SEMESTER 3rd		Contact Hrs.			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BCIE2-301	Engineering Mathematics-III	4	1	0	40	60	100	5
BCIE2-302	Organic Chemistry	3	1	0	40	60	100	4
BCIE2-303	Fluid Flow	3	1	0	40	60	100	4
BCIE2-304	Heat Transfer	3	1	0	40	60	100	4
BCIE2-305	Chemical Process Calculations	3	1	0	40	60	100	4
BCIE2-306	Organic Chemistry Lab.	0	0	2	60	40	100	1
BCIE2-307	Heat Transfer Lab.	0	0	2	60	40	100	1
BCIE2-308	Fluid Flow Lab.	0	0	2	60	40	100	1
BCIE2-309	Training-I#	0	0	2	60	40	100	1
Total		**15**	**5**	**10**	**440**	**460**	**900**	**25**

*# **Training of 4 Weeks during summer vacations after 2nd semester***

SEMESTER 4th		Contact Hrs.			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BCIE2-410	Reservoir Engineering-I	3	1	0	40	60	100	4
BCIE2-411	Mechanical Operations	3	1	0	40	60	100	4
BCIE2-412	Mass Transfer-I	3	1	0	40	60	100	4
BCIE2-413	Chemical Engineering Thermodynamics	3	1	0	40	60	100	4
BCIE2-414	Geology of Petroleum	3	1	0	40	60	100	4
BCIE2-415	Chemical Reaction Engineering-I	3	1	0	40	60	100	4
BCIE2-416	Mechanical Operation Lab.	0	0	2	60	40	100	1
BCIE2-417	Chemical Reaction Engineering Lab.	0	0	2	60	40	100	1
BCIE2-418	Computational Chemical Engineering Lab.	0	0	2	60	40	100	1
Total		**18**	**6**	**6**	**420**	**480**	**900**	**27**

Semester 5th		Contact Hours			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BCIE2-519	Chemical Reaction Engineering-II	3	1	0	40	60	100	4
BCIE2-520	Mass Transfer-II	3	1	0	40	60	100	4
BCIE2-521	Petroleum Refining-I	3	1	0	40	60	100	4
BCIE2-522	Industrial Pollution Control	3	1	0	40	60	100	4
BCIE2-523	Reservoir Engineering-II	3	1	0	40	60	100	4
BCIE2-524	Mass Transfer Lab.	0	0	2	60	40	100	1
BCIE2-525	Petroleum Testing Lab.-I	0	0	2	60	40	100	1
BCIE2-526	Chemical Process Plant Design-I	0	0	2	60	40	100	1
BCIE2-527	Training-II*	0	0	4	60	40	100	2
Total		**15**	**5**	**10**	**400**	**500**	**900**	**25**

** Training of 6 Weeks during summer vacations after 4th semester*

Semester 6th		Contact Hours			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BCIE2-628	Petroleum Refining-II	3	1	0	40	60	100	4
BCIE2-629	Petrochemicals	3	1	0	40	60	100	4
BCIE2-630	Process Instrumentation & Dynamic Control	3	1	0	40	60	100	4
BCIE2-631	Petroleum Equipment Design	3	1	0	40	60	100	4
Departmental Elective-I (Select any one)		3	1	0	40	60	100	4
BCIE2-656	Separation Techniques							
BCIE2-657	Transport of Oil & Gas							
BCIE2-658	Programming, Data Base Management and Information Systems for Oil & Gas Industry							
BCIE2-659	Mathematical Methods and Modeling in Petroleum Exploration and Production							
BCIE2-632	Petroleum Testing Lab.-II	0	0	2	60	40	100	1
BCIE2-633	Process Control Lab.	0	0	2	60	40	100	1
BCIE2-634	Literature Survey & Seminar	0	0	2	60	40	100	1
Total		**15**	**5**	**8**	**380**	**420**	**800**	**23**

Total Credits

Semester	Credits
I	25
II	25
III	25
IV	27
V	25
VI	23
VII	15
VIII	15
Total	**180**

ENGINEERING MATHEMATICS-III

Subject Code: BCIE2-301 **L T P C** **Duration: 45 Hrs.**
4 1 0 5

UNIT-I

Fourier Series:
Periodic functions, Euler's formula. Even and odd functions, half range expansions, Fourier series of different wave forms.

Laplace Transforms:
Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of unit step function, impulse function, periodic functions, applications to solution of ordinary linear differential equations with constant coefficients, and simultaneous differential equations. .

UNIT-II

Special Functions:
Power series solution. of differential equations, Frobenius method, Legendre's equation, Legendre polynomial, Bessel's equation, Bessel functions of the first and second kind. Recurrence relations, equations reducible to Bessel's equation.

Partial Differential Equations:
Formation of partial differential equations, Linear partial differential equations, homogeneous partial differential equations with constant coefficients

UNIT-III

Applications of PDEs:
Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation in Cartesian Coordinates, solution by the method of separation of variables. .

UNIT-IV

Functions of Complex Variable:
Limits, continuity and derivative of the function of complex variable, Analytic function, Cauchy-Riemann equations, conjugate functions, and harmonic functions;
Conformal Mapping: Definition, standard transformations, translation, rotation, inversion, bilinear. Complex Integration: Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. Taylor's and Laurent's expansions (without proofs), singular points, poles, residue,
Integration of function of complex variables using the method of residues.

Recommended Books

1. E. Kreyszig, 'Advanced Engineering Mathematics', 8th Edn., John Wiley, New Delhi.
2. B.S. Grewal, 'Higher Engineering Mathematics', Khanna Publishers, New Delhi.
3. Ian N. Sneedon, 'Elements of Partial Differential Equations', McGraw Hill, Singapore, **1957**.
4. Peter. V. O'Nil, 'Advanced Engineering Mathematics', Wadsworth Publishing Company.
5. H.C. Taneja, 'Engineering Mathematics', Vol.-I, -II, I.K. Publisher.
6. Babu Ram, 'Advance Engineering Mathematics', Pearson Education.
7. J.S. Bindra, 'Applied Mathematics', Vol.-III, Kataria Publications.

ORGANIC CHEMISTRY

Subject Code: BCIE2-302 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

UNIT-I

ALIPHATIC HYDROCARBONS AND ALCOHOLS

Alkanes: General methods of Preparation, Physical and Chemical Properties, Alkenes: General Methods of Preparation, Physical and Chemical Properties, Markovnikov's Rule, Peroxide effect, Bayer's Test, Alcohols-General methods of preparation and properties monohydric alcohols-Saytzeff Rule, Methods of distinguishing the three classes of Alcohols, Lucas Test, Dichromate test.

UNIT-II

ALDEHYDES, KETONES AND ACIDS

General methods of Preparation, Physical and Chemical Properties, Aldol condensation, Clemmensen reduction, Wolf-Kishner reduction, Haloform reaction, Cannizzaro Reaction, Reformatsky Reaction, Wittig Reaction, Saturated monocarbozylic Acids, Methods of Preparation, Physical and chemical properties.

UNIT-III

CARBOHYDRATES

Classification of Carbohydrates, Mono Saccharides, Reactions of glucose and fructose, Open chain and cyclic structures of glucose and fructose, Mutarotation, Epimerization, Killiani-Fisher synthesis, Ruff Degradation-Conversion of aldoses to ketoses and ketoses to aldoses, Disaccharides, Properties and structure of sucrose, Polysaccharides, Properties and structure of starch and cellulose, Derivatives of cellulose, Carboxy methyl cellulose and gun cotton.

UNIT-IV

AROMATIC HYDROCARBON, AMINE AND DIAZONIUM SALT

Benzene, Aromaticity, Huckel Rule, General methods of preparation of benzene, Electrophilic substitution reactions, Directive effects of substituent's Aromatic amino compounds, General methods of preparation, Physical and Chemical properties, Carbylamines reaction, Aryldiazonium salts, Preparation and synthetic applications.

DYES AND DYEING

Colour and constitution, Synthesis, Azodyes, Methyl orange, Methyl red and Congo red, Triphenylmethane dyes, Malachite green, Para rosaniline, Alizarin, Eosin, Introduction to Natural and reaction dyes.

FLUID FLOW

Subject Code: BCIE2-303 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: The course introduces the students to the principles of fluid mechanics that are of fundamental importance to chemical engineers i.e. fluid statics and dynamics, boundary layer, laminar and turbulent flows, fluid machinery etc. It is a prerequisite to Heat Transfer, Mass Transfer I & II.

UNIT-I

Introduction: Concept of fluid, difference between solids, liquids and gases; ideal and real fluids, Introduction to fluid statics and fluid flow.

Fluid Statics: Normal forces in fluids, Manometers of different types, Forces on submerged bodies, Buoyancy and stability.

UNIT-II

Fluid Properties: Concept of capillarity, vapour pressure, compressibility and bulk modulus, Newtonian and non- Newtonian Fluids, Nature of turbulence, Eddy Viscosity, Flow in Boundary Layers.

Basic Equation of Fluid Flow: Momentum Balance, Continuity equation, Bernoulli's Equations, Navier Stokes Equations, Derivation and Application Dimensional Analysis of Fluid Flow Problems using Rayleigh method and Buckingham π method, Dimensionless numbers and their significance.

UNIT-III

Flow of Incompressible Fluids: Concept of boundary layer, Laminar and Turbulent flow in pipes, Velocity distribution in pipes, Frictional Losses in pipes and fittings, effect of roughness, Fanning Equation, Estimation of Economic Pipe Diameter, Derivation of Hagen Poiseuille's equation and f =16/ Re.

Flow of compressible fluids: Compressible flow, basic equation, Mach number and its significance and isentropic flow through nozzles.

UNIT-IV

Flow Measurement:

In closed channels - Pitot tube, Orifice meter, venturimeter, Rotameter

In open channels- Notches, Weirs

Fluid Machinery:

Classification and performance of Pumps, Positive displacement pumps and its types, Centrifugal pumps- characteristic curves, Net positive Suction Head and cavitation, Turbines, Compressors, Blowers, Selection and specification.

Recommended Books

1. McCabe, Warren L., Smith, Julian C. and P. Harriot, 'Unit Operations of Chemical Engg.', 7th Edn., McGraw Hill, **2005**.
2. J.R. Backhurst, J.H. Harker, J.F. Coulson, J.M. Richardson, 'Chemical Engineering', Vol.-1, 6th Edn., Butterworth Heinemann, **1999**.
3. A.S. Foust, L.A. Wenzel, C.W. Clump, L. Maus, L.B. Anderson, 'Principles of Unit Operations', 2nd Edn., John Wiley & Sons, **2008**.
4. K.S. Raju, 'Fluid Mechanics, Heat Transfer and Mass Transfer: Chemical Engineering Practice', John Wiley and Sons, **2011**.

HEAT TRANSFER

Subject Code: BCIE2-304 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: The objective of the course is to introduce to the students about heat transfer mechanisms in solids and fluids and their chemical process applications. At the conclusion of the course, the student should possess the ability to model steady and unsteady

heat transfer in simple systems and design heat exchangers. It requires use of thermodynamics and fluid mechanics and sets the basis for the design of reactors and separation processes.

UNIT-I

Modes of Heat Transfer:

a) Conduction

Fourier's law, one dimensional heat conduction through plane and composite structures having plane wall, spherical & cylindrical geometry. Steady state heat flow with heat source through plane wall and cylindrical surface. Thermal conductivity of materials. Insulating materials and critical thickness of insulation.

Unsteady-state conduction; Lumped heat capacity system, semi-infinite solid and Heisler chart.

b) Convection

Free and forced convection, Concept of thermal boundary layer, concept of overall heat transfer coefficient for laminar and turbulent flow, Heat transfer inside & outside tubes with significance of Nusselt, Prandtl, Reynolds, Biot, Fourier and Peclet numbers. Modelling of convective heat transfer coefficient by using dimensional analysis for natural convection.

c) Radiation

Distribution of radiant energy, Definition of emissivity, absorptivity, Reflectivity and transmissivity, concept of Black and Grey bodies, Planck's law of monochromatic radiation, Kirchhoff's law, Wien's displacement law, Stefan-Boltzmann law, definition of intensity of radiation. Radiation formula for radiation exchange between simple bodies, two parallel surfaces and between any source and receiver, radiation shields

UNIT-II

Condensation and Boiling Heat Transfer:

Dropwise and Filmwise condensation of pure and mixed vapours, Convective, Nucleate & Film boiling, Theory and correlations, critical boiling flux

UNIT-III

Heat Exchangers

Heat exchangers - double pipe heat exchanger, Shell-and-Tube heat exchangers, plate type heat exchanger, concept and calculation of log mean temperature difference, temperature correction factor for shell & tube exchangers, fouling factors, overall heat transfer coefficient Theory of Fins and their applications, Reboiler and Condensers, counter current dry contact Condenser, parallel current- wet contact Condenser.

UNIT-IV

Evaporators

Various types of evaporators- Standard vertical tube evaporator, basket type vertical evaporator, forced circulation evaporator and horizontal tube evaporators. Single effect evaporators and multi-effect evaporators and its various types of feed arrangements, boiling point elevation, capacity and economy of evaporators. Evaporation under vacuum.

Recommended Books

1. J.P. Holman, 'Heat Transfer', 10th Edn., McGraw Hill, **2010**.
2. W.H. McAdams, 'Heat Transmission', 3rd Edn., Kreiger Publishing Co., **1985**
3. J.R. Backhurst, J.H. Harker, J.F. Coulson, J.M. Richardson, 'Chemical Engineering', Vol.-1, 6th Edn., Butterworth Heinemann, **1999**.
4. McCabe, Warren L., Smith, Julian C. and P. Harriot, 'Unit Operations of Chemical Engg.', 7th Edn., McGraw Hill, **2005**.
5. D.Q. Kern, 'Process Heat Transfer', McGraw Hill.

6. F. Kreith, R.M. Manglik, M.S. Bohn, 'Principles of Heat Transfer', 7th Edn., Brooks Cole Thomson Learning Publication, **2010**.
7. F.P. Incopera, D.P. DeWitt, T.L. Bergman, A.S. Lavine, 'Fundamentals of Heat and Mass Transfer', 7th Edn., John Wiley, **2011**.

CHEMICAL PROCESS CALCULATION

Subject Code: BCIE2-305 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objective: The objective of this course is to present to the students, an introduction to chemical engineering calculations, establish mathematical methodologies for the computation of material balances, energy balances and to present an overview of industrial chemical processes. It is prerequisite for several other courses in the curriculum, including courses in process dynamics, heat transfer and phase equilibrium.

UNIT-I

Introduction to Chemical Engineering Calculations:
Unit & Dimensions, Conversion of units, Mole concept, Basic Concept, Stoichiometric and composition relationship, limiting-excess- reactant, conversion and yield.

UNIT-II

Material Balance:
Without Chemical reaction - Ideal gas-law calculations, real-gas relationships, vapour pressure of immiscible liquids, solutions and problems based on Raoult's, Henry & Dalton's Law. Absolute Humidity, Relative Humidity, Saturation, Dry bulb temperature, Wet bulb temperature, Adiabatic saturation temperature & use of psychometric Chart.
With Chemical Reaction- Combustion, gas-synthesis, acid-alkali production recycle, purge, bypass in batch, stage wise and continuous operations in systems with or without chemical reaction.

UNIT-III

Energy Balance:
Review: Thermophysics, Thermochemistry-law of constant heat summation, Hess's Law, standard heat of reaction, combustion and formation, problems using Hess Law.
Heat balances for non-reacting processes and reaction processes. Theoretical flame temperature, Adiabatic reaction temperature, flame temperature, combustion calculation.

UNIT-IV

Material and Energy Balances:
Applied to industrial processes such as combustion and gasification of fuels, synthesis of ammonia, production of sulphuric acid, nitric acid, hydrochloric acid.

Books Recommended

1. P.A. Hougen, K.M. Watson, R.A. Ragatz, 'Chemical Process Principles', Part – I, John Wiley & Sons.
2. D.M. Himmelbleau, J.B. Riggs, 'Basic Principles and Calculations of Chemical Engg.', 7th Edn., Prentice Hall, **2004**.
3. B.L. Bhatt, S.M. Vora, 'Stoichiometry', Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4. R.M. Felder & R.W. Rousseau, 'Elementary Principles of Chemical Processes', 2nd Edn., John Wiley & Sons.
5. G.V. Reklaitis, 'Introduction to Material and Energy Balances', John Wiley & Sons.

6. W.K. Lewis, A.H. Radasch, H.C. Lewis, 'Industrial Stoichiometry', McGraw Hill.

ORGANIC CHEMISTRY LAB.

Subject Code: BCIE2-306 **L T P C**
0 0 2 1

EXPERIMENTS

1. Estimation of Alcohol
2. Estimation of Aldehydes & Ketenes
3. Estimation of Phenol
4. Pigment Analysis
5. Ore/Alloys analysis
6. Estimation of Amines
7. Estimation of Glucose
8. Preparation of Aspirin
9. Preparation of Methyl orange
10. Preparation of Schiff's base
11. Synthesis of Porphyrin
12. Qualitative analysis of simple Organic compounds.
13. Polymer Analysis
14. Hydrolysis of Sucrose.
15. Industrial Waste Water analysis

HEAT TRANSFER LAB.

Subject Code: BCIE2-307 **L T P C**
0 0 2 1

EXPERIMENTS

1. Determination of heat transfer coefficient for different types of heat transfer equipment.
2. Wilson Plots for unsteady state heat transfer in jacketed vessels.
3. Developing correlation of instantaneous heat transfer coefficients with time for steady deposition of scale on a heating surface.
4. Determination of heat losses from insulated pipes.
5. Performance characteristics of a shell and tube heat exchanger and an induced draft cooling tower.
6. Study and operation of long tube forced circulation and multiple effect evaporators.
7. Duhring's plot for solutions involving non-volatile solutes
8. To find the heat transfer coefficient of heat loss from a vertical cylinder by natural convection.
9. To find heat transfer coefficient for parallel flow and counter flow for double pipe heat exchanger.
10. To find heat transfer coefficient for heat loss by forced convection to air flowing through it for different air flow rates & heat flow rates.

FLUID FLOW LAB.

Subject Code: BCIE2-308 **L T P C**
0 0 2 1

EXPERIMENTS

1. Characteristic curves of a centrifugal pump.
2. Determination of stability of a floating body.
3. Verification of Bernoulli's equation for flow process.
4. Measurement of flow by a venturimeter
5. Measurement of flow by an orifice meter.
6. Measurement of flow by a rotameter
7. Measurement of flow by a V-notch in an open channel.
8. Measurement of losses in various fitting and valves.
9. Measurement of losses due to contraction and expansion.
10. Measurement of losses due to variation in cross section/ shapes
11. Verification of laminar/ turbulent flow regime in a flow process
12. Study of valves and fittings

RESERVOIR ENGINEERING - I

Subject Code: BCIE2-410 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: This course leads to the fundamental of reservoir engineering. The course integrates the concept of rock properties, the fluids and its flow through porous media and reservoir drives mechanics as well as techniques of reservoir estimations.

UNIT-I

Reservoir Rock Properties: Porosity, permeability determination, combination of permeability in parallel & series beds, porosity permeability relationship, fluid Saturation determination and significance, effective and relative permeability, wettability, capillary pressure characteristics, measurements and uses.

Reservoir Fluids: Phase behavior of hydrocarbon system, ideal & non ideal system, equilibrium ratios, reservoir fluid sampling, PVT properties determination, different correlations and laboratory measurements, data reduction, evaluation and application.

Flow of Fluids through Porous Media:

Darcy's law, single and multiphase flow, linear, radial & spherical flow, steady state & unsteady state flow, flow through fractures, GOR, WOR equations, Water and gas coning. Principles of Fluid Flow for steady state, semi steady state & non steady state conditions.

Reservoir Drives:

Reservoir drive mechanics and recovery factors.

Reserve estimation:

Estimation of petroleum reserve, resource & reserve concept, latest SPE/ WPC/IS classification, volumetric material balance.

Recommended Books

1. T, Ahmed, 'Reservoir Engineering Handbook', 3rd Edn., Elsevier, **2006**.

2. Slip Slider, H.C., 'Worldwide Practical Petroleum Reservoir Engineering Method', Penn Well Publishing Company, **1983**.
3. Gianluigi Chierici, 'Principles of Petroleum Reservoir Engineering', Elsevier, **1994**.

MECHANICAL OPERATIONS

Subject Code: BCIE2-411 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: The objective of this course is to develop the understanding of the students about solids, their characterization, handling and the various processes involving solids. The students are exposed to basic theory, calculations and machinery involved in various solid handling operations.

UNIT-I

Characterization and Handling of Solids:
Characterization of solid particles, Shape, size, specific surface, Particle size distribution Properties of particulate masses, Major distinctive properties, pressures in masses of particles, angle of internal friction, angle of repose. Conveying of bulk solids, Basic idea of conveyor, conveyor selection, screw, belt, vibrating, continuous flow and pneumatic conveyors. Storage and weighing: bulk storage, bin storage, feeders (vibrating hopper, screw feeder, belt feeder), batch and continuous weighing.

UNIT-II

Screening: Capacity and Effectiveness of a screen, calculation of average size of particles in mixture by screen analysis, types of screens.
Agitation and Mixing: Agitation of low viscosity particle suspensions, axial flow impellers, radial flow impellers, close-clearance stirrer, unbaffled tanks, baffled tanks, basic idea for designing agitators. Power number, Froude number, power consumption in agitation
Mixing of Solids: Types of mixers, various mixers for cohesive solids, power requirements, mixing index, axial mixing. Mixers for free flowing solids, ribbon blenders, screw mixers, tumbling mixers import wheels, mixing index in blending granular solids, mixing index at zero time, rate of mixing.

UNIT-III

Size Reduction: Principles of Comminution, Criteria for comminution, characteristics of products, Energy and Power requirements, Bond's, Rittinger's and Kick's Law and Work Index.
Size Reduction Equipment: Crushers, Grinders, and ultrafine grinders cutting machines, equipment operation.
Filtration: Classification of filters, various types of cake filters, principles of cake filtration,
Clarifying Filters: Liquid clarification, Gas cleaning, principles of clarification.
Filtration Equipment and centrifuges and their selection, Cross flow Filtration, micro filtration.

UNIT-IV

Settling: Motion of particles through fluids: Terminal velocity, hindered settling, Stoke's law,
Gravity Settling Processes: Classifiers, clarifiers, thickeners, flocculation, rate of sedimentation Centrifugal Settling processes: Cyclones, hydroclones, decanters, tubular, disk and nozzle discharge centrifugal sludge separators, Centrifugal class fitters, principles of centrifugal sedimentation.

Fluidization: Fluidization and fluidized bed, conditions for fluidization, Ergun equation and Kozeny-Carman equation, minimum fluidization velocity, types of fluidization, expansion of fluidized beds and particulate fluidization, continuous fluidization; industrial applications.

Recommended Books

1. McCabe, Warren L., Julian C. Smith and P. Harriot, Unit Operations of Chemical Engg., 7th Edn., McGraw Hill, **2005.**
2. A.S. Foust, L.A. Wenzel, C.W. Clump, L. Maus, L.B. Anderson, 'Principles of Unit Operations', 2nd Edn., John Wiley & Sons, **2008**.
3. J.H. Harker, J.F. Richardson, J.R. Backhurst, 'Chemical Engg.', Vol, 2, 5th Edn., Butterworth-Heinemann, **2003**.
4. W.L. Badger and J.T. Banchero, 'Introduction to Chemical Engg.', McGraw Hill.
5. R.H. Perry, D.W. Green, 'Chemical Engineers Handbook', 8th Edn., McGraw Hill, **2008**.

MASS TRANSFER-I

Subject Code: BCIE2-412 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: The objective of this course is to present the principles of mass transfer and their application to separation and purification processes. The concept of mass transfer coefficients, rate expressions and some mass transfer operations is developed.

UNIT-I

Introduction: Importance and classification of mass transfer operations in Chemical Engineering.

Diffusion: Diffusion in gases and liquids, Fick's First law of diffusion, Mass balance in simple situations - with and without chemical reaction. Diffusion in solids, diffusion through porous solids and polymers, unsteady state diffusion.

UNIT-II

Interphase Mass Transfer: Theories of Mass transfer, Individual and overall mass transfer coefficients, Convective mass transfer. Mass balance in concurrent and counter-current continuous contact equipment, Concept of operating line, Multi-stage counter current operations, Concept of ideal stage, Stage efficiencies, Design of continuous contact equipment, HTU and NTU concepts.

Gas Absorption: Design of plate and packed absorption columns, Scrubbers, Non-isothermal absorption, Simultaneous heat and mass transfer.

UNIT-III

Drying of Solids: Rate of drying curves, through circulation drying, Continuous drying, Types of dryers.

Humidification operations: VLE & Enthalpy, Reference substance plots, vapour gas mixtures, concept of adiabatic saturation, psychometric charts, adiabatic operations-humidification operations and water cooling operations.

UNIT-IV

Dehumidification Equipment: Water cooling towers & spray chambers.

Membrane Separations: Types of membranes, permeate flux for ultra-filtration concentration polarization, partial rejection of solutes, microfiltration, Reverse Osmosis and Electro-dialysis.

Recommended Books

1. Treybal Robert E., 'Mass Transfer Operations', 3rd Edn., McGraw Hill, **2001.**

2. T.K. Sherwood, R.L. Pigford, C.R. Wilke, 'Mass Transfer, Chemical Engineering Series', McGraw Hill, **1975**.
3. J.R. Backhurst, J.H. Harker, J.F. Coulson, J.M. Richardson, 'Chemical Engineering', Vol.-1, 6th Edn., Butterworth Heinemann, **1999**.
4. A.H.P. Skelland, 'Diffusional Mass Transfer', Krieger Publishing Co., **1985**.
5. McCabe, Warren L., Julian C. Smith and P. Harriot, Unit Operations of Chemical Engg., 7th Edn., McGraw Hill, **2005**.

CHEMCIAL ENGINEERING THERMODYNAMICS

Subject Code: BCIE2-413 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Prerequisite: The students should have studied Elements of Mechanical Engineering as a prerequisite to study this course

Course Objectives: This course covers the application of thermodynamic principles to chemical engineering problems. The concept of equations of state, phase and chemical equilibrium with emphasis on vapor/liquid systems and their applications to separation processes is included.

UNIT-I

Brief Review: Importance of thermodynamics in chemical engineering, State functions, types of systems, internal energy, heat and work reversible and irreversible processes. 1st law of thermodynamic and its engineering applications, i.e., constant volume processes, constant pressure processes, isothermal and adiabatic processes, Throttling process, Joule-Thomson coefficient, liquefaction of gasses Standard heat of reaction, standard heat of formation, standard heat of combustion, flame temperature, enthalpy for phase change etc.

UNIT-II

Review of 2nd and 3rd Law of Thermodynamics: Concept of Entropy and lost work, Microscopic interpretation of entropy. Third law of thermodynamics and its applications, free energy functions and their significance in phase and chemical equilibria. Clapeyron equation and some important correlations for estimating vapour pressures. Estimation of thermodynamic properties by using graphs and tables.

Equations of State: Equation of state for real gases and their mixtures. Principle of corresponding states and generalized compressibility factor, H-x diagrams, heat of solution

UNIT-III

Phase Equilibria: Partial molar properties, partial molar Gibbs free energy, chemical potential and its dependence on temperature and pressure. Ideal solutions (Lewis-Randall Rule). Fugacity and its calculations. Dependence of fugacity on temperatures and pressure. Solution behaviour of real liquids and solids. Activity and activity coefficients. Variation of activity co- efficient with temperature and composition. Activity coefficients of electrolytes. Standard states. Properties of mixing. Excess properties. Gibbs-Duhem equation and its application to vapour- liquid equilibria.

UNIT-IV

Chemical Equilibria: Equilibrium constant in terms of measurable properties, variations of equilibrium constant with temperature and pressure. Adiabatic reactions. Gibbs phase rule, equilibria in heterogeneous reactions. Electrochemical reactions.

Recommended Books

1. J.M. Smith and H.C. Van Ness, 'Introduction to Chemical Engineering Thermodynamics', 7th Edn., McGraw Hill Book Co., **2005**.
2. B.F. Dodge, 'Chemical Engg. Thermodynamics', McGraw Hill Book Company, Inc.
3. R. Balzhiser, M. Samuels, J. Eliassen, 'Chemical Engineering Thermodynamics', Prentice Hall, **1972**.

GEOLOGY OF PETROLEUM

Subject Code: BCIE2-414 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: To impart basic knowledge of minerals, rocks, principles of stratigraphy, structural geology and topographic maps.

UNIT-I

Minerals: General properties, Classification of minerals and properties of common rock forming minerals.
Petrology: Rocks; Classification and description of some common rocks.

UNIT-II

Stratigraphy: Principles of Stratigraphy, Concepts of palaeontology, Fossils, their mode of preservation and significance as indices of age and climate, Concept of index fossils, Broad stratigraphic subdivisions and associated rock types of important coal belts and oil fields of India.

UNIT-II

Structural Geology: Interpretation of topographic maps; Attitude of planar and linear structures; Effects of topography on outcrops. Unconformities, folds, faults and joints - their nomenclature, classification and recognition. Forms of igneous intrusions - dyke, sill and batholiths. Effects of folds and fractures on strata and their importance in exploration activities.

UNIT-II

Exploration: Meaning, methods of exploration, surface geological methods-gravity methods, magnetic methods, geophysical methods-electrical resistivity methods, seismic ewfraction methods, radiometric surveying.

Recommended Books

1. H.H. Rutely, 'Elements of Mineralogy', McGraw Hill Book Co., **2005**.
2. H.H. Read, 'Rutley's Elements of Mineralogy'.
3. M.S. Krishnan, 'Geology of India'.
4. P.K. Mukherjee, 'Introduction to Geology'.
5. M.P. Billings, 'Structural Geology'.
6. Philip Kearey, Michael Brooks, 'An Introduction to Geophysical Exploration', Blackwell Science.

CHEMICAL REACTION ENGINEERING - I

Subject Code: BCIE2-415 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: This course teaches the principles of reaction engineering and reactor design for homogeneous reactions. It is one of the core subjects in the chemical engineering

curriculum. The course integrates fluid mechanics and heat transfer to the design and analysis of isothermal, non-isothermal, ideal and non-ideal reactors. Students learn the application of stoichiometry and rate law to design a chemical reactor that produces the desired conversion of reactants.

UNIT-I

Introduction: Introduction & Importance of Chemical Reaction Engineering, Kinetics of homogeneous reactions, Concepts of reaction rates, rate equation, rate constant, order & molecularity, Mechanism for Elementary & Non-elementary reaction.

UNIT-II

Design for Single Reactions: Material balance equation for ideal batch reactor and its use for kinetic interpretation of data and isothermal reactor design for simple & complex rate equation. Performance equations for CSTR and PFR and their use for kinetic interpretation and design Comparison of batch reactor, CSTR & PFR, Recycle reactor, concept of yield & selectivity Reactor combinations of CSTR and PFR.

UNIT-III

Design for Multiple Reactions: Quantitative treatment of Series & parallel multiple reaction in a batch reactor, CSTR & PFR, Concept of Product distribution for multiple reactions.

Temperature & Pressure Effects:

Concept of adiabatic & non-isothermal operations, Energy balance equation for Batch, CSTR & PFR and their application to design of reactors, optimal temperature progression, multiple steady states in CSTR.

UNIT-IV

Non–Ideality: Basics of non-ideal flow, residence time distribution, States of segregation Measurement and application of RTD, E-Age distribution function & F-curve and inter-relationship between them, Conversion in non-ideal reactors.

Recommended Books

1. Levenspiel O., 'Chemical Reaction Engineering', 3rd Edn., John Willey, **2004**.
2. J.M. Smith, 'Chemical Engineering Kinetics', 3rd Edn., McGraw Hill, **1981**.
3. D.G. Peacock, J.F. Richardson, 'Chemical Engineering', Vol.- 3, 3rd Edn., Butterworth Heinemann, **1994.**
4. S.M. Walas, 'Reaction Kinetics for Chemical Engineers', 3rd Edn., McGraw Hill Book Co, Inc.
5. K.G. Denbigh, J.C.R. Turner, 'Chemical Reactor Theory – An Introduction', 3rd Edn., Cambridge Univ. Press London, **1984**.
6. H.S. Fogler, 'Elements of Chemical Reaction Engineering', 4th Edn., Prentice Hall, **2006**.

MECHANICAL OPERATIONS LAB.

Subject Code: BCIE2-416 **L T P C**
0 0 2 1

EXPERIMENTS

1. Verification of Stokes Law.
2. Screen analysis of given sample for its particle size distribution.
3. Determination of average size (different averages) from screen analysis.
4. Determination of variation in pressure drop & bed height with respect to superficial velocity for a bed of solids.

5. Determination of minimum fluidization velocity for a bed of solids.
6. Operating characteristics of crushing and grinding equipment (Jaw crusher, Roll crusher, Ball mill).
7. Evaluation of the filtration constants for $CaCO_3$ slurry in water and cake compressibility.
8. Determination of %age recovery of coal in froth from coal and sand mixture.
9. Determination of thickener capacity using batch sedimentation.
10. Determination of characteristics of centrifuge as a filter.
11. Determination of the separation efficiency of the classifier.

Recommended Books

1. McCabe, Warren L., Smith, C. Julian and P. Harriot, 'Unit Operations of Chemical Engg.', 7th Edn., McGraw Hill, **2005**.

CHEMICAL REACTION ENGINEERING LAB.

Subject Code: BCIE2-417 **L T P C**
0 0 2 1

Course Objectives: To impart knowledge on reaction engineering by practice. Students develop a sound working knowledge on different types of reactors.

EXPERIMENTS

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug Flow reactor
3. Kinetic studies in a PFR followed by a CSTR
4. RTD studies in a PFR
5. RTD studies in a Packed Bed Reactor.
6. RTD studies in CSTRs in series
7. Studies on micellar catalysis
8. Study of temperature dependence of rate constant using CSTR.
9. Kinetic studies in sono-chemical reactor
10. Batch reactive distillation
11. Kinetics of photochemical reaction
12. Demonstration of heterogeneous catalytic reaction
13. Demonstration of gas-liquid reaction

Recommended Books

1. Levenspiel O., 'Chemical Reaction Engineering', 3rd Edn., John Willey, **2004**.

COMPUTATIONAL CHEMICAL ENGINEERING LAB.

Subject Code: BCIE2-418 **L T P C**
0 0 2 1

EXPERIMENTS

Course Objectives: To give practice to students to solve chemical engineering problems through programming and using computational tools. Students will solve chemical engineering problems from core courses using C and MATLAB programming and also using computational tools like Excel and Aspen.

PROGRAMMING IN C: C programs will be written to solve problems from core courses of chemical engineering.

MICROSOFT EXCEL SOFTWARE: The computational, plotting and programming abilities in Excel will be used to solve different chemical engineering problems.
PROGRAMMING IN MATLAB: Chemical engineering problems will be solved using the powerful computational and graphical capability of MATLAB.
ASPEN SOFTWARE Individual process equipment and flowsheets will be simulated using Aspen Plus and property analysis and estimation will be done using Aspen Properties.
BOOKS RECOMMENDED:

1. B.A. Finlayson, 'Introduction to Chemical Engineering Computing', John Wiley & Sons, New Jersey, **2006**.

CHEMICAL REACTION ENGINEERING–II

Subject Code: BCIE2-519 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Prerequisite: The students should have studied Chemical Reaction Engg. – I as a prerequisite to study this course
Course Objectives: This course teaches the principles of reaction engineering and reactor design for heterogeneous reactions. It is one of the core subjects in the chemical engineering curriculum. The course includes the use of mass transfer and heat transfer principles as applicable to heterogeneous reactions and their application to reactor design.

UNIT-I

Kinetics of Heterogeneous Reactions:
Introduction to catalysts & their classification, Concepts of physical absorption and Chemisorption, Preparation of solid catalysts, Deactivation of Catalysts, Synthesis of rate law, mechanism & rate limiting step for catalytic reactions, Langmuir Hinshelwood rate equations and parameter estimation.

UNIT-II

Diffusion through Porous Catalyst Particles:
Effectiveness factor for pore diffusion resistance through a single cylindrical pore, Significance of Thiele modulus, Heat effects during reaction, Performance equations for solid- gas reactions for different reactor types & determination of controlling resistance.

UNIT-III

Kinetics of Fluid-Particle Reactions:
Modelling of gas-solid non-catalytic reactions and determination of parameters, Combination of resistances & determination of rate controlling step.
Kinetics & Design of Fluid-Fluid Reactions:
Interface behaviour for liquid-phase reaction, Regimes for different reaction kinetics for liquid-liquid reactions, Determination of reaction rate & tower height based on film and penetration theories, Concept of Enhancement factor & Hatta Number.

UNIT-IV

Design of Heterogeneous Reactors:
Analysis of rate data design outline and selection of fixed bed, fluid bed and slurry reactors, Reactor systems and design for gas-liquid-solid non-catalytic system.
Recommended Books

1. J.M. Smith, 'Chemical Engineering Kinetics', 3rd Edn., McGraw Hill, **1981**.
2. Levenspiel O., 'Chemical Reaction Engineering', 3rd Edn., John Willey, **2004**.

3. D.G. Peacock, J.F. Richardson, 'Chemical Engineering', Vol.-3, 3rd Edn., Butterworth Heinemann, **1994**.
4. S.M. Walas, 'Reaction Kinetics for Chemical Engineers', 3rd Edn., McGraw Hill Book Co. Inc.
5. K.G. Denbigh, J.C.R. Turner, 'Chemical Reactor Theory – An Introduction', 3rd Edn., Cambridge Univ. Press, London, **1984**.
6. H.S. Fogler, 'Elements of Chemical Reaction Engineering', 4th Edn., Prentice Hall, **2006.**
7. J.J. Carberry, 'Chemical and Catalytic Reaction Engineering', McGraw Hill, New York, **1976**.

MASS TRANSFER - II

Subject Code: BCIE2-520 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Prerequisite: The students should have studied Mass Transfer-I as a prerequisite to study this course

Course Objectives: The objective of this course is to present the principles of mass transfer and their application to separation and purification processes. The concept of various mass transfer operations is developed which are extensively used.

UNIT-I

Distillation:
Roult's law, ideal solutions, x-y & H-x-y diagrams, Flash vaporization and condensation. Differential distillation, Batch distillation, Rayleigh equation, Steam distillation, Binary distillation, McCabe-Thiele and Ponchon-Savarit method, Total reflux, minimum and optimum reflux ratios, Efficiency – local, overall and Murphree efficiency, Introduction to distillation column design, Design of distillation columns with open steam, partial condensers and total condensers. Approximate plate to plate calculations for multi-component distillation.

UNIT-II

Liquid-Liquid Extraction:
Extraction equipment, equilibrium diagram. Choice of solvent. Single stage and multistage counter-current extraction with/without reflux. Continuous contact extractors.

Leaching:
Leaching equipment and equilibrium. Single stage and multistage cross current and counter current leaching.

UNIT-III

Adsorption:
Types, nature of adsorbents, Adsorption equilibria- single species- Langmuir, Freundlich isotherms, Adsorption operations –single stage and multi stage, Adsorption column sizing

UNIT-IV

Crystallization:
Equilibria and yields, Methods of forming nuclei in solution and crystal growth, equipment-vacuum crystallizer, Draft tube-baffle crystallizer.

Books Recommended

1. Treybal Robert E., 'Mass Transfer Operations', 3rd Edn., McGraw Hill, **2001.**
2. T.K. Sherwood, R.L. Pigford, C.R. Wilke, 'Mass Transfer, Chemical Engineering Series', McGraw Hill, **1975**.

3. J.R. Backhurst, J.H. Harker, J.F. Coulson, J.M. Richardson, 'Chemical Engineering', Vol.-1, 6th Edn., Butterworth Heinemann, **1999.**
4. A.H.P. Skelland, 'Diffusional Mass Transfer', Kreiger Publishing Co., **1985**.
5. McCabe, Warren L., Julian C. Smith and P. Harriot, 'Unit Operations of Chemical Engg.', 7th Edn., McGraw Hill, **2005**.
6. J.H. Harker, J.F. Richardson, J.R. Backhurst, 'Chemical Engg.', Vol.-2, 5th Edn., Butterworth-Heinemann, **2003**.
7. C.J. King, 'Separation Process', Tata McGraw Hill Pub.
8. Holland, Charles D., 'Fundamentals and Modelling of Separation Processes', Prentice Hall, Inc., New Jersey.

PETROLEUM REFINING - I

Subject Code: BCIE2-521 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: The objective of this course is to impart knowledge about exploration and refining of crude oil. Imparting concept of various refining process.

UNIT-I

Exploration and Refining of Crude Oil: Introduction, Indian and world reserve of crude oil and its processing capacity, Market demand & supply of petroleum Fractions. Exploration, Drilling and Production of crude oil; engineering data of crude and fractions. Characterization factor, Key Fraction Number and correlation index methods for evaluation of crude & fractions. TBP, ASTM, EFV, and their inter-convertibility, yield Curve etc.

UNIT-II

Desalting of crude, pipe still furnaces, preflashing operation, Atmospheric and vacuum distillation units, different types of Reflux arrangements, Calculation of tray requirement for ADU column. Test methods and specifications: Distillation, Aniline point, Reid vapour pressure, Smoke point, flash point fire point, Carbon residue, viscosity and viscosity index, refractive index, Copper & silver strip corrosion, Octane No, cetane No, sulphur content, calorific value, Total acid number, oxidation stability, cloud point, pour point etc.

UNIT-III

Thermal Conversion Processes: Thermal cracking processes – mechanism, applications e.g. visbreaking, thermal cracking, coking operations, Catalytic Conversion Processes: Catalytic cracking processes, Different FCC operating modes, Catalytic reforming operations, Hydro cracking, Simple process calculations.

UNIT IV

Thermal Polymerization, Isomerization processes, Alkylation, Catalytic Polymerization for gasoline stock preparation.

Finishing & Treatment Processes: Different Hydro treatment (e.g. Hydro desulfurization) processes, Merox process, Doctor's sweetening, Smoke point improvement, etc. Simple process calculations Alternative fuels, Production and Specifications: Synthetic gasoline, Bio Diesel, Ethanol, Automotive LPG.

Recommended Books

1. W.L. Nelson, 'Petroleum Refinery Engineering', McGraw Hill.
2. B.K. Rao, 'Modern Petroleum Refining Processes', Oxford & IBM.
3. Ram Prasad, 'Petroleum Refining Technology', Khanna Publishers.

4. G.N. Sarkar, 'Advanced Petroleum Refining', Khanna Publishers.

INDUSTRIAL POLLUTION CONTROL

Subject Code: BCIE2-522 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Prerequisite: The students should have studied Mechanical Operations as a prerequisite to study this course

Course Objectives: The course aims at giving the students an insight into the environmental issues related to chemical process industries in terms of their impact on land, water and air and the possible mitigation techniques to reduce this effect for sustainable processing.

UNIT-I

Introduction: Ambient air and water standards, principle sources of pollution, Inter relationship between energy and environmental pollution, Prevention of environmental pollution through conservation.

UNIT-II

Air Pollution: Principal air pollutants and their usual sources, Effects of air pollution on human health, animals and vegetation and materials, Atmospheric dispersion of air pollutants, Temperature inversions. Ambient air sampling, dust fall jar and high volume sampler, stack sampling

Air pollution control techniques –

Process and equipment's used for the control of gaseous pollutants- equipment efficiency, gravity settler, cyclone separator, fabric filters, Electrostatic precipitators, scrubbers.

UNIT-III

Water Pollution: Types of water pollutants, their sources and effects. BOD and COD, BOD5, oxygen sag curve, waste water sampling- grab and composite sample.

Waste water treatment:

Primary Treatment through settling techniques and equipment like flocculation, skimming, flotation.

Secondary Treatment: aerobic and anaerobic digestion, activated sludge process, trickle filter and oxidation ponds.

UNIT-IV

Solid Waste: Control and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling.

Books Recommended

1. H.C. Perkins, 'Air Pollution', McGraw Hill, N.Y., **1974.**
2. B.G. Liptak, D.H.F. Liu, 'Environmental Engineers Handbook', 2nd Edn., CRC Press, **1999**.
3. S.J. Willisamson, 'Fundamentals of Air Pollution', Addison Wesley Co. N.Y., **1973**.
4. N.L. Nemerow, 'Liquid Wastes of Industry: Theory, Practices and Treatment', Addison Wesley Co. N.Y., **1971**.
5. C.S. Rao, 'Environmental Pollution Control Engineering', 2nd Edn., New Age International Pvt. Ltd., **2006**
6. Metcalf and Eddy, 'Waste-Water Engineering', 4th Edn., Tata McGraw Hill, **2007**.
7. S.P. Mahajan, 'Pollution Control in Process Industries', Tata McGraw Hill, **2008**.
8. A.P. Sincero, G.A. Sincero, 'Environmental Engineering', Prentice-Hall of India, **1999**.

RESERVOIR ENGINEERING - II

Subject Code: BCIE2-523 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: To impart knowledge about different drive mechanism for flow and measurements and different tests involved.

UNIT-1

Production behavior of gas, gas condensate and oil reservoirs. Rock and fluid compressibility effect. Generalized MBE & Gas MBE. Drive mechanism and recovery factors. Drive indices. Water influx in reservoir, Performance prediction of depletion, gas cap, water and combination drive, reservoir pressure maintenance. Displacement process, Immiscible, Buckeley & Leverett treatment of fractional flow &frontal advance equations. Water flood performance.

UNIT-II

Reservoir Management: Concepts of Reservoir Management and its Application, Well Test Analysis

UNIT-III

Diffusivity Equation Derivation & constant Terminal Rate Solution.

UNIT-IV

Measurements and Tests: Reservoir Pressure Measurements and Significance: Techniques of pressure measurement. Steady State Flow Tests (Indicator Diagram) and Gas Well Tests, Drill Stem Testing: Equipment, DST chart observation and preliminary interpretation, Pressure Transient Tests: Analysis and Pressure Draw-down Tests, Pressure buildup test, RLT etc. for oil and gas both. Treatment of PBU/ PDD in Horizontal wells. Pressure fall-off test in injection wells. Multirate testing, Average Reservoir Pressure, Type curves & its uses.

Recommended Books

1. T. Ahmed, 'Reservoir Engineering Handbook', 3rd Edn., Elsevier, **2006**.
2. Slip Slider, H.C. 'Worldwide Practical Petroleum, Reservoir Engineering Method', Penn Well Publishing Company, **1983**.
3. Gianluigi Chierici, 'Principles of Petroleum Reservoir Engineering', Elsevier, **1994**.

MASS TRANSFER LAB.

Subject Code: BCIE2-524 **L T P C**
0 0 2 1

EXPERIMENTS

1. To find out the critical moisture content of the given material and to find out the equations for constant and falling rate period of drying.
2. Determination of liquid hold up in a packed column.
3. To find the mass transfer coefficient for the vaporisation of organic vapour to air.
4. To verify the Rayleigh's equation for batch distillation.
5. To find the height equivalent to a theoretical plate and height of a transfer unit for the packed distillation column under total reflux.
6. To find the yield of crystals using batch crystallizer
7. To find the efficiency of rotary drier using a granular solid
8. To find the efficiency of a distillation column.

9. To study the adsorption characteristics and plot adsorption isotherm.
10. To find the yield of a natural oil by leaching from biomass.
11. To study liquid-liquid extraction in a packed column.
12. To determine mass transfer coefficient from a wetted wall column.

PETROLEUM TESTING LAB.- I

Subject Code: BCIE2-525 **L T P C**
0 0 2 1

Course Objectives: To introduce various methods of analysis by using sophisticated instruments and analytical equipment to determine various physical properties of crude, natural gas, petroleum products and petro-chemicals. On completion of the course, the students should be conversant with the theoretical principles and experimental procedures for quantitative estimation.

EXPERIMENTS

1. Aromatic content Determination
2. Carbon residue determination
3. Karl-Fisher Conductometer Apparatus for water estimation
4. Foaming characteristics of lube oil
5. Mercaptan as sulphur estimation
6. Copper Corrosion test of petroleum oil
7. Freezing point of Aqueous Engine coolant solution
8. True boiling point distillation, ASTM distillation.
9. Octane No. and Cetane No. determination.
10. Smoke point determination.
11. Viscocity and viscocity index determination.
12. Pour point and cloud point determination.

CHEMICAL PROCESS PLANT DESIGN-I

Subject Code: BCIE2-526 **L T P C** **Duration: 45 Hrs.**
0 0 2 1

EXPERIMENTS

1. Selection, Preparation of specification sheet for a centrifugal pump
2. Design of piping and piping networks
3. Process design of gravity chambers
4. Process design of cyclones
5. Process Design of Shell and Tube Heat Exchanger
6. Process Design of Condensers
7. Process Design of Agitated vessels
8. Introduction to plate heat exchangers and its design
9. Specification sheet for Heat exchangers

The student is to appear in a viva-voce examination.

Recommended Books

1. Coulson, Richardson & R.K. Sinnott, 'Chemical Engineering – An Introduction to Chemical Engineering Design', Vol.-6, 4th Edn., Elsevier Butterworth Heinemann, **2005**.

2. R.H. Perry, D.W. Green, 'Chemical Engineers Handbook', 8th Edn., McGraw Hill, **2008.**
3. A.K. Coker, 'Ludwig's Applied Process Design in Chemical & Petrochemical Plants', Vol.-1, 4th Edn., Gulf Publication- Butterworth Heinemann, **2007**.
4. E.E. Ludwig, 'Applied Process Design in Chemical & Petrochemical Plants', Vol.-3, 3rd Edn., Gulf Publication-Butterworth Heinemann, **2001.**
5. F.C. Vilbrandt, C.E. Dryden, 'Chemical Engg. Plant Design', 4th Edn., McGraw Hill, **1959**.
6. M.S. Peters, K.D. Timmerhaus, 'Plant Design and Economics for Chemical Engg.', 5th Edn., McGraw Hill, **2003.**
7. F. Molyneux, 'Chemical Plant Design–I', Butterworth Heinemann, **1963.**

TRAINING-II

Subject Code: BCIE2-527 **L T P C**
0 0 4 2

Each student will be required to submit a report after the completion of industrial/ institutional training. The reports will be assessed by teachers in-charge of the training. The student has to appear in Viva-Voce examination.

PETROLEUM REFINING-II

Subject Code: BCIE2-628 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: To impart knowledge of processes like cracking, reforming, alkylation, coking and asphalt technology.

UNIT-I

CRACKING: Need and significance, types and functions of Secondary Processing. Cracking, Thermal Cracking and Vis breaking, Hydro Cracking- principles, reactions in Hydro Cracking, Catalyst, Hydro Cracking Reaction Conditions. Different Feed Stocks, Products Yields, Qualities and Recent Development. Catalytic Cracking, Commercial Catalyst, Feedstock and Catalytic Cracking Conditions, Types and Processes- Fixed Bed Cracker, Fluid Catalytic Cracking (FCC), Flexi Cracking.

UNIT-II

CATALYTIC REFORMING: Theory, Reaction Conditions and Catalyst for Catalytic Reforming, Platforming, Houdri Forming, Rhein Forming, Power Forming, Selecto Forming. Ultra Forming and Rex Forming., Feedstock Selection and Effect of Steam.

UNIT-III

ALKYLATION AND ISOMERIZATION: Feed Stocks and Reactions for Alkylation Process- Cascade Sulphuric Acid Alkylation, Hydrofluoric Acid Alkylation. Isomerization Process- Isomerization with Platinum Catalyst and Aluminium Chloride Process.

UNIT-IV

COKING: Methods of Petroleum Coke Production – Koppers, Delayed Coking, Fluid Coking and Contact Coking. Iso Max Processes and Hydro Desulphurization Processes.
ASPHALT TECHNOLOGY: Source of Asphalt (Bitumen), Chemical Structure of Asphalt, Action of Heat on Asphalt, Types of Asphalts. Air Blowing of Bitumen and Upgradation of Heavy Crudes. Specialty Products: Industrial Grease- Manufacture of Calcium Grease, Liquid Paraffin and Petroleum Jellies.

Recommended Books

1. Ram Prasad, 'Petroleum Refining Technology', Khanna Publishers, **2007**.
2. D.S.J. Jones and P.R. Pujadó, 'Handbook of Petroleum Processing', Springer, The Netherlands, **2006**.
3. W.L. Nelson, 'Petroleum Refinery Engineering', McGraw Hill Publishing Company Limited, **1985**.
4. R.N. Watkins, 'Petroleum Refinery Distillations', 2nd Edn., Gulf Publishing Company, Texas, **1981**.
5. B.K. Bhaskar Rao, 'Modern Petroleum Refining Processes', 4th Edn., Oxford and IBH Publishing Company Pvt. Ltd., **2002**.
6. S. Parkash, 'Refining Processes Handbook', Gulf Professional Publishing, **2003**.
7. G.D. Hobson, 'Modern Petroleum Refining Technology', 5th Edn., John Wiky Publishers,**1984**.
8. J.H. Gary and G.E. Handwork, 'Petroleum Refining Technology and Economics', 4th Edn., Marcel Dekker Inc., **2001**.

PETROCHEMICALS

Subject Code: BCIE2-629 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: To Provide overall view of Petrochemical and impart knowledge of various processes and technology involved in their production

UNIT-I

Overview of petrochemical industrial Growth in India, Economics, Feedstock Selection for Petrochemicals

UNIT-II

Steam reforming, Hydrogen, Synthesis gas, cracking of gaseous and liquid for stocks, Olefins, Diolifins, Acetylene and Aromatics and their separation.

UNIT-III

Alkylation, Oxidation, Dehydrogenation, Nitration, Chlorination, Sulphonation and Isomerization

UNIT-IV

Chemicals from synthesis gas, Olefins, Diolefins, Acetylene and Aromatics.
Modes and techniques, Production of Polyethylene, PVC, Polypropylene, SAN, ABS, SBR, Polyacrylonitrile, Polycarbonates, Polyurethane, Nylon, PET.

Recommended Books

1. A.M. Brownstein, 'Trends in Petrochemical Technology', Petroleum Publishing Company, **1976**.
2. M. Sitting, 'Aromatics Hydrocarbons, Manufacture and Technology', Noyes Data Corporation, **1976**.
3. P.M. Stevens, 'Polymer Chemistry', Addison Wesley Publishing Company, **1975**.
4. F. Hatch and Sami Mater, 'From Hydrocarbon to Petrochemicals', Gulf Publishing Company, Texas, **1998**.
5. 'Petrochemical Hand Book of Hydrocarbon Processing', **1988, 1989.**
6. B.K.B. Rao, 'A Text on Petrochemicals', Khanna Publications, Delhi, **ISBN**.

PROCESS INSTRUMENTATION AND DYNAMICS CONTROL

Subject Code: BCIE2-630 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives:
To introduce control equipment used to control the production process of a chemical factory and to introduce the control mechanism through‟ automation and computers. Students will gain knowledge in designing a control system and identifying the alternative control configuration for a given process plant or entire plant. They will be familiar with the control mechanism before attempting to tackle process control problems.

UNIT-I

Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems in Laplace transformation, application. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics, transfer function for chemical reactors and dynamics.

UNIT-II

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulator problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, transient response of closed-loop control systems and their stability.

UNIT-III

Introduction to frequency response of closed-loop systems, control system design by frequency, Bode diagram, stability criterion, Nyquist diagram; Tuning of controller settings.

UNIT-IV

Controller mechanism, introduction to advanced control systems, cascade control, feed forward control, control of distillation towers and heat exchangers, introduction to microprocessors and computer control of chemical processes.

Principles of measurements and classification of process control instruments, measurements of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity and consistency, pH, concentration, electrical and thermal conductivity, humidity of gases, composition by physical and chemical properties and spectroscopy.

Recommended Books

1. Coughnowr and Koppel, ‘Process Systems Analysis and Control’, McGraw Hill, New York, **1986**.
2. George Stephanopolous, ‘Chemical Process Control’, Prentice-Hall of India Pvt. Ltd. New Delhi, **1990**.
3. D. Patranabis, ‘Principles of Process Control’, 2nd Edn., Tata McGraw Hill Publishing Co. Ltd., **1981**.
4. Peter Harriott, ‘Process Control’, Tata McGraw Hill Publishing Co., Reprint **2004**.
5. D.P. Eckman, ‘Industrial Instrumentation’, John Wiley, **2001**.

PETROLEUM EQUIPMENT DESIGN

Subject Code: BCIE2-631 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: To understand the concept of designing Equipment for Petroleum Exploration. To study and analyze the suitable equipment for particular reservoir conditions.

UNIT-I

Casing program, casing and tubing design, principles of cementing, completion added skin, well perforating and hydraulic fracturing. DRILL BIT DESIGN.ROLLER CONE BITS.PDC DRILL BITS.NOMENCLATURE AND IADC CODES for drill bits. BHA (Bottom hole assembly). ESP (Electrical submersible pumps). SRP (Sucker rod pumping) unit design.

UNIT-II

Design of Surface Facilities -Design of production and processing equipment, including separation problems, treating, and transmission systems.
Capstone design Student teams apply knowledge in the areas of geology, reservoir engineering, production, drilling and well completions to practical design problems based on real field data with all of the associated shortcomings and uncertainties. Use of commercial software.

UNIT-III

Oil desalting-horizontal and spherical electrical dehydrators- Natural Gas Dehydration-Hortonsphere- Natural Gas Sweetening. Crude & Condensate Stabilization-design of stabilizer-Oil and Gas Treatment. Treating Equipment.

UNIT-IV

Refinery Equipment Design-atmospheric distillation column Design and construction of on/ offshore pipelines, Fields Problems in pipeline, Hydrates, scaling & wax etc and their mitigation

Recommended Books

1. G.B. Moody, 'Petroleum Exploration Hand Book'.
2. Sahay. B et al, 'Wellsite Geological Techniques for Petroleum Exploration'.
3. William C. Lyons & Gary J. Plisga, 'Standard Hand Book of Petroleum & Natural Gas Engineering', 2nd Edn., Gulf Professional Publishing Comp (Elsevier), **2005**.

SEPARATION TECHNIQUES

Subject Code: BCIE2-656 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives: To understand the modern specialized separations techniques and to learn the basic principles used in such technique.

UNIT-I

MEMBRANE SEPARATIONS: Types and choice of membranes – Plate and frame membranes, tubular membranes, spiral wound membranes, hollow fibre membrane and their relative merits, membrane reactors, membrane permeators involving Dialysis – Reverse osmosis – Ultrafiltration

UNIT-II

CHROMATOGRAPHY TECHNIQUES: Affinity chromatography, immuno chromatography and Ion exchange chromatography –Introduction – Principles – Types of equipment – Commercial processes – Applications.

UNIT-III

SEPARATIONS BY ADSORPTION TECHNIQUES: Types of adsorption – Nature of adsorbents – Adsorption equilibria – Adsorption hysteresis adsorption isotherms – Effect of temperature and pressure – Freundlich equation – Stage wise adsorption – Single and multistage crosscurrent adsorption – Break through curves and rates of adsorption.

UNIT-IV

IONIC SEPARATIONS: Electrophoresis – Introduction – Electrokinetics – The electrical double layer – Zeta potential and electrophoresis – Laboratory methods – Analytical and Preparative methods – Applications.

ZONE MELTING: Zone melting – Introduction – Equilibrium Diagram – Apparatus and Applications – Large scale and continuous operations – Limitations.

Recommended Books

1. H.M. Schoen, 'New Chemical Engineering Separation Techniques', Interscience Publishers, **1972**.
2. R.E. Treybal, 'Mass Transfer Operations', 3rd Edn., McGraw Hill Book Co., **1980**.
3. C.J. Geankoplis, 'Transport Processes and Unit Operations', 3rd Edn., Prentice Hall of India Pvt. Ltd., **2000**.
4. B. Sivasankar, 'Bioseparations Principles and Techniques', Prentice Hall India Pvt. Ltd., **2006**.
5. J.D. Seader and E.J. Henley, 'Separation Process Principles', 2nd Edn., John Wiley and Sons, Inc., **2006**.

TRANSPORT OF OIL AND GAS

Subject Code: BCIE2-657 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives:

1. To familiarize the students with the various elements and stages involved in transportation of oil and gas.
2. To understand international standards and practices in piping design.
3. To know various equipment and their operation in pipeline transportation.
4. To understand modern trends in transportation of oil and gas.

UNIT-I

Hydrocarbon Properties and General Background: Introduction. Basic Principles. Steady State Liquid Flow. Gas Flow. Complex flow system, Flow Regimes in Vertical and Horizontal Multiphase Pipeline Flow. Gathering System. Storage tanks, Trunk line System. Role of Flow Improvers. Factors Affecting Flow Characteristics. Flow Correlations.

UNIT-II

Pipeline Transportation: Pressure Drop in Piping Basic Principles. Fluid Flow Equations. Heat Loss in Valves and Fit tings. Friction Factor and Flow types. Pressure drop in liquid line. Pressure drop in gas line. Pressure drop in two phase line Line Size and Wall Thickness Line Size Criteria. Wall Thickness Criteria. Pressure Rating Classes. Industrial Standards, Liquid line, Gas line, Two-Phase line. Pipe lines in Series and parallel. Problems based on piping design.

UNIT-III

Piping Operations: Onshore and offshore Pipelines, mechanical operations, Supervisory control. Leaks and ruptures in pipelines Maintenance and repair. Valve types. Working mechanism of different valves. Valve sizing. Process procedures. Changing operating conditions. Materials. Connect ions. Tees. Pigging Operation and equipment. Testing of pipeline. Metering.

Pumps and Compressor: Pump Classification. Centrifugal Pumps. Reciprocating Pumps. Diaphragm Pumps. Rotary Pumps. Basic Principles. Working Mechanism. Types. Head. Horsepower. Net Positive Suction Head. Basic Selection Criteria and calculations. Positive Displacement Compressors. Dynamic Compressors. Reciprocating Compressors. Working Mechanism. Stage Compression and Operations. Compressor Design and Operation. Multistage calculations.

UNIT-IV

Gas Monetization: Stranded gas, deep offshore gas reserves, marginal gas fields, associated gas reserves, and remote gas reserves Overview of gas transportation options, transportation as gas, solid, or liquid, and transmission as electric power. Gas to Gas, Gas to sol ids, Gas to liquids, various processes, gas to power, Pipelines, Compressed Natural Gas, processes, Liquefied Natural Gas, Gas to ammonia and urea, Gas to Liquids—Fischer -Tropsch Route, Gas to Methanol, Gas to Power, Evaluation of Gas Monetization Options

Subsea Challenges: Flow assurance, subsea system engineering, challenges, flow assurance process, system design and operability, hydraulics, heat transfer and thermal insulation, hydrate, wax and Asphaltene formation, inhibition methods Safety and supervision. Economics of long distance pipelines. Rules and regulations.

Recommended Books

1. A.H. Mouselli, 'Offshore Pipeline Design, Analysis and Methods', Pennwell Books, Tulsa, Oklahoma.
2. Francis S. Manning and Richard E. Thompson, 'Oil Field Processing of Petroleum', Vol.- I, Pennwell Publishing Company, Tulsa. Oklahoma.
3. Ken Arnold and Maurice Stewart, 'Surface Production Operations', Vol.- I, II, Gulf Publishing Company, London.
4. Lurie Mikhail, 'Modeling of Oil Product and Gas Pipeline Transport', John Wiley, **2008**.
5. Young Bai and Quang Bai, 'Subsea Pipelines and Risers', Elsevier Publishing, **2005**.

PROGRAMMING, DATABASE MANAGEMENT AND INFORMATION SYSTEMS FOR OIL AND GAS INDUSTRY

Subject Code: BCIE2-658 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives:

1. To understand importance of Microsoft Excel and Microsoft Access
2. To understand the basics of RDBMS and importance of handling data related to various operations in petroleum industry
3. To understand effective information systems capable of handling large petroleum data
4. To understand effective use of workspace and related database in important projects in petroleum industry.

UNIT-I

Programming: Salient features of programming language (C, C++, VBA etc.), Basic and Intermediate Use of Microsoft Excel, Coupling of Microsoft Excel with VBA – Basics of Macros.

Handling Excel and MS Access: Basic introduction to Microsoft Access, Coupling of Access and Excel, writing basic queries in Access, Writing small VBA codes for Access and Excel, Functionalities of Access.

UNIT-II

RDBMS: Basics of RDBMS, Basics of higher end databases – MySQL, Oracle, JavaDB, SQLite, SQL Server Express, Possible appl ications of database in the oil and gas industry

Geospatial Information System:

Introduction to GIS, Spatial Data Models, Spatial Data Structures, Spatial Data Inputs, Visualization and Query of Spatial Data.

UNIT-III

Spatial Data Transformation and Auto Correlation: Geostatistics in data handling, optimal interpolation, Spatial Data Transformations, Tool s for map analysis, spatial analysis, creation of single and multiple maps.

UNIT-IV

Project Design: Design of project using available database for subsurface mapping and correlation, Environmental assessment. Petroleum industry case studies Applications of different software used in Petroleum Industry.

Recommended Books

1. J.E. Billo, 'Excel for Scientists and Engineers: Numerical Methods', Wiley Interscience, **2007**.
2. David Hoppman, 'Effective Database Design', Pennwell Corporation, **2003**.
3. P.A. Longley, M.F. Goodchild, D.J. MaGuire, D.W. Rhind, 'Geographical Information Systems and Science', John Wiley and Sons, **2001**.
4. M. Niravesh, F. Aminzadeh and L.A. Zadeh (Editors), 'Soft Computing and Intelligent Data Analysis for Oil Exploration, Development in Petroleum Science', Elsevier, **2003**,

MATHEMATICAL METHODS AND MODELING IN PETROLEUM EXPLORATION AND PRODUCTION

Subject Code: BCIE2-659 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objectives:

1. To understand the philosophy of petroleum exploration
2. To learn the basic principles of seismic interpretations used in petroleum exploration.
3. To understand the principles used in developing a geological model building.
4. To understand the principles used in developing Reservoir Modeling

UNIT-I

Seismic Exploration-I: Introduction to Seismic Texture, Atlas of 3D Seismic Attributes, the Use of Structure Tensors in the Analysis of Seismic Data.

Seismic Exploration-II: Automated Structural Interpretation through classification of Seismic Horizons, Automatic Fault Extraction Using Artificial Ants, Seismic Stratigraphy, seismicfacies analysis.

UNIT-II

Geostatistics for Reservoir Characterization: Variogram, Kriging, autocorrelation, conditional simulation for heterogeneity modeling and uncertainty quantification, data integration.

Geological Model Building: Geological Modeling and Reservoir Simulation, Uncertainty and risk, flow through porous media, reservoir heterogeneity, auto correlation, stochastic modeling, Monte Carlo Simulation.

UNIT-III

Geological Model Building-II:

Geological Model Building**:** a Hierarchical Segmentation Approach, Mapping 3D Geo- Bodies, Modern Techniques in Seismic Tomography

UNIT-IV

Reservoir Modeling: From 3D Seismic Facies to Reservoir Simulation, up scaling, data integration, Reservoir flow simulation through adaptive ADER method, Optimal Multivariate Interpolation, Seismic Modeling and Time-Lapse Data.

Recommended Books

1. Armin Iske and Trygve Randen, 'Mathematical Methods and Modeling in Petroleum Exploration and Production', Springer Verlag, **2005**.
2. M. Beacon, R. Simm and T.D. Redshaw, 'Seismic Interpretation', Cambridge University Press, **2003**.
3. Clayton Deutsch, 'Geostatistical Reservoir Modeling', Oxford University Press, **2002**.
4. J.R. Fanchi, 'Shared Earth Modeling: Methodologies for Integrated Reservoir Simulations', Gulf Publishing, **2002.**
5. Veeken Paul, 'Seismic Stratigraphy, Basin Analysis and Reservoir Characterization', Elsevier Publications, **2007**.

PETROLEUM TESTING LAB.- II

Subject Code: BCIE2-632 **L T P C**
0 0 2 1

Course Objectives: To impart practical knowledge on different petroleum testing methods. Students learn petroleum testing, determination of aniline point, softening point, carbon residue, foaming characteristics, sulphur content etc.

EXPERIMENTS

1. Petroleum testing using Distillation Apparatus
2. Moisture estimation using Dean and Stark Apparatus
3. Determination of Aniline Point
4. Determination of Softening Point
5. Determination of Conradson Carbon Residue
6. Determination of Binder Content using Bitumen Apparatus.
7. Determination of foaming Characteristics
8. Determination of Congealing Point of Wax.
9. Determination of H_2S and Sulphur Content
10. Determination of Aromatic Content Determination

PROCESS CONTROL LAB.

Subject Code: BCIE2-633 **L T P C**
0 0 2 1

Course Objectives: To familiarize the students about the behaviour of first and second order, interacting and non- interacting systems, open and closed loop study on level, flow and thermal systems along with their respective tunings.

EXPERIMENTS

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting Level System
4. Response of Interacting Level System
5. Open loop study on a level system
6. Open loop study on a flow system
7. Open loop study on a thermal system
8. Closed loop study on a level system
9. Closed loop study on a flow system
10. Closed loop study on a thermal system
11. Tuning of a level system
12. Tuning of a flow system
13. Tuning of a thermal system
14. Flow co-efficient of control valves
15. Characteristics of different types of control valves

Minimum 10 experiments shall be offered

LITERATURE SURVEY & SEMINAR

Subject Code: BCIE2-634 **L T P C**
0 0 2 1

The students will be introduced to and made conversant with

1. Availability of literature, journals and patents
2. Concept of impact factor of journals
3. Presentation of bibliography and referencing of information

Each student will have to prepare and deliver a seminar based on literature survey and to attend the seminars, regularly. Depending on his/her performance in seminar he/she will be evaluated. Main aim is to develop presentation skills in the students.