Scheme & Syllabus of B.Tech Petrochem & Petroleum Refinery Engineering
Batch 2012 onwards

By
Department of Academics

Punjab Technical University

B.Tech Petrochem & Petroleum Refinery Engineering
Scheme of Syllabi
3rd Semester

Total Contact Hours= 31

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTAM-201	Engineering Mathematics -III	4	1	--	40	60	100	5
BTPC -301	Organic Chemistry	3	1		40	60	100	4
BTPC302/ BTCH303	Fluid Flow	3	1	--	40	60	100	4
BTPC303/ BTCH403	Heat Transfer	3	1	--	40	60	100	4
BTPC304/ BTCH302	Chemical Process Calculations	3	1	--	40	60	100	4
BTPC305	Organic Chemistry Laboratory	--	--	2	30	20	50	1
BTPC306	Heat Transfer Laboratory	--	--	4	30	20	50	2
BTPC307/ BTCH307	Fluid Flow Laboratory	--	--	4	30	20	50	2
BTPC308	Institutional Practical Training undertaken after 2nd Semester	--	--	--	100	--	100	--
	Total	**16**	**5**	**10**	**390**	**360**	**750**	**26**

B.Tech. Petrochem & Petroleum Refinery Engineering
Scheme of Syllabi
4th Semester

Total Contact Hours= 36

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTPC401	Reservoir Engineering -I	4	1	--	40	60	100	5
BTPC402/BTCH 301	Mechanical Operations	3	1	--	40	60	100	4
BTPC403/BTCH 402	Mass Transfer-I	3	1	--	40	60	100	4
BTPC404/BTCH305	Chemical Engineering Thermodynamics	3	1	--	40	60	100	4
BTPC405	Geology of Petroleum	3	--	--	40	60	100	3
BTPC406/BTCH 405	Chemical Reaction Engineering-I	3	1	--	40	60	100	4
BTPC407/BTCH 308	Mechanical Operation Laboratory	--	--	4	30	20	50	2
BTPC408	Chemical Reaction Engineering Laboratory	--	--	4	30	20	50	2
BTPC409	Computational Chemical Engineering Laboratory	--	--	4	30	20	50	2
--	General Fitness	--	--	--	100	--	100	--
Total		19	5	12	430	420	850	30

B.Tech. Petrochem & Petroleum Refinery Engineering
Scheme of Syllabi
5th Semester

Total Contact Hours= 32

Course Code	Course Name	Load Allocated			Marks Distribution		Total Mark	Credits
		L	T	P	Internal Marks	External Marks		
BTPC501/BTCH 601	Chemical Reaction Engineering-II	3	1	--	40	60	100	4
BTPC502/BTCH 502	Mass Transfer-II	3	1	--	40	60	100	4
BTPC503	Petroleum Refining-I	3	1	--	40	60	100	4
BTPC504/BTCH504	Industrial Pollution Control	3	1	--	40	60	100	4
BTPC505	Reservoir Engineering-II	3	1	--	40	60	100	4
BTPC506/BTCH505	Mass Transfer Laboratory	--	--	4	30	20	50	2
BTPC507	Petroleum Testing Laboratory-I	--	--	4	30	20	50	2
BTPC508/BTCH607	Chemical Process Plant Design-I	1	--	3	30	20	50	3
BTPC509	Industrial Practical Training**	--	--	--	60	40	100	2
	Total	16	5	11	350	400	750	29

There should be industrial / institutional training of 6 weeks duration in the summer vacation after 4thSemster.

B.Tech. Petrochem & Petroleum Refinery Engineering
Scheme of Syllabi
6th Semester

Total Contact Hours= 32

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTPC601	Petroleum Refining-II	3	1	0	40	60	100	4
BTPC602	Petrochemicals	3	1	0	40	60	100	4
BTPC603	Process Instrumentation & Dynamic Control	3	1	0	40	60	100	4
BTPC604	Petroleum Equipment Design	0	0	6	60	40	100	3
BTPC605	Elective-I **	4	0	0	40	60	100	4
BTPC606	Petroleum Testing Laboratory-II	0	0	4	30	20	50	2
BTPC607	Process Control Laboratory	0	0	4	30	20	50	2
BTPC608	Literature Survey & Seminar	0	0	3	30	20	50	2
General Fitness		0	0	0	100	--	100	--
		13	3	16	410	340	750	25

** **ELECTIVE - I**

Any one from the following:-

BTPC-605 (A) Separation Techniques

BTPC- 605 (B) Transport of Oil & Gas

BTPC-605 (C) Programming, Data base management and Information systems for oil & gas Industry

BTPC-605 (D) Mathematical methods and modeling in petroleum exploration and production

7th Semester

Course Code	Course Name	Load Allocated (Duration)	Marks Distribution		Total Marks	Credits
			Internal Marks	External Marks		
BTPC701/ BTCH 701	Software Training ***	8 Weeks	150	100	250	10
BTPC702/ BTCH 702	Industrial/Institutional Training	16 Weeks	300	200	500	20
	Total	24 Weeks	450	300	750	30

***** To enhance the professional capabilities of the students , The Petrochem & Petroleum Refinery Engineering Department in the institute is to provide software training in any two of the following:-**

- **ASPN**
- **CHEMCAD**
- **MATLAB**
- **Any other relevant software**

B.Tech. Petrochem & Petroleum Refinery Engineering
Scheme for Syllabi
8th Semester

Total Contact Hours= 31

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTPC801	Petroleum Exploration & Production Operation	3	1	--	40	60	100	4
BTPC802	Petroleum Refining-III	3	--	--	40	60	100	3
BTPC803	Elective-II ***	3	--	--	40	60	100	3
BTPC804	Environmental Technology & Safety in Petroleum Industry	3	--	--	40	60	100	3
BTPC805	Reservoir Modeling and Simulation	4	--	--	40	60	100	4
BTPC806/BTCH 806	Chemical Process Plant Design-II	--	--	4	30	20	50	2
BTPC807	Petrochemical Analysis Laboratory	--	--	4	30	20	50	2
BTPC808	Project	--	--	6	60	40	100	3
	General Fitness	--	--	--	100	--	100	--
	Total	16	1	14	420	380	800	24

*** **ELECTIVE – II**

Any one from the following:-

BTPC-803 (A) Natural Gas Technology
BTPC-803 (B) Enhanced Oil Recovery
BTPC-803 (C) Drilling & Well Engineering
BTPC-803 (D) Petroleum Economics

3rd Semester

BTAM-201 ENGINEERING MATHEMATICS-III

External Marks: 60 **L T P**
Internal Marks: 40 **4 1 0**
Total Marks : 100

Common to all (IV Semester)

PART-A

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. .

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.

PART-B

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

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. .

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.

BOOKS RECOMMENDED:

1. Kreyszig, E., Advanced Engineering Mathematics, Eighth edition, John Wiley, New Delhi
2. Grewal, B. S., 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. Taneja, H. C., Engineering Mathematics, Volume-I & Volume-II, I. K. Publisher.
6. Babu Ram, Advance Engineering Mathematics, Pearson Education.
7. Bindra, J. S., Applied Mathematics, Volume-III, Kataria Publications.

BTPC-301 ORGANIC CHEMISTRY

External Marks: 60 **L T P**
Internal Marks: 40 **3 1 0**
Total Marks : 100

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-Alkanes-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-Reformat sky 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.

UNIT-V

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.

BTPC-302/BTCH-303 FLUID FLOW

External Marks: 60 **L T P**
Internal Marks: 40 **3 1 0**
Total Marks: 100

Objective: 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

Indroduction
2 hrs
Concept of fluid, difference between solids, liquids and gases; ideal and real fluids, Introduction to fluid statics and fluid flow

Fluid Statics
4hrs
Normal forces in fluids, Manometers of different types, Forces on submerged bodies, Buoyancy and stability.

Fluid Properties
6 hrs
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
10 hrs
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

Flow of Incompressible Fluids
10 hrs
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
4 hrs
Compressible flow, basic equation, Mach number and its significance and isentropic flow through nozzles

Flow Measurement
6 hrs
In closed channels - Pitot tube, Orifice meter, venturimeter, Rotameter
In open channels- Notches, Weirs

Fluid Machinery
6 hrs
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.

BOOKS RECOMMENDED:
1. McCabe, Warren L., Smith, Julian C. and Harriot, P., Unit Operations of Chemical Engg., 7th Ed., McGraw
Hill, 2005
2. Backhurst J.R., Harker J.H., Coulson J.F., Richardson J.M., Chemical Engineering – Volume 1, 6th Ed.,

Butterworth Heinemann, 1999
3. Foust, A.S., Wenzel L.A., Clump C.W. Maus L., Anderson L. B., Principles of Unit Operations, 2nd Ed., John
Wiley & Sons, 2008.
4. Raju K.S., Fluid Mechanics, Heat Transfer, and Mass Transfer: Chemical Engineering Practice, John Wiley
and Sons, 2011

BTPC-303/BTCH-403 HEAT TRANSFER

External Marks: 60
L T P
Internal Marks: 40
3 1 0
Total Marks : 100

Objective: The objective of the course is to introduce to students 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.

Modes of Heat Transfer:
Conduction
8 hrs
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.
Convection **10 hrs**
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.
Radiation
6 hrs
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
Condensation and Boiling Heat Transfer:
6 hrs
Dropwise and Filmwise condensation of pure and mixed vapours, Convective, Nucleate & Film boiling, Theory and correlations, critical boiling flux
Heat exchangers:
10 hrs
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.
Evaporators
8 hrs
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.

BOOKS RECOMMENDED:

1. Holman, J.P., Heat Transfer, 10th Ed., McGraw Hill, 2010.
2. McAdams W.H., Heat Transmission, 3rd Ed., Kreiger Publishing Co, 1985
3. Backhurst J.R., Harker J.H., Coulson J.F., Richardson J.M., Chemical Engineering – Volume 1, 6th Ed., Butterworth Heinemann, 1999
4. McCabe, Warren L., Smith, Julian C. and Harriot, P., Unit Operations of Chemical Engg., 7th Ed., McGraw Hill, 2005
5. Kern D.Q., Process Heat Transfer, McGraw Hill.
6. Kreith F., Manglik R.M., Bohn M.S., Principles of Heat Transfer, 7th Ed., Brooks Cole Thomson Learning Publication, 2010
7. Incopera F.P., DeWitt D.P., Bergman T.L., Lavine A.S., Fundamentals of Heat and Mass Transfer, 7th Ed., John Wiley, 2011

BTPC-304/BTCH-302 CHEMICAL PROCESS CALCULATION

External Marks: 60 **L T P**
Internal Marks: 40 **3 1 0**
Total Marks: 100

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.

Introduction to Chemical Engineering Calculations: **10 hrs**

Unit & Dimensions, Conversion of units, Mole concept, Basic Concept, Stoichiometric and composition relationship, limiting-excess- reactant, conversion and yield.

Material Balance **16 hrs**

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, stagewise and continuous operations in systems with or without chemical reaction.

Energy Balance

16 hrs

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.

Material and energy balances:

6 hrs

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

BTPC-306/BTCH-406 HEAT TRANSFER LABORATORY

External Marks: 20 **L T P**
Internal Marks: 30 **0 0 4**
Total Marks : 50

1. Determination of heat transfer coefficient for different types of heat transfer equipments.
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.

BTCH-307 FLUID FLOW LABORATORY

External Marks: 20 **L T P**
Internal Marks: 30 **0 0 4**
Total Marks : 50

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

(BTPE305) ORGANIC CHEMISTRY LABORATORY

LIST OF 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 Asprin
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

4th Semester

BTPC 404/BTCH 305 CHEMCIAL ENGINEERING THERMODYNAMICS

External Marks: 60 **L T P**
Internal Marks: 40 **3 1 0**
Total Marks: 100

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

Objective: 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.

Brief review:
(8 hrs)
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.

Review of 2nd and 3rd Law of thermodynamics: (10hrs)
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: (7 hrs)
Equation of state for real gases and their mixtures. Principle of corresponding states and generalized compressibility factor, H-x diagrams, heat of solution

Phase Equilibria: (16 hrs)
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 coeffiecients. 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.

Chemical Equilibria:
(7 hrs)

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.

BOOKS RECOMMENDED:

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

BTCH-402/BTPC-403MASS TRANSFER- I

External Marks: 60 **L T P**
Internal Marks : 40 **3 1 0**
Total Marks: 100

Objective: 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.

Introduction (2 hrs)

Importance and classification of mass transfer operations in Chemical Engineering.

Diffusion: (6hrs)

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

Interphase Mass transfer: (10 hrs)

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 equipments, HTU and NTU concepts.

Gas absorption: (10 hrs)

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

Drying of solids: (6 hrs)

Rate of drying curves, Through circulation drying, Continuous drying, Types of dryers.

Humidification operations: (8 hrs)

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

Dehumidification

Equipments: water cooling towers & spray chambers

Membrane Separations: (6hrs)

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

BOOKS RECOMMENDED:

1. Treybal Robert E., Mass Transfer Operations, 3rd Ed., McGraw Hill, 2001

2. Sherwood T. K., Pigford R.L., Wilke C.R., Mass Transfer, Chemical Engineering Series, McGraw Hill, 1975.

3. Backhurst J.R., Harker J.H., Coulson J.F., Richardson J.M., Chemical Engineering – Volume 1, 6th Ed., Butterworth Heinemann, 1999

4. Skelland, A.H.P, Diffusional Mass Transfer, Kreiger Publishing Co., 1985.

5. McCabe, Warren L., Smith, Julian C. and Harriot, P., Unit Operations of Chemical Engg., 7th Ed., McGraw Hill, 2005

BTPC 402/ BTCH 301 MECHANICAL OPERATIONS

External Marks: 60 **L T P**
Internal Marks: 40 **3 1 0**
Total Marks: 100

Objective: 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.

Characterization and Handling of Solids: (8 hrs)

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.

Screening: (4 hrs)

Capacity and Effectiveness of a screen, calculation of average size of particles in mixture by screen analysis, types of screens.

Agitation and Mixing: (8 hrs)

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.

Size Reduction: (6 hrs)

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: (8 hrs)

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

Settling: (8 hrs)

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: (6 hrs)

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.

BOOKS RECOMMENDED:

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

BTPC 406/BTCH 405 CHEMICAL REACTION ENGINEERING - I

External Marks : 60 **L T P**
Internal Marks : 40 **3 1 0**
Total Marks : 100

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.

Introduction: **(8 hrs)**
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.

Design for Single Reactions: **(16 hrs)**
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

Design for Multiple Reactions: **(8 hrs)**
Quantitative treatment of Series & parallel multiple reaction in a batch reactor, CSTR & PFR, Concept of Product distribution for multiple reactions.

Temperature & Pressure effects: **(8 hrs)**
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.

Non –Ideality: **(8 hrs)**
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.

BOOKS RECOMMENDED:

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

BTPC-401 RESERVOIR ENGINEERING - I

External Marks: 60 **L T P**
Internal Marks : 40 **3 1 0**
Total Marks : 100

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

Course content:

Fundamentals of Reservoir Engineering and Classification of petroleum reservoir. **4 hrs**

Reservoir Rock Properties : **10 hrs**
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: **12 hrs**
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 : **12 hrs**
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 : **4 hrs**
Reservoir drive mechanics and recovery factors

Reserve estimation: **6 hrs**
Estimation of petroleum reserve, resource & reserve concept, latest SPE/ WPC/ IS classification, volumetric material balance.

BOOKS RECOMMENDED:-

1. Ahmed, T, "Reservoir Engineering Handbook", 3rd Edition, Elsevier, 2006.
2. Slip Slider, H.C. "World wide Practical Petroleum Reservoir Engineering Method", Penn Well Publishing Company, 1983.
3. Gianluigi chierici, "Principles of Petroleum Reservoir Engineering", Elsevier, 1994.

BTPC-405 GEOLOGY OF PETROLEUM

External Marks : 60 **L T P**
Internal Marks : 40 **3 0 0**
Total Marks : 100

Objective- To impart basic knowledge of minerals, rocks, principles of stratigraphy, structural geology and topographic maps

Minerals: 4 hrs
General properties; Classification of minerals and properties of common rock forming minerals.

Petrology: 4hrs
Rocks; Classification and description of some common rocks.

Stratigraphy: 9 hrs
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.

Structural Geology: 10 hrs
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.

Exploration: 9 hrs

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

BOOK RECOMMENDED :-

1. Rutely H.H, Elements of Mineralogy, McGrawHill Book Co 2005
2. Read, H. H., Rutley's Elements of Mineralogy
3. Krishnan, M. S., Geology of India
4. Mukherjee, P. K., Introduction to Geology
5. Billings, M. P., Structural Geology

6.Philip Kearey,michael brooks,an introduction to geophysical exploration,Blackwell science

BTPC 408 CHEMICAL REACTION ENGINEERING LABORATORY

External Marks : 20	**L T P**
Internal Marks : 30	**0 0 4**
Total Marks : 50	

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

LIST OF 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

Books refered: .Levenspiel O., Chemical Reaction Engineering, 3rd Ed., John Willey, 2004.

BTPC-407/BTCH-308 MECHANICAL OPERATIONS LABORATORY

External Marks: 20 **L T P**
Internal Marks: 30 **0 0 4**
Total Marks: 50

1. Verification of Stokes Law.
2. Screen analysis of given sample for it's 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 equipments (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.

BOOKS RECOMMENDED:

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

BTPC 409 COMPUTATIONAL CHEMICAL ENGINEERING LABORATORY

External Marks : 20 **L T P**
Internal Marks : 30 **0 0 4**
Total Marks : 50

OBJECTIVE 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 equipments and flowsheets will be simulated using Aspen Plus and property analysis and estimation will be done using Aspen Properties.

BOOKS RECOMMENDED:-

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

5th Semester

BTCH-601/BTPC-501 CHEMICAL REACTION ENGINEERING –II

External Marks: 60	**L T P**
Internal Marks: 40	**3 1 0**

Total Marks: 100

Prerequisite: The students should have studied Chemical Reaction Engg. – I as a prerequisite to study this course

Objective: 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.

Kinetics of heterogeneous reactions: (10 hrs)

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.

Diffusion through porous catalyst particles: (10 hrs)

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.

Kinetics of Fluid-Particle Reactions: (10 hrs)

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: (10 hrs)

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.

Design of heterogeneous reactors: (8 hrs)

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.

BOOKS RECOMMENDED:

1. Smith J.M., Chemical Engineering Kinetics, 3rd Ed., McGraw Hill, 1981.
2. Levenspiel O., Chemical Reaction Engineering, 3rd Ed., John Willey, 2004.
3. Peacock D.G., Richardson J.F., Chemical Engineering – Volume 3, 3rd Ed., Butterworth Heinemann, 1994
4. Walas S.M., Reaction Kinetics for Chemical Engrs, 3rd Ed., McGraw Hill Book Co, Inc.

5. Denbigh K.G. , Turner J.C.R., Chemical Reactor Theory –an Introduction, 3rd Ed., Cambridge Univ. Press London, 1984.
6. Fogler H. S., Elements of Chemical Reaction Engineering, 4th Ed., Prentice Hall, 2006
Carberry, J.J. Chemical and Catalytic Reaction Engineering, McGraw Hill, New York, 1976

BTPC-502/BTCH-502 MASS TRANSFER - II

External Marks: 60 **L T P**
Internal Marks: 40 **3 1 0**
Total Marks: 100

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

Objective: 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.

Distillation: **18 hrs**
Roult's law, ideal solutions, x-y & H-x-y diagrams, Flash vaporisation 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.

Liquid-liquid extraction: **10 hrs**
Extraction equipment, equilibrium diagram. Choice of solvent. Single stage and multistage counter-current extraction with/without reflux. Continuous contact extractors.

Leaching: **8 hrs**
Leaching equipment and equilibrium. Single stage and multistage cross current and counter current leaching.

Adsorption: **7 hrs**
Types, nature of adsorbents, Adsorption equilibria- single species- Langmuir, Freundlich isotherms, Adsorption operations –single stage and multi stage, Adsorption column sizing

Crystallization: **5 hrs**
Equilibria and yields, Methods of forming nuclei in solution and crystal growth, equipments- vacuum crystallizer, Draft tube-baffle crystallizer.

BOOKS RECOMMENDED:

1. Treybal Robert E., Mass Transfer Operations, 3rd Ed., McGraw Hill, 2001
2. Sherwood T. K., Pigford R.L., Wilke C.R., Mass Transfer, Chemical Engineering Series, McGraw Hill, 1975.
3. Backhurst J.R., Harker J.H., Coulson J.F., Richardson J.M., Chemical Engineering – Volume 1, 6th Ed., Butterworth Heinemann, 1999
4. Skelland, A.H.P, Diffusional Mass Transfer, Kreiger Publishing Co., 1985.
5. McCabe, Warren L., Smith, Julian C. and Harriot, P., Unit Operations of Chemical Engg., 7th Ed., McGraw Hill, 2005
6. Harker J. H., Richardson, J. F., Backhurst J. R., Chemical Engg. Vol, 2, 5th Ed., Butterworth-Heinemann, 2003.
7. King C.J, Separation Process, Tata McGraw Hill Pub.
8. Holland, Charles D., Fundamentals and Modelling of Separation Processes, Prentice Hall, Inc. New Jersey.

BTPC 503 PETROLEUM REFINING - I

External Marks: 60 **L T P**
Internal Marks : 40 **3 1 0**
Total Marks : 100

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

UNIT I **10 hrs**

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 correlaton index methods for evaluation of crude & fractions. TBP, ASTM, EFV, and their inter-convertibility, yield Curve etc.

UNIT II **10 hrs**

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 **9 hrs**

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 **9 hrs**

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

UNIT V **10 hrs**

Finishing & Treatment processes : Different Hydrotreatment (eg. 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

BOOKS RECOMMENDED:-

1. Petroleum Refinery Engineering – W.L. Nelson, Mc Graw Hill.
2. Modern Petroleum Refining Processes – B.K. Rao. Oxford & IBM.
3. Petroleum Refining Technology – Dr. Ram Prasad, Khanna Publishers.
4. Advanced Petroleum Refining: Dr. G. N. Sarkar, Khanna Publishers.

BTPC-504 /BTCH-504 INDUSTRIAL POLLUTION CONTROL

External Marks: 60	**L T P**
Internal Marks: 40	**3 1 0**

Total Marks: 100

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

Objective: 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.

Introduction: (12 hrs)

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

Air Pollution: (12 hrs)

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.

Water Pollution: (16 hrs)

Types of water pollutants, their sources and effects. BOD and COD, BOD_5, oxygen sag curve, waste water sampling- grab and composite sample.

Waste water treatment:

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

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

Solid Waste: (8 hrs)

Control and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling.

BOOKS RECOMMENDED:

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

BTPC-505 RESERVOIR ENGINEERING - II

External Marks : 60 **L T P**
Internal Marks : 40 **3 1 0**
Total Marks : 100

Objective:- To impart knowledge about different drive mechanism for flow and measurements and different tests involved.

UNIT-1 **16 hrs**

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 **9 hrs**

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

UNIT-III **3hrs**

Diffusivity Equation Derivation & constant Terminal Rate Solution.

UNIT-IV **16hrs**

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.

BOOKS RECOMMENDED:-

1. Ahmed, T, "Reservoir Engineering Handbook", 3rd Edition, Elsevier, 2006.
2. Slip Slider, H.C. "World wide Practical Petroleum Reservoir Engineering Method", Penn Well Publishing Company, 1983.
3. Gianluigi chierici, "Principles of Petroleum Reservoir Engineering", Elsevier, 1994.

BTCH-505/BTPC-506 MASS TRANSFER LABORATORY

External Marks: 20	**L T P**
Internal Marks: 30	**0 0 4**
Total Marks: 50	

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.

BTPC 507 PETROLEUM TESTING LABOTORY- I

External Marks: 20 **L T P**
Internal Marks : 30 **0 0 4**
Total Marks : 50

OBJECTIVES : To introduce various methods of analysis by using sophisticated instruments and analytical equipments 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.

LIST OF 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.

BTPC-508/BTCH-607 CHEMICAL PROCESS PLANT DESIGN-1

External Marks: 20	**L T P**
Internal Marks: 30	**1 0 3**
Total Marks: 50	

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.

BOOKS RECOMMENDED:

1. Coulson, Richardson & Sinnott R.K., Chemical Engineering Volume-6 – an Introduction to Chemical Engineering Design, 4th Ed., Elseveir Butterworth Heinemann, 2005
2. Perry R.H., Green D. W., Chemical Engineers' Handbook, 8th ed., Mc-Graw Hill, 2008
3. Coker A.K., Ludwig's Applied Process Design in Chemical & Petrochemical Plants- Vol 1, 4th Ed., Gulf Publication- Butterworth Heinemann, 2007
4. Ludwig E.E., Applied Process Design in Chemical & Petrochemical Plants- Vol 3, 3rd Ed., Gulf Publication- Butterworth Heinemann, 2001
5. Vilbrandt F.C., Dryden C. E., Chemical Engg. Plant Design, 4th Ed., McGraw Hill, 1959
6. Peters M.S. , Timmerhaus K.D., Plant Design and Economics for Chemical Engg., 5th Ed., McGraw Hill, 2003 Molyneux F., Chemical Plant Design –I, Butterworth Heinemann, 1963

BTPC-509 /BTCH-508 INDUSTRIAL/ INSTITUTIONAL PRACTICAL TRAINING

External Marks: 40
Internal Marks: 60
Total Marks: 100

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.

6th Semester

BTPC- 601 PETROLEUM REFINING - II

External Marks: 60 **L T P**
Internal Marks :40 **3 1 0**
Total Marks : 100

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

CRACKING: **9hrs**

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.

CATALYTIC REFORMING : **9hrs**

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.

ALKYLATION AND ISOMERIZATION **9hrs**

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

COKING **9hrs**

Methods of Petroleum Coke Production – Koppers, Delayed Coking, Fluid Coking and Contact Coking. Iso Max Processes and Hydro Desulphurization Processes.

ASPHALT TECHNOLOGY **9hrs**

Source of Asphalt (Bitumen), Chemical Structure of Asphalt, Action of Heat on Asphalt, Types of Asphalts. Air Blowing of Bitumen and Upgradarion of Heavy Crudes. Specialty
Products: Industrial Grease- Manufacture of Calcium Grease, Liquid Paraffin and Petroleum Jellys.

BOOKS RECOMMENDED:-

1. Ram Prasad , " Petroleum Refining Technology" Khanna Publishers, 2007
2. Jones, D.S.J. and Pujadó, P.R., Handbook of petroleum processing, Springer, The Netherlands, 2006
3. Nelson, W. L "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited, 1985.

4. Watkins, R. N “Petroleum Refinery Distillations”, 2nd Edition, Gulf Publishing Company, Texas, 1981.
5. Bhaskar Rao, BK, Modern Petroleum Refing Processes” 4th Edition, Oxford and IBH Publising company PVT.LTD.2002
6. Parkash, S., Refining processes handbook, Gulf Professional Publishing, 2003
7. Hobson, G. D “Modern Petroleum Refining Technology”, 5th Edition, John wiky Publishers,1984
8. Gary ,J.H and Handwork G.E, Petroleum Refining Technology and Economics, 4th Ed. Marcel Dekker Inc 2001

BTPC 602 PETROCHEMICALS

External Marks : 60 **L T P**
Internal Marks : 40 **3 1 0**
Total Marks : 100

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

UNIT I **9 hrs**

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

UNIT II **9 hrs**

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

UNIT III **9 hrs**

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

UNIT IV **9 hrs**

Chemicals from synthesis gas, Olefins, Diolefins, Acetylene and Aromatics.

UNIT V **9 hrs**

Modes and techniques, Production of Polyethylene, PVC, Polypropylene, SAN, ABS, SBR, Polyacrylonitrile, Polycarbonates, Polyurethane, Nylon, PET.

BOOKS RECOMMENDED:-

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

BTPC-603 PROCESS INSTRUMENTATION AND DYNAMICS CONTROL

External Marks : 60 **L T P**
Internal Marks : 40 **3 1 0**
Total Marks : 100

OBJECTIVES

To introduce control equipments 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 **9hrs**

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 **9hrs**

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 **9hrs**

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 **9hrs**

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.

UNIT V **9hrs**

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.

BOOKS RECOMMENDED:-

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.,NewDelhi,1990.
3. Patranabis.D, Principles of Process control, II edition, Tata McGraw-Hill Publishing Co.Ltd.,1981.
4. Peter Harriott, Processcontrol, Tata McGraw-Hill Publishing Co., Reprint 2004.
5. Eckman D.P., Industrial Instrumentation, John Wilay 2001.

BTPC-604 PETROLEUM EQUIPMENT DESIGN

External Marks: 40 **L T P**
Internal Marks: 60 **0 0 6**
Total Marks : 100

OBJECTIVE To understand the concept of designing Equipments for Petroleum Exploration. To study and analyze the suitable equipment for particular reservoir conditions.

UNIT I **9hrs**

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 **9hrs**

Design of Surface Facilities -Design of production and processing equipment, including deparation problems, treating, and transmission systems.

UNIT III **9hrs**

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 IV **9hrs**

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 V **9hrs**

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

BOOKS RECOMMENDED:-

1. Petroleum Exploration Hand Book by Moody, G.B.
2. Wellsite Geological Techniques for petroleum Exploration by Sahay.B et al
3. Standard Hand Book of Petroleum & Natural Gas Engineering" – 2nd Edition 2005-William C. Lyons & Gary J.Plisga-Gulf professional publishing comp (Elsevier).

**** ELECTIVE- I(A)**

BTPC-605 (A) SEPARATION TECHNIQUES

External Marks : 60 **L T P**
Internal Marks : 40 **4 0 0**
Total Marks : 100

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

UNIT I: MEMBRANE SEPARATIONS **9 hrs**
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 **9 hrs**
Affinity chromatography, immuno chromatography and Ion exchange chromatography – Introduction – Principles – Types of equipment – Commercial processes – Applications.

UNIT III: SEPARATIONS BY ADSORPTION TECHNIQUES **9 hrs**
Types of adsorption – Nature of adsorbents – Adsorption equilibria – Adsorption hysterisis adsorption isotherms – Effect of temperature and pressure – Freundlich equation – Stagewise adsorption – Single and multistage crosscurrent adsorption – Break through curves and rates of adsorption.

UNIT IV: IONIC SEPARATIONS **9 hrs**
Electrophoresis – Introduction – Electrokinetics – The electrical double layer – Zeta potential and electrophoresis – Laboratory methods – Analytical and Preparative methods – Applications.

UNIT V: ZONE MELTING **9 hrs**
Zone melting – Introduction – Equilibrium Diagram – Apparatus and Applications – Large scale and continuous operations – Limitations.

BOOKS RECOMMENDED:

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

**** ELECTIVE- I (B)**

BTPC-605 (B) TRANSPORT OF OIL AND GAS

External Marks : 60 **L T P**
Internal Marks : 40 **4 0 0**
Total Marks : 100

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 **8 hrs**

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

UNIT-II Pipeline Transportation I **8 hrs**

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 **7 hrs**

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.

UNIT-IV Pumps and Compressor: **8 hrs**

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-V Gas monetization **7 hrs**

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

UNIT-VI Subsea challenges **7 hrs**

Flow assurance, sub sea 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.

BOOKS RECOMMENDED:-

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", Volume I, Pennwell Publishing Company, Tulsa. Oklahama.
3. Ken Arnold and Maurice Stewart, "Surface Production Operations", Volume I and 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.

**** ELECTIVE- I (C)**

BTPC-605 (C) PROGRAMMING, DATABASE MANAGEMENT AND INFORMATION SYSTEMS FOR OIL AND GAS INDUSTRY

External Marks: 60 **L T P**
Internal Marks : 40 **4 0 0**
Total Marks : 100

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 **7 hrs**

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

UNIT-II Handling Excel and MS Access **7 hrs**

Basic introduction to Microsoft Access, Coupling of Access and Excel, Writing basic queries in Access, Writing small VBA codes for Access and Excel, Funct ionalities of Access

UNIT-III RDBMS **7 hrs**

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

UNIT-IV Geospatial Information System **8 hrs**

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

UNIT-V Spatial Data Transformation and Auto Correlation **8 hrs**

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

UNIT-VI Project Design **8 hrs**

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.

Books Recommended

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

**** ELECTIVE-I (D)**

BTPC-605 (D) MATHEMATICAL METHODS AND MODELING IN PETROLEUM EXPLORATION AND PRODUCTION

External Marks: 60 **L T P**
Internal Marks : 40 **4 0 0**
Total Marks : 100

Objectives:

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

UNIT-I Seismic Exploration I **7 hrs**

Introduction to Seismic Texture, Atlas of 3D Seismic Attributes, the Use of Structure Tensors in the Analysis of Seismic Data

UNIT-II Seismic Exploration II **7 hrs**

Automated Structural Interpretation through classification of Seismic Horizons, Automatic Fault Extraction Using Artificial Ants, Seismic Stratigraphy, seismicfacies analysis

UNIT-III Geostatistics for reservoir characterization **7 hrs**

Variogram, Kriging, autocorrelation, conditional simulation for heterogeneity modeling and uncertainty quantification, data integration

UNIT-IV Geological Model Building I **8 hrs**

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

UNIT-V Geological Model Building II **8 hrs**

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

UNIT-VI Reservoir Modeling **8 hrs**

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

BOOKS RECOMMENDED:-

1. Armin Iske and Trygve Randen, Mathematical Methods and Modeling in Petroleum Exploration and Production, Springer Verlag, 2005.
2. Beacon, M, Simm, R and Redshaw, T. D Seismic Interpretation. Cambridge University Press, 2003.
3. Clayton Deutsch, Geostatistical Reservoir Modeling, Oxford University Press, 2002.
4. Fanchi J R, Shared Earth Modeling: Methodologies for Integrated Reservoir Simulations, Gulf Publishing, 2002
5. Veeken Paul, Sei smic Stratigraphy, Basin Analysis, and reservoir characterization, El sevier Publications, 2007.

BTPC- 606 PETROLEUM TESTING LABOTORY- II

External Marks : 20	**L T P**
Internal Marks : 30	**0 0 4**
Total Marks : 50	

OBJECTIVE: 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.

LIST OF 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

BTPC-607 PROCESS CONTROL LABORATORY

External Marks : 20 **L T P** **Internal Marks : 30** **0 0 4**
Total Marks : 50

Objective: 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.

LIST OF 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

BTPC-608/BTCH-608 LITERATURE SURVEY & SEMINAR

External Marks: 20 **L T P**
Internal Marks: 30 **0 0 3**
Total Marks : 50

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.

7th Semester

Course Code	Course Name	Load Allocated (Duration)	Marks Distribution		Total Marks	Credits
			Internal Marks	External Marks		
BTPC701/ BTCH 701	Software Training ***	8 Weeks	150	100	250	10
BTPC702/ BTCH 702	Industrial/Institutional Training	16 Weeks	300	200	500	20
	Total	24 Weeks	450	300	750	30

***** To enhance the professional capabilities of the students , The Petrochem & Petroleum Refinery Engineering Department in the institute is to provide software training in any two of the following:-**

- **ASPN**
- **CHEMCAD**
- **MATLAB**
- **Any other relevant software**

8th Semester

BTPC-801 PETROLEUM EXPLORATION & PRODUCTION OPERATION

External Marks : 60 **L T P**
Internal Marks : 40 **3 1 0**
Total Marks : 100

Objectives:
1. To understand a petroleum reservoir system.
2. To understand the basic principles and operations in upstream petroleum industry

Unit I: Distribution of Reserves **8 hrs.**
Worldwide distribution of oil and gas reserves, Subsurface data sampling and data interpretation, Measurement scaling.

Unit II: Origin of Hydrocarbons **8 hrs.**
Origin of hydrocarbons, accumulation and migration of hydrocarbons, Reservoir traps.

Unit III: Properties of Reservoir Rocks and Fluids **8 hrs.**
Properties of reservoir rocks and fluids, Rock – fluid interface, Reservoir description by direct and indirect methods, Oil and Gas in place.

Unit IV: Drilling Operations **8 hrs.**
Drilling of oil and gas wells, Classification of wells, Drilling operating systems, Drilling fluids. New trends in drilling engineering.

Unit V: Well Stimulation **8 hrs.**
Well completions and stimulations, Gun perforating, Hydrocarbon production techniques, Hydrocarbon recovery mechanisms, Artificial lift techniques, Secondary recovery.

Unit VI: Recent Development **8 hrs.**
Non-conventional hydrocarbon energy sources, International trading in oil and gas, Recent developments.

Reference Books:
1. Bradley, "Petroleum Engineering Handbook", SPE
2. Mian, M. A., "Petroleum Engineering Handbook for Practicing Engineer", Vol. I and II, Pennwell Publication, 1992.
3. Deshpande, B.G., "World of Petroleum", Wiley, 1990.
4. John, F., Cook, M., and Graham, M., "Hydrocarbon Exploration and Production", Elsevier, 1998.

BTPC-802 PETROLEUM REFINING - III

External Marks : 60 **L T P**
Internal Marks : 40 **3 0 0**
Total Marks : 100

OBJECTIVE

To impart detailed knowledge on petroleum refining operations, this course being the last part in a three parts series .Students learn about the petroleum additives, support systems, safety measures, environmental, quality and economic aspects.

UNIT I **10 hrs**

Octane Improver – TEL, MTBE, Viscosity Index Improver, Pour Point Depressor, Anti Oxidants and others.

UNIT II **8 hrs**

Heavy oil upgradation processes- carbon rejection, hydrogen addition; Instability of petroleum products – distillate and residual products; Incompatibility in refining Operations

UNIT III **9 hrs**

Support systems – control systems, offsite systems, safety systems

UNIT IV **9hrs**

Quality control of products, Refinery operation planning, process evaluation and economics

Books Recommended

1. Jones, D.S.J. and Pujadó, P.R., Handbook of petroleum processing, Springer, The Netherlands, 2006
2. Nelson, W. L "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited,1985.
3. Watkins, R. N "Petroleum Refinery Distillations", 2nd Edition, Gulf Publishing Company, Texas, 1981.
4. Parkash, S., Refining processes handbook, Gulf Professional Publishing, 2003
5. Hobson, G. D "Modern Petroleum Refining Technology", 4th Edition, Institute of Petroleum,U. K. 1973.

*** ELECTIVE-II (A)
BTPC-803(A) NATURAL GAS TECHNOLOGY

External Marks : 60 **L T P**
Internal Marks : 40 **3 0 0**
Total Marks : 100

Objectives:
1) To understand markets, capacities, sources and technologies issues involved in natural gas production, processing and transport.
2) To get acquainted with technologies used in consumption of natural gas.

Unit I: Natural Gas Resources **6 hrs.**
Oil and gas reserves, Natural gas and associated gas, Outlook for world gas production, Indian Scenario. Future sources of natural gas – Coal Bed Methane and Hydrates. Composition of natural gas, Origin of hydrocarbon & non-hydrocarbon components, Formation of natural gas reservoirs, Sweet and sour gas.

Unit II: Natural Gas Properties **8 hrs.**
Phase diagram of a reservoir fluid, Cricondentherm and cricondenbar, Retrograde condensation, Dry gas, Wet gas, Condensate gas, Associated gas, Chemical components. Sampling methods for natural gas, Measurements taken during sampling. Volumetric properties of natural gas, Equations of state, Viscosity, thermal conductivity, surface and interfacial tension, Net and Gross Heating value – VLE calculations for natural gas.

Unit III: Hydrates **4 hrs.**
Water-hydrocarbon systems, Hydrate structures, Thermodynamic conditions for hydrate formation, Kinetics of hydrate formation, Hydrate prevention.

Unit IV: Natural Gas Processing **6 hrs.**
Different specifications required for transport and use, Separation of condensates, Gas-Liquid separators and their design, Fractionation and purification operations, Dehydration methods, Hydrocarbon liquids recovery, Acid gas removal, Removal of nitrogen, helium and mercury, Integrated natural gas processing.

Unit V: Natural Gas Transport & Storage **8 hrs.**
Different gas chains – Pipeline transport systems, Steady state flow calculations for a pipeline, Pipeline thickness calculation, Welding problems in large diameter steel pipelines, Corrosion protection, Recompression stations, Types of compressors, Multiphase flow handling. Instrumentation, Monitoring and control, Safety considerations, Expansion systems. Flow measurement. LNG transport chain, Natural gas liquefaction, LNG carriers. Natural gas storage-Cryogenic and Underground.

Unit VI: Natural Gas Outlets **4 hrs.**
Downstream utilization technologies for natural gas in petrochemical, fertilizer and power sectors. Lower hydrocarbons upgradation technologies**,** Methane conversion technologies.

Reference Books:
1) A. Rojey, C. Jaffret, "Natural Gas Production, Processing, Transport", Second Editions Technip, 1994.
2) Chi U. Ikoku, "Natural Gas Production Engineering", John Wiley and Sons, 1984.
3) A. Kohl and F. Riesenfeld, "Gas Purification", Gulf Publishing Company, 1985.
4) Sanjay Kumar, "Gas Production Engineering', Gulf Publishing Company, 1987.

***** ELECTIVE-II (B)**

BTPC-803 (B) ENHANCED OIL RECOVERY

External Marks : 60 **L T P**
Internal Marks : 40 **3 0 0**
Total Marks : 100

Objective: To understand the fundamental of enhanced oil recovery ,various operations and problems involved in enhanced oil recovery

UNIT-I FUNDAMENTALS OF ENHANCED OIL RECOVERY 9 hrs

Pore Geometry, Microscopic Aspects of Displacement. Residual Oil Magnitude and Mobilization. Buoyancy Forces and Prevention of Trapping, Wettability, Residual Oil and Oil Recovery. Macroscopic Aspect of Displacement.

UNIT-II WATER FLOODING 9 hrs

Properties, sampling and analysis of Oil Field Water; Injection waters; Water flooding – Sweep Efficiency, Predictive Techniques, Improved Water Flood Processes, Performance of some Important Water Floods.

UNIT-III ENHANCED OIL RECOVERY OPERATIONS-1 6 hrs

Flooding – miscible, CO2, polymer, alkaline, surfactants, steam

UNIT-IV ENHANCED OIL RECOVERY OPERATIONS-2 6 hrs

Gas injection, in-situ combustion technology, microbial method

UNIT-V PROBLEMS IN ENHANCED OIL RECOVERY 6 hrs

Precipitation and Deposition of Asphaltenes and Paraffins, Scaling Problems, Formation of Damage Due to Migration of Fines, Environmental factors.

BOOKS RECOMMENDED:-

1. Donaldson, E.C. and G. V. Chilingarian, T. F. Yen, "Enhanced oil Recovery – I & II",
2. Fundamentals and Analysis, Elsevier Science Publishers, New York, 1985.
3. Lake, L.W., "Enhanced oil recovery", Prentice Hall, 1989.
4. Schumacher, M.M., "Enhanced oil recovery: Secondary and tertiary methods", Noyes Data Corp., 1978.
5. Van Poollen, H.K. "Fundamentals of enhanced oil recovery", PennWell Books, 1980.

***** ELECTIVE-II (C)**

BTPC- 803 (C)DRILLING AND WELL ENGINEERING

External Marks: 60 **L T P**
Internal Marks : 40 **3 0 0**
Total Marks : 100

Objective: To familiarize students the concept of planning and drilling of well and how to manage drilling operations.

UNIT-I DRILLING GEOLOGY, OIL AND GAS MIGRATION 6 hrs

Rock Strengths and Stresses, Hydrostatic Pressure Forced by a Fluid. Rock Properties, Primary Migration, Reservoir Rock, Seal Rock and Secondary Migration. Reservoir Drives, Problems Related Fluids in the Reservoir.

UNIT-II PLANNING AND DRILLING OF WELL 6 hrs

Well Proposal, Gathering Data, Designing the Well, Drilling the Well and Testing the Well. Planning of Well, Hole and Casing Sizes and Drilling the Well. Selecting a suitable Drilling Rig, Classification of Drilling Rig, Rig Systems and Equipments.

UNIT-III DRILL BITS AND DRILLING FLUIDS 7 hrs

Roller Cone Bits, Fixed Cutter Bits and Cone Bits. Optimizing Drilling Parameters- Grading the Dull Bit and Bit Selection. Functions of Drilling Fluid, Basic Mud Classification Designing the Drilling Fluid.

UNIT-IV DIRECTIONAL DRILLING, CASING, CEMENTING AND EVALUATION 9hrs

Controlling the Well Path of a Deviated Well, Horizontal Wells and Multi Lateral Well. Importance of Casing in a Well, Designing the Casing String, Role of the Cement Outside the Casing, Mud Removal, Cement Design, Running and Cement Casing and other Cement Jobs.
Evaluation Techniques, Physical Sampling at Surface and Downhole, Electrical Logging and Production testing.

UNIT-V MANAGING DRILLING OPERATIONS, SAFETY AND ENVIRONMENTAL ISSUES 8 hrs

Personnel involved in Drilling Operation, Decision Making at the Well site and in the Office, Estimating the Well Cost. Safety Meetings, New Comers on the Rig, Training and Certification, Permit to Work Systems, Safety Alerts, Safety Equipments, Minimizing Spills and Environmental Impact Studies.

BOOKS RECOMMENDED:-

1. Devereux, S., “Drilling Technology”, PennWell Publishing Company, 2006.
2. Azar, J.J. and G. Rabello Samuel, “Drilling Engineering”, PennWell Corporation, 2001.
3. Devereux, S., “Practical Well Planning and Drilling”, PennWell Corporation, 1998.

***** ELECTIVE-II (D)**

BTPC-803 (D) PETROLEUM ECONOMICS

External Marks : 60 **L T P**
Internal Marks : 40 **3 0 0**
Total Marks : 100

Objective: To familiarize students basic fundamentals of petroleum economics.

UNIT-I Production Forecast and Reserves Estimation: 4 hrs
Decline Curve Analysis, Types and utility in production forecast, Reserves to Production Ratio, Statistical analysis, Hubert curves. Reserves auditing, standard practices for reporting of reserves. SEC/ SPE/WPC norms.

UNIT-II Oil and Gas Prices: International Market and Geopolitics 5 hrs
Crude oil characteristics, Marketing and trading of crude oil, Crude oil pricing mechanism and oil price elasticity, Inflation and effects on oil pricing. Factors control ling oil and gas pricing. Oil differential and influence on price of oil.

UNIT-III Cash Flow Analysis and Economic Parameters: 6 hrs
Time value of money, types of costs, Economic Yardsticks: Return on Investment, Payout Period, Net Present Value, Discounted Cash flow, DCFROR, Incremental Analysis, Replacement Analysis, Sensitivity analysis, Optimization. Ranking of projects based on economic parameters,

UNIT-IV Risk and Uncertainty: 4 hrs
Definition, Exploration and Production Probabilistic Analysis, Risk Analysis,
Management and Economic Assessment, Decision Analysis, Preference Theory, Real Option Theory, Stochastic Modeling.

UNIT-V Asset Management and Accounting: 8 hrs
Asset definition, performance evaluation, Analysis of ongoing costs, analysis of field development investments, purchase / sale of producing property, sources of funds. Project management techniques. Petroleum Industry Accounting and types, Petroleum Auditing, Tax Analysis, Cost, Expenditure and revenues under different heads and their proportion in Asset. Depreciation, Depletion, Amortization Methods and their use in tax calculations,

UNIT-VI Petroleum Fiscal System: 9 hrs
E and P Business in world and India, Historical development, Role of OPEC and non OPEC countries. Reasons for development of a fiscal system for petroleum industry. Classification of Petroleum Fiscal Systems, Current distribution of exploration and production contract types, and their comparison with possible equivalence. National Oil Companies and International Oil Companies: comparative assessment Petroleum industry in India. Product ion fiscal system in India and abroad. NELP and bidding process in India.

BOOKS RECOMMENDED:-

1) Abdel A. A., Bakr A. B, and Al Sahlawi M. A., "Petroleum Economics and Engineering", Decker Publications, 1992.
2) Johnston, D, "International Exploration Economics, Risk, and Contract Analysis", Penwell Books, 2003.
3) IFP, Oil and Gas Exploration and Production, Reserves, Costs and Contracts. Technip Publication 2007.
4) Mian M A, Project Economics and Decision Analysis, Penwell publications, Volume I and II, 2002.
5) Seba R. D., "Economics of Worldwide Petroleum Production", OGCL Publications, USA, 1998.

BTPC-804 ENVIRONMENTAL TECHNOLOGY AND SAFETY IN PETROLEUM INDUSTRY

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Basic Environmental compartments **9 hrs.**

Air pollution, Water pollution, Land pollution, Hazardous material s in relation to petroleum industry. HAZOP analysis, Environmental Impact of Gas flaring. Sampling methods. Environmental control and engineering – aqueous wastes, emission to the atmosphere, noise pollution

Fire Hazards and Control **8 hrs**

Components of Fire, Classification of Fires and Fire Extinguishment, Fire safety equipments, Causes of Refinery Fires and Explosion Hazards, Safety in Handling and Storage, Emergency Preparation. DOW fire index

Waste disposal and treatment **6 hrs.**

Surface and subsurface disposal, treatment of water, solid material and air emissions. Oil field waste management, effluent water treatment methods. Sampling methods.

Regulatory Approaches and Safety Measures **8 hrs.**

Salient provisions in the oil mines regulation act in India related to management, drilling, production and transport. Protect ion against leakage and fire, care of machinery, plant and equipment. Safety aspect s during drilling, logging, production, transportation, handling etc at onshore and offshore. Emergency Response Plan (ERP), Regulatory requirements for ERP, Determination of initial planning zone, Development at the society, government and company level .

Other aspects **5 hrs.**

Occupational health hazards, Estimation of Total Petroleum Hydrocarbon (TPH) and suggested measures. Case studies of history of accidents in petroleum industry. Disaster management- Case studies.

Reference Books:

1. Boesch D F and Rabalis Nancy, Long-term Environmental Effects of Offshore Oil and Gas Development, Elsevier Applied Science, 2003, 719 pp.
2. Boyce, A., “Introduction to Environmental Technology”, John Wiley and Sons, 1996
3. Orzu Orszulik, “Environmental Technology in oil Industry”, Springer – Verlag, 1996.
4. Reis, J.C., “Environmental control in Petroleum Engineering”, Gulf publications.1998

BTPC-805 RESERVOIR MODELING AND SIMULATION

External Marks : 60 **L T P**
Internal Marks : 40 **4 0 0**
Total Marks : 100

Objective: The objective of this course is to teach concept of reservoir modelling & simulation. Students should be able to predict future performance of a reservoir and understand working principle of reservoir simulation software.

Reservoir Modeling: **14hrs**
Introduction to general modeling: Introduction to concept geological modeling. Types of model and designing of various models depending on reservoir complexities, rock properties, fluid properties – concept of back oil model, compositional model.

Reservoir Simulation:

1. Overview : **2hrs**

Introduction, Historical background, application of simulator, various types of models.

2. Flow Conditions: **3hrs**

Single phase, two phase and multiphase flow equations for one, two and three dimension models.

3. Special Concept: **5hrs**

Explicit and implicit, grid system, finite difference & finite element method, matrix solution, iterative method, stability criteria.

4. Data Preparation: **2hrs**

5. Pseudo functions **2hrs**

6. Reservoir model Solution Techniques: Implicit Pressure and Explicit Saturation (IMPES), implicit pressure and Implicit saturation (IMPIS). **4hrs**

7. Preview of numerical solution methods: Direct process, iterative process. **4hrs**

8. History Matching: Mechanics and parameters of match **2hrs**

9. Special Concept on Coning and Compositional Models simulation. **3hrs**

10. Optimization using Economic and Techno-economic evaluation: Computation of economic indices viz. different variants base on technical and economic consideration. **4hrs**

11. Introduction to streamline simulation & comparison of conventional/Streamline simulation. **3hrs**

BOOKS RECOMMENDED:-

1. Mattax Dalton, Reservoir Simulation", SPE series, USA, 1990.
2. Bradley HB, Petroleum Engineering Handbook, 3rd Edition GPE,1992

BTPC- 806/ BTCH- 806 CHEMICAL PROCESS PLANT DESIGN –II

External Marks: 20 **L T P**
Internal Marks: 30 **0 0 4**
Total Marks: 50

1. Design of Sieve Tray Column and column internals
2. Design of Bubble Cap Column and column internals
3. Design of Packed Column and column internals
4. Specification sheet for fractionating column
5. Design of Homogeneous Reactors
6. Design of Heterogeneous reactors – Fixed bed
7. Design of Heterogeneous reactors – fluidised bed
8. Types of Flow Sheets
9. Overview of plant layout

The student is to appear in a viva-voce examination based on design report.

BOOKS RECOMMENDED:

1. Coulson, Richardson & Sinnott R.K., Chemical Engineering Volume-6 – an Introduction to Chemical Engineering Design, 4th Ed., Elseveir Butterworth Heinemann, 2005
2. Perry R.H., Green D. W., Chemical Engineers' Handbook, 8th ed., Mc-Graw Hill, 2008
3. Coker A.K., Ludwig's Applied Process Design in Chemical & Petrochemical Plants- Vol 1, 4th Ed.,Gulf Publication- Butterworth Heinemann, 2007
4. Siddiqui S., Ludwig's Applied Process Design in Chemical & Petrochemical Plants – Volume 2, 4th Ed., Gulf Publication, 2010
5. Ludwig E.E., Applied Process Design in Chemical & Petrochemical Plants- Vol 3, 3rd Ed., Gulf Publication- Butterworth Heinemann, 2001
6. Vilbrandt F.C., Dryden C. E., Chemical Engg. Plant Design, 4th Ed., McGraw Hill, 1959
7. Peters M.S. , Timmerhaus K.D., Plant Design and Economics for Chemical Engg., 5th Ed., McGraw Hill, 2003
8. Molyneux F., Chemical Plant Design –I, Butterworth Heinemann, 1963

BTPC-807 PETROCHEMICAL ANALYSIS LABORATORY

External Marks: 20 **L T P**
Internal Marks : 30 **0 0 4**
Total Marks : 50

LIST OF EXPERIMETS:

1. Sulphur content determination.

2. Flue gas Analysis – Orsat Apparatus.

3. Aromatic Content determination.

4. Hydrogen sulphide content determination.

5. Oil separation from lubricating Grease (Oil Separation Apparatus).

6. Analysis of petrochemicals using UV spectrophotometer.

7. Analysis of petrochemicals using NMR.

8. Analysis of petrochemicals using Gas chromatography.

9. Refractive index of petrochemicals.

10. Determination of moisture content

BTPC-808 **PROJECT**

External Marks: 40 **L T P**
Internal Marks: 60 **0 0 6**
Total Marks : 100

The project may be considered as the ultimate exercise presented to the final year semester student before graduation to measure accumulated engineering knowledge and experience , At the same time, the project it-self should provide the students with some new skills, innovation and information, and strengthen the aquired ones.

The project programme consists of different assignments, allotted time, submission of report under internal faculty guidance and evaluation by external member along with internal faculty. The activities performed during a project may cover one or more of the following:

Data collection, critical literature review, laboratory experience and tests. Mathematical modeling , software application, industrial visits, Design and assembly, Process analysis. The major project may be assigned to a group of two to three students . The project topic allotted may be of theoretical , experimental or industrial projects to be carried out under the supervision of internal guide and external guide(in case of industrial projects)

Major projects are to be executed strictly as per the project schedule prepared during VIII semester.

A committee of departmental faculty members comprising the project guide, one more faculty member and the head of department will monitor and review the progress achieved by the students at various stages. The internal assessment will be done by the committee based on the progress achieved on completion of the project work.

On completion of the project work, each student has to prepare a project report and submit the same in triplicate to the department. The project work and the report will be evaluated by the internal assessment committee for a total of 60 marks. The external university examination , which carries 40 marks, will have report evaluation and viva voce examination conducted by a committee of one external examiner and one internal examiner appointed by the university.