SHAHEED BHAGAT SINGH STATE TECHNICAL CAMPUS
FEROZEPUR

Ref. No.: SBS/FZR/ODA/708 Dated: 15/10/2016

NOTIFICATION

Teaching scheme and syllabus for the discipline of B.Tech, B. Arch, MBA, MCA and BCA (3rd Sem Onwards) for the students admitted in the year 2015 stands approved in the 6th Academic Council of the institute wide agenda item no. 6.16. The approved teaching scheme and syllabus are available on the institute website

Director 9/10/16

Endst. No. Dated:

A copy of the above is forwarded to the following for information and necessary action.

1. Mr. Amardeep Chopra to upload the teaching scheme and syllabus attached herewith on the institute website.
2. Registrar
3. Dr Tejeet Singh, Member Secretary Academic Council
4. PA to Director

Shaheed Bhagat Singh State Technical Campus, Ferozepur

B. Tech. Chemical Engineering

Scheme of Syllabi

3rd Semester

Total contact hours =30

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTCH-301A	Mechanical Operations	3	1	---	40	60	100	4
BTCH-302A	Chemical Process Calculations	3	1	---	40	60	100	4
BTCH-303A	Fluid Flow	3	1	---	40	60	100	4
BTCH-304A	Chemical Engineering Thermodynamics	3	1	---	40	60	100	4
BTCH-305A	Chemical Process Industries	3	--	---	40	60	100	3
BTCH-306A	Chemical Technology lab	---	---	3	30	20	50	1
BTCH-307A	Fluid Flow Laboratory	---	---	3	30	20	50	1
BTCH-308A	Mechanical Operations Laboratory	---	---	3	30	20	50	1
BTCH-309A	Training-I*	---	---	---	60	40	100	2
BTHU-301A	Professional Skills-I	--	---	2	30	20	50	1
	Total	**15**	**4**	**11**	**380**	**420**	**800**	**25**

*** Training-I (6 weeks Institutional Training during summer vacation after 2nd semester)**

B. Tech. Chemical Engineering
Scheme of Syllabi
4th Semester

Total contact hours =29

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTCH-401A	Chemical Reaction Engineering - I	3	1	---	40	60	100	4
BTCH-402A	Heat Transfer	3	1	---	40	60	100	4
BTCH-403A	Energy Engineering	3	--	---	40	60	100	3
BTCH-404A	Strength of Materials	3	1	---	40	60	100	4
BTAM-201A	Engineering Mathematics-III	3	1	---	40	60	100	4
BTCH-405A	Heat Transfer Laboratory	--	--	3	30	20	50	1
BTCH-406A	CAD in Chemical Engineering Laboratory	---	---	3	30	20	50	1
BTCH-407A	SOM lab	---	---	2	30	20	50	1
BTHU-401A	Professional Skills-II	--	---	2	30	20	50	1
	Total	**15**	**4**	**10**	**320**	**380**	**700**	**23**

B. Tech. Chemical Engineering
Scheme of Syllabi
5th Semester

Total contact hours =29

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTCH-501A	Mass Transfer - I	3	1	---	40	60	100	4
BTCH-502A	Chemical Reaction Engineering - II	3	1	---	40	60	100	4
BTCH-503A	Industrial Pollution Control	3	---	---	40	60	100	3
BTCH-504A	Chemical Process Instrumentation	3	--	---	40	60	100	3
BTCH-	Department Elective - I	3	--	---	40	60	100	3
BTCH-505A	Chemical Reaction Engineering lab	---	---	3	30	20	50	1
BTCH-506A	Environment & Pollution control lab	---	---	3	30	20	50	1
BTCH-507A	PED lab	1	--	3	30	20	50	2
BTCH-508A	Training-II**	--	--	--	60	40	100	3
BTHU-501A	Professional Skills-III	--	---	2	30	20	50	1
	Total	**16**	**2**	**11**	**380**	**420**	**800**	**25**

****<u>There should be Industrial/Institutional Training of 6 weeks duration in the summer vacation after 4th semester</u>**

B. Tech. Chemical Engineering
Scheme of Syllabi
6th Semester

Total contact hours =28

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTCH-601A	Mass Transfer - II	3	1	---	40	60	100	4
BTCH-602A	Process Dynamics & Control	3	1	---	40	60	100	4
BTCH-603A	Numerical Methods in Chemical Engineering	2	1	---	40	60	100	3
BTCH-604A	Dept. Elective-II	3	---	---	40	60	100	3
	Open Elective-I	3	--	---	40	60	100	3
BTCH-605A	Process Instrumentation, Dynamics & Control Laboratory	---	---	3	30	20	50	1
BTCH-606A	Numerical Methods in Chemical Engineering Laboratory	--	---	3	30	20	50	1
BTCH-607A	Mass Transfer Laboratory	---	---	3	30	20	50	1
BTHU-601A	Professional Skills-IV	--	---	2	30	20	50	1
	Total	**14**	**3**	**11**	**320**	**380**	**700**	**21**

B. Tech. Chemical Engineering
Scheme of Syllabi
7th Semester

Total contact hours =26

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTCH-701A	Chemical Process Simulation	3	--	---	40	60	100	3
BTCH-702A	Process Engineering & Economics	3	1	---	40	60	100	4
BTCH-	Dept. Elective-III	3	--	---	40	60	100	3
	Open Elective-II	3	---	---	40	60	100	3
BTCH-703A	Process Simulation Laboratory	--	--	3	30	20	50	2
BTCH-704A	Chemical Process Plant Design-I	1	--	3	30	20	50	2
BTCH-705A	Project-I	--	--	6	30	20	50	3
BTCH-706A	Training-III***	--	--	--				3
	Total	**13**	**1**	**12**	**250**	**300**	**550**	**23**

***<u>**There should be Industrial Training of 6 weeks duration in the summer vacation after 6th semester**</u>

B. Tech. Chemical Engineering
Scheme of Syllabi
8th Semester

Total contact hours =20

Course Code	Course Name	Load Allocated			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BTCH-801A	Safety in Chemical Plants	3	--	---	40	60	100	3
	Open Elective-III	3	--	----	40	60	100	3
BTCH-802A	Chemical Process Plant Design-II	1	---	3	30	20	50	2
BTCH-803A	Project-II	---	---	10	60	40	100	5
	Total	**7**	**0**	**13**	**170**	**180**	**350**	**13**

Syllabi (3rd Semester)
BTCH-301A MECHANICAL OPERATIONS

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

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

Characterization and Handling of Solids: **(8 hrs)**
Characterization of solid particles: Shape, size, specific surface, Particle size distribution
Properties of particulate masses: Major distinctive properties, pressures in masses of particles, angle of internal friction, angle of repose.
Storage and Conveying of bulk solids: Basic idea of conveyor, conveyor selection, screw, belt, vibrating, continuous flow and pneumatic conveyors, bulk storage, bin storage, feeders .

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

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

Size Reduction: **(6 hrs)**
Principles of Comminution: Criteria for comminution, characteristics of products, Energy and
Power requirements, Bond's, Rittinger's and Kick's Law and Work Index.
Size Reduction Equipment: Crushers, Grinders, and ultrafine grinders cutting machines, equipment operation.

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

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

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

BOOKS RECOMMENDED:

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

COURSE OUTCOMES

Students will be able to:-

1. Characterize the particulate solids and demonstrate knowledge of its handling and conveying.
2. Demonstrate the knowledge of principles of size reduction and select the relevant equipment.
3. Analyze mixing processes and separation methods for solid-solid, solid-liquid and solid-gas mixtures.
4. Differentiate and analyze fluid flow through packed and fluidized beds.

BTCH-302A CHEMICAL PROCESS CALCULATIONS

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

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

Introduction to Chemical Engineering Calculations: **(10 hrs)**
Units & Dimensions, Conversion of units, Mole concept, Basic Concept, Stoichiometric and composition relationship, limiting-excess- reactant, conversion and yield, Degrees of Freedom.

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

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

Material and energy balances: **(6 hrs)**
Applied to industrial processes such as combustion and gasification of fuels, synthesis of ammonia, production of sulphuric acid, nitric acid, hydrochloric acid

BOOKS RECOMMENDED:

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

COURSE OUTCOMES

Students would be able to:-

1. Calculate degree of freedom and its application
2. Implement material balance on various processes
3. Implement energy balance on various processes
4. Implement simultaneously energy balance and material balance.
5. Comprehend the concept of humidity and usage of psychometric charts.
6. Demonstrate the knowledge of simple phase equilibrium relationships.

BTCH-303A FLUID FLOW

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

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

Introduction **(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 Equations of Fluid Flow **(10 hrs)**
Momentum Balance, Continuity equation, Bernoulli's Equations, Navier Stokes Equations, Derivation and Application
Dimensional Analysis of Fluid Flow Problems using Rayleigh method and Buckingham π method, Dimensionless numbers and their significance

Flow of Incompressible Fluids **(10 hrs)**
Concept of boundary layer, Laminar and Turbulent flow in pipes, Velocity distribution in pipes, Frictional Losses in pipes and fittings, effect of roughness, Fanning Equation, Estimation of Economic Pipe Diameter, Derivation of Hagen Poiseuille's equation and f =16/ Re.

Flow of Compressible Fluids **(4 hrs)**
Compressible flow, basic equation, Mach number and its significance and isentropic flow through nozzles

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

Fluid Machinery **(6 hrs)**
Classification and performance of Pumps, Positive displacement pumps and its types, Centrifugal pumps- characteristic curves, Net positive Suction Head and cavitation, Turbines, Compressors, Blowers, Selection and specification.

BOOKS RECOMMENDED:

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

COURSE OUTCOMES

1. Knowledge of basic principles of fluid mechanics
2. Ability to analyze fluid flow problems with the application of the momentum and energy equations.
3. Ability to decide when appropriate to use ideal flow concepts, continuity equation and Bernoulli equation
4. Understanding and analysis of problems using methodical dimensional analysis
5. Capability to analyze pipe flows as well as fluid machinery

BTCH-304A ENERGY ENGINEERING

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

Objective: 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 non-conventional energy sources.

Introduction: **(2 hrs)**
Energy crisis in the world and position in India.

Conventional Sources of Energy:
Solid Fuels: **(10 hrs)**
Principal solid fuel-coal, origin, composition and classification of coal, origin, composition and classification of coals, analysis and properties of coal, characteristics and distribution of Indian coals, coal preparation, Storage of coal, coal carbonization, briquetting, gasification and liquefaction of solid fuels.
Liquid Fuels: **(12 hrs)**
Petroleum and Related Products:
Introduction: Origin, occurrence and reserves, reserves, Production and consumption, classification and characteristics of Petroleum properties and characteristics, petroleum refining in India.
Refining Unit Processes: Cracking, thermal cracking, catalytic cracking, hydrocraking, reforming thermal and catalytic reforming, alkylation, and polymerization, Isomerization.
Petroleum Products - Naphtha, motor gasoline, aviation gasoline, kerosene, diesel oil, gas oils, fuel oils, lubricants, petroleum waxes, Petroleum coke.
Gaseous Fuels: **(6hrs)**
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, Liquified natural gas, Compressed natural gas, Shale gas.
Combustion Process and Appliances: **(6 hrs)**
Nature and types of combustion processes, mechanism of combustion reaction, spontaneous ignition temperature, gas and oil burners, coal burning equipments, fluidized bed combustion.
Furnaces: General classification and description of different types of furnaces with special reference to furnaces used in ceramic, petroleum and pharmaceutical industries.

BOOKS RECOMMENDED:

1. Sarkar Samir, Fuels and Combustion, 2nd 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.
4. Griswold, J. Fuels, Combustion and Furnaces, McGraw Hill, 2006.
5. Francis, W., Peters M.C., Fuels and Fuel Technology: a Summarized Manual, 2nd Ed., Pergarmon Press, 1980.
6. Haslam R.T. Russal, R.P, Fuels and their Combustion, McGraw Hill.
7. Brame, J.S. and King, J.C, Fuels-Solid Liquid and Gaseous, St. Martin Press, 1967.
8. Rai G D, Non-Conventional Energy Sources, 3rd Ed., Khanna Publishers, 1994.

9. Rao, S., Parulekar, B.B., Energy Technology – Non-conventional, Renewable & Conventional, 3rd Edition, Khanna Publishers, 2007

COURSE OUTCOMES:

Students are able to:-

1. Comprehend knowledge about Energy scenario in world and environmental impacts.
2. Demonstrate the knowledge of various types of fossil fuels and their effective utilization.
3. Demonstrate knowledge of exploration of non- conventional energy resources and their effective tapping technologies.
4. Solve problems based on combustion principles.

BTCH-305A CHEMICAL PROCESS INDUSTRIES

External Marks: 60	**L T P**
Internal Marks: 40	**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: **(4 hrs)**
Status and scope, major oil seeds production in India; solvent extraction, energy and solvent requirements, hydrogenation of oils, Corrosion problems and materials of construction.

Soaps and Detergents: **(5 hrs)**
History and growth, raw material, manufacturing of detergents, biodegradability, Fat-splitting, purification of fatty acids, soap manufacture, glycerine manufacture, materials of construction.

Sugar: **(4 hrs)**
Manufacturing equipment and technology, cane sugar refining, baggase utilization, energy requirements and conservation, environmental considerations.

Pulp and Paper: **(4 hrs)**
Growth of industry, raw materials, pre-treatment, pulping, manufacture of paper, recovery of chemicals.

Acids **(3 hrs)**
Manufacture and uses of Phosphoric acid, hydrochloric acid, nitric acid, sulphuric acid, major engineering problems.

Fertilizers: **(4 hrs)**
Synthesis: naphtha, natural gas and ammonia based fertilizers, manufacture of phosphatic fertilizers and potash fertilizers, N-P-K values. Corrosion problems and materials of construction.

Soda Ash: **(4 hrs)**
Manufacturing processes- Solvay and modified Solvay process, environmental considerations, corrosion problems and material of construction.

Chlor Alkali: **(4 hrs)**
Electrochemistry of brine electrolysis, current efficiency, energy efficiency, diaphragm cells, mercury cells, mercury pollution and control, caustic soda, chlorine, corrosion problems and materials of construction.

Glass and Cement: **(4 hrs)**
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.

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

COURSE OUTCOMES:

Students will be able to:-

1. Demonstrate the knowledge of various Chemical Industries and their status in India.
2. Demonstrate knowledge about process flow sheet of various organic and inorganic industries.
3. Demonstrate knowledge about history, current issues, and trends in process industries.
4. Demonstrate knowledge about MOC being used, environment and safety precautions in design and operations.
5. Demonstrate knowledge about chemical and physical processes involved including equipments and various alternative technologies being used in industries

BTCH-306A CHEMICAL TECHNOLOGY LABORATORY

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

LIST OF EXPERIMENTS
PART A

1. To perform proximate analysis of a given sample.
2. Determination of HCV and LCV of a given fuel by bomb calorimeter.
3. To determine the acid value of an oil/fat.
4. To determine the saponification value of an oil/fat.
5. To determine the iodine value of an oil/fat.
6. To estimate the given reducing/non-reducing sugar.
7. To determine the sediment in Crude Petroleum and Fuel oils .
8. To determine the viscosity of a given sample by Flow cup/Ostwald viscometer.

PART B

1. Preparation of an addition /condensation polymer.
2. Preparation of polymer product using injection moulding.
3. Preparation of compounded polymer sample using two roll mill.
4. Preparation of polymer product using compression moulding
5. Determination of performance of a given polymer sample under tensile loading like stress-strain curve, modulus of elasticity.
6. To find the cement composition in a given mortar sample.
7. To prepare soap by Hot and Cold process by mustard oil.

At least five experiments should be conducted from each part.

BTCH-307A FLUID FLOW LABORATORY

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

LIST OF EXPERIMENTS

1. Plot the characteristic curves of a centrifugal pump.
2. Verification of Bernoulli's equation for flow process.
3. Measurement of flow by a venturimeter
4. Measurement of flow by an orifice meter.
5. Measurement of flow by a rotameter
6. Measurement of flow by a V-notch in an open channel.
7. Measurement of losses in various fitting and valves.
8. Measurement of losses due to contraction and expansion.

9. Measurement of losses due to variation in cross section/ shapes.
10. Verification of laminar/ turbulent flow regime in a flow process.

BTCH-308A MECHANICAL OPERATIONS LABORATORY

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

LIST OF EXPERIMENTS

1. Verification of Stokes Law.
2. Screen analysis of given sample for it's particle size distribution.
3. Determination of average size (different averages) from screen analysis.
4. Determination of variation in pressure drop & bed height With respect to superficial velocity for a bed of solids.
5. Determination of minimum fluidization velocity for a bed of solids.
6. Operating characteristics of crushing and grinding equipments (Jaw crusher, Roll crusher, Ball mill).
7. Evaluation of the filtration constants for $CaCO_3$ slurry in water and cake compressibility.
8. Determination of %age recovery of coal in froth from coal and sand mixture.
9. Determination of thickener capacity using batch sedimentation.
10. Determination of characteristics of centrifuge as a filter.
11. Determination of the separation efficiency of the cyclone separator.

BTAM-201A ENGINEERING MATHEMATICS-III

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

Common to all (IV Semester)

PART-A

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

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

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

PART-B

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

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

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

BOOKS RECOMMENDED:

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

COURSE OUTCOMES

The students will be able to:

1. Solve problems involving periodic functions by using Fourier Series
2. Solve differential equations using special functions.
3. Apply Laplace Transform technique to the solution of linear ODEs and simultaneous ODEs.
4. Apply mathematical principles to solution of equations involving complex variable.
5. Formulate Partial Differential Equation for a given situation and solve the same.

BTCH-401A CHEMCIAL ENGINEERING THERMODYNAMICS

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

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

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

Brief review: **(8 hrs)**
Importance of thermodynamics in chemical engineering, State functions, types of systems, internal energy, heat and work reversible and irreversible processes. 1st law of thermodynamic and its engineering applications, i.e., constant volume processes, constant pressure processes, isothermal and adiabatic processes, Throttling process, Joule-Thomson coefficient, liquefaction of gasses
Standard heat of reaction, standard heat of formation, standard heat of combustion, flame temperature, enthalpy for phase change etc.

Review of 2nd and 3rd Law of thermodynamics: **(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.

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

COURSE OUTCOMES

The students will be able to:

1. Apply the laws of thermodynamics to chemical engineering processes.
2. Apply thermodynamic principles for analysis of solutions, ideal solutions, their excess properties and residual properties.
3. Apply thermodynamic principles for different types of chemical engineering systems like Vapor/Liquid systems, Liquid/ Liquid systems and Solid/Liquid systems.
4. Analyze chemical reactions in relation to thermodynamic principles.
5. Apply Phase Equilibria and Chemical Equilibria for solution to problems involving more than one phase and chemical reactions.

BTCH-402A CHEMICAL REACTION ENGINEERING-1

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

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

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

Material balance equation for ideal batch reactor and its use for kinetic interpretation of data and isothermal reactor design for simple & complex rate equation.

Performance equations for CSTR and PFR and their use for kinetic interpretation and design

Comparison of batch reactor, CSTR & PFR, Recycle reactor, concept of yield & selectivity

Reactor combinations of CSTR and PFR

Design for Multiple Reactions: **(8 hrs)**

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

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

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

Non –Ideality: **(8 hrs)**

Basics of non-ideal flow, residence time distribution, States of segregation

Measurement and application of RTD, E-Age distribution function & F-curve and inter-relationship between them, Conversion in non-ideal reactors.

BOOKS RECOMMENDED:

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

COURSE OUTCOMES

At the end of the course the student will be able to:

1. Demonstrate the basic concepts of chemical reaction Engg and develop rate laws for homogeneous reactions
2. Perform design calculations of ideal reactors for single and complex reactions for isothermal and non-isothermal reactors.
3. Compare the relative performance of different reactors.
4. Distinguish between various RTD curves and predict the conversion from a non ideal reactor using tracer information.
5. Determine optimal reactor configurations and operating policies for systems involving multiple reactions .

BTCH-403A HEAT TRANSFER

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

Objective: The objective of the course is to introduce to students heat transfer mechanisms in solids and fluids and their chemical process applications. At the conclusion of the course, the student should possess the ability to model steady and unsteady heat transfer in simple systems and design heat exchangers. It requires use of thermodynamics and fluid mechanics and sets the basis for the design of reactors and separation processes.

Modes of Heat Transfer:

Conduction **(8 hrs)**

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

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

Convection **(10 hrs)**

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

Modelling of convective heat transfer coefficient by using dimensional analysis for natural convection.

Radiation **(6 hrs)**

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

Condensation and Boiling Heat Transfer: **(6 hrs)**

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

Heat exchangers: **(10 hrs)**

Heat exchangers - double pipe heat exchanger, Shell-and-Tube heat exchangers, plate type heat exchanger, concept and calculation of log mean temperature difference, temperature correction factor for shell & tube exchangers, fouling factors, overall heat transfer coefficient

Theory of Fins and their applications

Reboiler and Condensers, counter current dry contact Condenser, parallel current- wet contact Condenser.

Evaporators **(8 hrs)**

Various types of evaporators- Standard vertical tube evaporator, basket type vertical evaporator, forced circulation evaporator and horizontal tube evaporators.

Single effect evaporators and multi-effect evaporators and its various types of feed arrangements, boiling point elevation, capacity and economy of evaporators. Evaporation under vacuum.

BOOKS RECOMMENDED:

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

COURSE OUTCOMES

Upon successful completion of this course, the student will be able to:

1. Demonstrate the basic laws of heat transfer.
2. Solve problems involving steady and unsteady state heat conduction in simple geometries with and without heat generation.
3. Evaluate the heat transfer in natural and forced convection.
4. Solve simple radiation heat transfer problems
5. Perform the analysis of heat transfer processes involved in evaporation, condensation and boiling.

BTCH-404A STRENGTH OF MATERIALS

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

Objective: 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.

Simple Stresses & Strains: **(8 hrs)**

Simple stresses and strains : Concept of stress and strain; St. Vernants principle, stress and strain diagram, Hooke's law, Young's modulus, Poisson ratio, stress at a point, stress and strains in bars subjected to axial loading. Modulus of elasticity, stress produced in compound bars subject to axial loading .Temperature, stress and strain calculations due to applications of axial loads and variation of temperature in single and compound bars.

Theory of Bending: **(8 hrs)**

Compound stress and strains, the two dimensional system; stress at a point on a plane, principal stresses and principal planes; Mohr's circle of stress; ellipse of stress and their applications. Generalized Hook's Law, principal stresses related to principal strains

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 Macullay'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/ spheres: **(7 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: **(7 hrs)**

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

BOOKS RECOMMENDED:

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

COURSE OUTCOMES

BTCH-405A HEAT TRANSFER LABORATORY

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

LIST OF EXPERIMENTS

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

BTCH-406A CAD IN CHEMICAL ENGINEERING LABORATORY

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

1. Traditional drafting of various assemblies, pipe joints, sectional views and valves.
2. Introduction to various Computer Softwares and Computer Aided Drafting. Study and use of various commands from Menus, Command Tool Box and Command prompt area.
3. Introduction to Chem– CAD and use of various commands from Menus, Command Tool Box and Command prompt area.
4. Applications of Chem– CAD :
    - Drawing of Process , Flow Sheets and Process Calculations.
    - Heat Exchangers and Columns: Packed Columns, Plate Column.
    - Distillation : Batch and continous.

BOOKS RECOMMENDED:

1. Rakar, A., Inside Auto Cad, B.P.B. Publications, New Delhi.
2. Omura, G., Mastering Auto Cad, P.B.S. Publications, New Delhi.
3. Voisinet, D.D., Computer Aided Drafting & Design.
4. Rogers, D.F., Procedural Elements for Computer Graphics, McGraw Hill, N.Y.

BTCH-407A STRENGTH OF MATERIALS LABORATORY

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

LIST OF EXPERIMENTS

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.