For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

BEANT COLLEGE OF ENGINEERING & TECHNOLOGY, GURDASPUR

Scheme & Syllabus
of
B. Tech.
Chemical Engineering
Batch 2015 onwards

By
Department of Academics
BEANT COLLEGE OF ENGINEERING & TECHNOLOGY
GURDASPUR

Beant College of Engineering & Technology, Gurdaspur
Department of Chemical Engineering
Scheme of Syllabi

3rd Semester

Contact Hours: 29

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTCH-301	Mechanical Operations	3	1	0	40	60	100	4
BTCH-302	Chemical Process Calculations	3	1	0	40	60	100	4
BTCH-303	Fluid Flow	3	1	0	40	60	100	4
BTCH-304	Numerical Methods in Chemical Engineering	3	1	0	40	60	100	4
BTCH-305	Chemical Engineering Thermodynamics	3	1	0	40	60	100	4
BTCH-306	Numerical Methods in Chemical Engineering Laboratory	0	0	3	30	20	50	2
BTCH-307	Fluid Flow Laboratory	0	0	3	30	20	50	2
BTCH-308	Mechanical Operations Laboratory	0	0	3	30	20	50	2
BTCH-309	Institutional Practical Training*	0	0	0	60	40	100	1
Total		15	5	9	350	400	750	27

Minimum Subjects : 09 Maximum Subjects : 09

*Institutional Practical Training (during summer vacations) after second semester.

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur
Department of Chemical Engineering

Scheme of Syllabi

4th Semester

Contact Hours: 28

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTCH-401	Chemical Process Industries	3	0	0	40	60	100	3
BTCH-402	Mass Transfer – I	3	1	0	40	60	100	4
BTCH-403	Heat Transfer	3	1	0	40	60	100	4
BTCH-404	Chemical Process Instrumentation	3	1	0	40	60	100	4
BTCH-405	Chemical Reaction Engineering - I	3	1	0	40	60	100	4
BTCH-406	Heat Transfer Laboratory	0	0	3	30	20	50	2
BTCH-407	Chemical Technology Laboratory	0	0	3	30	20	50	2
BTCH-408	CAD in Chemical Engineering	0	0	3	30	20	50	2
BTGF-400	General Fitness				100	-	100	1
Total		15	4	9	390	360	750	26

Minimum Subjects: 09 Maximum Subjects: 09

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur
Department of Chemical Engineering

Scheme of Syllabi

5th semester

Contact Hours: 28

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTCH-501	Chemical Reaction Engineering - II	3	1	0	40	60	100	4
BTCH-502	Mass Transfer - II	3	1	0	40	60	100	4
BTCH-503	Process Dynamics & Control	3	1	0	40	60	100	4
BTCH-504	Industrial Pollution Control	3	1	0	40	60	100	4
BTCH-XXX	DE-I	3	0	0	40	60	100	3
--	Open Elective-1	3	0	0	40	60	100	3
BTCH-505	Mass Transfer Laboratory	0	0	3	30	20	50	2
BTCH-506	Chemical Reaction Engineering & Pollution Control Laboratory	0	0	3	30	20	50	2
BTCH-507	Industrial\Institutional Training*	0	0	0	60	40	100	1
Total		18	4	6	360	440	800	27

Minimum Subjects: 09 Maximum Subjects: 09

*There should be industrial training of six weeks duration in summer vacation after fourth semester.

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur
Department of Chemical Engineering

Scheme of Syllabi

6th Semester

Contact Hours: 32

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTCH-601	Transport Phenomenon	3	1	0	40	60	100	4
BTCH-602	Chemical Process Optimization	3	1	0	40	60	100	4
BTCH-603	Engineering Materials	3	1	0	40	60	100	4
BTCH-XXX	DE-II	3	0	0	40	60	100	3
--	Open Elective-2	3	0	0	40	60	100	3
BTCH-604	Process Instrumentation, Dynamics & Control Laboratory	0	0	3	30	20	50	2
BTCH-605	Chemical Equipment Design	0	0	3	30	20	50	2
BTCH-606	Minor Project	0	0	2	30	20	50	2
BTGF-600	General Fitness				100	0	100	1
Total		16	3	13	390	360	750	25

Minimum Subjects: 10 Maximum Subjects: 10

Beant College of Engineering & Technology, Gurdaspur
Department of Chemical Engineering

Scheme of Syllabi

7th /8th Semester

Contact Hours: 28

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTCH-801	Process Modeling & Simulation	3	1	0	40	60	100	4
BTCH-802	Process Engineering Economics	3	1	0	40	60	100	4
BTCH-XXX	DE-III	3	0	0	2	60	100	3
BTCH-803	Industrial Safety & Hazards Management	3	1	0	40	60	100	4
BTCH-804	Energy Engineering	3	1	0	40	60	100	4
BTCH-805	Chemical Process Plant Design	0	0	3	30	20	50	3
BTCH-806	Process Optimization & Simulation Laboratory	0	0	3	30	20	50	2
BTCH-807	Major Project	0	0	3	30	20	50	2
BTGF-800	General Fitness				100	0	0	2
Total		15	4	09	420	380	800	27

Minimum Subjects: 09 Maximum Subjects: 09

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur
Department of Chemical Engineering

Scheme of Syllabi

7th /8th Semester

Course Code	Course Name	Load Allocation	Marks Distribution		Total Marks	Credits
			Internal	External		
BTCH-701	Industrial Training	32hr/week	450	300	750	24
Total			450	300	750	

Minimum Subjects: 01 Maximum Subjects: 01

Departmental Elective I (5th Semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTCH-901	Polymer Science & Engineering	3	0	0	3
BTCH-902	Enzyme Technology	3	0	0	3
BTCH-903	Nano-Technology	3	0	0	3
BTCH-904	Separation Processes	3	0	0	3

Departmental Elective-II (6th semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTCH-911	Petroleum Refining Engineering	3	0	0	3
BTCH-912	Intellectual Property Right	3	0	0	3
BTCH-913	Membrane Separations	3	0	0	3
BTCH-914	Project Management	3	0	0	3

Beant College of Engineering & Technology, Gurdaspur
Department of Chemical Engineering

List of Open Electives (5th semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTCH-951	Corrosion Engineering	3	0	0	3
BTCH-952	New & Renewable Energy Sources	3	0	0	3

List of Open Electives (6th semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTCH-961	Environment Impact Assessment	3	0	0	3
BTCH-962	Hydrocarbon Engineering	3	0	0	3

Departmental Elective III (7th/8th semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTCH-931	Bio-Chemical Engineering	3	0	0	3
BTCH-932	Polymer Reactor Design	3	0	0	3
BTCH-933	Plant Utilities	3	0	0	3
BTCH-934	Petro-Chemical Technology	3	0	0	3

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur

Third Semester

BTCH- 301 MECHANICAL OPERATIONS

Internal Marks: 40 **L T P**
External Marks: 60 **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:
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. **(8)**

SCREENING:
Capacity and Effectiveness of a screen, calculation of average size of particles in mixture by screen analysis, types of screens **(4)**

AGITATION AND MIXING:
Agitation of low viscosity particle suspensions: axial flow impellers, radial flow impellers, close-clearance stirrer, unbaffled tanks, baffled tanks, basic idea for designing agitators. Power number, Froude number, power consumption in agitation. Mixing of Solids: Types of mixers, various mixers for cohesive solids, power requirements, mixing index, axial mixing. Mixers for free flowing solids: ribbon blenders, screw mixers, tumbling mixers import wheels, mixing index in blending granular solids, mixing index at zero time, rate of mixing. **(8)**

SIZE REDUCTION:
Principles of Comminuting: 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. **(6)**

FILTRATION:
Classification of filters, various types of cake filters, principles of cake filtration, clarifying filters: liquid clarification, Gas cleaning, principles of clarification. Filtration Equipment and centrifuges and their selection, Cross flow Filtration, micro filtration. **(8)**

SETTLING:
Motion of particles through fluids: Terminal velocity, hindered settling, Stoke's law, Gravity settling processes: Classifiers, clarifiers, thickeners, flocculation, rate of sedimentation Centrifugal Settling processes: Cyclones, hydroclones, decanters, tubular, disk and nozzle discharge centrifugal sludge separators, Centrifugal class fitters, principles of centrifugal sedimentation. **(8)**

FLUIDIZATION:

Fluidization and fluidized bed, conditions for fluidization, Ergun equation and Kozeny-Carman equation, minimum fluidization velocity, types of fluidization, expansion of fluidized beds and particulate fluidization, continuous fluidization; industrial applications **(6)**

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. Mau's 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

BTCH- 302 CHEMICAL PROCESS CALCULATIONS

	L	T	P
Internal Marks : 40			
External Marks: 60	**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:
Unit & Dimensions, Conversion of units, Mole concept, Basic Concept, Stoichiometric and composition relationship, limiting-excess- reactant, conversion and yield. **(10)**

MATERIAL BALANCE:
Without Chemical reaction - Ideal gas-law calculations, real-gas relationships, vapour pressure of immiscible liquids, solutions and problems based on Raoult's, Henry & Dalton's Law. Absolute Humidity, Relative Humidity, Saturation, Dry bulb temperature, Wet bulb temperature, Adiabatic saturation temperature & use of psychometric Chart.
With Chemical Reaction - Combustion, gas-synthesis, acid-alkali production, recycle, purge, bypass in batch, stage-wise and continuous operations in systems with or without chemical reaction. **(16)**

ENERGY BALANCE:
Review: Thermophysics, Thermochemistry-law of constant heat summation, Hess's law, standard heat of reaction, combustion and formation, problems using Hess Law. Heat balances for non reacting processes and reaction processes. Theoretical flame temperature, Adiabatic reaction temperature, flame temperature, combustion calculation. **(16)**

MATERIAL AND ENERGY BALANCES:
Applied to industrial processes such as combustion and gasification of fuels, synthesis of Ammonia, production of sulphuric acid, nitric acid, hydrochloric acid. **(6)**

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.

BTCH- 303 FLUID FLOW

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

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

FUNDAMENTALS OF FLUID MECHANICS:
Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), vapour pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian and non-Newtonian fluids. **(10)**

FLUID DYNAMICS:
Derivation of Euler's equation of motion in Cartesian coordinates, and along a streamline; Derivation of Bernoulli's equation (using principle of conservation of energy and equation of motion) and its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation; Kinetic energy and momentum correction factors; Flow along a curved streamline; Free and forced vortex motions. **(10)**

DIMENSIONAL ANALYSIS AND SIMILITUDE:
Need of dimensional analysis; Fundamental and derived units; Dimensions and dimensional homogeneity; Rayleigh's and Buckingham's π - method for dimensional analysis; Dimensionless numbers (Reynolds, Froude, Euler, Mach, and Weber) and their significance; Need of similitude; Geometric, kinematic and dynamic similarity; Model and prototype studies; Similarity model laws. **(8)**

INTERNAL FLOWS:
Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number, hydraulic diameter, flow regimes; Hagen – Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes, Moody's chart. **(6)**

PRESSURE AND FLOW MEASUREMENT:
Manometers; Pitot tubes; Various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) and weirs; Rotameters. **(6)**

CENTRIFUGAL PUMPS LAYOUT AND INSTALLATION:
Main elements and their functions; Various types and classification; Pressure changes in a pump - suction, delivery and manometric heads; vane shape and its effect on head-capacity relationships. **(5)**

RECIPROCATING PUMPS:
Components parts and working; pressure variations due to piston acceleration; acceleration effects in suction and delivery pipes; work done against friction; maximum permissible vacuum during suction stroke; Air vessels. **(5)**

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
5. Badger, W.L. and Banchero, J.T, Introduction to Chemical Engg., McGraw Hill.
6. Philip J. Pritchard P. J., Fox and McDonald's Introduction to Fluid Mechanics, 8th Ed., John Wiley and Sons, 2011
7. Chattopadhyay, P., Unit Operations of Chemical Engg. Vol.1, 3rd Ed., Khanna Publishers

BTCH- 304 NUMERICAL METHODS IN CHEMICAL ENGINEERING

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

OBJECTIVES:
This course is aimed at providing the students with knowledge about the numerical solutions to various mathematical expressions that they may come across in Chemical Engg. Practice, those are not easily solvable by conventional techniques. These techniques are very useful for the students for experimental data analysis, integration and differentiation of involved functions, solutions of certain implicit equations.

INTRODUCTION & ERROR ANALYSIS:
Introduction to Numerical methods and its significance in chemical engineering, Classification of errors, significant digits and numerical stability. **(5)**

LINEAR ALGEBRAIC EQUATIONS:
Cramer's rule, Gauss Elimination and LU Decomposition, Gauss-Jordan elimination, Gauss-Seidel and Relaxation Methods. **(7)**

NON LINEAR ALGEBRAIC EQUATIONS:
Single variable successive substitutions (Fixed Point Method), Multivariable successive substitutions, single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique. **(10)**

EIGEN VALUES AND EIGEN VECTORS OF MATRICES:
Faddeev-Leverrier's Method, Power Method. **(6)**

FUNCTION EVALUATION:
Newton's Divided Difference Interpolation Polynomial, Lagrangian Interpolation Unequal intervals). Numerical Differentiation, Numerical Integration or Quadratures (Trapezoidal, Simpson's 1/3 and 3/8 rules). **(12)**

ORDINARY DIFFERENTIAL EQUATIONS & PARTIAL DIFFERENTIAL EQUATIONS:
The Finite difference Technique, Runge-Kutta method **(8)**

BOOKS RECOMMENDED:
1. Gupta S.K., Numerical Methods for Engineers, 2nd Ed., New Age International Publishers, 2009
2. Jain M.K., Iyengar SRK and Jain R.K., Numerical Methods for Scientific and Engineering Computation, New Age International.
3. Finlayson, B.A. Nonlinear Analysis in Chemical Engineering, McGraw Hill, New York, 1980
4. Villadsen J, and Michelsen, M.L. Solution of Differential Equation Models by Polynomial Approximation, Prentice Hall, N.J., 1978.
5. Rice R. G., Do Duong D., Applied Mathematics and Modelling for Chemical Engineers, John Wiley & Sons, Inc, 1995.

BTCH- 305 CHEMICAL ENGINEERING THERMODYANMICS

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

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:
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**.** **(8)**

REVIEW OF 2ND AND 3RD LAW OF THERMODYNAMICS:
Concept of Entropy and lost work, Microscopic interpretation of entropy. Third law of thermodynamics and its applications, free energy functions and their significance in phase and chemical equilibria. Property relations for Homogeneous phases, Maxwell's Equations, Clapeyron equation and some important correlations for estimating vapour pressures. Estimation of thermodynamic properties by using graphs and tables. **(10)**

EQUATIONS OF STATE:
Equation of state for real gases and their mixtures. Principle of corresponding states and generalized compressibility factor, H-x diagrams, heat of solution. **(7)**

PHASE EQUILIBRIA:
Partial molar properties, partial molar Gibbs free energy, chemical potential and its dependence on temperature and pressure. Ideal solutions (Lewis-Randall Rule). Fugacity and its calculations. Dependence of fugacity on temperatures and pressure. Solution behavior of real liquids and solids. Activity and activity coefficients. Variation of activity co- efficient with temperature and composition. Properties of mixing. Excess properties. Gibbs-Duhem equation and its application to vapour- liquid equilibria. **(16)**

CHEMICAL EQUILIBRIA:
The reaction Coordinate, Applications of Equilibrium criteria to chemical Reactions, Standard Gibbs Energy Change and Equilibrium constant, variations of equilibrium constant with temperature and pressure. Relation of Equilibrium constant to composition for gas phase reaction, Liquid phase reactions, Equilibrium conversion for single reactions, Gibbs phase rule. **(7)**

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- 306 NUMERICAL METHODS IN CHEMICAL ENGINEERING LAB

Internal Marks : 30
External Marks: 20
Total Marks: 50

L	T	P
0	0	3

1. Solution of a system of linear equations in unknowns by Gaussian elimination.
2. Gauss-Seidel iterative method to solve a linear system of equations.
3. Solution of least square curve fitting method.
4. Method for finding dominant Eigen value and corresponding Eigen vectors by power method.
5. Solution of nonlinear equation by Newton Raphson method.
6. Application of Newton's formulae for interpolation.
7. Application of Lagrange polynomial interpolation formula.
8. Application of Newton's formula for numerical differentiation.
9. Numerical integration by Trapezoidal rule.
10. Numerical integration by Simpson's rules.
11. Solution of an O.D.E. by Runge-Kutta Methods.

BTCH- 307 FLUID FLOW LABORATORY

Internal Marks : 30
External Marks: 20
Total Marks: 50

L	T	P
0	0	3

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 Rotameters.
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

BTCH- 308 MECHANICAL OPERATION LABORATORY

Internal Marks : 30
External Marks: 20
Total Marks: 50

L	T	P
0	0	3

1. Verification of Stokes Law.
2. Screen analysis of given sample for its particle size distribution.
3. Determination of average size (different averages) from screen analysis
4. Determine the efficiency of Cyclone separator and Venturi scrubber.
5. Operating characteristics of crushing and grinding equipments (Jaw crusher, Roll crusher, Ball mill).
6. Evaluation of the filtration constants for $CaCO_3$ slurry in water and cake compressibility.
7. Determination of percentage recovery of coal in froth from coal and sand mixture.
8. Determination of thickener capacity using batch sedimentation.
9. Determination of characteristics of centrifuge as a filter.
10. Determination of the separation efficiency of the classifier.

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Fourth Semester

BTCH- 401 CHEMICAL PROCESS INDUSTRIES

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

OBJECTIVE:
The main aim of this course is to acquaint the students with various broad categories of chemicals, their properties, usage and various technologies available for manufacture. The concept of flow diagrams and requirement of engineering materials for these technologies is included.

OILS AND FATS:
Status and scope, Major oil seeds production and oil availability in India; Chemical composition and physical properties of vegetable oils, Solvent extraction process, Manufacturing process of Cotton seed oil and Soybean oil, Hydrogenation of oils, Types of Animal fats and oils, Types of Waxes. **(6)**

SOAPS AND DETERGENTS :
History and growth, Raw material, Manufacturing of detergents, Biodegradability, Fatsplitting process, Soap manufacture, Glycerine manufacture, Materials of construction. **(5)**

SUGAR:
History and Growth, Uses and Economics, Manufacturing of sugar from sugarcane, refining of cane sugar, Bagasse utilization, Energy requirements and conservation, Environmental considerations, Manufacturing process of sugar from Beet Sugar, Molasses based industries, Manufacturing of Industrial Alcohol and Absolute Alcohol**.** **(6)**

PULP AND PAPER:
History and Growth of industry, Raw materials, Types of pulping process, Kraft sulphate Pulping Process, Sulphite Pulping Process, Recovery of Black Liquor from Kraft Sulphate Process Manufacture of paper, Beating and Refining Process, use of sizing agents, Fourdrinier Machine, Cylinder Machine. **(4)**

INDUSTRIAL GASES:
Manufacture and uses of hydrogen, carbon dioxide, acetylene, oxygen, nitrogen, inert gases. **(4)**

ACIDS:
Manufacture and uses of Phosphoric acid, hydrochloric acid, nitric acid, sulphuric acid, major engineering problems **(3)**

FERTILIZERS:
Status of industry, Grading and classification of fertilizers, N-P-K values, Nitrogen based industries: Method of Production of ammonia by Synthetic ammonia process, Manufacture of Urea from ammonium carbamate and major Engg. problems, Manufacture of Ammonium Nitrate, Manufacture of Red and Yellow phosphorus, Manufacture of Calcium superphosphate and Calcium Triple superphosphate, Corrosion problems and materials of construction. **(7)**

SODA ASH:
Manufacturing processes- Solvay and modified Solvay process, corrosion problems and material of construction. **(4)**

CHLOR ALKALI:
Electrochemistry of brine electrolysis, Voltage efficiency, Current efficiency, energy efficiency, Current density, Types of cells: Diaphragm cells, Membrane cells and Mercury cells, Electrolysis process for production of Caustic soda and Chlorine and major engineering problems. **(5)**

GLASS AND CEMENT:
Types and properties of cement, Method of production of Portland Cement, major engineering problems. Types and properties of glass, Manufacturing process of glass, Applications, major engineering problems. **(5)**

BOOKS RECOMMENDED:
1. Austin G., Shreve's Chemical Process Industries, 5th Ed., Tata McGraw Hill, 1990
2. Rao M.G., Sittig M, Dryden's Outlines of Chemical Technology- for 21st Century, 3rd Ed., Affiliated East West Press Pvt. Ltd., 2008.
3. Pandey, G.N., Chemical Technology Volume-I and II, Vikas Publication, 2010.
4. Moulijn J.A., Makkee M., Diepen A., Chemical Process Technology, John Wiley, 2001.

BTCH- 402 MASS TRANSFER-1

Internal Marks : 40 | **L T P**
External Marks: 60 | **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:
Importance and classification of mass transfer operations in Chemical Engineering. **(2)**

DIFFUSION:
Diffusion in gases and liquids, Fick's First law of diffusion, Mass balance in simple situations - with and without chemical reaction. Diffusion in solids, diffusion through porous solids and polymers, unsteady state diffusion **(6)**

INTERPHASE MASS TRANSFER:
Theories of Mass transfer, Individual and overall mass transfer coefficients, Convective mass transfer. Mass balance in concurrent and counter-current continuous contact equipment, Concept of operating line, Multi- stage counter current operations, Concept of ideal stage, Stage efficiencies, Design of continuous contact equipments, HTU and NTU concepts. **(10)**

GAS ABSORPTION:
Design of plate and packed absorption columns, Scrubbers, Non-isothermal absorption, Simultaneous heat and mass transfer. **(10)**

DRYING OF SOLIDS:
Rate of drying curves, through circulation drying, Continuous drying, Types of dryers. **(6)**

HUMIDIFICATION OPERATIONS:
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. **(8)**

MEMBRANE SEPARATIONS:
Types of membranes, permeate flux for ultra filtration concentration polarization, partial rejection of solutes, microfiltration, Reverse Osmosis and Electro-dialysis **(6)**

BOOKS RECOMMENDED:
1. Treybal Robert E., Mass Transfer Operations, 3rd Ed., McGraw Hill, 2001
2. Backhurst J.R., Harker J.H., Coulson J.F., Richardson J.M., Chemical Engineering - Volume 1, 6th Ed., Butterworth Heinemann, 1999
3. Skelland, A.H.P, Diffusional Mass Transfer, Kreiger Publishing Co., 1985.
4. McCabe, Warren L., Smith, Julian C. and Harriot, P., Unit Operations of Chemical Engg., 7th Ed.,McGraw Hill, 2005

BTCH- 403 HEAT TRANSFER

Internal Marks : 40 | **L T P**
External Marks: 60 | **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 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. **(8)**

CONVECTION:
Free and forced convection, Concept of thermal boundary layer, concept of overall heat transfer coefficient for laminar and turbulent flow, Heat transfer inside & outside tubes with significance of Nusselt, Prandtl, Reynolds, Biot, Fourier and Peclet numbers. Modeling of convective heat transfer coefficient by using dimensional analysis for natural convection. **(10)**

RADIATION:
Distribution of radiant energy, Definition of emissivity, absorptivity, Reflectivity and transmissivity, concept of Black and Grey bodies, Planck's law of monochromatic radiation, Kirchhoff's law, Wien's displacement law, Stefan-Boltzmann law, definition of intensity of radiation. Radiation formula for radiation exchange between simple bodies, two parallel surfaces and between any source and receiver, radiation shields **(6)**

CONDENSATION AND BOILING HEAT TRANSFER:
Dropwise and Film wise condensation of pure and mixed vapors, Convective, Nucleate & Film boiling, Theory and correlations, critical boiling flux. **(6)**

HEAT EXCHANGERS:
Heat exchangers - double pipe heat exchanger, Shell-and-Tube heat exchangers, plate type heat exchanger, concept and calculation of log mean temperature difference, temperature correction factor for shell & tube exchangers, fouling factors, overall heat transfer coefficient Theory of Fins and their applications Reboiler and Condensers, counter current dry contact Condenser, parallel current- wet contact Condenser. **(10)**

EVAPORATORS:
Various types of evaporators- Standard vertical tube evaporator, basket type vertical evaporator, forced circulation evaporator and horizontal tube evaporators. Single effect evaporators and multi-effect

evaporators and its various types of feed arrangements, boiling point elevation, capacity and economy of evaporators. Evaporation under vacuum. **(8)**

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. Incropera F.P., DeWitt D.P., Bergman T.L., Lavine A.S., Fundamentals of Heat and Mass Transfer,7th Ed., John Wiley, 2011.

BTCH- 404 CHEMICAL PROCESS INSTRUMENTATION

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

OBJECTIVE:
The objective of the course is to introduce to student's various types of instruments and their chemical process applications.

INTRODUCTION:
Importance of instruments in Chemical Process industries, Classification of instruments, Static and Dynamic characteristics of instrument. **(5)**

TEMPERATURE MEASUREMENT:
Thermocouples, resistance & filled thermometers, thermistors, optical and radiation pyrometer **(8)**

FLOW & LEVEL MEASUREMENTS:
Liquid level measurement-Direct and differential method and Flow measuring devices, Use of obstruction type meters, Variable area meters. Pressure probes, positive displacement type meters. **(8)**

INSTRUMENTS FOR PRESSURE MEASUREMENT:
Use of manometers, Bourdon gauge, bellow type gauge, Measurement of vacuum and pressure, Transducers. **(8)**

INSTRUMENTS FOR MISCELLANEOUS MEASUREMENTS:
Measurement of Nuclear Radiation, Viscosity, Conductivity, Humidity and pH value, Industrial weighing and feeding systems, Instrument for gas analysis, gas chromatography, Masspectroscopy. Process instrumentation, recording instruments, indicating and signaling instruments, Transmission of instrument reading, control centre, Instrumentation diagram, Instrumentation in modern plant. **(14)**

CONTROLS:
Introduction to the concept of Automatic process control and Process and Instrumentation diagrams of typical units like Reactors and Evaporators. **(5)**

BOOKS RECOMMENDED:
1. Eckman D.P., Industrial Instrumentation, Wiley Eastern, 1974
2. Harriott P., Process Control, Tata McGraw Hill, 2001.
3. Patranabis D., Principles of Process Control, 2nd Ed., Tata McGraw Hill, 2001
4. Pollard, Process Control for Chemical and Allied Industries, Butterworth Heinnemann, 1971.
5. Weber T. W., An Introduction to Process Dynamics & Control, Kreiger Publishing Co, 1988
6. Coughanour, D. R., Process System Analysis & Control, McGraw Hill.
7. Coughanowr D. R., Leblanc S., Process System Analysis and Control, 3rd Ed., McGraw Hill, 2009

BTCH- 405 CHEMICAL REACTION ENGINEERING-I

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

OBJECTIVE:
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:
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. **(8)**

DESIGN FOR SINGLE REACTIONS:
Material balance equation for ideal batch reactor and its use for kinetic interpretation of data and isothermal reactor design for simple & complex rate equation. Performance equations for CSTR and PFR and their use for kinetic interpretation and design Comparison of batch reactor, CSTR & PFR, Recycle reactor, concept of yield & selectivity Reactor combinations of CSTR and PFR **(16)**

DESIGN FOR MULTIPLE REACTIONS:
Quantitative treatment of Series & parallel multiple reaction in a batch reactor, CSTR & PFR, Concept of Product distribution for multiple reactions. **(8)**

TEMPERATURE & PRESSURE EFFECTS:
Concept of adiabatic & non-isothermal operations, Energy balance equation for Batch, CSTR & PFR and their application to design of reactors, optimal temperature progression, multiple steady states in CSTR. **(8)**

NON-IDEALITY:
Basics of non-ideal flow, residence time distribution, States of segregation, Measurement and application of RTD, E-Age distribution function & F-curve and inter-relationship between them, Conversion in non-ideal reactors. **(8)**

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 Engg, 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.

BTCH- 406 HEAT TRANSFER LABORATORY

Internal Marks : 30
External Marks: 20
Total Marks: 50

L	T	P
0	0	3

1 To determine the thermal conductivity of insulating powder.
2.To determine total thermal resistance and thermal conductivity of composite wall. Also find temperature gradient along composite wall structure.
3 To determine the thermal conductivity of a Good Conducting material, say Brass.
4.To determine heat flow rate through the lagged pipe for known value of thermal conductivity of lagging material.
5.To determine the Stefan's Boltzmann constant by Stefan's Boltzman Apparatus.
6.To find the heat transfer coefficient of heat loss by vertical pipe by natural convection.
7.To find heat transfer coefficient for parallel flow and counter flow for double pipe heat exchanger.
8.To find heat transfer coefficient loosing heat by forced convection to air flowing through it for different air flow rates & heat flow rates.
9. To determine the emissivity of a given test plate and the effect of temperature on it.
10.To determine the super thermal conductivity of heat pipe and to compare its working with best conductor i.e. Cu pipe and SS pipe.
11.To determine the temperature distribution in the fin and effectiveness of Fin by Natural convection and forced convection

BTCH- 407 CHEMICAL TECHNOLOGY LABORATORY

Internal Marks : 30
External Marks: 20
Total Marks: 50

L	T	P
0	0	3

1. To perform proximate analysis of a given sample of coal.
2. To determine the acid value of an oil/fat.
3. To determine the saponification value of an oil/fat.
4. To determine the iodine value of an oil/fat.
5. Preparation of phenol-formaldehyde.
6. Preparation of urea-formaldehyde.
7. To determine the viscosity of a given sample of oil.
8. To estimate the given reducing sugar using BENEDICT'S METHOD.
9. Determination of N-P-K value of a fertilizer
10. Preparation of polymer product using Injection moulding or compression moulding.

BTCH- 408 CAD IN CHEMICAL ENGINEERING

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

1. Traditional drafting of various assemblies, pipe joints, sectional views and valves.
2. Introduction to various computer software's and Computer Aided Drafting. Study and use of various commands from Menus, Command Tool Box and Command prompt area.
3. Applications of Auto – CAD
   - Drawing of Process and Flow Sheets.
   - X-Y Graphs, Heat Exchangers.
   - Columns: Packed Columns, Plate Columns.
   - Jacketed vessels, Boiler parts like spring loaded steam stop valve.
   - Cut View of Centrifugal pump and rotary compressor to show internal details.
4. Introduction to CHEMCAD.
5. Applications of CHEMCAD in Plant Design.

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur

Fifth Semester

BTCH-501 CHEMICAL REACTION ENGINEERING-II

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

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:
Introduction to catalysts & their classification, Concepts of physical absorption and Chemisorptions, 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. **(10)**

DIFFUSION THROUGH POROUS CATALYST PARTICLES:
Effectiveness factor for pore diffusion resistance through a single cylindrical pore, Significance of Thiele modulus, Heat effects during reaction, Performance equations for solid- gas reactions for different reactor types & determination of controlling resistance **(10)**

KINETICS OF FLUID-PARTICLE REACTIONS:
Modelling of gas-solid non-catalytic reactions and determination of parameters, Combination of resistances & determination of rate controlling step. **(10)**

KINETICS & DESIGN OF FLUID-FLUID REACTIONS:
Interface behavior 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 **(10)**

DESIGN OF HETEROGENEOUS REACTORS:
Analysis of rate data design outline and selection of fixed bed, fluidized bed and slurry reactors, Reactor systems and design for gas-liquid-solid non-catalytic system**.** **(8)**

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 Engineer, 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
7. Carberry, J.J. Chemical and Catalytic Reaction Engineering, McGraw Hill, New York, 1976.

BTCH-502 MASS TRANSFER-II

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

L	T	P
3	1	0

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:
Vapor-liquid equilibria, Raoult's Law and Dalton's law, relative volatility, Flash distillation, Differential distillation, Continuous Rectification- Binary system, Steam distillation, Multistage tray tower- McCabe-Thiele method, Ponchon-Savarit method, Underwood and Fenske equations, Minimum and optimum reflux ratios, multiple feeds and side streams, principles of azeotropic and extractive distillation. (**18)**

LIQUID-LIQUID EXTRACTION:
Equilibrium diagram, Choice of solvent, Single stage and multistage counter-current extraction with/without reflux. Extraction equipment: Rotating disc contractor, Scheibel extractor, Pulsed column extractor, Podbilniak extractor. (**10)**

LEACHING:
Single stage and multistage cross current and counter current leaching. Leaching equipment: Rotocel extractor, Kennedy extractor, Bollman extractor, Continuous horizontal extractor, Equilibrium. **(8)**

ADSORPTION:
Types, nature of adsorbents, Adsorption equilibria- single species- Langmuir, Freundlich isotherms, Adsorption operations –single stage and multi stage. **(7)**

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

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. McCabe, Warren L., Smith, Julian C. and Harriot, P., Unit Operations of Chemical Engg. 7th Ed., McGraw Hill, 2005
5. Harker J. H., Richardson, J. F., Backhurst J. R., Chemical Engg. Vol, 2,5th Ed., Butterworth-Heinemann, 2003.
6. Holland, Charles D., Fundamentals and Modelling of Separation Processes, Prentice Hall, Inc. New Jersey.

BTCH-503 PROCESS DYNAMICS & CONTROL

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

L	T	P
3	1	0

OBJECTIVE:
The course is devoted to the analysis of the dynamical behavior of systems and the mathematical tools used in their analysis. Further, the control of these processes by using various types of controllers and their design is included in the course. After studying this course, a student is expected to understand analysis of the dynamical behavior of systems and the mathematical tools used in their analysis.

GENERAL PRINCIPLES OF PROCESS CONTROL:
Basic control elements, degree of freedom & fixing of control parameters, Simple system analysis, laplace transformation and transfer functions, block diagrams, linearization. First and higher order systems, interacting & non-interacting systems distributed & lumped parameter systems, dead time. **(12)**

DIFFERENT MODES OF CONTROL AND THEIR BASIC CHARACTERISTICS:
Proportional, Integral and Derivative Control action, Controller characteristics- P, PI & PID controllers, process characteristics and choice of indicating, recording & controlling instruments for chemical industries, Feedback control servo and regulation control. Time domain-closed loop frequency response, optimization of control system response, stability analysis – Routh criteria, Bode plots. **(16)**

INTRODUCTION TO ADVANCED CONTROL TECHNIQUES:
Feed forward, feedback, cascade, ratio, adaptive and digital computer control. **(8)**

PROCESS DYNAMICS AND APPLICATIONS:
Process identification, dynamics and control of chemical equipment's such as exchangers, distillation columns **(12)**

RECOMMENDED BOOKS:

1. Coughanowr D. R., Leblanc S., Process System Analysis and Control, 3rd Ed., McGraw Hill, 2009
2. Stephanopoulos, G., Chemical Process Control - An Introduction to Theory and Practice, 1st Ed., Prentice Hall of India, 1990.
3. Peacock D.G., Richardson J.F., Chemical Engineering Vol. 3rd Ed., Butterworth Heinemann, 1994.
4. Bequette B.W., Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall, 1998
5. Bequette B. W., Process Control: Modeling, Design and Simulation, Prentice Hall, 2003
6. Pollard, Process Control for Chemical and Allied Industries, Butterworth Heinemann, 1971.
7. Weber T. W., An Introduction to Process Dynamics & Control, Krieger Publishing Co, 1988
8. Harriott, P., Process Control, TMH Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2001.

BTCH-504 INDUSTRIAL POLLUTION CONTROL

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

L	T	P
3	1	0

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

INTRODUCTION:
Ambient air and water standards, principle sources of pollution, Interrelationship between energy and environmental pollution, Prevention of environmental pollution through conservation **(3)**

AIR POLLUTION:
Definition and scales of concentration of air pollution, Classification and properties of Air Pollutants, Sources of Air Pollutants, Photochemical Smog, Effects of air pollution on human health, animals, vegetation and materials **(7)**

ASPECTS OF AIR POLLUTANT DISPERSION:
Temperature Lapse rate and stability, Adiabatic lapse rate, Atmospheric stability, Temperature inversions. Types of Plume Behavior, Atmospheric dispersion of air pollutants **(8)**

AIR POLLUTION SAMPLING AND MEASUREMENTS:
Ambient air sampling: Grab sampling, Sedimentation (dust fall jar) and High Volume Filtration (The Hi-volume sampler) Stack sampling and Particulate sampling. **(4)**

AIR POLLUTION CONTROL METHODS AND EQUIPMENTS:
Source correction methods & cleaning of gas effluents, Collection efficiency Equipment, Gravitational settling chamber, Cyclone Separator, Fabric Filters, Electrostatic Precipitators, Wet collectors (Scrubbers) **(8)**

WATER POLLUTION:
Types of water pollutants, their sources and effects.BOD and COD, oxygen sag curve, Waste water sampling- Grab and Composite sample. **(8)**

WASTE WATER TREATMENT:
Primary Treatment: Pre-treatment Sedimentation and Flotation, Secondary Treatment: Activated sludge process, Trickling filters, Aerobic and Anaerobic digestion and oxidation ponds. **(7)**

SOLID WASTE
Sources and classification of solid waste, Methods of collection, Disposal methods: Open dumping, Sanitary Landfill, Incineration and compositing Recovery and recycling. **(3)**

RECOMMENDED BOOKS:

1. Perkins H. C., Air Pollution, McGraw Hill, N.Y., 1974
2. Rao C.S., Environmental Pollution Control Engineering, 2nd Edition, New Age International Pvt. Ltd., 2006
3. Metcalf and Eddy, Waste-Water Engineering, 4thEdition, Tata McGraw Hill, 2007.
4. Mahajan S. P., Pollution Control in Process Industries, McGraw Hill, 2008

BTCH-505 MASS TRANSFER LABORATORY

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**3**
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 vaporization of organic vapour to air.
4. To verify the Rayleigh's equation for batch distillation.
5. To find the yield of crystals using batch crystallizer
6. To study the adsorption characteristics and plot adsorption isotherm.
7. To study the cooling tower for humidification process.
8. To study liquid-liquid extraction in a packed column.
9. To determine mass transfer coefficient from a wetted wall column.

BTCH-506 CHEMICAL REACTION ENGINEERING AND POLLUTION CONTROL LABORATORY

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

1. To determine total dissolved and suspended solids of given sample of water.
2. To determine Chemical Oxygen Demand (COD) of given sample of water.
3. To determine Alkanity and hardness of a given sample of water.
4. To determine Dissolved Oxygen of a given sample of water
5. To determine BOD of a given sample of water
6. To determine Optimum dose of Alum for coagulation of water.
7. To find Rate Constant for non-catalytic homogeneous reaction in an isothermal batch Reactor.
8. To find Rate Constant for homogeneous reaction in an isothermal CSTR Reactor.
9. To find Rate Constant for homogeneous reaction in an isothermal Plug Flow Reactor.
10. RTD studies in PFR Reactor.
11. RTD studies in CSTR Reactor.

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur

Sixth Semester

BTCH-601 TRANSPORT PHENOMENON

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

OBJECTIVE:
This course introduces the student to the rigorous formulation of transport problems and develop a fundamental knowledge of the physical principles that govern the transport of momentum, energy and mass, with emphasis on the mathematical formulation of the conservation principles in biological and Chemical processes.

INTRODUCTION:

MOMENTUM TRANSPORT: Newton's law of Viscosity, Generalization of Newton's Law of Viscosity, Effect of Temperature and Pressure on Viscosity, Molecular theory of Viscosity of Gases at Low density, Molecular theory of Viscosity of Liquids Convective Momentum Transport, Non-Newtonian Fluids. **(4)**

Shell Momentum Balances and Velocity distributions in Laminar Flow, Flow of Falling film, Inclined Parallel plate, Flow through Circular tube, Hagen -Poiseuille equation, Flow through an Annulus, Couette viscometer. **(8)**
Principles of conservation of mass and momentum, continuity equation, equations of motion, Bernoulli Equation, Navier-Stokes equations. Equation of mechanical energy, Equation of angular momentum equation of change in substantial derivative. **(5)**

Mechanism of Turbulence, Stream function, Velocity potential, Flow near solid surfaces by Boundary Layer theory. Velocity distribution in Turbulent Flow, Intensity of Turbulence, Reynolds stresses, Power Law Velocity Profiles. Friction factors for flow in Tubes and around sphere. Pressure Rise and Friction loss in a sudden enlargement. **(6)**

ENERGY TRANSPORT:
Shell energy balances and temperature distributions in solids and laminar flow, Principle of conservation and equation of energy. Fourier's law, Thermal conductivity and mechanism of energy transport, Effect of Temperature and Pressure on Thermal Conductivity. **(3)**
Heat Conduction with an electrical heat source, Heat Conduction with an viscous heat source, Heat conduction through Composites walls, Composite cylindrical pipe, Heat conduction in a cooling fin. Free and Forced Convection, Heat transfer coefficients for forced convection in tubes. **(8)**

MASS TRANSPORT:
Diffusivity and the mechanisms of mass transport, Fick's Law of Binary diffusion, Effect of Temperature and Pressure on Diffusivity. Theory of ordinary diffusion in gases at low density, Theory of ordinary diffusion in liquids. **(4)**
Mass and Molar Transport by convection: Definition of concentrations, velocities and fluxes. Diffusion through stagnant gas film, Equimolar counter diffusion, Diffusion in a falling liquid film. Interphase mass

transport, Definition of Transfer coefficients in Two Phases, mass transfer coefficients-individual and overall. Introduction to the concept of heat and mass transfer coefficients, Analogy between momentum, heat and mass transfer. **(10)**

RECOMMENDED BOOKS:

1. Bird, R.B., W.E. Stewart, E.N. Lightfoot D.J. Klingender, Introduction to Transport Phenomena, Wiley, 2015
2. Geankoplis C.J., Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed., Prentice Hall, 2003
3. Bennett.C.O. and Myres J.E., Momentum Heat and Mass Transfer, 3rd Ed., McGraw Hill, 1982.
4. Welty, J.R., C.E. Wicks, R.E. Wilson and G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 5th edition, Wiley, 2008.

BTCH-602 CHEMICAL PROCESS OPTIMIZATION

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

OBJECTIVES:
This course aims at training the students in the use of various optimization techniques for finding the best operating conditions or values for design variables such that some objective is justified. It includes the optimization of linear, non-linear, single variable and multivariable problems. After studying this course, a student is expected to understand operating conditions or values for design variables.

INTRODUCTION:
Engineering application of optimization, Design variables, constraints, objective function, variable bounds, statement and formulation of an optimization problem, Examples of chemical engineering Optimization problems, Classification of optimization problems, different optimization algorithms. Optimal Point: Local optimal point, global optimal point and inflection point. **(05)**

SINGLE VARIABLE OPTIMIZATION TECHNIQUES:
1. Optimality criterion.
2. Bracketing method (Bounding phase method).
3. Region elimination methods (Internal halving, Fibonacci search method, Golden section method).
4. Point estimation method (Successive quadratic estimation methods).
5. Gradient-based methods (Newton-Raphson method, Bisection method, Secant, Cubic search method.)
6. Root finding using optimization techniques. **(12)**

MULTIVARIABLE OPTIMIZATION TECHNIQUES:
1. Optimality criterion – Hessian Matrix and its use in optimization
2. Unidirectional search method.
3. Direct search method (Evolutionary method, Hooke-Jeeves Pattern Search method, Powell's conjugate direction method)
4. Gradient-based methods (Steepest descent method, Newton's method, Marquardt's methods) **(12)**

CONSTRAINED OPTIMIZATION ALGORITHMS:
1. Kuhn - Tucker conditions
2. Transformation method (penalty function method)
3.Direct search for constrained minimization (variable elimination method, complex search method.) **(12)**

LINEAR PROGRAMMING
Linear programming problems, Degeneracy, Simplex method of linear programming, dual phase simplex method. **(7)**

RECOMMENDED BOOKS:
1. Deb K., Optimization for Engg. Design Algorithms and Examples, Prentice Hall of India, 2005.
2. Edgar T.I. &Himmelblau D.M., Lasdon L.S., Optimization of Chemical Processes, McGraw Hill, 2001.
3. Rao S.S., Engineering Optimization Theory and Practice, 4 th Ed., John Wiley and Sons, 2009.
4. Ray W.H., &Szekely J., Process Optimization with Applications to Metallurgy & Chemical Engg. Wiley Interscience, 1973.
5. Beveridge S.G. & Schechter R.S., Optimization: Theory & Practice, McGraw Hill, 1970.
6. Grewal B.S., Numerical Methods in Engineering and Science, Khanna Publishers, 1991.

BTCH-603 ENGINEERING MATERIALS

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

OBJECTIVES:
This course is aimed at giving the students information about the availability of various types and classes of materials for engineering usage as per the demands of the end use. This course will help the students in choosing a suitable material of construction for various equipment's being used in a particular processing technology.

CRYSTAL STRUCTURE:
Review of bonding in solids, structure – property-processing relationship. Space lattice, FCC, HCC, crystal systems, Miller indices, effect of radius ratio on coordination, structures of common metallic, polymeric, ceramic, amorphous and partly crystalline materials. **(6)**

MECHANICAL, THERMAL AND ELECTRICAL PROPERTIES:
Methods of improving strength-reinforcement, additives, Specific heat, glass transition temperature, crystalline melting temperature, thermal conductivity; dielectric strength, dielectric constant, power loss and electrical diffusivity. **(5)**

FERROUS METALS:
Important varieties of iron ores, cast iron: types, properties and uses of cast iron; Pig iron: Types of pig iron. Wrought iron: properties and uses of wrought iron. Steel: factors affecting physical properties of steel and uses of steel (No manufacturing process). **(6)**

NON FERROUS METALS:
Aluminum, cobalt, copper, lead, magnesium, nickel, tin and zinc their properties and uses. **(3)**

ALLOYS:
Introduction to Phase-Diagrams of metals and its alloys; Fe-Fe3C; Cu-Ni, Cu-Zn, Al-Cu equilibrium diagrams, methods of improving strength, and applications of metals and alloys. **(8)**

CERAMICS:
Definition of ceramic, clay: properties of clay, earthen wares and stoneware, uses of stoneware. **(3)**

GLASS:
Definition, classification, composition, types and properties of glass **(2)**

REFRACTORIES:
Definition of refractory, classification of refractories, properties of refractories. common refractory bricks like silica bricks, fire clay bricks, dolomite bricks, high alumina bricks and carbon bricks **(3)**

POLYMERS & COMPOSITES:
Classification of polymers, Properties and Engineering Usage of Nylon-66, nylon-6, polyesters, polycarbonates, polyurethanes, PVC, polypropylene, rubber, polymer composite blends **(8)**

NOVEL MATERIALS:
Introduction to nano materials and biomaterials and their uses **(4)**

RECOMMENDED BOOKS:
1. Patton W J, Materials in Industry, 2nd Ed., Prentice Hall, 1975.
2. Van Vlack L.H., Elements of Material Science & Engineering, 6th Ed., Pearson Education Inc., 2008.
3. Aggrawal B.K., Introduction to Engineering Materials, Tata McGraw Hill, 2008.
4. Narula G.S., Narual K. S., Gupta V.K., Material Science, Tata McGraw Hill, 2007.
5. Bawa HS, Materials and Metallurgy, Tata McGraw Hill, 1986.
6. Callister, W. D., Rethwisch D.G., Materials Science & Engineering- An introduction, 8th Ed., Wiley International, 2010.

BTCH-604 PROCESS INSTRUMENTATION, DYNAMICS & CONTROL LABORATORY

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

1. Calibration of temperature measuring instruments.
2. To study the characteristics of thermometer and thermocouple in first order system.
3. Study of process dynamics of interacting / non-interacting tank
4. To estimate theoretical time constant and damping coefficient for U-tube manometer second order system.
5. Investigation of the operation of pneumatic and electronic controllers with proportional integral derivative action using Simulink.
6. To determine the best setting of a controllers with controlling an actual process.
7. Estimate the stability of first order or higher order system with the help of computer and to study control problems by simulation.
8. To study the step response of a two tank interacting liquid level system and compare the observed transient response with the theoretical response.
9. Study of control valve characteristics.
10. Study of Programmable Logic Control system.

BTCH-605 CHEMICAL EQUIPMENT DESIGN

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

1. Mechanical Design of Process Equipment: Introduction, Classification of pressure vessels, pressure vessel codes and standards, Fundamental Principles and equations review
2. Design Considerations: Design Pressure, Design Temperature, Materials of construction, Weld joint efficiency, corrosion allowance, and Design loads.
3. Design of thin walled vessels under Internal Pressure: Cylindrical and spherical vessels
4. Design of heads and closures – design of flat head, conical head, dished heads, hemispherical and elliptical heads
5. Design of thick walled vessels under Internal Pressure
6. Design of Vessels subject to External Pressure: Cylindrical & spherical vessels, Stiffening rings, vessel heads
7. Design of vessels under combined loading: Dead Weight, wind load
8. Design of supports: Skirt support, lug support.

The examination shall include a viva-voce examination based on the design report.

RECOMMENDED BOOKS:

1. Brownell L.E. and Young E. H., Process Equipment Design, Wiley Interscience, 1959.
2. Bhattacharya, R.C., An Introduction to Chemical Equipment Design- Mechanical Aspects, 1st Ed., CBS Publication, 1985
3. Mahajani V.V., Umarji S.B., Joshi's Process Equipment Design, 4th Ed., Macmillan Indian Ltd., 2009

BTCH-606 MINOR PROJECT

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

The problem of the minor project formulated during 6th Semester is to extended and executed in major project by the same group of students. The literature survey, problem formulation, assessment for viability of the project, objectives and methodology of the project shall be decided in 6th semester. The same project problem is to be extended in the major project in 7th/8th semester. The minor project may be carried out by a group of students 2 to 4.

The examination shall include a viva-voce examination based on the report.

BTCH- 901 POLYMER SCIENCE & ENGINEERING

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

L	T	P
3	0	0

OBJECTIVES:
The course will provide an overview of Polymers, focusing on the various types of polymers, polymerization processes, their properties and characterization.

INTRODUCTION TO POLYMERS:
Global scenario of polymer industry, Present status of polymer industry in India, Classification of polymers, polymerization process, Kinetics of step growth and chain growth polymerization, polymerization techniques: Bulk, Solution, Suspension and Emulsion Polymerization **(6)**

MOLECULAR WEIGHT & SIZE OF POLYMERS:
Number average and weight average molecular weight, Significance of molecular weight, determination of molecular weight, viscosity method, osmotic pressure, light scattering method, gel permeation chromatography method. **(4)**

POLYMER PROPERTIES & THEIR TESTING:
Glass transition temperature and associated properties, Tensile strength & impact strength and their determination, softening point, heat distortion dielectric and power factor. **(4)**

SYNTHESIS & PROPERTIES OF COMMERCIAL POLYMERS:
Manufacture, processing and properties of resins and fiber forming polymers such as phenol formaldehyde, epoxy resins and silicon polymers, LDPE, HDPE, polypropylene, polyvinyl chloride, polystyrene, polyurethane and polyamides. **(6)**

INTRODUCTION TO RUBBER & ELASTOMERS:
Natural & synthetic rubber, Buna S, Buna N, Butyl rubber, neoprene, Thiokol, polyurethane, Fillers, accelerators, activators, antioxidants & other additives, mastication & compounding, vulcanization theory & technology **(7)**

POLYMER DEGRADATION:
Thermal, Mechanical and by ultrasonic waves, photo degradation, heat energy radiation, oxidation and hydrolysis **(2)**

POLYMER PROCESSING:
Compression molding, injection molding, blow molding, reaction injection molding, extrusion, calendaring, rotational molding **(7)**

RECOMMENDED BOOKS:
1. Gowariker V.L., Viswanathan N.V. and Sreedhar J., Polymer Science, 1st Ed., New Age International
2. Ghosh P., Polymer Science & Technology of Plastics & Rubber, 3rd edition, Tata McGraw Hill, New Delhi, 2010
3. Billmeyer F.W., Text Book of Polymer Science, 3rd edition, John Wiley,
4. Sinha R., Outlines of Polymer Technology - Manufacture of Polymers, PHI
5. Kumar A., Gupta R.K., Fundamentals of Polymer Science and Engineering, Tata McGraw Hill New Delhi, 1978
6. Polymer Processing, Morton & Jones, Chapman & Hall.,1990

BTCH- 902 ENZYME TECHNOLOGY

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

OBJECTIVE:
The course is aimed at enabling the students to understand the enzymatic reactions, their importance and the various fundamentals involved in enzymatic reactions.

KINETICS AND MECHANISM OF ENZYME ACTION:
Nature and function of enzyme, classification of enzymes, quantification of enzyme activity and specific activity, Estimation of Michaelis Menten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition. Modeling of rate equations for single and multiple substrate reactions **(8)**

IMMOBILIZED ENZYME REACTIONS:
Techniques of enzyme immobilization-matrix entrapment, ionic and cross linking, column packing; Analysis of mass transfer effects of kinetics of immobilized enzyme reactions; Analysis of Film and Pore Diffusion Effects on Kinetics of immobilized enzyme reactions.
calculation of Effectiveness Factors of immobilized enzyme systems; Bioconversion studies with immobilized enzyme packed -bed reactors. **(7)**

MASS TRANSFER EFFECTS IN IMMOBILIZED ENZYME SYSTEMS
Analysis of film and Pore Diffusion Effects on kinetics of immobilized enzyme reactions; Formulation of dimensionless groups and calculation of Effectiveness Factors Reactor design and analysis for immobilized enzyme reactors. **(8)**

APPLICATIONS OF ENZYMES
Extraction of commercially important enzymes from natural sources, Commercial applications of enzymes in food, pharmaceutical and other industries; enzymes for diagnostic applications, Industrial production of enzymes, Use of enzymes in analysis-types of sensing-gadgetry and methods, Case studies on application - chiral conversion, esterification etc., **(8)**

ENZYME BIOSENSORS
Applications of enzymes in analysis, Design of enzyme electrodes and case studies on their application as biosensors in industry, healthcare and environment. **(5)**

RECOMMENDED BOOKS:

1. Blanch, H.W., Clark, D.S., Biochemical Engineering, 1st Ed., Marcel Dekker, 1997
2. Lee, James M. Biochemical Engineering, PHI, USA, 2009
3. Bailey J.E. & Ollis, D.F., Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986
4. Wiseman, Alan, Hand book of Enzyme Biotechnology, Ellis Harwood, 1995.

BTCH- 903 NANO TECHNOLOGY

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

L	T	P
3	0	0

OBJECTIVE: The course will provide an overview of Nano materials, their characterization, usage and use in biomaterials.

INTRODUCTION:
Terminologies, History & Scope of nano technology. **(3)**

CHARACTERIZATION & FABRICATION:
Contemporary Characterization Methods, top down & Bottom up Fabrication, Solution based Synthesis of Nanoparticles, Vapour Phase Synthesis & Synthesis with framework, Nanolithography, Dip Pen Lithography. Artificially Layered Materials: Quantum Well, Quantum Dots, Super lattices & Layered Structures. **(15)**

SELF ASSEMBLY:
Supra-molecular & dimension Control in Nanostructure, thermodynamics and coded self assembly. **(6)**

BIOMATERIALS:
DNA & Nanomaterials, Bioanocomposites, Biometrics, molecular motor **(6)**

NANOELECTRONICS AND MOLECULAR COMPUTING:
Molecular wires, Nanowires, Nanotubes, Molecular switch, Molecular logic gates and molecular storage devices, DNA Computing Quantum Computing. **(6)**

RECOMMENDED BOOKS:

1. Poole C.P., Owens F.J., Introduction to Nanotechnology, Wiley, 2003.
2. Understanding Nanotechnology, Scientific American 2002.
3. Ratner M & Ratner D, Nanotechnology: A Gentle Introduction to the Next Big Idea, Prentice Hall, 2003
4. Wildon M., Kannagara K., Smith G, Simmons M. & Raguse B, Nanotechnology, CRC

BTCH- 904 SEPARATION PROCESSES

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

L	T	P
3	0	0

OBJECTIVE:
The course is aimed at providing the understanding of separation techniques used in industry. It includes the study of details of techniques like membrane separations, adsorption, and chromatography.

SEPARATION PROCESSES
Industrial chemical processes, Mechanism of separation, separation power, selection of feasible separation processes. **(6)**

MEMBRANE SEPARATIONS
Membrane Materials, Membrane Modules, Transport in Membranes – Porous Membranes, Bulk Flow, Liquid Diffusion in Pores, Gas Diffusion, Nonporous Membranes, Solution-Diffusion for Liquid Mixtures, Solution-Diffusion for Gas Mixtures, Module Flow Patterns, Cascades, External Mass-Transfer Resistances, Concentration Polarization and Fouling.
Dialysis and Electrodialysis, Reverse Osmosis, Gas Permeation, Pervaporation, Ultrafiltration, Microfiltration. **(15)**

ADSORPTION, ION EXCHANGE, AND CHROMATOGRAPHY
Sorbents: Adsorbents, Ion Exchangers, Sorbents for Chromatography, Equilibrium Considerations: Pure Gas Adsorption, Liquid Adsorption, Ion Exchange Equilibria, Equilibria in Chromatography
Kinetic and Transport Considerations: External Transport, Internal Transport, Mass Transfer in Ion Exchange and Chromatography Sorption Systems: Adsorption, Ion Exchange, Chromatography, Slurry Adsorption (Contact Filtration), Fixed-Bed Adsorption (Percolation), Thermal-Swing Adsorption, Pressure-Swing Adsorption, Continuous, Countercurrent Adsorption Systems, Simulated-Moving-Bed Systems, Ion-Exchange Cycle, Chromatographic Separations. **(15)**

RECOMMENDED BOOKS:
1. Seader J D & Henley E J, Separation processes principles, 2nd edition, John Wiley & sons, 2006
2. Rousseau R W, Handbook of separation process technology, Wiley-Interscience, 1987
3. Strathmann H, Ion exchange membrane separation processes, Elsevier Science.

BTCH- 911 PETROLEUM REFINING ENGINEERING

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

L	T	P
3	0	0

OBJECTIVE:
The course is aimed at providing the understanding of petroleum refining industry. It includes the characterization of crude and petroleum products and their usage and the various processes involved.

INTRODUCTION TO PETROLEUM INDUSTRY:
World petroleum resources, petroleum industry in India. Brief review of petroleum origin, its composition and classification. Exploration: Meaning, methods of exploration. Drilling: Concept of drilling, various drilling operations e.g. cable drilling, rotary drilling, directional drilling. Transportation of crudes and products. **(8)**

CRUDE PRETREATMENT AND METHODS OF EVALUATION/ CRUDE PROCESSING:
Desalting and stabilization of crude. Process description of a typical simple distillation, fractional distillation, atmospheric distillation, vaccum distillation, crude oil distillation. Methods of evaluation: ASTM, TBP and EFV distillation. Properties and specifications of petroleum products such as LPG, gasoline, naphtha, kerosene, diesel oils, lubricating oils, waxes. **(8)**

CONVERSION PROCESS:
Cracking, Thermal cracking, visbreaking, coking, ccatalytic cracking, reforming, alkylation, polymerization, isomerization and hydro processing. **(8)**

SEPARATION PROCESSES:
Sweetening: Doctor's sweetening process, copper chloride sweetening process, merox sweetening process. Solvent extraction: Edeleanu process. Solvent dewaxing: Chilling and pressing, Ketone dewaxing, Propane dewaxing, Urea dewaxing. Deasphalting: Propane deasphalting process. Safety and pollution considerations in refineries. **(12)**

RECOMMENDED BOOKS:
1. Nelson, W.L., Petroleum Refinery Engineering, 5th Edition, McGraw Hill, 1985.
2. Hobson, G.D., Pohl. W., Modern Petroleum Technology, 5th Edition, John Wiley, 1984.
3. Guthrie, V.B., Petroleum Products Handbook, McGraw Hill, 1960.
4. Rao, B.K., Modern Petroleum Refining Processes, 5th Edition, Oxford & IBH Publishing Co., 2009.

BTCH- 912 INTELLECTUAL PROPERTY RIGHTS

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

L	T	P
3	0	0

OBJECTIVE:
The course is designed to introduce fundamental aspects of Intellectual Property Rights to students who are going to play a major role in development and management of innovative projects in industries. The course introduces all aspects of the IPR Acts. It also includes case studies to demonstrate the application of the legal concepts in Science, Engineering, Technology and Creative Design.

OVERVIEW OF INTELLECTUAL PROPERTY:
Introduction and the need for intellectual property right (IPR) IPR in India – Genesis and Development IPR in abroad some important examples of IPR. **(5)**

PATENTS:
Macro economic impact of the patent system, Patent and kind of inventions protected by a patent document, Protection of inventions, granting of patent Rights of a patent, patent protection extensive, protect inventions by patents, searching a patent, Drafting of a patent Filing of a patent, Different layers of the international patent system (National, Regional and International options). **(8)**

COPYRIGHT:
Meant of copyright and contents covered by copyright, Copyright duration and protection, Necessity to protect copyright, Related rights, Distinction between related rights & copyright. **(5)**

TRADEMARKS:
Significance & rights of trademark, Signs and types of trademark, Protection and registration of trademark, Necessity to register and protection of trademark, Domain name and it relation to trademarks. **(6)**

INDUSTRIAL DESIGNS:
Industrial design and protected of design, Kind of protection is provided by industrial designs, Necessity to protect industrial designs and its terms. **(6)**

ENFORCEMENT OF INTELLECTUAL PROPERTY RIGHTS:
Infringement of intellectual property rights, Enforcement Measures, Emerging issues in IPR. **(2)**

INTELLECTUAL PROPERTY:
Overview of Biotechnology and Intellectual Property Biotechnology Research and Intellectual Property Rights Management Licensing and Enforcing Intellectual Property Commercializing Biotechnology Invention Case studies of Biotechnology, Case studies of patents in other areas. **(4)**

RECOMMENDED BOOKS:
1. T. M Murray and M.J. Mehlman, Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons 2000
2. P.N. Cheremisinoff, R.P. Ouellette and R.M. Bartholomew, Biotechnology Applications and Research, Technomic Publishing Co., Inc. USA, 1985

3. D.Balasubramaniam, C.F.A.Bryce,K. Dharmalingam, J. Green and K. Jayaraman, Concepts in Biotechnology, University Press (Orient Longman Ltd.), 2002
3. Bourgagaize, Jewell and Buiser, Biotechnology: Demystifying the Concepts, Wesley Longman, USA, 2000.
4. Ajit Parulekar and Sarita D' Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd, 2006
5. B.L.Wadehra; Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000
6. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010

BTCH- 913 MEMBRANE SEPARATIONS

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

L	T	P
3	0	0

OBJECTIVE:
The course will provide an overview of membrane processes used in separations in the chemical industry and their applications.

INTRODUCTION:
Definition of membrane and membrane process, Commercial membrane separation processes, new membrane separation process under development **(5)**

REVERSE OSMOSIS:
Introduction and definition, theory and design, different membrane modules, selected applications and economics **(7)**

ULTRA FILTRATION:
Introduction and definition, theory and design, membrane module and process configuration, applications and economics **(7)**

MICRO FILTRATION:
Introduction and definition, theory of cross flow filtration, dead end micro filtration, applications and economics. **(7)**

EMULSION LIQUID MEMBRANES:
Introduction and definition, theory and design, selected applications and economics **(6)**

DIALYSIS, ELECTRODIALYSIS, PERVAPORATION, GAS PERMEATION:
Brief introduction and applications **(4)**

RECOMMENDED BOOKS:
1. Wilson & Sirkar, Membrane Handbook, Mc Graw hill, London, 2001
2. Nune and Peinemann, Membrane Technology in Chemical Industries, Wiley, New York, 2000
3. Cheryan Munir, Ultra Filtration Handbook, Technomic, New York, 1985
4. Noble and Stern, Membrane Separation and Technology, Principles and applications, Elsevier, 1995
5. Baker R W, Membrane Technology and Applications, Wiley, New York, 2000

BTCH-914 PROJECT MANAGEMENT

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

L	T	P
3	0	0

OBJECTIVE:
The aim of this course is to provide an overview of project management for small scale and medium scale industries and the regulations relevant to these industries.

INTRODUCTION & OVERVIEW:
Definitions, Types of projects, Project life cycle (Project phases) and decisions **(6)**

SMALL SCALE INDUSTRIES AND GOVERNMENT POLICIES:
Small scale industries and list of products reserved under it. Relative merits and demerits of SSI and Present status of small scale industry in the country. **(10)**

SMALL SCALE INDUSTRY-REQUIREMENTS AND TRENDS:
Types of product and standardization of their qualities, Raw materials requirements, Utilities services, market survey, economic viability, employment potential, promotion of regional development Trends of growth in India and abroad **(10)**

PROJECT MANAGEMENT OF SSI:
Feasibility report, patterns of financial assistance, available from state/central government and financial institutions. Turnkey and other projects. Import license, marketing techniques, product identification and selling, Promotion of export and legal obligation **(10)**

RECOMMENDED BOOKS:
1. Geoffery G. Mcredity, R.E, Neck, P.A, The Practice of Entrepreneurship, Dialogue Publication, 1982.
2. Chaudhary S., Project Management, Tata McGraw Hill Publishing Co., Ltd., 2004
3. Aswathappa, Factory Organisation and Management, Himalaya Publishing House.
4. Bhojwani Ramesh, Small, Medium & Large Scale Industries Vol. I & II, Small industry Research Institute Delhi.

BTCH-951 CORROSION ENGINEERING

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

L	T	P
3	0	0

OBJECTIVE:
The course will provide an overview of corrosion effects, the various processes and applications where corrosion is dominant and mitigation strategies.

BASIC CONCEPTS:
Corrosion Engineering, Definition of corrosion, Corrosion Damage **(3)**

CORROSION PRINCIPLES:
Corrosion rate expressions, Electrochemical Aspects, Polarization, Passivity, Environmental Effects **(4)**

FORMS OF CORROSION:
Galvanic corrosion: EMF and Galvanic series, Environmental Effects, Prevention and Beneficial applications **(12)**
Crevice Corrosion: Environmental effects, Mechanism and Prevention
Pitting: Pit Shape and Growth, Autocatalytic nature of Pitting, Solution composition, Evaluation and prevention
Inter granular Corrosion: Austenitic Stainless steels, Weld Decay, Control for Austenitic Stainless Steels
Selective Leaching: Dezincification: Characteristics, Mechanism and Prevention
Erosion Corrosion: Erosion Corrosion, Factors which effect Erosion Corrosion, Combating erosion Corrosion
Stress Corrosion: Crack morphology, Stress Effects, Environmental and Metallurgical factors, Classification of Mechanisms, Methods of Prevention
Hydrogen Damage: Characteristics, Environmental Factors and Prevention.

MATERIALS:
Properties of Metals and Alloys like Cast Iron, Carbon Steels and Irons, Aluminum, Lead, copper, Zinc, Tin and its Alloys, Thermoplastics like Nylon. Polyethylene and Polypropylene, Thermo setters like Polyesters, Phenolics and Urea **(6)**

CORROSION PREVENTION:
Materials Selection, Alteration of Environment, Cathodic and Anodic Prevention, Coatings **(4)**

PASSIVITY:
Basic concepts of passivity; Properties of passive films **(2)**

HIGH TEMPERATURES CORROSION:
Mechanisms and Kinetics: Pitting- Bedworth Ratio, Electrochemical and Morphological Aspects of Oxidation. Oxidation Kinetics, Effect of Alloying, High Temp Materials, Corrosion in acidic and alkaline process streams. **(5)**

RECOMMENDED BOOKS:
1.Fontana, Mars.G., “Corrosion Engineering”, McGraw-Hill.
2.Jones, D.A., “Principal and Protection of Corrosion”, Prentice-Hall
3.Unling, H.H., Corrosion Control, John Wiley & Sons, 1971
4.Rajagopalan , K S. Corrosion and its prevention, Chemical Engineering Education Development Centre, IIT Madras, 1975

BTCH-952 NEW & RENEWABLE ENERGY

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

L	T	P
3	0	0

OBJECTIVE:
The objective of this course is to acquaint the students with the renewable energy sources available to supplement and augment the energy requirements.

INTRODUCTION:
Global and Indian scenario, sources, Energy conservation, types of NCES with applications **(4)**

SOLAR ENERGY:
Role and development of new renewable energy sources, instruments for measuring solar radiations, solar radiation data, Flat plat and concentrating collectors, classification of concentrating collectors, advanced collectors, different methods of solar energy storage, solar ponds solar applications: Solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion. **(8)**

GEOTHERMAL & WIND ENERGY:
Resources, types of wells, methods of harnessing the energy, Wind Energy: Sources and potentials, horizontal and vertical axis, wind mills, wind regime analysis and evaluation of wind mills. **(8)**

BIOMASS AND BIOFUELS:
Recycling of agricultural waste, anaerobic/ aerobic digestion and types of biogas digesters; gas yield, and combustion characteristics of bio gas, design of biogas system for heating, lighting and running IC engines, Introduction to Biofuels such as biodiesel, ethanol, bio-butanol etc., their production and present status **(10)**

OCEAN & TIDAL ENERGY:
OTEC, settling of OTEC plants, thermodynamic cycles, Tidal Energy: Potential and conversion technique, mini hydel power plants and their economics **(6)**

RECOMMENDED BOOKS:
1. Rai G D, Non-Conventional Energy Sources, 4th edition, Khanna Publishers, 2009
2. Kumar Ramesh, Udayakumar K., Anandakrishnan M., Renewable Energy Technologies: Ocean Thermal Energy Conversion and Sustainable Energy Options, Narosa Publication, 1997
3. Desai Ashok V, Jhirad D., Munasinghe M., Non-Conventional Energy, New Age International, 1990
4. Sukhatme S. P., Solar Energy: Principles of Thermal Collection and Storage, 3rd Edition, Tata McGraw-Hill Education, 2008
5. Mittal K.M., Non-Conventional Energy System, Principles, Progress and Prospects, Pub, 1997.

BTCH-961 ENVIRONMENT IMPACT ASSESSMENT

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

L	T	P
3	0	0

INTRODUCTION:
Historical perspective and evolution of guidelines, developmental and economic activities and their impact on environmental quality, objectives and scope of EIA, EIA process flow chart **(5)**

ENVIRONMENTAL IMPACT POLICY:
EIA notification, environmental clearance process, screening, scoping, public consultation and appraisal. Environmental Components: air, water, land, vegetation, wild life, socio-economic, social development and aesthetics, noise. **(9)**

ENVIRONMENTAL DOMAIN AND ITS DIVISIONS:
Parametric analysis, environmental indices and indicators, operational framework, rapid and comprehensive EIA**.** **(6)**

IMPACT ASSESSMENT METHODOLOGIES:
Tools and methods to identify, predict, and evaluate different types of impacts, models and expert systems and professional judgments. **(8)**

ENVIRONMENTAL MANAGEMENT PLAN:
Principles, elements of approach and measures used for mitigating the impacts, anticipated environmental impacts and mitigation measures. EIA Case Studies of Process Industries **(8)**

RECOMMENDED BOOKS:

1. Sadler, B. and McCabe, M., Environmental Impact Assessment: Resource Manual, UNEP (2002).
2. Canter, R.L., Environmental Impact Assessment, Tata McGraw-Hill (1981).
3. MOEF, Govt. of India, EIA Manual, Ministry of Environment and Forests, GOI (MOEF web site).
4. EIA notification, Gazette Notification: SO 1533 dated 14-09-2006, MOEF, GOI (2006).

BTCH-962 HYDROCARBON ENGINEERING

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

L	T	P
3	0	0

SCOPE AND PURPOSE OF REFINING:
Global and Indian refining scenario, Petroleum refining industry in India practice and prospects, Separation and Conversion processes etc. **(5)**

REFINERY DISTILLATION PROCESSES:
Desalting, Process description of typical crude distillation, Fractional and Vacuum distillation, Flooding, Weeping, Entrainment, setting of cut point, Crude assay analysis, ASTM, TBP EFV Distillation etc. **(5)**

FUEL REFINING AND LUBE REFINING:
Cracking, Coking, Reforming, Alkylation, Isomerization, Polymerization, and Sweetening etc. Solvent extraction, De-waxing, Propane deasphalting etc. **(5)**

HYDRO PROCESSING:
Hydro cracking, Hydro treating, Hydro desulphurization
Oil and Gas separators: Principal of separation, Types of separators, their description. Various control and vessel internals, Oil and gas gravitational separator, Vertical two and three phase separator, Horizontal three phase separator etc. **(10)**

QUALITY MONITORING OF PETROLEUM PRODUCTS:
API gravity, Flash point, Fire point, Smoke point, Aniline point, Carbon residue, Kinetic viscosity, Pour point, Freezing point, octane number, Cetane number, Viscosity index, Diesel index Calorific value, Burning test 24 hours, Characterization factor, Cloud Point, Vapour lock index, Carbon hydrogen ratio, Calculated ignition index, Calculated carbon aromaticity index, U.O.P Characterization factor, Conrad son carbon residue, Water and sediment content etc. **(6)**

STORAGE AND TRANSPORTATION OF PETROLEUM PRODUCTS:
Classification of inflammable liquids, Classification of storage tank, Floating roof tank, fixed roof tank, Semi buried tank, Import/export loss, Breathing losses, Hazards and non-hazards area, and underground storage tank etc. Transportation of oil and natural gas by rail, road and pipeline, various type of pipelines, Multiproduct pipelines, Product handling, Pumping cycle, Interface, Problems in waxy crude, Role of flow behavior etc. **(5)**

RECOMMENDED BOOKS:

1. Nelson W. L., “Petroleum Refinery Engineering”, Mc Graw Hill Book Co., (1985).
2. Watkins R. N., “Petroleum Refinery Distillation”, Gulf Publishing Co.
3. Gary J. H., Handwork G. E., “Petroleum Refining Technology and Economics”, Marcel Dekker, Inc., (2001).
4. Jones D. S. J., “Elements of Petroleum processing”, John Wiley & Sons, (1995).
5. Waquier J. P., “Petroleum Refining” Vol. I & II, Technip, (1995)
6. Rao, B.K., Modern Petroleum Refining Processes, 5th Edition, Oxford & IBH Publishing Co., 2009.

7th/8th Semester

BTCH-801 Process Modeling & Simulation

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

Prerequisite: The students should have studied Numerical Methods in Chemical Engineering as a pre-requisite to study this course.

Objective: This course aims at developing the ability of the students in the mathematical treatment of chemical engineering processes. This course includes the concept of models, variables, parameters, parametric sensitivity and model formulation and their solution through simulation.

Introduction:

Concept of Dynamics, Variables and Degrees of freedom, Definition of mathematical model, lumped parameter model, distributed parameter model, uses of mathematical models, principles of formulation of models, parametric sensitivity. **(11)**

Fundamental Laws:

Continuity equations, energy equations, equations of motion, transport equations, equations of state, equilibrium, chemical kinetics. **(9)**

Mathematical Models of Chemical Engineering Systems:

1. Model for Series of isothermal CSTRs
2. Model for an Isothermal/non-isothermal plug-flow reactor.
4. Model involving energy equation of heated tanks.
5. Model for a gas phase pressurized CSTR
6. Model for a Non isothermal CSTR
7. Model for a Single component vaporizer
8. Model for Multi component flash drum
9. Model for a Jacketed Batch reactor
10. Model for a Reactor along with Mass Transfer
11. Model for Ideal/ Non-ideal distillation column
12. Model for batch distillation column
14. Equilibrium-constant & titration curve models for PH systems
15. Lumped parameter model of a gas absorber
16. Lumped parameter model of a liquid-liquid extraction column
17. Model for Heat-exchangers
18. Model for a system of interacting & non-interacting tanks.
19. Model for Biochemical reactor. **(22)**

Simulation:

Meaning of simulation; simulation strategy for simple isothermal CSTR, simple non-isothermal CSTR and simple isothermal batch reactor. **(6)**

Books Recommended:

1. Luyben W.L., Process Modeling and Simulation and Control for Chemical Engineers, McGraw Hill
2. Husain, Chemical Process Simulation, 1st edition, Wiley Eastern, 1986
3. Ramirez F. W., Computational Methods in Process Simulation, 2nd Ed., Butterworth Heinemann, 1998
4. Bequette B.W., Process Control: Modeling, Design and Simulation, Prentice Hall, 2003
5. Surya Narayana A., Chemical Instrumentation & Process Control, Khanna Pub 2010

BTCH-802 Process Engineering & Economics

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

Course Objective: The objective of this course is to enable the students to make an economic analysis of different technologies or operations based on understanding of various costs involved. A brief introduction to patents and IPRs is also included to give an insight to the students in this field.

Cost Estimation:

Factors affecting investment and production costs, Capital investments - fixed investments and working capital, Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimation capital investment, Estimation of total product cost. Different costs involved in the total product for a typical chemical process plant. **(8)**

Balance sheet and income statement:

Concept of Gross Profit, Net Profit, Return on Investment, Current Ratio, Quick Ratio, Debt-equity ratio. **(6)**

Interest and investment costs:

Simple and compound interest, Nominal and effective rates of interest, Continuous interest, Annuity, Perpetuity and capitalized costs. **(6)**

Taxes and Insurance:

Types of taxes and tax returns, types of insurance and legal responsibility **(4)**

Depreciation:

Types of depreciation, service life, salvage value, present value and methods of determining depreciation, single unit and group depreciation. **(6)**

Profitability:

Alternative Investments and Replacements: Mathematical methods of profitability evaluation, Cash flow diagrams, Determination of acceptable investments alternative when an investment must be made and analysis with small increment investment, replacement, Break even analysis. **(8)**

Optimum Design:

Procedure with one variable, Optimum reflux ratio in distillation and optimum pipe diameter **(3)**

IPR and Patent Systems:

Intellectual property, IPRs and its types, Patent claims, legal decision making process and ownership of tangible and intellectual property. Indian patent system, current IPR laws and legislations in India for IPR Documents required for filing patent, infringement of patents and remedies. **(7)**

Suggested Books:

1. Peters M.S.Timmerhaus K.D., Plant Design and Economics for Chemical Engg.,5th Ed., Tata McGraw Hill, 2005
2. Ulrich, G.D., A Guide to Chemical Engineering Process Design and Economics, John Wiley, 1984
3. Guthrie, K.M., Process Plant Estimating, Evaluation and Control, Craftsman Solano Beach, Calif
4. Couper James R, Process Engineering Economics, Marcel Dekker, NY, 2003

BTCH-803 Industrial Safety and Hazards Management

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

Objective:
The course will provide an overview of Process Safety in the Chemical Industry, focusing on the nature of chemical plant accidents, their causes, and steps to eliminate them, with emphasis on inherently safe designs and safety management. The students are expected to have active participation through case studies of disasters in the past.

Introduction:
Concept of Loss prevention, Ingredients of successful safety program, accident and loss statistics, acceptable risks, public perceptions, nature of accident process, inherent safety **(5)**

Toxicology:
Toxicants entry and elimination route, effect of Toxicants on Biological Organisms ,Guassian model for dose and response curves, TLV and PEL **(5)**

Industrial Hygiene
Identification, Material safety data sheets, Industrial hygiene evaluation and control **(8)**

Basics of Fires and Explosion:
Fire triangle, definitions, flammability characteristics of liquid and vapours, LOC and inerting, types of explosions **(8)**

Hazard identification:
Hazard survey, checklist, HAZOP study, safety reviews, what if analysis **(6)**

Risk Assessment:
Probability theory, Revealed and Unrevealed failures, event tree, fault tree, QRA and LOPA, Dow's fire and explosion index, Mond's index, **(8)**

Planning and Safety Management:
Objectives and approaches to safety management, Basic considerations and components of planning safety management, Concept of safety leadership. **(4)**

Accident Investigations:
Significant Disasters, Bhopal gas tragedy, Flixborough disaster, Pasadena accident, IOCL disaster, nuclear disaster in Japan in 2011 **(4)**

Books Suggested:
1. Crowl D.A., Louvar J.F., Chemical Process Safety: Fundamentals with Applications, 3rd Ed., Prentice Hall, 2011
2.Coulson, Richardson & Sinnott R.K., Chemical Engineering Volume-6 –an Introduction to Chemical Engineering Design, 4thEd., Elsevier Butterworth Heinemann, 2005
3 Dow Chemical Company, Dow's Chemical Exposure Index Guide, 1993
4. Lees F P , Loss Prevention in Process Industries, 2nd ed, Butterworth, London, 1996
5. Wells G L, Safety in Process Plant Design, George Godwin ltd., New York, 1980

BTCH-804 Energy Engineering

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

Course Objective/s: The objective of this course is to teach the students about the various options available to meet the ever growing demand of energy by the industry. It includes both the conventional and nonconventional energy sources. After the study of this course, a student is expected to understand different sources of energy, their production & uses.

Conventional Sources of Energy:

Solid Fuels: Principal solid fuel-coal, origin, composition and classification of coal, properties of coal, characteristics of Indian coals, briquetting, gasification and liquefaction of solid fuels. **(04)**

Liquid Fuels: Petroleum and Related Products: Introduction: Origin, classification and characteristics of Petroleum properties and characteristics, petroleum refining in India. Petroleum Products - Naphtha, motor gasoline, aviation gasoline, kerosene, diesel oil, gas oils, fuel oils, lubricants, petroleum waxes, Petroleum coke. **(08)**

Gaseous Fuels: Types, natural gas, methane from coal mines, producer, water carburettor, water, coal, blast furnace and refinery gases, gases from biomass, LPG, gasification of coal and oil, purification of gaseous fuels. **(06)**

Furnaces: General classification and description of different types of furnaces with special reference to furnaces used in ceramic, petroleum and pharmaceutical industries. **(06)**

Non- Conventional Sources of Energy

Nuclear energy: Nuclear reactions, fuel materials, moderators and structural materials, reactors. **(04)**

Solar Energy: Role and development of new renewable energy sources, instruments for measuring solar radiations, solar radiation data, classification of concentrating collectors, different methods of solar energy storage, solar applications: Solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion. **(10)**

Biomass and Biofuels: Recycling of agricultural waste, anaerobic/ aerobic digestion and types of biogas digesters; design of biogas system for heating, lighting. Introduction to Biofuels such as biodiesel, ethanol, bio-butanol etc., their production and present status. **(06)**

Introduction to Wind Energy, Ocean Energy, Tidal Energy**.** **(04)**

Suggested Books:

1. Sarkar Samir, Fuels and Combustion, 2 nd Ed., Orient Longman, 2003.
2. Gupta O.P., Elements of Fuels, Furnaces and Refractories, Khanna Publications, 1997.
3. Wilson, P.J., Wells, G.H., Coal, Coke and Coal Chemicals, McGraw Hill, 1950.

BTCH-805 Chemical Process Plant Design

Internal Marks: 30
External Marks: 20
Total Marks: 50

L	T	P
0	0	3

1. Design of piping and piping networks
2. Selection, Preparation of specification sheet for a centrifugal pump
3. Design of Sieve Tray column internals
4. Process Design of Shell & Tube heat exchanger
5. Process Design of plate heat exchangers
6. Process Design of Condensers
7. Specification sheet for distillation (sieve) column
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 Suggested:

1. Coulson, Richardson & Sinnott R.K., Chemical Engineering Volume-6 – an Introduction to Chemical Engineering Design, 4th Ed., Elsevier 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

BTCH-806 Process Optimization & Simulation Laboratory

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

1. Application of single variable optimization method in Chemical Engineering
2. Application of gradient based method.
3. Application of multivariable optimization method.
4. Application of Constrained optimization method in Chemical Engineering.
5. Application of Linear programming for Chemical Engineering.
6. Simulation for calculation of Bubble point & Dew point of mixtures.
7. Program involving Simulation of Gravity Flow tank.
8. Program involving Simulation of isothermal CSTR.
9. Program involving Simulation of non- isothermal CSTR.
10. Program involving Simulation of isothermal batch reactor.
11. Program involving Simulation of non - isothermal batch reactor.
12. Program involving Simulation of isothermal of distillation column.

BTCH-807 Major Project

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

The problem of the minor project formulated during 6th Semester is to extended and executed in major project by the same group of students. Each student is required to submit 3 hard bound type written copies of a project report on a proposed research oriented work :- either theoretical or practical (design of sophisticated process plant, modeling & simulation of sophisticated chemical process, optimization of sophisticated of chemical process, chemical process experimentation & data analysis) The object is to test the ability of the student to incorporate his entire knowledge of chemical engineering principles, to judge his knowledge, originality and capacity for application of laboratory data in designing chemical plants and to determine the level of his proficiency at the end of the course. The student is to appear in a Viva-Voce Examination.

BTCH-931 Bio-Chemical Engineering

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

Objective: This course is aimed at giving the students an insight into biochemical processes, their importance and fundamentals in these processes like biochemistry, kinetics and transport.

Biochemistry:
Structure and function of carbohydrates, lipids, amino acids and peptides, nucleic acid and nucleotides, Proteins, enzymes. **(6)**

Classification of microorganisms:
Morphological, structural and biochemical characteristics of prokaryotes and eukaryotes **(4)**

Microbial nutrients and growth media.
Kinetics of microbial growth, Enzyme kinetics including enzyme inhibition. Nutrient transport across cell membrane. Sterilization of air and media **(10)**

Mass transfer and microbial respiration:
Mass transfer resistance, physical and enzymatic considerations, critical value of dissolved oxygen concentration, respiration of mycelia pellet, Bubble aeration and mechanical agitation, Single bubbles, series of bubbles, power number versus Reynolds number, decrease of power requirement in aeration. **(12)**

Cardinal rules for Fermentor design, materials of construction. (4)

Suggested Books:

1. Pelzer M.J., Chan E.C.S. and Kerig N.R., Microbiology, 3rd edition, McGraw Hill Book Co., 1993
2. Stryer L, Freeman W.H., Biochemistry, 5th edition, W.H.Freeman and co, 2002
3. Bailey J.E. & Ollis, D.F., Biochemical Engineering Fundamentals, 2nd edition, McGraw Hill, 1986.
4. Shuler M.L., Kargi F., Bioprocess Engineering: Basic Concepts, 2nd Ed., Prentice Hall, 200
5. Shuichi Aiba, Biochemical Engineering, 2nd edition, Academic Press Inc. New York, 1973

BTCH-932 Polymer Reactor Design

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

Objectives and Course Outcomes: This course gives an introduction to polymer science and engineering, the polymerization reactions mechanism, and their effect on the design of polymerization reactors. Introduce the students to the design of various types of polymerization reactors for the production of polymers .After the study of this course the student is expected to have ,understanding of different types of polymerisation process, and the significance in each of: initiation, propagation, termination, branching; and, for copolymerisation, reactivity ratios and monomer ratio. Understand the basic design equations of polymerisation reactors of a variety of types: batch, plug-flow, CSTR, emulsion, HCSTRs. Ability to apply the various processing and manufacturing techniques.

Brief introduction to various types of polymers, polymerization methods and their importance **(4)**
Reactors: Definition, type's application-fields. Reactor Design: meaning, general design procedure Reaction Engineering of step growth polymerization: introduction, analysis of semi batch reactors, MWD of ARB polymerization in homogeneous continuous flow stirred-tank reactors (HCSTRs) advanced stage of polymerization, similarity solution of step growth polymerization in films with finite mass transfer. **(12)**
Reaction Engineering: chain growth polymerization; introduction, design of tubular Reactors, copolymerization, solution of equations describing isothermal radical polymerization **(10)**
Emulsion polymerization: Introduction emulsion polymerization in homogeneous continuous flow stride tank reactors (HCSTRSs) **(5)**
Detailed Design: ideal batch reactor for the production of Phenol-formaldehyde (Novolac) starting from phenol & formaldehyde as raw materials **(5)**

Suggested Books:

1. Fundamentals of Polymers, Anil Kumar and Rajesh K. Gupta McGraw Hill, 1998.
2. Fundamentals of Polymer Science and Engineering, Anil Kumar and K. Gupta listed Tata McGraw Hill, New Delhi, 1978.
3. Elements of Chemical Reaction Engg, H. Scott, Fogler (PHI).

BTCH-933 Plant Utilities

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

Objective: The aim of this course is to familiarize the students with utility services required in chemical process industries, their importance and fundamental principles.

Importance of Process utilities in Chemical Plant

Steam:

Boilers- classification, various types, construction, boiler mountings & accessories, properties of steam tables, Mollier Diagram **(8)**

Power Generation:

Internal Combustion Engines- classification, two- stroke, four stroke petrol & diesel engine, valve timing diagram, carburetor, Combustion Phenomena . **(6)**

Refrigeration:

Air refrigeration cycles, vapour compression cycle, P-H diagram, liquefactions processes **(6)**

Compressed Air and Vacuum:

Use of compressed air, Classification of compressors, Reciprocating compressors-mechanical details, single stage and two stage reciprocating compressor, inter cooler, minimum work input in multistage. Centrifugal compressor- velocity diagram for centrifugal compressors, dimensional parameters, slip factor, impeller blade shapes, losses in axial flow compressors. **(10)**

Water:

Cooling water, cooling towers, raw water, DM water, soft water **(4)**

Waste Disposal:

Plant sewer system and waste disposal **(2)**

Suggested Books:

1. Yadav B, Thermodynamics & Heat Engines, Central Publishing House, Allahabad, 2000.
2. Vasandani, Treatise on Heat Engines, 4th edition, Metropolitan Book Co. Pvt Ltd, New Delhi, 2008
3. Lyle O, The efficient Use of Steam, Her Majesty's Stationary Office, London, 1974.
4. Baasal W D, Preliminary Chemical Engineering Plant Design, 2nd edition, New York, 1989.
5. Dodge B F, Chemical Engineering Thermodynamics, 2nd edition, McGraw Hill, 1967

BTCH-934 Petro-Chemical Technology

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

Objective: The course aims at providing the knowledge of petrochemical industry to the students which includes the processes, products and their production in petrochemical industry.

Introduction:
Petro chemicals; Definition, History, importance and growth potential of the field **(8)**

Petrochemical Feed stocks:
Raw material for petrochemical industries, Production of olefin containing gases-their purification and separation processes. **(8)**

Processes for petrochemical feed stocks:
Naphtha cracking, steam reforming, xylene Isomerization, synthesis gas **(8)**

Manufacture of important petrochemicals and their uses, properties:
Methanol, Ethylene oxide, Ethylene glycol, Iso-propanol, Acrylic acid, Butadiene, Acetic acid, Poly-vinyl chloride, LDPE, HDPE, Phenol formaldehyde resin, urea formaldehyde resin, Propylene oxide, Nylon 6, Nylon 66, Polyethylene terepthalate, Styrene Butadiene Rubber, Fertilizers: ammonia, urea. Carbon Black, Synthetic Detergents
Concepts of quality and environmental pollution control in petrochemical industries. **(12)**

Books Suggested:
1. Rao B.K. B, Modern Petroleum Refinery Processes, 5th edition, Oxford & IBH Publishing Co. Pvt. Ltd., 2009
2. Steiner H, Industries to Petroleum Chemicals, Pergammon Press, 1992
3. Waddone, A.C., Chemicals from Petroleum, John Murry, 1988
4. Top Chev, A.V. Synthetic Materials from Petroleum, Pergammon Press, 1982
5. Astle M.J., Synthetic Materials from Petroleum, Pergammon Press
6. Rao B. K. B., “A textbook on Petrochemicals” 5thEdition, Khanna Publisher, 2010.

Scheme of Syllabi
7th /8th Semester

Course Code	Course Name	Load Allocation	Marks Distribution		Total Marks	Credits
			Internal	External		
BTCH-701	Industrial Training	32hr/week	450	300	750	24
Total			450	300	750	

Minimum Subjects: 01	Maximum Subjects: 01