NOTE: First Year (I & II Semester) Courses are common for all branches

THIRD SEMESTER

AM- 241 : HIGHER MATHEMATICS

UNIT I: Vector differentiation, scalar field, gradient of a scalar field, vector field, divergence & curves of vector fields, solenoidal angle and irrotational field. Determination of potential function.

UNIT II: Vector integration, line integral, conservation fields, Gauss divergence theorems, Greens theorem and Stokes theorem.

UNIT III: Laplace's transformation, shifting theorems, transforms of derivatives and integrals. Differentiation and Integration of transforms. Inverse transforms, Application with single and system of linear differential equations.

UNIT IV: Boundary Value Problems, solution of 2D laplace equation in Cartesian and polar co-ordinates, solution of one dimensional diffusion and wave equation by method of separation of variables.

BOOKS:

1. Prasad, C., "Mathematics for Engineers", Prasad Mudranalaya, New Delhi, 1985.

PK-214: REACTION KINETICS AND REACTOR DESIGN

UNIT I: Rate of Reaction , elementary and non-elementary reactions molecularity and order of reaction, thermodynamics formulations of rates, mechanism of reaction, Temperature dependency from thermodynamics, arrhenius, collision and activated complex theories, Introduction of industrial reactors.

UNIT II: Integral and differential methods for analyzing kinetics data, interpretation of constant volume batch reactor data for zero, first second and third order reactions, half life period, irreversible reactions in parallel and series, auto catalytic reaction, shifting order reactions enzyme catalyzed and surface catalyzed reactions. Interpretation of variable volume batch reactor data for zero, first and second order reactions.

UNIT III: Design equations for batch, plug flow, back mix, flow and semi batch reactors for isothermal, adiabatic reactions holding time and space time for flow system Design of batch plug flow and mixed flow reactors for first and second order single reactions. Optimum reactor size plug flow reactors in series / parallel Equal and different size of mixed reactors in series and finding the best system for a given conversion recycle reactor

UNIT IV: Multiple reactions, independent, parallel and series reactions; mixed reactions, instantaneous and over all fractional yield, choice of reactors for simple and complex reactions and multiple reactor system; Introduction to thermal stability of reactors; temperature and pressure effects and optimal temperature progression for first order reactions. Introduction to Residence time Distribution of fluid in Vessel.

BOOKS:

1. Levenspiel, O., Chemical Reaction Engineering, John Wiley and Sons, New York, 3/e, 1998
2. Fogler, H. S., Elements of Chemical Reaction Engineering, Prentice Hall, USA 4/e, 2005
3. Smith, J. M., Chemical Engineering Kinetics, McGraw Hill Publications, New York, 1981

PK-211: BASIC PRINCIPLES OF CHEMICAL ENGINEERING

1. Units and dimensions, Process Variables, Application of thermodynamics and chemical principles in estimation of physical properties of single and multi-phase system, Stoichiometry.
2. Material Balance on single and multiple unit processes, Recycle, bypass and purge, Balance on reactive systems
3. Fundamentals of Energy balance, Introduction, Mechanical energy balance, Balance on reactive and non-reactive processes.
4. Combined material and energy balance: Psychrometry, Material and energy balance on transient processes, industrial applications, Material and energy balance on process flowsheet.

Text Book:

Felder, R.M. and R.W. Rousseau, Elementary Principles of Chemical Processes, 3/e, Wiley, Singapore, 2000.

Reference Books:

1. Himmelblau, D. M., Basic Principles and Calculations in Chemical Engineering, 6/e, Prentice Hall of India, New Delhi, 1996.
2. Hougen, O. A., K. M. Watson and R. A. Regatz, Chemical Process Principles Part-I, 2/e, CBS Publishers, 1995.
3. Bhatt, B.I. and S.M. Vohra, Stoichiometry, 4/e, Tata McGraw Hill, New Delhi, 2004
4. Narayanan, K. V. and B. Lakshmikutty, Stiochiometry and Process Calculations, Prentice hall of India, 2006.
5. Sharifa Begum, Process Calculations, Prentice hall of India.

PK-232: FLUID MECHANICS

Unit I: Continuum concept of matter, Classification of matter based on deformation. The two axioms of Rheology, Fluid and its properties, Newton's law of viscosity, classification of fluids. Fluid statics: Hydrostatic law, hydrostatic force and buoyancy on submerged bodies, piezometric head, manometry.

Unit II: Study of fluid motion: Velocity field streamlines and path lines, Eulerian and Lagrangian approaches to the study of fluid motion, Bernoulli's Theorem, Continuity equation, Navier –Stokes equation ,Concept of stream function, irrotational flow, potential flow ,Laminar and turbulent flow , boundary layer concept ,Drag and boundary layer separation.

Unit III: Dimensional analysis and Study of Similitude: Advantages and limitations of dimensional analysis, methods of dimensional analysis: Buckingham's pi theorem, Rayleigh's method, dimensionless groups and their physical significance, Similitude study, principle of geometric, kinematics, dynamics and similarity.

Unit IV: Fluid flow operations: pipes and tubes ,size specification and selection, valves and fitting energy loss factor, equivalent length, estimation of frictional losses in piping systems. Flow meters: Variable head and variable area meters, Weir and Notches Transportation of Fluids: Pumps, compressors, fans, blowers, Classification of pumps: positive displacement and centrifugal pumps, performance characteristics of centrifugal pump.

Textbook

1. Shames, Irving H. , *Mechanics of Fluid*, McGraw Hill

Reference Book(s):

1. White , Frank M., *Fluid Mechanics* , McGraw Hill
2. Denn M., "*Process Fluid Mechanics*", Prentice Hall.1998
3. Darby R., "*Chemical Engineering Fluid Mechanics*", 2nd Ed., Marcel Dekker Inc. 2001
4. Nevers, N.D., "*Fluid Mechanics for Chemical Engineers*", 3rd Ed., McGraw Hill Higher Education. 2005
5. Holland F.A., '*Fluid Flow for Chemical Engineers'*, Chemical Publishing Co. Inc., New York
6. Schlichting, H., *Boundary-Layer Theory*, 7th Ed., McGraw-Hill, 1979.
7. Bird, R.B., W.E. Stewart & E.N. Lightfoot, *Transport Phenomena*, Wiley, 1960.
8. Douglas, J.F., Gasiorek, J.M., Swaffield, J., "*Fluid Mechanics*", 4th Ed., Prentice Hall, 2001
9. Fox, R.W., McDonald, A.T., "*Introduction toFluid Mechanics*", 5th Ed., Wiley, 2008
10. Gupta, S.K., "*Momentum Transfer Operations*" Tata McGraw Hill, New Delhi, 1982.
11. Gupta, V., and Gupta, S.K., "*Fluid Mechanics and Its Applications*", 1984.

PK-233: FLUID -PARTICLE OPERATIONS

Unit 1: Characteristics of solid masses. Particle size measurement and sieve analysis size estimation in sub-sieve range capacity and effectiveness of industrial screens. Storage of solid masses. Conveying of solids. Classification and design of Industrial Conveyers.

Unit 2: Size reduction: Theory of crushing and grinding, Types of grinding, Laws of comminution size reduction equipment and their selection.

Unit 3: Laws of motion of particles in a fluid. Settling and thickening, their Classification. Characteristics of rotating fluid, Centrifuge and cyclone separation. Classification and selection of settling equipments. Design of continuous thickner and Classification and selection of settling equipments. Design of continuous thickner and sedimentation tank.
Agitation and Mixing: Agitated vessels, blending and mixing, suspension of solid particles, dispersion operation, agitator selection and scale up.

Unit 4: Flow through packed beds: Types of Packing, characteristics of packing pressure drop in packed bed. Flooding and loading characteristics. Fluidization and its application classification of fluidization Characteristics of fluidized bed Filtration Theory and Principles, Filter aids classification and selection of filtration equipments.

Text Book:
Mc Cabe, Warren L., Smith Julian C. and Peter Harriot, "Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill.

Reference Books:

1. Gupta, S.K. "Momentum Transfer Operations, Tata McGraw Hill.
2. Brown G.G., "Unit Operations, CBS Publisher.
3. Coulson, J.M. and J.F. Richardson, 'Chemical Engineering', Vol. II, 5th ed., Butterworth-Heinemen.

4. Narayanan, C.M., B.C. Bhattacharya, 'Mechanical Operation for Chemical Engineers' Khanna Publisher Delhi, 1992.
5. Christie J.Geankopolis, 'Transport Processes and Unit Operations' 4th Ed., Prentice Hall of India, 2004.
6. Sitting, M., Particulate and Fire Dust Removal in Process Equipment, N.Y.C. Publication.
7. Chopey N.P. and Hicks T.G. 'Handbook of Chemical Engineering Calculations, McGraw Hill
8. Banchero, Badger, Unit Operations, McGraw Hill.

PK-231: CHEMISTRY OF HYDROCARBONS

Unit I: origin and formation of Petroleum, Reserves and deposits, Indian Petroleum Industry, Composition of crude Oils, ultimate and chemical composition , non-hydrocarbons in petroleum, Asphltenes and Resins, classification of petroleum, evaluation of crude oil, Bench mark crudes.

Unit II: characterization of crude oils : TBP and ASTM distillation, Classification by chemical composition, Correlation Index, Density, API gravity, Viscosity, UOP characterization factor, etc. Physical & Thermal properties of petroleum, ASTM, TBP, EFV distillation curves.

Unit III: Distillation: Pretreatment, Electric desalting, atmospheric and vacuum distillation, petroleum products and their quality control tests.

Unit IV: Value addition of petrochemicals from feedstock to consumer end products, chemical reactions of hydrocarbons like Decomposition (Thermal & Catalytic), Halogenations, Isomerization, Hydrogenation, Alkylation, Nitration, Sulfonation, etc. with chemistry and reaction mechanism.

BOOKS:

1. Speight, J.C.; "The Chemistry and Technology of Petroleum", Marcel Dekkar, New York, 3/e1999.
2. Lucas, A.G. (ed.), "Modern Petroleum Technology", Vol. 2, Downstream, John Wiley & Sons Limited, New York, 6/e, 2000.
3. Simanzhenkov, V. and Idem, R., "Crude oil Chemistry", Marcel Dekker Inc., New York, 2003.
4. Hobson, G.D., "Modern Petroleum Technology" Vol I & II, John Wiley & Sons, New York, 5/e, 1984
5. Rao, B.K.B., "Modern Petroleum Refining Processes", Oxford & IBH Co. Pvt. Ltd., New Delhi, 4/e, 2002,
6. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000

ME – 294: MACHINE DRAWING AND COMPUTER GRAPHICS

Drawing of following machine parts: threaded fasteners, screw jack, flexible coupling, stuffing box, swivel bearing, stop valve and some introduction of Auto CAD.

FOURTH SEMESTER

AM-242: APPLIED NUMERICAL METHODS

UNIT I: General iteration method, Newton Raphson method, application of Newton Raphson method, Solution of system of linear equation by Gauss elimination method and Gauss Siedel method, Convergence of iteration.

UNIT II: Interpolation-Finite difference operator, Central difference operator, backward difference operator, relation between operators, Newton's forward Interpolation formula, Newton's backward Interpolation formula, Newton's Interpolation formula for unequal interval, Lagrange's Interpolation formula for unequal interval.

UNIT III: Numerical Differentiation- Newton's divided difference formula; Numerical integration-Trapezoidal rule, Simpson's rule, Weedle's rule; Numerical Solution of differential equation-Solution with Taylor's series, Euler's method, modified Euler method, Runge-Kutta method, Boundary value problems.

UNIT IV: Graphical and analytical methods of optimization, Numerical search methods, search of optimum over single and several design variables, Optimum of process systems, linear programming.

BOOKS :

1. Sastry, S.S., "Introductory Methods of Numerical Analysis", Prentice Hall of India Pvt. Ltd., 2004.

PK – 221N: CHEMICAL ENGINEERING THERMODYNAMICS

. **Unit 1:** Laws of Thermodynamics, their application to engineering processes, Thermodynamics analysis of Chemical Processes.
Refrigeration cycles and liquification processes.

Unit 2: Properties of Pure Substances, Changes to thermodynamics properties and their inter relationship, properties of single and two phase system, types of thermodynamic diagrams. Generalized correlation for thermodynamic properties of gases. Multicomponent system: Partial molar properties, Chemical potential, fugacity and fugacity coefficients excess properties of mixture.

Unit 3: Phase Equilibria system. V-L-equilibrium for miscible and immiscible system and their phase diagram, activity coefficients from experimental data.

Unit 4: Reaction coordinates, chemical equilibria, application of the criteria for equilibrium to chemical reactions. Standard Gibb's Free energy change and the equilibrium constant, temperature and pressure effects on equilibrium constant, calculation of equilibrium conversion for single and multiple reaction system.

Text Book:

Smith J.M., Van Ness H.C. and Abbott M.M., Introduction to Chemical Engineering Thermodynamics, 7th Ed., Mc Graw Hill, 2005

Reference Books

1. Koretsky M.D., "Engineering and Chemical Thermodynamics", John Wiley, 2004.
2. Sandler S.I. "Chemical Biochemical and Engineering Thermodynamics, 4th Ed. John Wiley, 2006.

3. Kyle B.G., "Chemical and Process Thermodynamics", 3rd ed., Prentice Hall, 1999.
4. Narayanan, K.V., "Chemical Engineering Thermodynamics, Prentice Hall, 2007.
5. Rao, Y.V.C., Chemical Engineering Thermodynamics, University Press India 2nd Ed. 2001
6. Rao Y.V.C. Theory and Problems of Thermodynamics, New Age International (P) Ltd New Delhi.

PK 242 PROCESS DEVELOPMENT AND EQUIPMENT DESIGN

UNIT I: Principles of process synthesis: reaction path synthesis, species allocation, separation task selection, task integration.
Unit II: Diagrams for understanding chemical processes: Block Flow Diagram, Process Flow Diagram, Piping & Instrumentation Diagram. Structure and synthesis of process flow diagrams.

Unit III: Chemical product design, tracing chemicals through the process flow diagram, understanding process conditions.

UnitIV: Introduction to design codes, design of cylindrical and spherical shells, design of storage tanks, designs of tall vertical vessels, selection and design of flanges and supports for equipment.

BOOKS:

1. Turton, Richard, Bailie, Richard C., Wallace B. Whiting, Shaeiwitz, Joseph A.; "Analysis, Synthesis and Design of Chemical Processes", Prentice Hall, USA 3/e, 2009.
2. Douglas, J.M., "Conceptual Design of Chemical Processes", McGraw-Hill, 1988
3. Joshi, M.V. and Mahajani, V.V.; Process Equipment Design, 3/e, 1996, MacMillan India Ltd, New Delhi
4. Bhattacharya, B.C. Introduction to Chemical Equipment Design –Mechanical Aspect, Chemical Engineering Education Development Centre I.I.T Madras.

PK-241: SEPARATION PROCESSES IN HC INDUSTRIES

UNIT-I: Introduction to separation processes, Phase equilibrium thermodynamics, Flash calculation, Distillation: Flash distillation, Differential distillation & Steam distillation; Binary distillation, Multi stage tray towers; McCabe & Thiele method, Ponchon & Savarit method, Continuous contact system (packed towers).

UNIT-II: Multi-component distillation, Adsorption: Adsorption Equilibrium, Fixed bed adsorption column, Ion exchange method

UNIT-III: Liquid-Liquid Extraction: Extraction Equilibrium, Extractive solvent, Extraction equipment, Multistage cross current and counter current operations, Liquid-solid leaching operation.

UNIT-IV: Membrane Separation Processes: Types of membrane process, liquid and gas permeation membrane process, types of membrane, Applications

BOOKS:

1. Treybal, Robert E., "Mass Transfer Operations", McGraw Hill Publications, 3/e, 2003.
2. Geankoplis, Christie J., "Transport Processes and Unit Operations", Prentice Hall of India, New Delhi, 3/e, 1997.
3. Seader, J.D., Henley, Ernest J., "Separation Process Principles", John Wiley & Sons, Inc, 1998.

PK-234 (DEPARTMENTAL ELECTIVE- I)

PK-234A :ALTERNATE FUELS AND ENERGY RESOURCES

Unit I: Introduction to alternate fuels: the legislation for alternate fuels, the method of production, properties and characteristics of the different alternate fuels and proper handling procedures.

Unit II: Gas to Liquids Technology Fuels - Introduction to GTL route for cleaner fuels, properties and characteristics of the fuels produced.

Unit III: Gasification technologies, gasification reactions, working of different types of gasifiers: moving bed, fluidized bed and entrained bed gasifiers, types of processes, fuels from biomass – thermal, chemical and biochemical conversions.

Unit IV: Coal Liquefaction technologies: Carbonisation and Pyrolysis, Direct Liquefaction, Indirect Liquefaction

BOOKS:

1. T. N. Veziroglu, Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 1978.
2. Rao, S. and Parulekar, B.B., "Energy Technology", Khanna Publishers, Delhi.
3. Speight, J.G., "Fuel Science and Technology Handbook", Marcel and Dekker., New York, 1995.
4. Abbasi, S.A. & Abbasi, N., "Renewable Energy Sources and Their Environmental Impact", Prentice Hall of India, New Delhi, 2002.

PK-234 B:RENEWABLE ENERGY

Unit-I: Solar Energy ,Wind Energy ,Ocean Energy and Other Sources:

Unit-II: Biomass resources and their classification; Chemical constituents and physicochemical characteristics of biomass; Biomass conversion processes; Biofuels, Biomass conservation methods.

Unit-III: Classification of wastes and their characteristics; Physical and chemical conversion processes: Incineration, pelletalization, landfill, and anaerobic digestion.

Unit- IV: Fuel Cells **;**Thermodynamics and electrochemical principles; Basic design, types, applications. Hydrogen Energy; Economics of hydrogen; Production methods; Biophotolysis: Hydrogen generation from algae /biological pathways; Storage and transportation; Applications

BOOKS:

1. Kreith, F. and Kreider, J.F., "Principles of Solar Engineering" , McGraw-Hill, 1978
2. Kreider, J.F. and Kreith, F., "Solar Energy Handbook" McGraw-Hill 1981.
3. T.N. Veziroglu, Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 1978.
4. Khan, B.H., "Non-conventional Energy Resources", Tata McGraw Hill, New Delhi, 2008.
5. Sukhatme, S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw-Hill, New Delhi, 1984.
6. Duffie, J. A. and Beckman, W. A., "Solar Engineering of Thermal Processes", John Wiley, 3/e, 2006.
7. Sorensen, B., "Renewable Energy", Academic press, New York, 2/e, 2000.

PK-234 : ENERGY RESOURCES AND ENVIRONMENT MANAGEMENT(DE-I)

Unit I: Global and Indian energy Scenario, Energy consumption pattern, energy as a factor limiting growth, need for use of new and renewable energy sources, Energy Crisis-Historical events

Unit II: Non- renewable energy sources - coal, oil, natural gas, and nuclear energy

Unit III: Renewable energy sources – Hydel energy, Solar Energy, tidal energy, biomass energy, wind energy, etc.

Unit IV: Environmental degradation due to energy production and utilization, Primary and secondary pollution, air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation.

BOOKS:

1. Abbasi, S.A. & Abbasi, N., "Renewable Energy Sources and Their Environmental Impact", Prentice Hall of India, New Delhi, 2002.
2. Sukhatme, S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw-Hill, New Delhi, 1984.
3. Khan, B.H., "Non-conventional Energy Resources", Tata McGraw Hill, New Delhi, 2008.
4. Rai, G.D., "Non Conventional Energy Sources", Khanna Publishers, Delhi, 2004.

PK-234 : SYNTHETIC FUELS (DE-I)

Unit-I: Fuels from coal development of synfuels, Properties & principles of coal conversion, thermodynamic of coal conversion Low, medium & high BTU gas from coal Clean liquid from coal Pyrolysis, liquefaction, coal & oil processing Environmental issues, CTL.

Unit-II: Liquid fuels from NG, GTL, DME, Methanol, MTBE.

Unit-III: Fuels from Biomass Biomass thermal conversion processes, Biological conversion processes, Lignocellulosic conversion processes.

Unit-IV: Fuels from oil shales & tar sands, Properties of oil shales & tar sand above ground processes & insitu processes, Constraint in commercial production for oil shales & tar sands.

BOOKS:

1. Anderson, L.L. and Tillman, D.A., "Synthetic Fuels from Coal: Overview and Assessment", Wiley-Interscience, New York, 1979.
2. Lee, S., Speight, J.G. and Loyalka, S.K., "Handbook of Alternative Fuels Technologies", CRC Press, 2007.

CH – 292: UNIT OPERATION LAB-I

EXPERIMENTS:

1. To investigate validity of Bernoulli's theorem as applied to flow of water in tube of varying cross section
2. To find the efflux time of the tank
3. Flow through straight circular tube
4. Capillary flow viscometer
5. Flow through helical tube coils
6. Flow through spiral tubes
7. Pipe flow of compressible fluids
8. Flow through annulus

PK-293: PETROLEUM TESTING LABORATORY

Various Experiments related Analysis & Testing of Petroleum and Petroleum Products.

FIFTH SEMESTER

PK-311N: PETROLEUM REFINING PROCESSES

Unit I: Thermal conversion processes like Visbreaking, Delayed Coking, Fluid coking, Flexicoking, etc.

Unit II: Catalytic conversion processes - fluid catalytic cracking, RFCC, DCC, Hydrocracking, Hydrotreating processes, etc.

Unit III: Reforming, hydrogen production, Alkylation, Polymerization, Isomerisation etc.

Unit IV: Evaluation of crude for LOBS, Production of lubes and waxes.

BOOKS:

1. Speight, J.G. and Ozum, B. "Petroleum Refining Processes", Marcel Dekker Inc, New York, 2002.
2. Gary, J.H. and Handiwerk, G.E., "Petroleum Refining Technology and Economics", Marcel Dekker, Inc., New York, 2001.
3. Hobson, G.D., "Modern Petroleum Technology" Vol I & II, John Wiley & Sons, New York, 5/e, 1984
4. Rao, B.K.B., "Modern Petroleum Refining Processes", Oxford & IBH Co. Pvt. Ltd., New Delhi, 4/e, 2002,
5. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000

PK-313N: MASS TRANSFER OPERATIONS

UNIT I: General Introduction: Mass transfer operations and its classifications, Diffusion mass transfer, Mass transfer coefficient, Mass transfer models, Mass transfer with chemical reactions

UNIT II: Gas Absorption Operations: Equilibrium, Choice of solvents, co-solvents, co-current and counter current operations, packed bed and staged columns.

UNIT III: Humidification Operations: Psychrometry, Adiabatic humidification and dehumidification operations, Packed bed columns, Humidification equipments.
Drying: Fundamentals, drying curves, equipment for drying

UNIT IV: Equipment for Gas-Liquid Operations: Sparged vessels, mechanically agitated vessels.

BOOKS:

1. Treybal, R.E., "Mass Transfer Operations, Mc. Graw Hills, New York, 3/e, 1983
2. Geankoplis, C.J., "Transport Processes and Unit Operations", Prentice Hall of India, New Delhi, 4/e, 2003.
3. Mc. Cabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations of Chemical Engineering", Mc. Graw Hills, New York, 6/e, 2001
4. Skelland, A.H.P., "Diffusional Mass Transfer", John Wiley and Sons, New York, 1974

PK- 312N: HEAT TRANSFER OPERATIONS

Unit 1:Fundamental laws of heat transfer,conduction through single and composite layer,concept of film resistance and thermal boundary layer,concept of heat transfer coefficient and its prediction Mechanism of heat transfer in forced and free convection.Empirical correlation for estimating heat transfer coefficient in various conditions
Insulation material, cold and hot insulation material thickeness calculation for insulating material Heat transfer fluids

Unit 2: Boiling: Boiling Charectristics,Nucleate pool Boiling and Force convection

boiling.boling mechanismboiling curve and heat transfer correlation Heat pipe Condensation:Mechanism and type of condensation of vapours,Nusselt equation for film wise condensation on vertical surface, inclined and horizontal surface ,condensation Number,film condensation inside horizontal tubes Evaporators:classification and use of Evaporators in process industries effect of boiling point elevationand hydrostatic head on evaporator performance estimation of surface area in multiple effect evaporator evaporator calcul;ation in process industries,fouling in evaporator

Unit 3 Heat Exchangers: Importance of heat exchanger in process industries various types of heat exchange devices and theit selection double pipe and shell and tube heat exchanger design and rating calculation Ft correction factor, Liquid liquid gas liquid and gas gas system Concept of effectiveness and NTU of heat exchanger Extended durface for heat Transfer

Unit 4: heat transfer in agitated vessel Heat transfer to fixed and fluidized bed Radiative haet transfer basic laws black body and gray body radiation view factor Radiation ibn gase and vapours.

Text Book

Dutta, B.K.**,** *Heat Transfer: Principles and Applications*, Prentice-Hall of India Pvt.Ltd 2009.

Reference Book(s)

1. Holman, J.P., *Heat Transfer*, Tata McGraw Hill Publishing Company, New Delhi, 9/e, 2009.
2. Chapman, A.J.,*Heat Transfer*, Mc Millan Publishing Company, New York, 4/e, 1984.
3. Cengel Y.A., *Heat and Mass Transfer: A Practical Approach* , McGraw Hill, New York, 3/e, 2007.
4. Kern D Q Process Heat Transfer McGraw hill
5. Incropera F P and Dewitt D P Fundamentals of Heat and Mass Transfer 5th ed John wiley
6. Kreith F and Bohn M Principles of Heat transfer 6th Ed Brooks cole

AC-311: ENGINEERING MATERIALS

Unit-I : Engineering Materials and their Structure: (08 Lecture)

Introduction to materials – basis of materials properties, Crystals Structure – brief outlines of atomic bonding crystal structure, periodicity in crystal lattice unit cell direction, crystal planes, Miller indices, inter planar spacing, X-ray analysis, Crystals defects –classifications and impact on the properties of engineering materials.

Unit-II : Engineering Materials and their Properties: (08 Lecture)

Engineering Materials, Definition, Classification Steels and Cast Irons, Classification of Steels, Plain Carbon Steel, Alloy Steel, Stainless Steels, Austenitic Stainless Steels, Ferritic Stainless Steels, Ferritic Stainless Steels, Martensitic Stainless Steels, Duplex Stainless Steels and Precipitation hardening Stainless Steels, Cast Iron, Gray Cast Iron, White Cast Iron, Malleable Cast Iron.

Unit-III : Phase Equilibria and Heat Treatment : (08 Lecture)

Phase equilibria – phase rule, phase, change in pure Iron, binary systems, solid solution, Eutectic, Eutectoid Peritectic and Peritectoid reactions, General principles of heat treatment; Annealing, normalizing, Hardening, tempering and age hardening.

Unit-IV : Properties and Applications Construction Materials : (08 Lecture)
Properties and applications of materials of construction, factors affecting selection of materials, corrosion of materials of construction and its control.

Unit-V : Characterization of Engg. Materials : (08 Lecture)
Characterization of microstructure using Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and its sample preparation techniques, EDS, Atomic force microscopy (AFM), Dielectric spectroscopy, Fluorescence spectroscopy.

Unit-VI Miscellaneous Materials (08 Lecture)
Adhesives and Adhesion, Classification of Adhesives, Factors Controlling the Properties of Adhesives, Definition of Composites, Classification of Composites, Applications of Composites, Abrasion, Natural Abrasives, Artificial Abrasives, Definition, and Applications of Conductors, Semiconductors and Insulators, Introduction to Nanomaterials.
Books:

1. Van Vlack L.H. "Elements of Materials Science and Engineering" ed 6th Addison Wesley Inc New York.
2. ED. Dyson R.W. "Engineering Polymers", Blackie, New York.
3. Smith C.O. "The Science of Engineering Materials third edition, Prenticc Hall Inc. New Jersey.

PK-331: REFINERY ENGINEERING CALCULATIONS

Unit I: Overview of Global and Indian Refining Industry, Refinery configurations, ASTM, TBP, EFV distillation curves, computation of the curves Average boiling points. Separation criteria in crude oil fractionation
Unit II: Atmospheric distillation tower, types of refluxes, Watkins method of converting crude TBP to product TBP curves, concept of overflash. Energy balance in a topping tower, and calculations involve estimation of top , side, bottom draw tray temperatures. Calculation of side steam strippers
Unit III: Vacuum distilation tower, type of operations, economic consideration, flash zone & tower base calculations, flash zone pressure, steam requirements, heat & material balance calculation
Unit IV: Types of pipe still heaters, calculations of radiant absorption rates, Wilson lobo Hotel equations, lobo Evans method pipe still design. Heat exchanger in refinery design and operational problems fluid mechanics and refinery applications use of combustion Charts.
BOOKS

1. R.N. Watkin, Petroleum Refinery Distillation, 2/e Gulf Publishing Co, Houstan, Texas, USA, 1981.
2. B.K Bhaskar Rao, Modern Petroleum Refining Processes, 3/e, Oxford & IBH Publishing Co Pvt. Ltd., 1997.
3. Wayne C. Edmister, Applied Hydrocarbon Thermodynamics, 2/e, Gulf Publishing Co., 1988.

ME-340: ECONOMICS AND MANAGEMENT

UNIT I: Evolution of management, theories of management (scientific management, classical organizational management, Henry Gantt and Gilberth's theory of management, behavorial approach, management science school), Functions of management (forecasting, planning organizing staffing directing, co-ordinating, controlling, decision making). Ownership-factors affecting the choice of ownerships, types of ownerships (individual ownerships, partnership firms, joint stock companies, co-operative societies, public sector undertakings).

UNIT II: Steps in organizational design (division of work, departmentation, hierarchy, co-ordination), span of control or span of management, Garicuna's theory, approaches to organizational design, classiscal approach, task technology approach, environmental approach. Leadership-source of power (Reward power, Coercive power, legitimate powers, expert powers, referent power), theories of leadership (trait theories, behavorial theory, situation theory and contingency approach)

UNIT III: Types of behavior (status-meritorial, etc), leadership (democratic, autocratic, lessen free), motivation. Engineering economy (Law of supply and demand), Laws of diminishing return, unit cost function, elements of cost, overheads, break-even analysis and charts.

UNIT IV: Forecasting and techniques, kinds and types of forecasting, methods of forecasting, qualitative methods (consumer survey model, composite sales team method, Delphi method). Statistical Approach - time series models, components of TS models, trend, seasonal variation, cyclic variation, Random variables, least square method, moving average method, weighted moving average method, semi-average method, and exponential smoothup. Casual Models – regression analysis, correlation analysis, standard deviation, Depreciation, cash flow diagrams and various numerical problems based on it. Present worth method, future worth, annual worth, ERR worth and ERR worth methods.

BOOKS:

1. Barthwal, R.R., "Industrial Economics", New Age International Pvt. Ltd., New Delhi, 2/e, 2000.
2. De Garmo, P.E., "Engineering Economy", Printice Hall Inc., New Jersey, 10/e, 1997
3. Stoner, A.F., Freeman, E.R., Gilbert, D.R., Printice Hall Inc., New Jersey, 6/e, 1995

PK-393: COMPUTER APPLICATION LABORATORY

Application of software/tools related to Chemical/Refinery/Petrochemical processes.

SIXTH SEMESTER

PK-323: TRANSPORT PHENOMENA

UNIT 1 : General introduction to Transport Process. Equation of continuity and equation of change. Steady Flow of incompressible fluids in conduits and thin layers, Flow of falling film, flow between parallel plates, flow through circular pipes and annulus, adjacent flow of two immiscible fluids etc.
UNIT-2: Analysis of Thermal Transport Process: Fourier's law of Heat Conduction, steady one dimensional heat conduction without and with internal heat Source, Conduction through plane wall, hollow cylinder, composite walls and multilayer tubes, critical thickness of insulation.

UNIT-3: Analysis of Species Transport Processes: equation of continuity and change for multicomponent system. Definition of concentrations, velocities and fluxes in multi species system, Fick's Law of diffusion .the continuity equation for binary systems. Transport of species through stagnant and counter diffusing phase.
UNIT-4: Macroscopic Analysis of Momentum, Heat and Species transport Processes: Power requirement for pipe flows, Efflux time of tanks.Interphase Transport of Momentum, Heat and Species in turbulent flows : Definition of friction factor, heat transfer coefficient and Binary species transfer coefficients.

Text Book :

Bird, Steward and Lightfoot, *Transport phenomena*, 2nd Edition (2002) John Wiley and Sons, Inc.

Reference Books:

Welty, J.R, Wicks, C.E and Wilson, R.E, *Fundamentals of Momentum, Heat and Mass Transfer, 3rd* Edition, John Wiley and Sons.
Frank P. Incropera and David P. Dewitt , Fundamentals of Heat and Mass Transfer,4th Edition (2000), John Wiley and Sons.

Brodkey and Hershey, *Transport Phenomena --- A Unified Approach, Vol 2*, Parts II and III (2001),McGraw Hill.
Bodh Raj , Introduction to Transport Phenomena --- Momentum ,Heat and Mass transfer ,2012 PHI Learning Private Limited

PK-343: HEALTH, SAFETY AND ENVIRONMENT IN HC INDUSTRIES

Unit I: Introduction, Types of hazards, analysis of hazards, Major process hazards, Fire hazards, classification of fire, Grades of fire hazard, Fire analysis, fire fighting, Different types of fire alarms / detectors & extinguishers, sprinkler, fire fighting services

Unit II: Explosion Hazards in process Industries: Types of Explosions, Principles of Explosion-detonation and blast waves-explosion parameters-explosion prevention and protection

Unit III: General discussion on toxicology, Physiological effects of various compounds, Classification of hazardous chemicals / conditions, local and systemic and chronic effects temporary and cumulative effects, Occupational health & safety concepts.

Unit IV: Environmental pollution: Classification and properties of air pollutants-Pollution sources – automobile pollution, dispersion of pollutants, control of particulate and gaseous air pollutants. Water pollutants classification, different industrial effluents and their treatment and disposal – advanced water treatment.

BOOKS:

1. Mannan, S. (ed.), " Lees' Loss Prevention in Process Industries: Hazard Identification, Assessment and Control" Butterworth-Heinemann, 2004.
2. Sanders R.E. "Chemical Process Safety: Learning From Case Histories", Elsevier India Pvt. Ltd., 3/e, 2006.
3. Rao, C.S., "Environmental Pollution Engineering:, Wiley Eastern Limited, New Delhi, 1992.
4. Mahajan, S.P., "Pollution Control in Process Industries", Tata McGraw Hill Publishing Company, New Delhi, 1993.

PK-315N: NATURAL GAS PROCESSING

Unit I: Natural Gas-origin and occurrence, properties of natural gases, phase behavior of Natural Gas systems, vapor liquid equilibrium calculations.

Unit II: Natural gas- liquid separation, separation principles, separation equipment, low temperature separation.

Unit III: Water-hydrocarbon phase behaviour, measurement of water content in Natural gases, Hydrate formation and prevention of hydrates, Gas dehydration- types of processes.

Unit IV: Acid gases in natural gas, acid gas treatment, types of processes. Natural gas storage, Natural gas liquids removal, Transportation of Natural Gas, LNG chain.

BOOKS:

1. Kumar, S., "Gas Production Engineering", Gulf Publishing Company Book Division, London, 1960.
2. Mokhatab, S., William, A.P. and Speight, J.G., "Handbook of Natural Gas Transmission and Processing", Gulf Professional Publishing, Oxford, 2006.
3. Francis, S.M. and Thompson, R.E., "Oil Field Processing of Petroleum, Volume one: Natural Gas", Penn Well Books, Penn Well Publishing Company, Oklahoma, 1995.

PK-342: PETROCHEMICAL TECHNOLOGY - I

UNIT I: History and importance of Petrochemical industry, growth in India, Classification of Petrochemicals, Feedstock of the Petrochemicals, Preparation of feedstrock from ethane / propane and naphtha / gas oil cracking, syngas.

UNIT II: Petrochemicals from C1, C2, C3, C4, Syngas & aromatics.

UNIT III: Chemistry and technology for the production of Methanol formaldehyde, Ethylene oxide , glycol and Vinyl Chloride

UNIT IV: Chemistry and Technology for the Production of Acetone, Cumene, Acrylonitrile, Linear alkyl benzene etc

BOOKS:

1 Waddams, A.L., 'Chemicals from Petroleum', 4th edition, Gulf Publishing Company, London, 1980.
2 Lewis F. Hatch & S Matar, From Hydrocarbon to Petrochemicals
3 Chauvel and B. Lefebvre, Petrochemical Processes 1 & 2; Gulf Publishing Co. Houston,Texas, USA.
4 M. Gopala Rao and Marshall Sitting, Outlines of Chemical Technology, 3/e, Affiliated East –West Press Pvt. Ltd, New Delhi.

PK-341(DEPARTMENTAL ELECTIVE II)

PK-341A:HETEROGENEOUS REACTION ENGINEERING

Unit 1: Catalysts, selecting catalytic agents, properties and characteristics of industrial catalysts, preparation of catalysts, catalyst testing, Classification and Kinetics of Catalysis.

Unit II: Steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting steps design of reactors for non catalytic and catalytic reactions, gas-solid reactions. Heterogeneous Data Analysis for reactor design, catalyst deactivation.

Unit III: External Diffusion effects on Heterogeneous Reactions, Diffusion and Reaction in Porous Catalysts, Effectiveness factors

Unit IV: Reactor modeling with the RTD, zero parameter models, analysis of nonideal reactors, one parameter and two parameter models, testing a model and determining its parameters.

BOOKS:

1. Denbigh, K.G. and Turner, J.C.R., "Chemical Reactor Theory- An Introduction", ELBS Publishing House, Cambridge, 2/e, 1981.
2. Fogler, H. S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Private Limited, New Delhi, 3/e, 2005.
3. Smith, J.M., "Chemical Engineering Kinetics", McGraw Hill , New York, 3/e, 1981.
4. Holland, C.D., and Anthony, R.G., "Fundamentals of Chemical Reaction Engineering", Prentice Hall, New Jersey, 3/e, 1989.
5. LE Page, J.F., "Applied Heterogeneous Catalysis-Design. Manufacture and Use of solid Catalysts", Editions Technip..

PK-341B: CATALYSIS

Unit I: Introduction of catalysis, Properties & chrematistics of catalysis
Unit II: Preparation, testing and classification of catalysis.

Unit III: Heterogeneous catalysis: Active centers, adsorption phenomena, active, encumbers & electron notions.

Unit IV: Poisoning & Deactivation of Catalysis.

BOOKS:

1. Panchenkou, G.M. and Lebedev, V.P., "Chemical Kinetics & Calalysis, Mir Publishers, Moscov, 1976.
2. Viswananthan. B., Sivasankar and Ramaswamy, A.V. (ed.), "Catalysis – Principles and Applications", Narose Publishing House, New Delhi, 2002.
3. Thomas, J.W. and Thomas, W.U., "Introduction to the Principle of Heterogeneous Catalysis, Academic Press, 1967.

PK-341C: CHEMICAL REACTOR DESIGN

UNIT I: Behavior of Chemical Reactors: Ideal & Non-Ideal Flow; Classification of Reactors: Isothermal, Ideal batch, CSTR, PFR, Multiple Reactors, Non-isothermal Reactors, Multiplicity, Non-ideal reactors, Fluid Solid Non-Catalytic reactions, Fluidized Beds.

UNIT II: Introduction to Reactor Design; Detailed Design of Batch Reactors.

UNIT III: Flow Reactors; Detailed Design for CSTR; CSTR Design; Single CSTR Battery; CSTR at Differential Temperature etc.

UNIT IV: Detailed Design for Plug Flow Reactor: Single; Series And Parallel; Mixed Reactor (Combination); Reactor stability, Design aspects for Non-ideal Reactors.

BOOKS:

1. Octave Levenspiel, "Chemical Reaction Engineering", 3rd Edition, John Wiley &Sons (Asia) Pte Ltd. (1998), ISBN: 978-0-471-25424-9.

2. H. Scott Fogler, "Elements of Chemical Reaction Engineering" 3rd Edition November, Prentice Hall of India Pvt Ltd (1998).

3. L. D. Schmidt, "The Engineering of Chemical Reactions", Oxford Press (1998).

4.J.M. Smith, "Chemical Engineering Kinetics", 2nd, McGraw-Hill (1981).

CH – 393: UNIT OPERATION LAB II EXPERIMENTS

1. Study of film and drop wise condensation.
2. To determine experimentally the overall heat transfer coefficient at various cold water flow rate and estimate film heat transfer coefficient on the shell side
3. To study the boiling heat transfer phenomena for pool boiling of methylene chloride
4. To determine surface heat transfer coefficient for heated vertical cylinder in natural convection
5. To study convective heat transfer coefficient in an open pan evaporator under laminar and turbulent flow conditions. etc

PK – 394: REACTION ENGINEERING LABORATORY

Experiments related to reaction engineering such as Residence Time Distribution studies in CSTR, Studies of Plug Flow Reactor, etc.

PK- 395: PROCESS EQUIPMENT DESIGN

Flow sheet, Symbols of pipe fittings, valves and process equipment, Sketching and drawing of process equipment, General format of a design report. Process and Mechanical Design of Equipment used in Hydrocarbon Industries, design problems such as fluid transportation, storage, heat and mass transfer equipment. Preparation of process design data sheet.

SEVENTH SEMESTER

PK - 411: PROCESS DYNAMICS AND CONTROL

Unit I: Process Control systems, Basic Concepts in Process Control., Process variables, control configurations & physical elements of a control System, Block diagrams, Dynamic Modeling of processes, Linearization of Non-linear systems,

Unit II: Response of first order system, Response of first order system in series (Interacting and non-interacting systems) , Second order system, Dynamic Response of second order system Transportation

Unit III: Closed loop transfer functions, Modes of control action, Classification of Controllers, Transient response of some simple control systems. Stability analysis of control systems, Root locus Method, Controller Tuning, Frequency response analysis, Bode diagrams, control system design by frequency response, Bode stability criterion, Nyquist plots.

Unit IV: Introduction to Advance Control Systems, Control systems with multiple loops, feed forward and Ratio Control systems. Process Control using Digital Computers, Reconstruction of continuous signals from their discrete-time values, conversion of continuous to discrete time models, Z-transforms.

BOOKS:

1. Coughanowr**,** D. R., "Process Systems Analysis and Control", McGraw Hill, New York, 1991.
2. Stephanopoulos G., "Chemical Process Control", Prentice Hall of India, 1991.
3. Weber, T.W., "An Introduction to Process Dynamics & Control", John Wiley & Sons, New York, 1976.
4. Bequette, B.W., "Process Control-Modeling, Design and Simulation", Prentice Hall of India Pvt. Limited, New Delhi, 2003.
5. Luyben, W.L., "Process Modelling Simulation and Control for Chemical Engineers, McGraw Hill, New York, 2/e, 1990.
6. Seborg, D.E., Edgar, T.E. and Mellichamp, D.A., "Process Dynamics and Control", Wiley New York ,1989.
7. Luyben, M.L. & Luyben, W. L., "Essentials of Process Control", McGraw Hill, New York, 1997.
8. Palm, W.J., "Modelling, Analysis and Control of Dynamic Systems", John Wiley and Sons, New York, 1983.

PK 432: PETROCHEMICAL TECHNOLOGY II

UNIT I: Chemistry and technology for the production of Phenol, Maleic anhydride, Phthalic anhydride, styrene etc.

UNIT II: Chemistry and technology for the production of DMT, Terephalic acid, Acrylic acid, Methyl methacrylate etc

UNIT III: Properties, applications and production technologies of the following commodity polymers – polyethylene, LLDPE, HDPE, polypropylene, polystyrene, PVC.

UNIT IV: Properties, applications and production technologies of the following engineering and thermoset polymers: ABS plastic, nylon-6, polycarbonate, epoxy resin, unsaturated polyester resin, rubber.

BOOKS:

1 Waddams, A.L., 'Chemicals from Petroleum', 4th edition, Gulf Publishing Company, London, 1980.
2 Lewis F. Hatch & S Matar, From Hydrocarbon to Petrochemicals
3 B.K. Bhaskara Rao, A Text on Petrochemicals, 2/e, Khanna Publishers, Delhi, 1998.
4 Mall, I.D., "Petrochemical Process Technology", Macmillan India Limited, Delhi, 2007.
5 F.A. Lowenheim and M. K. Moran; Industrial Chemicals, John Wiley & Son Inc.,USA.

PK 431: PLANT DESIGN AND ECONOMICS

UNIT I: Introduction, Process Design development, General design considerations, Cost and asset accounting, Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment.

Unit-II: Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing, Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

Unit-III: Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self insurance, Depreciation: types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

Unit-IV: Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period ,alternative investments, analysis with small investments, increments and replacements.

BOOKS

1. Max S. Peters, Klaus D. Timmerhaus and Ronal E. West, Plant Design and Economics for Chemical Engineers, 5th ed. (2002), McGraw-Hill, New York.

PK-433: POLYMER SCIENCE AND TECHNOLOGY

Unit I: Classification of polymers, , Linear branched and cross – linked polymers, Molecular weights of polymers, Polydispersity and Mol. Wt. distribution in polymers, Random, alternate, block and graft co – polymers, polymer characterization techniques,polymer degradation.

Unit II: Kinetics of chain & Step polymerization, techniques of molecular weight control, Initiators, Chain transfer agents, Inhibitors. Techniques of polymerization Bulk, Solution, Suspension & Emulsion polymerization.

Unit III: Introduction to polymer rheology, Newtons law of viscosity, viscometris plots, rheometers, rheological models, theory of viscoelasticity, Tg, Heat distortion temperature.

Unit IV: Basic concept of polymer processing: Compounding methods, Extrusion molding, Injection molding, Blow molding, Rotational molding. Introduction to fiber reinforced plastics.

BOOKS:

1. Gowariker, V.R., Viswanathan, N.V. and Sreedhar, J., "Polymer Science", New Age International (P) Ltd, New Delhi, 1986.
2. Odian, G., "Principles of Polymerization", John Wiley & Sons Inc, New York, 1991.
3. Tager, A., "Physical Chemistry of Polymers", Mir Publishers, Moscow, 1978.
4. Perepechko, I.I., "An Introduction to Polymer Physics", Mir Publishers, Moscow, 1981.
5. Billmeyer, F. W. "Textbook of Polymer Science", John Wiley & Sons, New York, 1984.
6. Kumar, A., "Fundamentals of Polymer Engineering", 2/e, Marcel Dekker, New York, 2003.

PK-493A: PROJECT

Techno-economic feasibility analysis, presentation and report.

PK-481: SEMINAR

Effective technical and professional communication that develops skills in Oral presentations, proposal writing, technical report writing, document design and basic research techniques through online and library sources. Read, write and evaluate a number of short reports, including mechanism and product descriptions, instructions, abstracts and summaries, project proposals, and progress reports. Business Communications: principles of effective business writing, writing business letters and memos, resume preparation and job search techniques; understand the principles of communication theories and the application of those theories in a variety of settings. Technical Writing; Technical Communication; Deliver an oral presentation of the findings.

Books :

1. Business correspondence and Report writing by R. C. Sharma and Krishnamohan, Tata McGrawHill2.
2. Communication skills by B. V. Pathak, Nirali Publications.

EIGHTH SEMESTER

PK-422N: PROCESS UTILITIES AND ENERGY MANAGEMENT IN HC INDUSTRY

Unit-I: Process utilities electricity, air, fuel oil, refrigerant. Classification and application of refrigerant. Classification, specification and application of fuel oils. Handling and preparation of fuel oil. Burner operation and maintenance.

Unit-II: Sources uses, impurities & treatment methods for water, refinery water system. Efficient generation and utilization of steam. High pressure, low pressure and exhaust steams, Steam traps.

Unit-III: Energy Management approach, Energy Audit, Energy conservation in major equipment used in refining, petrochemical and fertilizer industries like furnace, boilers, pumps, heat exchangers, distillation and extraction columns. Introduction to pinch technology.

Unit-IV: Energy conservation equipment like waste heat boiler, recuperator, regenerator, heat pipe, heat pump, direct contact heat exchanger, economizer, fluidized bed boiler, continuous furnaces.

BOOKS
:

1. Rajan, G. G., "Optimizing Energy Efficiencies in Industry", Tata McGraw Hill Publishing Company,
New Delhi, 2000.
2. PCRA's Thermal Booklet Series, Petroleum Conservation Research Association, Sanrakshan
Bhawan, New Delhi
3. Sinnot, R.K. " Coulson and Richardson's Chemical Engineering, Volume 6 – Chemical Process
Design", Elsevier, New Delhi, 4/e, 2008.
4. O'Callaghan, P.W., "Energy Management", McGraw Hill Company, 1993.

PK-441(DEPARTMENTAL ELECTIVE III)

PK-441A:PROCESS INSTRUMENTATION

Unit I: Introduction to process control and instrumentation. Dynamic and static characteristics of instruments, Sensors for pressure, temperature, flow, level, humidity, viscosity, pH, density etc.

Unit II: Pressure regulators, safety valves, level regulators, flow control valves such as globe valve, butterfly valve etc. pneumatic and electrical actuation of control valve.

Unit III: Instrument and process equipment symbols, process flow diagram, process instrumentation diagram, development of P&ID for process industry.

Unit IV: Introduction to PLC based instrumentation, Distributed Control System (DCS) system, and Supervisory Control and Data Acquisition (SCADA).

BOOKS:

1. William C. D., "Fundamental of Industrial Instrumentation and Process Control", McGraw-Hill, New York, 2005.
2. Eckman, D.P., "Industrial Instrumentation", CBS Publishers, New Delhi, 2004.
3. Nakra, B.C., Chaudhury, K.K., "Instrumentation Measurements and Analysis", Tata McGraw-Hill, 1985.
4. Barney, G.C., "Intelligent Instrumentation", Prentice Hall of India Pvt. Ltd., New Delhi, 1992.

PK-441B:PIPING AND INSTRUMENTATION

UNIT I Types of flow sheets, Flow sheet Presentation, Flow Sheet Symbols, Process flow diagram- Synthesis of steady state flow sheet - Flow sheeting software.

UNIT II P & I D objectives, guide rules, Symbols, Line numbering, Line schedule, P & I D development, typical stages of P & I D. P & I D for rotating equipment and static pressure vessels, Process vessels, absorber, evaporator.

UNIT III Control System for Heater, Heat exchangers, reactors, dryers, Distillation column, Expander.

UNIT IV Applications of P & I D in design stage - Construction stage - Commissioning stage - Operating stage - Revamping stage - Applications of P & I D in HAZOPS and Risk analysis.

BOOKS:

1. Ernest E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Vol.-I Gulf Publishing Company, Houston, 1989.
2. Max. S. Peters and K.D.Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw Hill, Inc., New York, 1991.
3. Anil Kumar,"Chemical Process Synthesis and Engineering Design", Tata McGraw Hill publishing Company Limited, New Delhi - 1981.
4. A.N. Westerberg, et al., "Process Flowsheeting", Cambridge University Press, 1979

PK-441C: INSTRUMENTATION ENGINEERING

UNIT I: Measurements and measurement systems: what is measurement measuring instruments measurementsystems functional elements and block diagram of a measurement system. Classification of measuringinstruments standards calibration of measuring instruments.

UNIT II : :Static characteristics specifications of instrument static characteristic s order of the instrument systemstandard test signals. Transfer function of a measurement system.

UNIT III: Types of errors sources of errors methods of elimination or reduction Statistical analysis of errors selectionsof the instrument.Data presentation systems analog and digital indicators recorders self balancing or servo recordersmagnetic tape & disc storage systems date acquisition systems.

UNIT IV: :Introduction control terinalogy open and closed loop control basic elements of open and closed loop controlsystems types of control actions.Metrology: standardization and standardizing organizations international systems of units. Toleranceslimits of size linear measurements – calipers – pitch screw gauge – feeler gauges – vernier instruments –dial gauges angular measurements – vernier and optical level potracters – angle gauges – angle deccer –spirit level.

BOOKS:

1. Patranabis D – Principles of Industrial Instrumentation, TMH publication, N. Delhi, 1976.
2. Liptak B.G (Ed) – Instrument Engineers' Handbook, Vol I and II and supplement I and II, Chilton Book Co., Philadelphia, 1972.
3. Jones E B – Instrument Technology, Vol. II, Analysis Instruments, Butterworths Scientific Publication, London

. **PK-442(DEPARTMENTAL ELECTIVE-**

IV) PK-442A:FERTILIZER TECHNOLOGY

Unit I: Macro- and micro nutrients, fertilizer Grades, Various fertilizers and their demand and production in India, Biofertilizers, case studies.

Unit II: Nitrogenous fertilizers , Nitrogen , Hydrogen , Nitric Acid ,Ammonia Synthesis , Urea , Sulphuric Acid**,** Ammonium Sulphate, Ammonium Nitrate , Calcium Ammonium Nitrate.

Unit III: Phosphatic fertilizers, phosphoric acid,, super phosphate , Triple super phosphate, Mono and diammonium phosphate , Nitro phosphate ,

Unit IV: Potassic fertilizers, Mixed Fertilizers, secondary nutrient fertilizers

BOOKS:

1. Slack, A.V. and James, G.R., "Fertilizers Science and Technology Series", Marcel Dekker Inc. New York, 1983.
2. Rao, M.G. and Marshall Sittig, "Out lines of Chemical Technology", East-West Press, 1996.
3. Pandey G.N. and Shukla, B.D. "A Text Book of Chemical Technology, Vol I, Vikas. Publishing House, New Delhi.

PK-442B:COAL AND GAS CONVERSION TECHNOLOGY

UNIT I Origin and Classification of Coal, Characterization and Industrial uses, Carbonization Processes, Chemicals from coal.

UNIT II Theory of Gasification reaction, Industrial Gasification of Coal with oxygen and steam.

UNIT III Important Petrochemicals derived from Natural Gas /Methane syngas,

UNIT IV Conversion of Syngas to liquid fuels- Gasoline, Diesel, Olefins, DME, Oxo-alcohols, mixed alcohols, Polymethylene.

BOOKS

1. F.A Lowenheim and M.KMoran; Industrial Chemicals, John Wiley & Sons Ins. USA.
2. Considine, D.M., Energy Technology HandBook, McGraw Hill Book Company, New York.
3. Sarkar S., Fuels and Combustion, Second Edition, Orient Longman Ltd, Kamani Marg, Ballard Estate, Mumbai-400001
4. Chemical Process Industries, R.N. Shreve and J.A. Brink, Jr. McGraw Hill Book Company, New York.

PK-442C:SELECTED TOPICS IN REFINING & PETROCHEMICALS

UNIT I: Transportation and storage of crude oil and petroleum products, Types of tanks, Pressure vessels and underground storage.

UNIT II: Sweetening processes, hydrogen sulphide removal, Sulfur conversion processes, Solvent Deasphalting, Gasification

UNIT III: Ammonia, Nitric Acid, Ammonium Nitrate, Urea.

UNIT IV: Phosphatic fertilizers, super phosphate, Triple super phosphate, Mono and diammonium phosphate, Nitro phosphate, Mixed Fertilizers.

BOOKS:

1. Speight, J.G., "The Chemistry & Technology of Petroleum", CRC Press, New York, 4/e, 2007.
2. Speight, J.G. and Ozum, B. "Petroleum Refining Processes", Marcel Dekker Inc, New York, 2002.
3. Gary, J.H. and Handiwerk, G.E., "Petroleum Refining Technology and Economics", Marcel Dekker, Inc., New York, 2001.
4. Hobson, G.D., "Modern Petroleum Technology" Vol I & II, John Wiley & Sons, New York, 5/e, 1984
5. Chauvel, A. and Lefebvre, G., "Petrochemical Processes", Gulf Publishing Company, Houston, 1989.
6. Matar, S., "Chemistry of Petrochemical Processes", Gulf Publishing Company, Houston, 2/e, 2000
7. Waddams, A.L., "Chemicals from Petroleum", Gulf Publishing Company, London, 4/e, 1980.
8. Mall, I.D., "Petrochemical Process Technology", Macmillan India Limited, Delhi, 2007.
9. Meyers, R.A. (ed.), "Handbook of Petrochemicals Production Processes", McGraw Hill, New York, 2005.

PK-493B:
PROJECT

Techno-economic feasibility analysis, presentation and report.

PK – 494: INSTRUMENTATION AND PROCESS CONTROL LABORATORY

Experiments related to Process instrumentation and control.

PK-495: POLYMER LABORATORY

Experiments related to polymer Science and Technology.

PK-443(OPEN ELECTIVES

PK-443J: POLYMER STRUCTURE PROPERTY RELATIONSHIP

UNIT I Linear, branched, cross linked and other polymer structures, Homochain and heterochain polymers, random, alternate, block and graft copolymers. Pressure volume temperature (PVT) relationship. Prediction of polymer properties.

UNIT II Mechanical and Rheological properties - Stress-strain relationship in polymer. Introduction to modulus, tensile strength, yield strength, percentage elongation, toughness, creep, fatigue and stress relaxation. Effect of additives on mechanical properties of polymers. Flow Behaviour of non – Newtonian fluids. Rheological models like power law, truncated power law, Bird – Carreau model etc. Effect of structure on viscometeric plot (shear rate vs. true viscosity). Introduction to Rheometers.

UNIT III Thermal and Chemical Properties – Transition temperature in polymers, glass transition (Tg), melt transition (Tm), relationship between Tg and Tm. Heat Deflection Temperature (HDT) and its significance. Thermal characterization techniques like DSC, TGA, etc. Effect of polymer structure on thermal properties of polymer. Cohesive energy, cohesive energy density, solubility parameter, Prediction of solubility parameter -Effect of polymer structure on solubility of polymer. Influence of structure in prediction of flame retardancy, water repellency.

UNIT IV Electrical properties - Effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor - effect of frequency of voltage and temperature on dielectric properties. Effect of additives on electrical properties of polymers

BOOKS:

1. Norbert M. Bikales, “Mechanical Properties of Polymers” Encyclopedia Reprints, Wiley Interscience, New York , ISBN: 0-471-07234-6.
2. Johan J. Aklonis, William J. Macknights, M. Shen, “Introduction to Polymer Viscoelasticity” Wiley Interscience, New York , ISBN: 0-471-01860-0.
3. W. Van Krevelen And P.J. Hoftyzen, "Properties Of Polymer , 3rd Edition Elsevier Scientific PublishingCompany Amsterdam - Oxford - Newyork. 1990.
4. D.A. Seanor, ed., Electrical properties of polymers, Acadamic press, Newyork, 1982.

PK-443E:BIO PROCESS ENGINEERING

Unit I: Introduction to Bioprocesses, outline of an integrated bioprocess and the various (upstream and down stream) unit operations involved in bioprocesses, generalized process flow sheets

Unit II: Fermentation Processes and Microbial growth ;General requirements of fermentation processes, Basic design and construction of fermentor and ancillaries, solid-substrate, slurry fermentation and its applications, behaviour of microbes in different reactors (air lift, fluidized, batch, continuous fed batch condition)

Unit III: Bioreactors;Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; Immobilized cells; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Culture-specific design aspects: plant/mammalian cell culture reactors.

Unit IV: Bioseparations andindsstrial processes;Biomass removal; Biomass disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography

BOOKS:

1. Biochemical Engineering Fundamentals Bailey and Ollis, McGraw Hill (2nd Ed.), 1986.
2. Bioprocess Engineering, Shule and Kargi, Prentice Hall, 1992.
3. Stanbury, P. F., Whitaker, A., & Hall, S. J., (1998), Principles of fermentation

PK-443F: MODELLING AND SIMULATION

Unit I: Fundamentals of Modelling, classification of models, determination of the process model, typical mathematical forms of models, component balance, energy balance, equation of motion and transport equations.

Unit II: Process models examples of importance, modeling of Reactors, Distillation columns, furnaces, heat exchangers etc. Linearization of non-linear models.

Unit III: Simulation of systems: Scope of process simulator, flowsheeting and specification problem, optimization problem, synthesis problem, steps for steady state simulation, flowsheeting decomposition and equation ordering.

Unit IV: Simulation strategies, process simulator Process simulation with software's, Integrated computer aided design,

BOOKS:

1. W. F. Ramivez, computational Methods for Process Simulation, 2nd ed., Butter worth's 1997.
2. K.M. Hangos & I.T. Cameras, Process Modulating & Model Analysis, Academic Process, 2009.
3. Process Modelling and Simulation, R.W.Gaikwad and Dhirendra, Central Techno Publications, Nagpur, First Edition, 2003.
4. Bird, R-P, Stewart, W.E, and light foot, E.N., Transport Pheromona, John Wiley & Sons, 1994.
5. Westerberg. A.W., etal, Process flow sheeting, canbridge university Process, 1990,

PK-443M:WASTE MANAGEMENT TECHNOLOGY

Unit I: Sources, Classification and Composition of solid, liquid and gaseous wastes Hazardous and non- hazardous wastes, special waste materials

Unit II: Waste Collection, Storage and Transport, Waste Disposal, Waste Processing Techniques.

Unit III: Management of wastes, minimization, reuse and recycling Waste utilization and materials recovery.

Unit IV: Treatment of wastes; biological treatment, composting, anaerobic digestion, combustion, incineration

BOOKS:

1. Peavy, H.S., Rowe, D.R., and Techbanoglous, G., "Environmental Engineering", McGraw Hill Books Company, 1985.
2. Corbitt, R.A., "Standard Handbook of Environmental Engineering"; McGraw Hill, New York, 1989.
3. Martin, M. (ed), "Bio-conservation of Waste Materials to Industrial Products"; Elsevier, Amsterdam, 1991.

4. Kharbanda, O.P. and Stellworthy, E.A., "Waste Management-Towards a Sustainable Society", Gower Pub. Company, 1990.

5. Mortensen, E., "Introduction to Solid Waste", Lecture Notes to Graduate Diploma in Environmental Engineering, University College, Ireland, 1990-1993.

6. Zirm, K.L., "The Management of Hazardous Substances in the Environment", Routledge, New York, 1990.
7. Somasekhar, R.K. and Mariyengar (ed.), "Solid Waste Management- Current Status and Stratagies for Future", Allied Publishers, Mumbai, 2002.

PK-443N: POLLUTION CONTROL EQUIPMENT DESIGN

UNIT I: Introduction to air quality standards, effects of air pollution at regional and global scales, industrial air pollution sources, air quality parameters.

UNIT II: Introduction to water quality standards, effects of air pollution at regional and global scales, industrial water pollution sources, water quality parameters.

UNIT III: Design of selected gaseous and particulate pollutants control equipment such as Cyclones, Wet Scrubbers, Electrostatic Precipitators, incinerators, etc. Control of motor vehicle emissions, noise pollution and control.

UNIT IV: Classification of wastewater treatment processes, Design of selected wastewater treatment equipment such as settling tank, trickling bed filter, etc.

BOOKS:

1. Nicholas, P.C. "Handbook of Air Pollution Prevention and Control", Butterworth Heineman, N&P limited 2002.
2. Schiftner, K.C., "Air Pollution Control Equipment Selection Guide", Lewis Press, New York, 2002.
3. Peavy, H. S., Rowe, D.R., Tchobanoglous, G., "Environmental Engineering", McGraw Hill.
4. Louis T., "Air Pollution Control Equipment Calculations", John Wiley and Sons, New Jersey, 2008

PK-443O: PROCESS EQUIPMENT AND PIPING DESIGN

Unit I: Classification, selection, design and specification of selected process equipment like drums and tanks, mixers and agitators, etc.

Unit II: Introduction to pressure vessel design, elementary idea of theories of failure of vessel under pressure, introduction to national and international design codes and their scopes, Design of cylindrical and spherical shells, design of storage tanks.

Unit III: Introduction to high pressure vessel design, design of tall vertical vessels. Selection and design of flanges and support for vessels and piping, selection and design of heads and closures.

Unit IV: Piping design, classification of pipes and tubes, important fittings and valves and their uses, color codes for pipelines, selection of optimum pipe size, schedule number, piping layout.

BOOKS:

1. Joshi, M.V. and Mahajani, V.V.; Process Equipment Design, , MacMillan India Ltd, New Delhi, 3/e, 1996
2. Sinnot, R. K., "Coulson and Richardson's Chemical Engineering, Volume 6 – Chemical Process Design", Elsevier, New Delhi, 2008.
3. Brownell, L.L. and Young, E.H., "Process Equipment Design: Vessel Design", John Wiley and Sons, New Delhi,

4. Bhattacharya, B.C., "Introduction to Chemical Equipment Design – Mechanical Aspect", CBS Publishers, New Delhi, 2009.
5. IS 2825 – 1969, code for unfired pressure vessels, Indian Standards Institution, New Delhi.

PK-443P: PROCESS DESIGN AND INTEGRATION

Unit I: Background Concepts: Hierarchy of process design and integration, Onion Model, approaches to process design and integration. Role of process economics, capital costs for new design and retrofits, operating costs, criteria for economic evaluation.

Unit II: Reaction Process Design: Choice of reactors, reactor conditions, reactor configuration.

Unit III: Separation Process Design: choice of separation technology, operating conditions and configurations.
Reaction, Separation and Recycle systems for Batch and continuous process.

Unit IV: Heat Exchanger Networks: Basic elements of Pinch Technology – Grid diagram, composite curves, problem table algorithm. Targeting of Heat Exchange Networks, HEN Design.

BOOKS:

1. Smith, R. "Chemical Process: Design and Integration", John Wiley and Sons, 2005.
2. Kemp I. C., "Pinch Analysis and Process Integration: A user Guide on Process Integration for the Efficient Use of Energy", Butterworth-Heinemann, 2/e, 2007
3. El Halwagi M. M., "Process Integration", Academic Press, 7/e, 2006.

PK-443Q-REFINERY EQUIPMENT DESIGN

Unit I: ASTM, TBP EFV distillation curves, average boiling points, thermo-physical properties of hydrocarbon, Review of refinery operations

Unit II: Separation criteria in crude oil, atmospheric distillation column: refluxes, over flash; Energy and material balance calculations, estimation of top, side, bottom draw tray temperatures, topping tower design procedure.

Unit III: Vacuum atmosphere tower, type of operations, economic consideration, flash zone & tower base calculations, flash zone pressure, steam requirements, heat & material balance calculation

Unit IV: Types of pipe still heaters, thermal efficiency and component of furnaces, calculations of radiant absorption rates, Wilson lobo Hotel equations, lobo Evans method pipe still design.

BOOKS
:

1. Watkins, R.N., "Petroleum Refinery Distillation", Gulf Publishing Company, Houstan, 2/e, 1981.
2. Rao, B.K.B., "Modern Petroleum Refining Processes", Oxford & IBH Co. Pvt. Ltd., New Delhi, 4/e, 2002,
3. Edmister, W. C., "Applied Hydrocarbon Thermodynamics", Gulf Publishing Company, Houstan, 2/e, 1988.
4. Trambouze, P., "Petroleum Refining - Material and Equipment" Part 4, Editions Technip, Paris, 2000.

PK-443H: FUNDAMENTAL OF PETROLEUM ENGINEERING

UNIT I: Global/Indian petroleum and petrochemical industry. Origin and occurrence of oil & gas. Migration and accumulation of oil and gas. Source, reservoir and cap rocks, Petroleum Traps, physical properties of oil bearing rocks.

UNIT II: Oil & gas exploration methods, direct oil finding methods, geological and geophysical methods.

UNIT III: Introduction to drilling operations, drilling equipment – drilling rigs and drill string, drilling fluids and mud testing, mud circulation and treating equipment, etc.

UNIT IV : Production principles, types of reservoir drives, primary oil recovery, secondary oil recovery, enhanced oil recovery methods.

BOOKS:

1. Dawe, R.A. (ed.), "Modern Petroleum Technology", Volume 1, John Wiley & Sons Limited, New York, 6/e, 2000
2. Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, Penn Well Corporation, Oklahoma, USA, 2/e, 2001
3. Mian, M.A., "Petroleum Processing Handbook for Practicing Engineer", Penn Well Corporation, Oklahoma, USA, 1992
4. Deshpande, B.G., "The world of Petroleum", Wiley Eastern Industry

PK-443R: FUNDAMENTALS OF PETROLEUM PROSPECTING

UNIT-I: Introduction, Historical Review, Prospecting for oil, seismic reflection method, seismic waves & seismic pulses,

UNIT-II: The composition of reflection, seismic noise, data acquisition & data processing, Interpretation of seismic sections,

UNIT-III: Direct indication of petroleum, earths magnetic field, air borne instruments, production of magnetic maps & interpretation, filtering methods.

UNIT-IV: Gravity meters, Gravity reductions, Rock densities & interpretation, well logging, Bore hole conditions, Resistivity logs, Radioactivity logs, and other logs.

BOOKS:

1. Dawe, R.A. (ed.), "Modern Petroleum Technology", Volume 1, John Wiley & Sons Limited, New York, 6/e, 2000
2. Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, Penn Well Corporation, Oklahoma, USA, 2/e, 2001
3. The Petroleum Industry-A Nontechnical Guide, Charles F. Conaway, Penn Well Corporation, Oklahoma, USA.
4. Production of Oil & Gas, F. Abdulin , Mir Publishers, Moscow
5. Mian, M.A., "Petroleum Processing Handbook for Practicing Engineer", Penn Well Corporation, Oklahoma, USA, 1992
6. The world of Petroleum , B.G, Despande , Wiley Eastern Industry

PK-443S: OIL RECOVERY TECHNIQUES

Unit-I: Recovery of Hydrocarbons, exploration, drilling, well completion, well Products & product quality.

Unit-II: Primary Recovery (Natural Methods): Dissolved gas drive, gas cap drive, water drive gravity drive & general considerations.

Unit-III: Secondary Recovery Methods: Influence of Interfacial tension, oil recovery using gas or water injection, etc.

Unit-IV: Enhanced oil Recovery methods (Tertiary Methods): Effect of Research Heterogeneity type on oil recovery, Chemical Methods, Miscible Methods, Thermal Methods, Mining Methods, Microbial Enhanced Oil Recovery, etc.

BOOKS:

1. Dawe, R.A. (ed.), "Modern Petroleum Technology", Volume 1, John Wiley & Sons Limited, New York, 6/e, 2000
2. Speight, J.C.; "The Chemistry and Technology of Petroleum", Marcel Dekkar, New York, 3/e1999.
3. . Hobson, G.D, Pohl, W., Modern Petroleum Technology (Part I &II), John Wiley & Sons, N.Y., 1986.
4. Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, Penn Well Corporation, Oklahoma, USA., 2/e, 2001
5. The Petroleum Industry-A Nontechnical Guide, Charles F. Conaway, Penn Well Corporation, Oklahoma, USA.
6. Production of Oil & Gas, F. Abdulin , Mir Publishers, Moscow
7. Mian, M.A., "Petroleum Processing Handbook for Practicing Engineer", Penn Well Corporation, Oklahoma, USA, 1992
8. The world of Petroleum , B.G, Despande , Wiley Eastern Industry

NOTE:The Syllabi of the Courses PK-214, PK-211, PK-213, PK-215, PK – 221, PK-223, CH – 292, PK-313, PK- 312, PK-391, PK-323, CH – 393, PK – 411, PK 412and PK-492 will be either as written or same as similar course offered by Department of Chemical Engineering AMU Aligarh.

Course Title — Basic Principles of Chemical Engineering

Course Number:	**PKC2010 / CH2010**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Contact Hours (L-T-P)	**03-1-0**
Type of Course:	**Theory**
Semester	**3**

Course Objective

To enable the students to learn the basic principles of chemical Engineering and their application in writing the mass and energy balance balances to solve the chemical engineering problems.

Syllabus

Unit 1. Units and dimensions, Process Variables, Applications of thermodynamics and Chemical Principles in estimation of physical properties of single multi-phase system. Stoichiometry.

Unit 2. Material Balance on single and multiple unit processes, Recycle, bypass, Balance on reactive systems.

Unit 3. Fundamentals of Energy Balance, Introduction, Mechanical energy balance, Balance on reactive and non-reactive processes.

Unit 4. Combined material and energy balance: Psychometric, Materials and energy balance on transient processes, industrial applications, Material and Energy Balance on Process Flow sheet.

Text Book(s)/ Reference Book(s)

- Felder, R.M. and R.W. Rousseau, Elementary Principles of Chemical Processes, 3/e Wiley Singapore, 2000.
- Himmelblau, D.M., Basic Principles and Calculations in Chemical Engineering, 6/e, Prentice Hall of India, New Delhi, 1996.
- Bhatt, B.I. and S.M. Vohra, Stoichiometry, 4/e Tata McGraw Hill, New Delhi, 2004
- Narayanan, K.V. and B. Lakshmikutty Stoichiometry and Process Calculations, Prentice hall of India, 2006.
- Sharifa Begum. Process Calculations. Prentice hall of India.

Course Title — Chemistry of Hydrocarbons

Course Number:	**PKC2030**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Contact Hours (L-T-P)	**03-01--**
Type of Course:	**Theory**
Semester	**3**

Syllabus

Unit 1. Origin and formation of Petroleum, Reserves and deposits, Indian Petroleum Industry, Composition of crude Oils, ultimate and chemical composition , non-hydrocarbons in petroleum, Asphltenes and Resins, classification of petroleum, evaluation of crude oil, Bench mark crudes.

Unit 2. Characterization of crude oils : TBP and ASTM distillation, Classification by chemical composition, Correlation Index, Density, API gravity, Viscosity, UOP characterization factor, etc. Physical & Thermal properties of petroleum, ASTM, TBP, EFV distillation curves.

Unit 3. Distillation: Pretreatment, Electric desalting, atmospheric and vacuum distillation, petroleum products and their quality control tests.

Unit 4. Value addition of petrochemicals from feedstock to consumer end products, chemical reactions of hydrocarbons like Decomposition (Thermal & Catalytic), Halogenations, Isomerization, Hydrogenation, Alkylation, Nitration, Sulfonation, etc. with chemistry and reaction mechanism.

Course Outcomes

1. To understand the chemistry, characteristics and evaluation of crude oils.
2. To understand the crude oil fractionation processes (Atmospheric and Vacuum distillation), different petro products and physical and thermal properties.
3. Ability to understand quality control tests on crude and products and be able to analyze the results.
4. Ability to understand Petrochemicals classification and the basic reactions for the production of different petrochemicals.

Text Book(s)/ Reference Book(s)

- Rao, B.K.B., "Modern Petroleum Refining Processes", Oxford & IBH Co. Pvt. Ltd., New Delhi, 4/e, 2002,
- Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000

- Speight, J.C.; "The Chemistry and Technology of Petroleum", Marcel Dekker, New York, 3/e1999.
- Lucas, A.G. (ed.), "Modern Petroleum Technology", Vol. 2, Downstream, John Wiley & Sons Limited, New York, 6/e, 2000
- Simanzhenkov, V. and Idem, R., "Crude oil Chemistry", Marcel Dekker Inc., New York, 2003.

- Hobson, G.D., "Modern Petroleum Technology" Vol I & II, John Wiley & Sons, New York, 5/e, 1984.
- Rao, B.K.B., "Petrochemicals", Khanna pubs. New Delhi.
- Sukumar Maiti , Introduction to petrochemicals , Oxford and IBH pubs co. New Delhi.

PKC2030: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a	X	X				
b	X			X		
c		X	X			
d		X	X	X		
e				X		
f	X		X			
g						
h						
i						
j						
k			X	X		
l						

Course Title — Fluid Mechanics

Course Number:	**PKC2050 / CHC2030**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Contact Hours (L-T-P)	**3-1-0**
Type of Course:	**Theory**
Semester	**3**

Course Objective

To introduce our students to the basic concepts and laws of Fluid Mechanics and their application. This course mainly deals with basic fluid flow phenomena, problem associated with metering and transportation of industrial fluids.

Syllabus

Unit 1. Continuum concept of matter, Classification of matter based on deformation. The two axioms of Rheology, Fluid and its properties, Newton's law of viscosity, Classification of fluids. Fluid statics: Hydrostatic law, hydrostatic force and buoyancy on submerged on submerged bodies, piezometric head manometer.

Unit 2. Study of fluid motion: Velocity field streamlines, path lines and Streakline. Eulerian and Lagrangin approaches to the study of fluid motion, Bernoulli's Theorem, Continuity equation Navier-Stokes equation, Concept of stream function irrotational flow, potential flow, Laminar and turbulent flow, boundary layer concept, Drag and boundary layer separation.

Unit 3. Dimensional analysis and Similitude: dimensional analysis, dimensionless groups and their physical significance, Buckingham's pitheorem, Rayleigh's method, Similitude study, principle of geometric, kinematics, dynamics and similarity.

Unit 4. Fluid Flow Operations: pipes and tubes, size specification and selection, valves and fitting energy loss factor, equivalent length, estimation of frictional losses in piping systems. Flow meters: Variable head and variable area meters, weir and Notches: Pumps compressor, fans blowers.

Course Outcomes

1. To be able to understand the fundamental of fluid and fluid statics.
2. To apply conservation of law for mass, momentum and mechanical energy for fluid mechanics problems and their applications in chemical engineering systems.
3. Ability to perform dimensional analysis and use of dimensional analysis and similarity considerations in the design and scale.
4. Ability to apply the concept of fluid mechanics for flow meters, pipe and pumps etc.

Text Book(s)/ Reference Book(s)

- Shames, Irving H., Mechanics of Fluid, McGraw Hill.
- White, Frank M., Fluid Mechanics, McGraw Hill
- Denn M., Process Fluid Mechanics, Prentice Hall. 1998
- Darby R., Chemical Engineering Fluid Mechanics, 2nd Ed., Dekker Inc. 2001
- Nevers, N.D., Fluid Mechanics for Chemical Engineers, 3rd Ed., McGaw Hill Higher Education. 2005
- Holland F.A., Fluid Flow for Chemical Engineers, Chemical Publishing Co. Inc., New York.
- Schlichting, H., Boundary – Layer Theory, 7th Ed., McGraw-Hill, 1979.
- Bird, R.B., W.E. Strewart & E.N. Lightfood, Transport Phenomena, Wiley, 1960.
- Douglas, J.F., Gasiorek, J.M., Swaffield, J., Fluid Mechanics, 4th Ed., Prentice Hall, 2001
- Fox, R.W., McDonald, A.T., Introduction to Fluid Mechanics, 5th Ed., Wiley, 2008
- Gupta, S.K., Momentum Transfer Operations Tata McGraw Hill, New Delhi, 1982.
- Gupta, V., and Gupta, S.K., "Fluid Mechanics and Its Applications", 1982.

Course Title — Reaction Kinetics and Reactor Design

Course Number:	**PKC2070**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**AM111**
Contact Hours (L-T-P)	**03-01-0**
Type of Course:	**Theory**
Semester	**3**

Syllabus

Unit 1. Rate of Reaction, elementary and non-elementary reactions molecularity and order of reaction, thermodynamics formulations of rates, mechanism of reaction, Temperature dependency from thermodynamics, arrhenius, collision and activated complex theories.

Unit 2. Integral and differential methods for analyzing kinetics data, interpretation of constant volume batch reactor data for zero, first second and third order reactions, half life period, irreversible reactions in parallel and series, auto catalytic reaction, shiftingorder reactions enzyme catalyzed and surface catalyzed reactions. Interpretation of variable valume batch reactor data for zero, first second order reactions.

Unit 3. Design equations for batch, plug flow, back mix, flow and semi batch reactors for isothermal, adiabatic reactions holding time and space time for flow system Design of batch plug flow and mixed flow reactors for first and second order single reactions. Optimum reactor size plug flow reactors in series / parallel Equal and different size of mixed reactors in series and finding the best system for a given conversion recycle reactor.

Unit 4. Multiple reactions, independent, parallel and series reactions; mixed reactions, instantaneous and over all fractional yield, choice of reactors for simple and complex reactions and multiple reactor system; Introduction to thermal stability of reactors; temperature and pressure effects and optimal temperature progression for first order reactions.

Course Outcomes

1. To develop /express rate laws for use in the reaction kinetics and reactor design & to interpret reactors data to obtain reaction rate expressions.
2. To calculate volume of batch and flow reactors in constant-and variable-volume systems.
3. To Make comparisons of ideal reactor types (batch, plug flow, mixed flow, etc) and be able to determine the best choice for simple objectives when using a single reactor or a set of reactors.

4. To determine optimal ideal reactor design for multiple reactions for yield or selectivity.

5. To predict reactor performance for temperature and pressure effects & to determine the optimal temperature progression profile for first order reactions for the batch and flow reactors
6. Applying this knowledge in the analysis and design of a suitable reactor for homogenous reactions.

Text Book(s)/ Reference Book(s)

- Levenspiel, O., Chemical Reaction Engineering, John Wiley and Sons, New York, 3/e, 1998
- Fogler, H. S., Elements of Chemical Reaction Engineering, Prentice Hall, USA 4/e, 2005
- Smith, J. M., Chemical Engineering Kinetics, McGraw Hill Publications, New York, 1981

PKC2070: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a	X	X	X	X	X	X
b						
c						X
d	X	X				
e						
f						
g						
h			X	X	X	X
i						X
j						
k						
l						X

Course Title — Fluid Particle Operations

Course Number:	**PKC2090 / CH2040**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**PK211**
Contact Hours (L-T-P)	**03-01—**
Type of Course:	**Theory**
Semester	**3**

Syllabus

Unit 1. Characteristics of solid masses. Particle size measurement and sieve analysis size estimation in sub-sieve range capacity and effectiveness of industrial screens. Storage of solid masses. Conveying of solids. Classification and design of Industrial Conveyers.

Unit 2. Size reduction: Theory of crushing and grinding, Types of grinding, Laws of comminution size reduction equipment and their selection

Unit 3. Laws of motion of particles in a fluid. Settling and thickening, their Classification. Characteristics of rotating fluid, Centrifuge and cyclone separation. Classification and selection of settling equipments. Design of continuous thickner and Classification and selection of settling equipments. Design of continuous thickner and sedimentation tank. Agitation and Mixing: Agitated vessels, blending and mixing, suspension of solid particles, dispersion operation, agitator selection and scale up

Unit 4. Flow through packed beds: Types of Packing, characteristics of packing pressure drop in packed bed. Flooding and loading characteristics. Fluidization and its application classification of fluidization Characteristics of fluidized bed Filtration Theory and Principles, Filter aids classification and selection of filtration equipments.

Course Outcomes

1. Explain Characteristics , Storage and Conveying of solids with Particle size measurement and sieve analysis
2. Define Laws of size reduction and Identify size reduction equipment and their selection
3. Explain Laws of motion of particles in a fluid and understanding of Settling , thickening, Agitation and Mixing.
4. Explain Flow through packed beds ,Fluidization and Filtration

Text Book(s)/ Reference Book(s)

- Mc Cabe, Warren L., Smith Julian C. and Peter Harriot, "Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill.
- Gupta, S.K. "Momentum Transfer Operations, Tata McGraw Hill.
- Brown G.G., "Unit Operations, CBS Publisher.

- Coulson, J.M. and J.F. Richardson, 'Chemical Engineering', Vol. II, 5th ed., Butterworth-Heinemen
- Narayanan, C.M., B.C. Bhattacharya, 'Mechanical Operation for Chemical Engineers' Khanna Publisher Delhi, 1992
- Christie J.Geankopolis, 'Transport Processes and Unit Operations' 4th Ed., Prentice Hall of India, 2004
- Sitting, M., Particulate and Fire Dust Removal in Process Equipment, N.Y.C. Publication.
- Chopey N.P. and Hicks T.G. 'Handbook of Chemical Engineering Calculations, McGraw Hill

PKC2090 / CH2040: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a	X	X	X	X		
b	X	X	X	X		
c	X	X	X	X		
d						
e						
f						
g						
h						
i						
j						
k						
l						

Course Title — Higher Mathematics

Course Number:	**AMS2410**
Credits:	**04**
Course Category:	**BS** Pre-
requisite(s):	**NIL**
Contact Hours (L-T-P)	**03-01--**
Type of Course:	**Theory**
Semester	**3**

Syllabus

Unit 1. Vector differentiation, scalar field, gradient of a scalar field, vector field, divergence & curves of vector fields, solenoidal angle and irrotational field. Determination of potential function.

Unit 2. Vector integration, line integral, conservation fields, Gauss divergence theorems, Greens theorem and Stokes theorem.

Unit 3. Laplace's transformation, shifting theorems, transforms of derivatives and integrals. Differentiation and Integration of transforms. Inverse transforms, Application with single and system of linear differential equations

Unit 4. Boundary Value Problems, solution of 2D laplace equation in Cartesian and polar co-ordinates, solution of one dimensional diffusion and wave equation by method of separation of variables.

Course Outcomes

1. apply methods of vector differentiation and vector integration in engineering problems
2. apply Laplace transform method for solving ordinary differential equations
3. solve two dimensional Laplace equation , one dimensional diffusion and wave equation by the method of separation of variables

Text Book(s)/ Reference Book(s)

- Prasad, C., "Mathematics for Engineers", Prasad Mudranalaya, New Delhi, 1985.

AMS2410: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a	X	X	X			
b	X					
c						
d						
e						
f						
g						
h						
i						
j						
k						
l						

Course Title — Machine Drawing and Computer Graphics

Course Number: **MEA2940**
Credits: **02**
Course Category: **ESA**
Pre-requisite(s): **NIL**
Contact Hours (L-T-P) **--01-02**
Type of Course: **Lab**
Semester **3**

Syllabus

Unit 1. Drawing of following machine parts: threaded fasteners, screw jack, flexible coupling, stuffing box, swivel bearing, stop valve and some introduction of Auto CAD.

Course Outcomes

1. Understand conventions, symbols and standards used in engineering drawing as per ISIO recommendations.
2. Understand and appreciate the importance of mechanical design of machine parts.
3. Do part and assembly drawings of different machines assemblies and sub-assemblies.
4. Use CADD packages like AutoCAD/Solid Works.
5. Model simple assemblies and sub-assemblies of machine parts and prepare part and assemble drawings using above packages.
6. Visualize and sharpen their creativity skills in developing new ideas efficiently.
7. Improve their communications skills through technical drawings of machine assemblies as a design engineer.

Text Book(s)/ Reference Book(s)

MEA2940: Mapping of Course Outcomes with Program Outcomes

Program	Course outcomes						
	1	2	3	4	5	6	7
a	X		X				
b		X			X		
c							
d							
e			X	X	X		
f							
g							
h							
i							
j						X	X
k							
l						X	

Course Title — Chemical Engineering Thermodynamics

Course Number:	**PKC2020**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**ME101**
Contact Hours (L-T-P)	**03-01--**
Type of Course:	**Theory**
Semester	**4**

Syllabus

Unit 1. Laws of Thermodynamics, their application to engineering processes, Thermodynamics analysis of Chemical Processes. Refrigeration cycles and liquification processes.

Unit 2. Properties of Pure Substances, Changes to thermodynamics properties and their inter relationship, properties of single and two phase system, types of thermodynamic diagrams. Generalized correlation for thermodynamic properties of gases. Multicomponent system: Partial molar properties, Chemical potential, fugacity and fugacity coefficients excess properties of mixture

Unit 3. Phase Equilibria system. V-L-equilibrium for miscible and immiscible system and their phase diagram, activity coefficients from experimental data.

Unit 4. Reaction coordinates, chemical equilibria, application of the criteria for equilibrium to chemical reactions. Standard Gibb's Free energy change and the equilibrium constant, temperature and pressure effects on equilibrium constant, calculation of equilibrium conversion for single and multiple reaction system

Course Outcomes

1. A fundamental understanding of the first and second laws of thermodynamics, Refrigeration, liquification processes and their application to a wide range of systems.
2. Familiarity with basic concepts in solution thermodynamics ,an ability to evaluate Properties of Pure Substances, single and two phase system, Partial molar properties, Chemical potential, fugacity, excess properties etc.
3. An ability to understand Phase Equilibria system, V-L-equilibrium, activity coefficients etc.
4. Familiarity with basic concepts of chemical equilibria and an ability to relate the criteria for equilibrium to chemical reactions.

Text Book(s)/ Reference Book(s)

- Smith J.M., Van Ness H.C. and Abbott M.M., Introduction to Chemical Engineering Thermodynamics, 7th Ed., Mc Graw Hill, 2005
- Koretsky M.D., "Engineering and Chemical Thermodynamics", John Wiley, 2004.

- Sandler S.I. “Chemical Biochemical and Engineering Thermodynamics, 4th Ed. John Wiley, 2006.
- Kyle B.G., “Chemical and Process Thermodynamics”, 3rd ed., Prentice Hall, 1999.
- Narayanan, K.V., “Chemical Engineering Thermodynamics, Prentice Hall, 2007
- Rao, Y.V.C., Chemical Engineering Thermodynamics, University Press India 2nd Ed. 2001
- Rao Y.V.C. Theory and Problems of Thermodynamics, New Age International (P) Ltd New Delhi

PKC2020: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a	X	X	X	X		
b	X	X	X	X		
c	X	X	X	X		
d						
e						
f						
g						
h						
i						
j						
k						
l						

Course Title — Separation Processes in Hydrocarbon Industries

Course Number:	**PKC2040**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**PK211**
Contact Hours (L-T-P)	**03-01--**
Type of Course:	**Theory**
Semester	**4**

Syllabus

Unit 1. Introduction to separation processes, Phase equilibrium thermodynamics, Flash calculation, Distillation: Flash distillation, Differential distillation & Steam distillation; Binary distillation, Multi stage tray towers; McCabe & Thiele method, Ponchon & Savarit method, Continuous contact system (packed towers).

Unit 2. Multi-component distillation, Adsorption: Adsorption Equilibrium, Fixed bed adsorption column, Ion exchange method

Unit 3. Liquid-Liquid Extraction: Extraction Equilibrium, Extractive solvent, Extraction equipment, Multistage cross current and counter current operations, Liquid-solid leaching operation.

Unit 4. Membrane Separation Processes: Types of membrane process, liquid and gas permeation membrane process, types of membrane, Applications

Course Outcomes

1. Recognize the basic defnition, driving force, equlibrium & equipment of separation processes, being used in chemical/petrochemical industries.
2. Able to evaluate and compare the various separation processes on the basis of technological differences
3. Able to design and evaluate the separators on the basis of the multiple parameters that affect the separator

Text Book(s)/ Reference Book(s)

- Treybal, Robert E., "Mass Transfer Operations", McGraw Hill Publications, 3/e, 2003.
- Geankoplis, Christie J., "Transport Processes and Unit Operations", Prentice Hall of India, New Delhi, 3/e, 1997
- Seader, J.D., Henley, Ernest J., "Separation Process Principles", John Wiley & Sons, Inc, 1998

PKC2040: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a	X	X	X			
b		X				
c			X			
d						
e						
f						
g						
h						
i						
j						
k						
l						

Course Title — Health, Safety and Environment Management

Course Number:	**PKH2060**
Credits:	**03**
Course Category:	**DC**
Pre-requisite(s):	**N I L**
Contact Hours (L-T-P)	**2-1-0**
Type of Course:	**Theory**
Semester	**4**

Syllabus

Unit 1: Incident process, Major Process Hazards, Causes of loss, Trend of Injuries and loss Regulatory Agencies, Codes and Standards, Occupational Safety and Health, Safety Audits, Materials Properties, Hazard Analysis, Risk Assessment, Even Tree and Fault Tree Analysis, Hazard and Operability Studies, Human Error Analysis

Unit 2: Combustion and Flammability, Ignition Sources, Hazardous Area Classification, Fire in Process Plant, Radiant Heat Transfer, Vapor Cloud fire, Fireballs, Pool fires, Flares, etc., Effects of Fire, Fire protection and firefighting using water, foam, dry chemicals, etc.

Unit 3: Detonation and deflagration, Explosion in closed vessels and in buildings, Explosion prevention, Explosion protection, Explosion types, Effects of explosion, Dust explosions, Toxic substances and effects, Toxicity assessment, Hygiene standards and occupational exposure limits, Gas toxicity and major industrial gases, Toxic release response

Reference Book(s):

1. Mannan, S. (editor), "Lees' Loss Prevention in Process Industries: Hazard Identification, Assessment and Control", Butterworth-Heinemann, 4th edition, 2012.
2. Sanders R.E. "Chemical Process Safety: Learning from Case Histories", Butterworth-Heinemann, 4th edition, 2014.

Course Title — Alternate Fuels and Energy Resources

Course Number:	**PKC2080**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Contact Hours (L-T-P)	**3-1-0**
Type of Course:	**Theory**
Semester	**4**

Syllabus

Unit 1. Introduction to alternate fuels: the legislation for alternate fuels, the method of production, properties and characteristics of the different alternate fuels and proper handling procedures

Unit 2. Gas to Liquids Technology Fuels - Introduction to GTL route for cleaner fuels, properties and characteristics of the fuels produced

Unit 3. Gasification technologies, gasification reactions, working of different types of gasifiers: moving bed, fluidized bed and entrained bed gasifiers, types of processes, fuels from biomass – thermal, chemical and biochemical conversions.

Unit 4. Coal Liquefaction technologies: Carbonisation and Pyrolysis, Direct Liquefaction, Indirect Liquefaction

Course Outcomes

1. Describe significance of energy and create awareness about energy security
2. List various alternate fuels and energy resources and justify their suitability in Indian perspective
3. Understand the working principles, pathways and technical developments for chemical and biochemical conversions
4. Outline of processes and new technologies to convert and utilize conventional and unconventional energy resources in a better way

Text Book(s)/ Reference Book(s)

- T. N. Veziroglu, Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 1978.
- Rao, S. and Parulekar, B.B., "Energy Technology", Khanna Publishers, Delhi
- Speight, J.G., "Fuel Science and Technology Handbook", Marcel and Dekker., New York, 1995
- Abbasi, S.A. & Abbasi, N., "Renewable Energy Sources and Their Environmental Impact", Prentice Hall of India, New Delhi, 200

PKC2080: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a			X	X		
b						
c						
d						
e						
f		X				
g	X	X				
h	X	X				
i						
j						
k			X	X		
l				X		

Course Title — Introduction to Petroleum Engineering (DE-1)

Course Number:	**PKE2510**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Contact Hours (L-T-P)	**3-1-0**
Type of Course:	**Theory**
Semester	**4**

Syllabus

Unit 1. Global/Indian Petroleum and Petrochemical Industry. Origin and occurrence of oil & Gas. Migration and accumulation of oil and Gas. Source, reservoir and cap rocks, Petroleum Traps, Physical Properties of oil bearing rocks.

Unit 2. Oil and Gas exploration methods, direct oil finding methods, geological and geophysical methods.

Unit 3. Introduction to drilling operations, drilling equipment – drilling rigs and drill string, drilling fluids and mud testing, mud circulation and treating equipment, etc.

Unit 4. Production Principles, types of reservoir drives, primary oil recovery, secondary oil recovery, enhanced oil recovery methods.

BOOKS:

1. Dawe, R.A. (ed.), "Modern Petroleum Technology", Volume 1, John Wiley & Sons Limited, New York, 6/e, 2000
2. Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, Penn Well Corporation, Oklahoma, USA, 2/e, 2001
3. Mian, M.A., "Petroleum Processing Handbook for Practicing Engineer", Penn Well Corporation, Oklahoma, USA, 1992
4. Deshpande, B.G., "The world of Petroleum", Wiley Eastern Industry

Course Title — Applied Numerical Methods

Course Number:	**AMS2420**
Credits:	**04**
Course Category:	**BS**
Pre-requisite(s):	**NIL**
Contact Hours (L-T-P)	**03-01-0**
Type of Course:	**Theory**
Semester	**4**

Syllabus

Unit 1. General iteration method, Newton Raphson method, application of Newton Raphson method, Solution of system of linear equation by Gauss elimination method and Gauss Siedel method, Convergence of iteration.

Unit 2. Interpolation-Finite difference operator, Central difference operator, backward difference operator, relation between operators, Newton's forward Interpolation formula, Newton's backward Interpolation formula, Newton's Interpolation formula for unequal interval, Lagrange's Interpolation formula for unequal interval.

Unit 3. Numerical Differentiation- Newton's divided difference formula; Numerical integration-Trapezoidal rule, Simpson's rule, Weedle's rule; Numerical Solution of differential equation-Solution with Taylor's series, Euler's method, modified Euler method, Runge-Kutta method, Boundary value problems.

Unit 4. Graphical and analytical methods of optimization, Numerical search methods, search of optimum over single and several design variables, Optimum of process systems, linear programming.

Course Outcomes

1. solve system of linear equations and, non-linear equations.
2. understand interpolation and apply it in relevant problems
3. find numerical integration
4. to solve differential equations and boundary value problems

Text Book(s)/ Reference Book(s)

- Sastry, S.S., "Introductory Methods of Numerical Analysis", Prentice Hall of India Pvt. Ltd., 2004

AMS2420: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a	X	X	X	X		
b				X		
c						
d						
e		X	X	X		
f						
g						
h						
i						
j						
k						
l						

Course Title — Unit Operations Laboratory-I

Course Number: **CHA2920**
Credits: **02**
Course Category: **ESA**
Pre-requisite(s): **NIL**
Contact Hours (L-T-P) **0 1 - 01-02**
Type of Course: **Lab**
Semester **4**

Syllabus

- To investigate validity of Bernoulli's theorem as applied to flow of water in tube of varying cross section
- To find the efflux time of the tank
- Flow through straight circular tube
- Capillary flow viscometer
- Flow through helical tube coils
- Flow through spiral tubes
- Pipe flow of compressible fluids
- Flow through annulus

Course Outcomes

1. Understanding of fluid and fluid particle operations including flow, filtration and size reduction phenomena
2. Ability to apply techniques of manometry, and calculate pressure drop, friction factor and Reynolds number, viscosity of various types of Newtonian/Non-Newtonian fluids
3. Ability to use potential flow theory, and apply Euler's and Bernoulli's equations to solve problems in fluid mechanics and fluid-particle operations
4. A knowledge of fluid-flow phenomena observed in chemical engineering systems, such as flow in a pipe, annulus and coils. fluidized beds, filter press, etc.
5. Ability to plot and analyze the velocity profile related to different fluid flow phenomena in chemical industries and nature
6. Ability to apply the concepts developed for fluid flow to analyze and handle any industrial fluid flow problem associated with chemical processes like flow meters, pipe and pump operation & design
7. Ability to analyze and interpret experimental data in the light of chemical engineering principles and prepare technical reports, learn to work as a team and develop technical communication skills

Text Book(s)/ Reference Book(s)

CHA2920: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes						
	1	2	3	4	5	6	7
a	X	X					
b		X	X	X		X	
c							
d		X	X		X	X	X
e					X	X	X
f						X	
g							
h							
i							X
j							X
k							
l							X

Course Title — Petroleum Testing Laboratory

Course Number: **PKC2920**
Credits: **02**
Course Category: **DC**
Pre-requisite(s): **PK231**
Contact Hours (L-T-P) **01-01-02**
Type of Course: **Lab**
Semester **4**

Syllabus

- Various Experiments related to Analysis & Testing of Petroleum and Petroleum Products.

Course Outcomes

1. To perform the ASTM standard test for petroleum products
2. Compare and Discuss the results obtained with stadard value of the test
3. Able to understand the significance of experimental analysis of the petroleum products

Text Book(s)/ Reference Book(s)

- ASTM Standard Manual
- JAMES G. SPEIGHT, "Handbook of Petroleum
- Product Analysis", JOHN WILEY & SONS, INC., PUBLICATION,2002
- Rao, B.K.B., "Modern Petroleum Refining Processes", Oxford & IBH Co. Pvt. Ltd., New Delhi, 4/e, 2002,
- Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000.

PKC2920: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a	X					
b						
c						
d		X	X			
e						
f						
g						
h						
i						
j						
k						
l						

Course Title — Communication Skills Laboratory

Course Number: **EZH2910**
Credits: **02**
Course Category: **HM**
Pre-requisite(s): **NIL**
Contact Hours (L-T-P) **01-01-02**
Type of Course: **Lab**
Semester **4**

Syllabus

- In this Lab various activities related to improvement of communication skills are carried out

Course Outcomes

1. Analyze and apply the basic concepts of communication effectively
2. Develop written and spoken communication skills
3. Able to present their ideas rationally and logically
4. Use modern communication tools for effective communication and presentation
5. Describe the importance of constructive feedback for consistent self-development
6. Communicate one‘s point of view with clarity duly attributing courtesy and formality to their conveying
7. Engage in debates, group discussions and personal interviews
8. Deliver oral presentation, and seminars confidently

Text Book(s)/ Reference Book(s)

EZH2910: Mapping of Course Outcomes with Program Outcomes

Program outcomes	Course outcomes					
	1	2	3	4	5	6
a						
b		X				
c						
d						
e					X	
f						
g						
h		X				
i						
j	X		X	X		X
k						
l						

Course Title	**Health, Safety and Environment in Hydrocarbon Industries**
Course Number:	**PKH2060**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**N I L**
Contact Hours (L-T-P)	**3-1-0**
Type of Course:	**Theory**
Semester	**4**

Syllabus

Unit 1: Incident process, Major Process Hazards, Causes of loss, Trend of Injuries and loss Regulatory Agencies, Codes and Standards, Occupational Safety and Health, Safety Audits, Materials Properties, Hazard Analysis, Risk Assessment, Even Tree and Fault Tree Analysis, Hazard and Operability Studies, Human Error Analysis

Unit 2: Combustion and Flammability, Ignition Sources, Hazardous Area Classification, Fire in Process Plant, Radiant Heat Transfer, Vapor Cloud fire, Fireballs, Pool fires, Flares, etc., Effects of Fire, Fire protection and firefighting using water, foam, dry chemicals, etc.

Unit 3: Detonation and deflagration, Explosion in closed vessels and in buildings, Explosion prevention, Explosion protection, Explosion types, Effects of explosion, Dust explosions, Toxic substances and effects, Toxicity assessment, Hygiene standards and occupational exposure limits, Gas toxicity and major industrial gases, Toxic release response

Unite 4: Safety Management systems, Offshore Process Safety, Inherently safer design, Human Factors in process control and operation, Human Error, Quantitative Human reliability Analysis, Common elements, Legislation, Environmental Management, Environmental Hazard Assessment, Waste Minimization, Hazardous effluents, emissions and solid wastes, Oil Spills, LNG Spills.

Reference Book(s):

1. Mannan, S. (editor), "Lees' Loss Prevention in Process Industries: Hazard Identification, Assessment and Control", Butterworth-Heinemann, 4th edition, 2012.
2. Sanders R.E. "Chemical Process Safety: Learning from Case Histories", Butterworth-Heinemann, 4th edition, 2014.

CHAPTER - XXXIV (F)

Bachelor of Technology in the Faculty of Engineering & Technology
(Effective from the Session 2011 – 2012)

1. Introduction

(a) The Faculty of Engineering & Technology, Aligarh Muslim University offers full-time program leading to the Bachelor of Technology (B. Tech.) degree in Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Electronics Engineering, Mechanical Engineering, and Petrochemical Engineering.

(b) The medium of instruction in B. Tech. Program is English.

2. Eligibility

A candidate will be eligible for admission to B. Tech. program if he/she has passed the Senior Secondary School Certificate (10+2) Examination of this University or an Examination recognized by this University as its equivalent with 50% marks in aggregate of English, Physics, Chemistry, and Mathematics, or have passed the Diploma in Engineering Examination of this University with 50% marks in aggregate.

3. Admission

(a) The admissions to the B. Tech. programs will be made normally in the Autumn Semester as per the admission policy approved by the Academic Council of the University from time to time. The admission of each student will be made in a particular branch.

(b) A limited number of students may be allowed to change over from one branch of study to another, after first year of study, depending on the availability of seats and their performance in the first two semesters.

4. Academic Session

The academic session is divided into two regular semesters – Autumn and Winter, each of which shall be of approximately 20 weeks duration. The Autumn semester will normally commence in the month of July/August every year, and the Winter in the month of December/January. In the beginning of every session the Dean, in consultation with the Chairmen of the departments concerned, shall notify a detailed academic calendar indicating the schedule of teaching, examination, and other activities.

5. Duration of the Program

5.1 Minimum Duration
The minimum duration of the program shall be eight consecutive semesters after admission.

5.2 Maximum Duration
The maximum duration of the program shall be fourteen consecutive semesters after admission.

6. Curriculum and Credit System

6.1 Credit System

Each B. Tech. program will have a curriculum in which every course will be assigned certain credits reflecting its weight and contact periods per week, as given below.

1 Lecture period (L) per week = 1 Credit
1 Tutorial period (T) per week = 1 Credit
1 Practical period (P) per week = 0.5 Credit

In addition to theory and laboratory courses there may be other courses such as seminar, colloquium, project, etc., which will be assigned credits as per their contribution in the program without regard to contact periods.

6.2 Course Categories

The curriculum for each branch will contain courses in the following categories having credits in the ranges given below in such a way that the total of all credits will be equal to that required for the award of degree as specified elsewhere in these ordinances.

(a) Basic Sciences (BS) (Courses such as Physics, Chemistry, Mathematics etc.)	20-36 credits
(b) Engineering Sciences & Arts (ESA) (Foundation and applied engineering courses that are used across many branches)	20-40 credits
(c) Humanities and Management (HM) (Language, Social science, & Management)	10-18 credits
(d) Departmental Core (DC)	60-116 credits
(e) Departmental Electives (DE)	16-32 credits
(f) Open Electives (OE)	8-16 credits

6.3 Coordinators and Curriculum Development Committee

There shall be a Chief Coordinator, B. Tech. Programs, to be nominated by the Dean, and a Coordinator, B. Tech. Program for each branch in each department, to be nominated by the Chairman of the department concerned. Normally the Chief Tabulator will be the Chief Coordinator, B. Tech. Programs. There shall also be a standing Curriculum Development Committee (CDC), to be constituted by the Faculty. The Chief Coordinator, B. Tech. Programs will be the Convener of the CDC.

6.4 The Curriculum Structure

The curriculum for each branch will contain a listing of all courses, with each course having a course category, course number, course title, number of contact periods per week, number of credits assigned, and the marks assigned to various components of evaluation. It will also have a list of alternative courses in the new curriculum for the old curriculum courses and filler courses to compensate for the shortfall in credits earned by taking alternative courses in any category, if needed. It will also specify all other conditions required for the award of degree.

6.5 Approval of the Curriculum

The curriculum for each branch of B. Tech. program will be prepared by the department concerned and will be approved by the Board of Studies of the department. It will then be vetted by the CDC and will then be placed in the Faculty along with the recommendations of the CDC for approval. Once approved by the Faculty, the Curriculum will be implemented. The same procedure shall be used for any modification in the Curriculum.

7. Registration

7.1 Registration Procedure and Schedule

(a) Every student is required to register, in each semester, for the courses that he/she wants to pursue in that semester. The registration schedule will be announced by the Dean/Chairman for every semester. The registration process involves:

(i) Submitting a registration form in the office of the Chairman and obtaining a registration card signed by the Chairman;

(ii) Paying the required fees.

(b) A student will normally register for higher semester courses only if he has also registered for un-cleared courses of previous semesters, especially in the case of un-cleared courses of first two semesters.

(c) A student will have the option to add/delete/alter the courses in his/her registration within a week of the registration subject to such conditions as may be imposed by the department concerned from time to time.

(d) A student can drop a course from his/her registration by submitting a request to his/her department coordinator up to a date specified on his/her registration card. A registered course will be counted as an attempt even if the student remains absent in the Examination(s).

(e) No student will be allowed to register for more than 40 credits in a semester. A graduating course, however, will not be included in this limit.

(f) A student may be denied registration in a course due to reasons of paucity of staff or space or other facilities, especially in case the student is registering a course for improving the grade in a passed course.

(g) If a student fails to register in two consecutive semesters without specific permission from the Dean, his/her name may be removed from the rolls of the faculty. Such a student may apply to the Dean for re-admission stating the reasons for not being able to register for two consecutive semesters and the Dean will take suitable decision on the merit of the case.

7.2 Graduating Course

A student may be allowed to register for one course of not more than 5 credits if he/she is able to graduate by passing such a course, irrespective of whether the course is being offered in the current semester to regular students or not, provided that the student has fulfilled the attendance requirement earlier and has been awarded E or I grade in that course. Such a course shall be known as a graduating course.

8. Attendance (In lieu of Chapter XVII of the Academic Ordinances)

Attendance in each course separately is compulsory at least once. Students who have put in 75% or more attendance in a course in a semester will be eligible to appear in the End-Semester Examination of that course. Students who have put in 65% or more but less than 75% attendance in a course may be considered for condonation of shortage of attendance in that course by the condonation committee. Students whose attendance in a course is less than 65% or whose shortage in attendance has not been condoned will not be eligible to appear in the End-Semester Examination of that course and will be awarded grade ‘F’ in that course and all marks obtained in any component of the course-evaluation will stand cancelled. However, in case a student is repeating a course and

the student has already fulfilled the attendance requirement in that course, he/she will not be detained due to shortage of attendance in that course during the repeating semester.

9. Examination and Evaluation (In lieu of Clause (9) of Chapter XV of the existing Academic Ordinances)

9.1 Components of Evaluation

Each course will be evaluated out of 100 marks. The courses will normally have the following components of evaluation:

(a) Theory courses:

Course work	15 marks Mid-Semester Examination	
	25 marks End-Semester Examination	60 marks

(b) Laboratory courses including Seminar, Colloquium, Project, etc.

Course work	60 marks
End-Semester Examination	40 marks

However, for special academic reasons, some courses may have different weight for different components of evaluation from that given above. Such special reasons will be spelt out clearly in the curriculum.

9.2 Grading System

The combined marks obtained by a student in various components of evaluation of a course shall be converted into regular letter grades with their equivalent grade points as specified below

Grade	Grade points	Description
A	10	Outstanding
B	8	Very good
C	6	Good
D	4	Satisfactory (Minimum Pass Grade)
E	2	Unsatisfactory (Fail)
F	0	Detained due to shortage of attendance
I	0	Incomplete/Absent in the End-Semester Examination
Z	0	Cancelled due to other reasons

The following marks ranges may ordinarily be used for the award of grades to the students in a course.

Range	Grade
75 and above	A
60 and above but less than 75	B
45 and above but less than 60	C
35 and above but less than 45	D
Less than 35	E

Two grace marks may be awarded by the examiner for passing a course and one grace mark may be awarded by the examiner to elevate the grade. Any fraction in any component of evaluation should be rounded off to the next whole number.

The examiner(s) may propose higher or lower grade ranges depending upon the nature of the course and general performance of the students in the course, but the final decision rests with the Result Moderation Committee. However, the minimum passing grade `D` should never be awarded if a student secures below 35 marks (including 2 grace marks) in a course.

9.3 Evaluation of a Graduating Course

A graduating course shall be evaluated on the basis of the End-Semester Examination component of the course alone. The student shall appear only in the End-Semester Examination of the graduating course. Grade D shall be awarded if the student concerned obtains 35 or more of the marks allotted to End-Semester Examination alone. In case the marks obtained are less than 35, grade E will be awarded. Two grace marks, however, will be awarded for passing the course.

9.4 Earned Credits (EC)

If a student passes a course by obtaining grade D or above he/she earns the credits assigned to that course.

9.5 Performance Indices

At the end of every semester a student's performance will be indicated by Earned Credits (EC), a Semester Performance Index (SPI), and a Cumulative Performance Index (CPI). The SPI is the credit-weighted average of grade points of all courses registered during a semester and is computed as follows:

$SPI = (C_1G_1 + C_2G_2 + \ldots\ldots) / (C_1 + C_2 + \ldots\ldots.)$

Where C_1, C_2, ….. are the credits assigned to courses and G_1, G_2, …… are the grade points earned in those courses.

The CPI is the credit-weighted average of grade points of all courses passed in all the semesters since admission.

9.6 Repetition of a Failed Course

If a student fails in a course his/her marks of all components of evaluation in that course will be cancelled. The student will have to register the course again or its alternative and will be required to appear in all components of evaluation afresh. No previous marks shall be used in any case.

9.7 Repetition of a Passed Course

A student may repeat a course to try to improve his/her grade in that course only once, provided that he/she has passed that course in a single attempt. In such case the student will have to register the course again and will be required to appear in all components of evaluation afresh. No previous marks shall be used in any case. For the purpose of calculating the SPI the recently obtained grade will be considered while for CPI the better of the two grades will be counted.

9.8 Conduct of Examinations

(a) The examiners for the End-Semester Examination of all theory courses will normally be the teacher(s) associated with the course. The Seminar, Colloquium courses will be examined by the teacher(s) associated with the course and one or more examiners from among the teachers of the department to be recommended by the BOS of the department concerned. The laboratory and project courses will be examined by the teachers(s) associated with the course and an external examiner not in the service of the university at the time of examination. In case the external examiner does not turn

up for the examination, the Chairman of the department concerned, in consultation with the course in-charge, shall call another person to act as the external examiner, even from within the University, if necessary.

(b) The End-Semester Examination of all graduating courses shall be conducted simultaneously along with the End-Semester Examination of regular courses of the current semester examination.

9.9 Moderation Committees

(a) Question Paper Moderation Committee: There shall be a Moderation Committee of the concerned Department consisting of the following members to moderate the Question Papers of the End-Semester Examination.

(i) Chairman of the Department concerned – (Convener)
(ii) One senior teacher of the Department in each broad area of specialization (to be appointed by the BOS).

Note: The Paper Setter(s) may be invited, if necessary, to clarify the necessary details of the question paper.

(b) Result Moderation Committee: There shall be a Result Moderation Committee of the concerned Department consisting of the following members to moderate course-wise results of the End-Semester Examinations.

(i) Chairman of the Department concerned - (Convener)
(ii) One senior teacher of the Department in each broad area of specialization (to be appointed by the BOS).
(iii) Examiner(s) concerned.

The Result Moderation Committee will examine the result of each theory course and in case of an abnormal situation; it may take suitable corrective measures in consultation with the examiner(s). The examiner(s) will place the evaluated answer scripts along with the brief solution and marking scheme before the Committee. In case of difference of opinion among the members of the Committee, the majority decision will prevail, in which the examiner(s) will not participate.

10. Degree Requirement

(a) A student who earns 200 credits subject to the break up in various course categories and fulfills such other conditions as may be mentioned in the curriculum will be awarded the degree of Bachelor of Technology. He/she must also pay all University dues as per rules. Moreover, there should be no case of indiscipline pending against him/her.

(b) If a student earns more credits than the minimum required for the award of degree, his/her CPI will be calculated by considering the best grades subject to fulfilling the criteria of required credits as specified in the curriculum.

11. Name Removal from the Rolls of the University and Mercy Appeal

11.1 Name Removal

The earned credits (EC) of every student will be checked at the end of even number of semesters and if the total credits earned by the student are less than the minimum required as given below, his/her admission to the B. Tech. program will be cancelled and his/her name will be removed from the rolls of the University.

Check Point (No. of semesters after admission)	Minimum EC requirement
2 semesters	0
4 semesters	25
6 semesters	50
8 semesters	80
10 semesters	110
12 semesters	140
14 semesters	200

11.2 Mercy Appeal

If the name of a student is removed from the rolls of the University as per provisions of clause 11.1 of these ordinances, he/she may appeal to the Vice-Chancellor stating the reasons for not being able to earn the required credits and the Vice-Chancellor, if he is satisfied with the reasons, may allow the continuation of admission of the student only once during the tenure of the program, extending the total duration of the program by two semesters, at the maximum, beyond 14 semesters, if required. Under no circumstances a student will be allowed to complete the program after the lapse of 16 semesters after admission.

12. Result

(a) If a student passes all the examinations and fulfills all the requirements for the award of degree his/her result will be shown as “Graduated”.

(b) The Division awarded to “Graduated” students will be based on CPI as given below:

First Division (Honours)	CPI $\geq$ 8.5
First Division	6.5 $\leq$ CPI < 8.5
Second Division	CPI < 6.5

There shall be no formula for conversion of CPI or SPI into equivalent percentage of marks during the program. However, once the program is completed by a student and he/she is graduated, his/her final CPI will be converted into equivalent percentage of marks by the following formula:

$$\mathbf{y = (20x^3 - 380x^2 + 2725x - 1690)/84}$$

where y is the percentage of marks and x is the CPI.

(c) If a student earns more credits than the minimum required as given in the table in clause 11.1 before fulfilling the degree requirements, his/her result will be shown as “Continued”.

(d) If the name of a student is removed from the rolls of the University as per provisions of clause 11.1 of these ordinances his/her result will be shown as “Name Removed”.

(e) Ranks/Positions will be determined at the end of even semesters. Only those students who fulfill the following conditions will be eligible for ranks/positions:

(i) They do not have any break in their studies;
(ii) They have passed every scheduled course in first attempt;
(iii) They have passed every course on time as per the curriculum;
(iv) They have earned credits as per the schedule given in the curriculum;

(v) They have not improved grade in any course after passing the course.

The students who violate any of the above conditions will not be awarded any rank/position. The ranks/positions will be determined on the basis of CPI.

13. **Transitory Ordinance**

Candidates admitted prior to the implementation of these Ordinances shall be governed by the Ordinances (Academic) under which they were admitted. Students who fail in the courses that are no more offered in these new ordinances and new curriculum will be allowed to pass the alternative courses, and in case there are no alternative courses, the old courses may be offered. For such candidates, any marks obtained earlier shall not be taken into account for passing the course(s) and they will have to obtain marks in all components of evaluation afresh. A student admitted previously may apply to the Dean through the Chairman concerned, to be governed by these ordinances. Such cases may be allowed on a case by case basis.