Chander,Fuels & Combustion, Tata Mcgraw Hill,1984

MCL 2037 Advances in NanoTechnology

MODULE 1 : Nanotechnology and definition, classification of nanomaterials. Top-down versus bottom up approach in manufacturing. Novel physics and chemistry of nanodimensions. Unique chemical, electronic, magnetic, optical, thermal and mechanical properties. Metals, ceramics & semiconductors. [7]

MODULE 2 : Principles of Mesoscale heat, mass and momentum transport, Fundamentals of vector/tensor algebra/calculus and order of magnitude analysis; Stability analysis; linear, weakly –nonlinear, and nonlear, instabilities: Rayleigh-Benard, Raleigh-Taylor, Kelvin-Helmholtz and Saffman-Taylor. Thin film dynamics and colloidal domain; Intermolecular and capillary forces; Electrohydorodynamics(EHD) Maxwell stresses; Electro kinetics, zeta-potential; Magneto-hydrodynamics(MHD). [10]

MODULE 3 : Dendrimers – synthesis, properties & structure Fullerenes – synthesis, properties & structure Carbon Nanotube - synthesis, properties & structure . Core Shell nano particles. Stimuli responsive Polymers. [5]

MODULE 4 : Conducting polymers – synthesis & properties of Polyacetylenes, Polyanilines, polyphenylene, polythiophene, polypyrrole & poly(phenylene vinylene) and its deribatives. Charge transfer polymers, Ionically conducting polymers, Conductively filled polymers [6]

MODULE 5 : Polymer dopant interaction. Diffusion of dopants, chemistry of doping. Doping level. Marphology of pristine polymers, doped polymers. Mechanism of conduction, Applications [7]

MODULE 6 : Principles of molecular self assembly and self organization, surfactant solutions, polymers. Self assembled monolayers, thiol and silane monolayers, Langmnir – Blodgett films, Topological substrate Patterning. [5]

MODULE 7 : Micro-nano fabrication: photolithography; Fabrication and characterization in mesoscale employing lithography, microscopy, chromatography and spectroscopy. MEMS and NEMS fabrication

Books:

1. L.G.Leal, Advanced Transport Phenomena Fluid Mechanics and Convective transport processes, 1st Ed Cambridge Series in Chemical Engineering 2007
2. M.J.Madou, Fundamentals of Microfabriation. The Science of Miniaturization, 2nd Ed Taylor and Francis, 2002
3. S. Chakraborty, Microfluidics and microfabrication, 1st Ed Springer
4. Nano the essentials, T. Pradeep
5. Nanoscale Materials in Chemistry Ed. K. J. Klabunde
6. Intermolecular and Surface Forces By Jacob N. Issacelachvir AP. NY.1991.