PUNJAB TECHNICAL UNIVERSITY
KAPURTHALA

Scheme and Syllabus
of
B. Tech. ChemicalEngineering(CH)

Batch 2011

By

Board of Studies Chemical Engineering

**There should be industrial/institutional training of 04weeks duration in the summer vacation after 2nd semester

Third Semester **Contact Hours: 30 Hrs.**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTCH-301	Mechanical Operations	3	1	-	40	60	100	4
BTCH-302	Chemical Process Calculations	3	1	-	40	60	100	4
BTCH-303	Fluid Flow	3	1	-	40	60	100	4
BTCH-304	Strength of Materials	3	1	-	40	60	100	4
BTCH-305	Chemical Engineering Thermodynamics	3	1	-	40	60	100	4
BTCH-306	Strength of Materials Lab	-	-	2	30	20	100	4
BTCH-307	Fluid Flow Lab	-	-	4	30	20	50	2
BTCH-308	Mechanical Operations Lab	-	-	4	30	20	50	2
BTCH-309	Institutional Practical Training of 4 weeks duration after 2nd semester				60	40	100	1
	Total	**15**	**05**	**10**	**350**	**400**	**750**	**29**

Fourth Semester **Contact Hours: 34 Hrs.**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTAM	Engineering Mathematics -III	4	1	-	40	60	100	5
BTCH-401	Chemical Process Industries	4	-	-	40	60	100	4
BTCH-402	Mass Transfer –I	3	1	-	40	60	100	4
BTCH-403	Heat Transfer	3	1	-	40	60	100	4
BTCH-404	Chemical Process Instrumentation	3	-	-	40	60	100	3
BTCH-405	Chemical Reaction Engineering - I	3	1	-	40	60	100	4
BTCH-406	Heat Transfer Lab	-	-	4	30	20	50	2
BTCH-407	Chemical Technology Lab	-	-	3	30	20	50	2
BTCH-408	CAD in Chemical Engineering Lab	-	-	3	30	20	50	2
General Fitness					100	-	100	-
	Total	**20**	**04**	**10**	**430**	**420**	**850**	**30**

**There should be industrial/institutional training of 06 weeks duration in the summer vacation after 4th semester

Fifth Semester **Contact Hours: 32 Hrs.**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTCH-501	Numerical Methods in Chemical Engineering	3	1	-	40	60	100	4
BTCH-502	Mass Transfer –II	3	1	-	40	60	100	4
BTCH-503	Process Dynamics & Control	3	1	-	40	60	100	4
BTCH-504	Industrial Pollution Control	3	1	-	40	60	100	4
BTCH XX	Elective - I	3	1	-	40	60	100	4
BTCH-505	Mass Transfer Lab	-	-	4	30	20	50	2
BTCH-506	Chemical Reaction Engineering & Pollution Control Lab	-	-	4	30	20	50	2
BTCH-507	Numerical Methods in Chemical Engineering Lab	-	-	4	30	20	50	2
BTCH-508	Industrial Practical Training				60	40	100	1
	Total	**15**	**05**	**12**	**330**	**420**	**750**	**27**

Sixth Semester **Contact Hours: 35 Hrs**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTCH-601	Chemical Reaction Engineering –II	3	1	-	40	60	100	4
BTCH-602	Optimization Techniques	3	1	-	40	60	100	4
BTCH-603	Energy Engineering	3	1	-	40	60	100	4
BTCH-604	Engineering Materials	3	-	-	40	60	100	3
BTCH-605	Transport Phenomenon	3	1	-	40	60	100	4
BTCH-YY	Elective - II	3	1	-	40	60	100	4
BTCH-606	Process Optimization Lab	-	-	3	30	20	50	2
BTCH-607	PIDC Lab	-	-	4	30	20	50	2
BTCH-608	Process Plant Design-I	-	-	3	30	20	50	2
BTCH-609	Literature Survey & Seminar**	-	-	2	-	-	-	-
General Fitness					100	-	100	-
	Total	**18**	**05**	**12**	**430**	**420**	**850**	**29**

Seventh Semester

Course Code	Course Name	Marks Distribution		Total Marks	Credits
		Internal	External		
BTCH-701	(a) Software Training*	150	100	250	7
	(a) Industrial Training	300	200	500	23
	Total	**450**	**300**	**750**	30

***List of Softwares for Training to be learnt during Training Period will be provided shortly.**

Eighth Semester **Contact Hours: 33 Hrs**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTCH-801	Chemical Process Simulation	3	1	-	40	60	100	4
BTCH-802	Process Engineering & Economics	3	1	-	40	60	100	4
BTCH-803	Open Elective	3	-	-	40	60	100	3
BTCH-ZZ	Elective-III	3	1	-	40	60	100	4
BTCH-805	Safety in Chemical Plants	3	-	-	40	60	100	3
BTCH-806	Chemical Equipment Design	-	-	3	30	20	50	2
BTCH- 807	Process Simulation Lab	-	-	3	30	20	50	2
BTCH- 808	Chemical Process Plant Design-II	-	-	3	30	20	50	2
BTCH-809	Project	-	-	6	60	40	150	3
General Fitness					100	-	100	
	Total	**15**	**03**	**15**	**450**	**400**	**850**	**27**

List of Electives:

Elective – I (BTCH-XX) Semester V	
Course Code	**Course Title**
BTCH-521	Polymer Science & Engineering
BTCH-522	Enzyme Technology
BTCH-523	Fluidization Engineering
BTCH-524	Nano-Technology
BTCH-525	Separation Processes

Elective – II (BTCH-YY) Semester VI	
Course Code	**Course Title**
BTCH-621	Petroleum Refining Engg
BTCH-622	New & Renewable Energy Sources
BTCH-623	Membrane separations
BTCH-624	Fuel Cell Technology
BTCH-625	Corrosion Engg
BTCH-626	Project Management

Elective – III (BTCH-ZZ) Semester VII/ VIII	
Course Code	**Course Title**
BTCH-821	Bio-chemical Engineering
BTCH-822	Polymer Reactor Design*
BTCH-823	Plant Utilities
BTCH-824	Heat Exchangers
BTCH-825	Petro-chemical Technology

** Polymer Reactor Design Elective III is allowed only for students who have opted for Polymer Science & Engineering as Elective I.*

Third Semester

BTCH 301 Mechanical Operations

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

Characterization and Handling of Solids: (8 hrs)

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

Screening: (4 hrs)

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

Agitation and Mixing: (8 hrs)

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

Size Reduction: (6 hrs)

Principles of Comminution: Criteria for comminution, characteristics of products, Energy and Power requirements Bond's, Rittinger's and Kick's Law and Work Index. Size Reduction Equipment: Crushers, Grinders, and ultrafine grinders cutting machines, equipment operation.

Filtration: (8 hrs)

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

Settling: (8 hrs)

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

sedimentation.

Fluidization: **(6 hrs)**

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

Suggested Readings / Books:

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

BTCH-302 Chemical Process Calculations

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

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

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

Material Balance **(16 hrs)**

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

Energy Balance **(16 hrs)**

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

Material and energy balances: **(6 hrs)**

Applied to industrial processes such as combustion and gasification of fuels, synthesis of ammonia, production of sulphuric acid, nitric acid, hydrochloric acid

Suggested Readings / Books:

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

BTCH-303 Fluid Flow

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

Indroduction **(2 hrs)**

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

Fluid Statics **(4hrs)**

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

Fluid Properties **(6 hrs)**

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

Basic Equation of Fluid Flow **(10 hrs)**

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

Flow of Incompressible Fluids **(10 hrs)**

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

Flow of compressible fluids **(4 hrs)**

Compressible flow, basic equation, Mach number and its significance and isentropic flow through nozzles

Flow Measurement **(6 hrs)**

In closed channels - Pitot tube, Orifice meter, venturimeter, Rotameter. ***In open channels***- Notches, Weirs

Fluid Machinery **(6 hrs)**

Classification and performance of Pumps, Positive displacement pumps and its types,

Centrifugal pumps- characteristic curves, Net positive Suction Head and cavitation, Turbines, Compressors, Blowers, Selection and specification.

Suggested Readings / Books:

- McCabe, Warren L., Smith, Julian C. and Harriot, P., Unit Operations of Chemical Engg., 7th Ed., McGraw Hill, 2005.
- Backhurst J.R., Harker J.H., Coulson J.F., Richardson J.M., Chemical Engineering – Volume 1, 6th Ed., Butterworth Heinemann, 1999
- Foust, A.S., Wenzel L.A., Clump C.W. Maus L., Anderson L. B., Principles of Unit Operations, 2nd Ed., John Wiley & Sons, 2008.
- Raju K.S., Fluid Mechanics, Heat Transfer, and Mass Transfer: Chemical Engineering Practice, John Wiley and Sons, 2011.
- Badger, W.L. and Banchero, J.T, Introduction to Chemical Engg., McGraw Hill.
- Philip J. Pritchard P. J., Fox and McDonald's Introduction to Fluid Mechanics, 8th Ed., John Wiley and Sons, 2011
- Chattopadhyay, P., Unit Operations of Chemical Engg. Vol.1, 3rd Ed., Khanna Publishers.

BTCH 304 Strength of Materials

Objective/s and Expected Outcome: This course is aimed at giving an insight to students about the behaviour of materials under external forces. The concept of stress, strain, elasticity etc. as applied to various structural members under loading are included.

Mechanical Properties and Testing: (6 hrs)

Concept of strength, yield strength, ultimate strength hardness, impact strength, ductility, brittleness, tensile, compressive, bending, torsion, hardness and impact tests.

Theory of Bending: (6 hrs)

Review of bending moment, shear force, bending and shear stresses. Bending & Shear stresses in composite beams.

Unsymmetrical Bending: (6 hrs)

Principal axes, analytical and graphical methods, stresses due to unsymmetrical bending 7-polygen deflections of beams under unsymmetrical bending.

Slopes and Deflections of Beams: (6 hrs)

Slopes and deflections in beams and cantilevers calculation of slopes and deflections using double integration moment area theorems and Macaulay's method.

Theories of failure: (6 hrs)

Strain energy, various theories of failure, their necessity and significance, graphical representation of theories of failure.

Torsion of shafts and springs: (6 hrs)

Torque, angle of twist and shear stresses in hollow and solid shafts with in elastic limit, assumptions intrusion, power transmitted by a shafts, analysis of close coil spring subjected to axial load couple. Shafts subjected to torsion.

Thin Cylinders: **(6 hrs)**

Thin cylinders subjected to internal pressure, circumferential and longitudinal stress and strains, maximum shear stress, increase in diameter and volume, thin spheres subjected to internal pressure.

Columns: **(6 hrs)**

Columns under uniaxial loads, buckling of columns slenderness ration, and conditions. Derivations of Euler's formula for elastic-buckling load and equivalent length. Rankine-Garden empirical formula.

Suggested Readings / Books:

- Timoshenko, S., Strength of Materials Vol-I: Elementary Theory and Problems, 3rd Edition, CBS Publishers, 2002
- Vazirani V.N. & Ratwani, Analysis of Structures, Vol. I, 17th Ed., Khanna Publishers
- Bansal, R.K., Strength of Materials, 4th Ed., Luxmi Publishers, 2010.
- Popov E. P., Engineering Mechanics of Solids, 2nd Ed., Prentice Hall, 1999.

BTCH 305 Chemical Engineering Thermodynamics

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

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

Brief review: **(8 hrs)**

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

Review of 2nd and 3rd Law of thermodynamics: **(10 hrs)**

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

Equations of state: **(7 hrs)**

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

Phase Equilibria: **(16 hrs)**

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

Chemical Equilibria: **(7 hrs)**

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

Suggested Readings / Books:

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

BTCH-306 Strength of Materials Lab.

1. Determination of yield points, tensile strength and ultimate strength of mild steel specimen.
2. Determination of compressive strength of mild steel specimen.
3. Bending test of mild steel specimen.
4. Tensile test of a specimen of brittle material.
5. Torsion test of a mild steel specimen.
6. Determination of Brinell hardness of ductile and brittle materials.
7. Determination of Rockwell Hardness of a hard material.
8. Performance of Vickers's Hardness test.
9. Determination of Impact strength of a specimen.

BTCH 307 Fluid Flow Lab.

1. Characteristic curves of a centrifugal pump.
2. Determination of stability of a floating body.
3. Verification of Bernoulli's equation for flow process.
4. Measurement of flow by a venturimeter
5. Measurement of flow by an orifice meter.
6. Measurement of flow by a rotameter
7. Measurement of flow by a V-notch in an open channel.
8. Measurement of losses in various fitting and valves.

9. Measurement of losses due to contraction and expansion.
10. Measurement of losses due to variation in cross section/ shapes
11. Verification of laminar/ turbulent flow regime in a flow process
12. Study of valves and fittings

BTCH 308 Mechanical Operations Lab.

1. Verification of Stokes Law.
2. Screen analysis of given sample for it's particle size distribution.
3. Determination of average size (different averages) from screen analysis.
4. Determination of variation in pressure drop & bed height w.r.t superficial velocity for a bed of solids.
5. Determination of minimum fluidization velocity for a bed of solids.
6. Operating characteristics of crushing and grinding equipments (Jaw crusher, Roll crusher, Ball mill).
7. Evaluation of the filtration constants for $CaCO_3$. slurry in water and cake compressibility.
8. Determination of %age recovery of coal in froth from coal and sand mixture.
9. Determination of thickener capacity using batch sedimentation.
10. Determination of characteristics of centrifuge as a filter.
11. Determination of the separation efficiency of the classifier.