Shaheed Bhagat Singh State Technical Campus, Ferozepur Punjab
Department of Chemical Engineering
B.Tech. Chemical Engineering
Scheme of Syllabi (2018 Onwards)
3rd Semester (Second Year) -Curriculum

Total Contact Hours= 25

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	BTCH-301B	Engineering & Solid Mechanics (SOM)	3	1	0	40	60	100	4
2.	BTCH-302B	Thermodynamics-I	3	1	0	40	60	100	4
3.	BTCH-303B	Transport Phenomena	3	1	0	40	60	100	4
4.	BTCH-304B	Material & Energy Balance Computations	3	1	0	40	60	100	4
5.	BTCH-305B	Fluid Mechanics	3	1	0	40	60	100	4
6.	BTCH-306B	Environmental Sciences (Mandatory Non-credit course)	2	-	-	40*	60*	100*	0 (*Sat/ Unsat)
7.	BTCH-307B	Chemical Engineering Lab-I (FF & SOM lab)	0	0	3	30	20	50	1
8	BTCH-308B	Training-I (Mandatory Non-credit course)	-	-	-	60*	40*	100*	0 (*Sat/ Unsat)
Total			**17**	**5**	**3**	**230**	**320**	**550**	**21**

*- marks are only given for awarding Satisfactory/Unsatisfactory grade

For Batches 2018 & Onwards
Academic Autonomous Status vide letter No. 22-1/2015(AC)

Shaheed Bhagat Singh State Technical Campus, Ferozepur Punjab
Department of Chemical Engineering
B.Tech. Chemical Engineering
Scheme of Syllabi (2018 Onwards)
4th Semester (Second Year) -Curriculum

Total Contact Hours= 26

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	BTCH-401B	Heat Transfer	3	1	0	40	60	100	4
2.	BTCH-402B	Mass Transfer-I	3	1	0	40	60	100	4
3.	BTCH-403B	Thermodynamics-II	3	1	0	40	60	100	4
4.	BTCH-404B	Materials Science	3	0	0	40	60	100	3
5.	BTCH-405B	Numerical Methods in Chemical Engineering	3	1	0	40	60	100	4
6.	HSMC-***	HASS-II	3	0	0	40	60	100	3
7.	BTCH-406B	Numerical Methods in Chemical Engineering Lab	0	0	2	30	20	50	1
8.	BTCH-407B	Chemical Engineering Lab-II (Thermo & HT lab)	0	0	3	30	20	50	1
Total			**18**	**4**	**5**	**300**	**400**	**700**	**24**

For Batches 2018 & Onwards
Academic Autonomous Status vide letter No. 22-1/2015(AC)

Shaheed Bhagat Singh State Technical Campus, Ferozepur Punjab
Department of Chemical Engineering
B.Tech. Chemical Engineering
Scheme of Syllabi (2018 Onwards)
5th Semester (Third Year) -Curriculum

Total Contact Hours= 25

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	BTCH-501B	Chemical Reaction Engineering-I	3	1	0	40	60	100	4
2.	BTCH-502B	Mass Transfer-II	3	1	0	40	60	100	4
3.	BTCH-503B	Particle & Fluid Particle Processing	3	0	0	40	60	100	3
4.	Core Elective-I		3	0	0	40	60	100	3
	BTCH-511B	Optimization Techniques							
	BTCH-512B	Plant Utilities							
	BTCH-513B	Enzyme Tech.							
5.	BTCH-	Open Elective-I	3	0	0	40	60	100	3
6.	BTHU-501B	HASS-III (Project Management)	3	0	0	40	60	100	3
7.	BTCH-504B	Chemical Engineering Lab-III (MT lab)	0	0	3	30	20	50	1
8.	BTCH-505B	Constitution of India/Essence of Indian Traditional Knowledge	2	-	-	40*	60*	100*	0 (**Sat/ Unsat)
Total			**20**	**2**	**3**	**270**	**380**	**650**	**21**

**- marks are only given for awarding Satisfactory/Unsatisfactory grade

For Batches 2018 & Onwards
Academic Autonomous Status vide letter No. 22-1/2015(AC)

Shaheed Bhagat Singh State Technical Campus, Ferozepur Punjab
Department of Chemical Engineering
B.Tech. Chemical Engineering
Scheme of Syllabi (2018 Onwards)
6th Semester (Third Year) -Curriculum

Total Contact Hours= 26

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	BTCH-601B	Chemical Reaction Engineering-II	3	1	0	40	60	100	4
2.	BTCH-602B	Chemical Process Industries	3	0	0	40	60	100	3
3.	BTCH-603B	Energy & Pollution Engg.	3	1	0	40	60	100	4
4.	Core Elective-II		3	0	0	40	60	100	3
	BTCH-611B	Chemical Process Safety							
	BTCH-612B	Corrosion Engg.							
	BTCH-613B	Fluidization Tech.							
5.	BTHU- 601B	HASS-IV (Process Engg. Economics)	3	0	0	40	60	100	3
6.	BTCH-604B	Chemical Engineering Lab –IV (CRE & Enviromental Engg. lab)	0	0	3	30	20	50	1
7.	BTCH-605B	Chemical Equipment Design	1	0	2	30	20	50	2
8.	BTCH-	Open Elective-II	3	0	0	40	60	100	3
Total=			**19**	**2**	**5**	**300**	**400**	**700**	**23**

For Batches 2018 & Onwards
Academic Autonomous Status vide letter No. 22-1/2015(AC)

Shaheed Bhagat Singh State Technical Campus, Ferozepur Punjab
Department of Chemical Engineering
B.Tech. Chemical Engineering
Scheme of Syllabi (2018 Onwards)
7th Semester (Fourth Year) -Curriculum

Total Contact Hours= 25

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	Core Elective-III		3	0	0	40	60	100	3
	BTCH-711B	Polymer Science & Reactor Design							
	BTCH-712B	Heat Exchangers							
	BTCH-713B	Separation Processes							
2.	Core Elective - IV		3	0	0	40	60	100	3
	BTCH-714B	Petroleum Engg. & Tech							
	BTCH-715B	Biochemical Engg.							
	BTCH-716B	Fuel Cell Technology							
3.	BTCH-701B	Process Instrumentation dynamics & Control	3	1	0	40	60	100	4
4.	BTCH-	Open Elective-III	3	0	0	40	60	100	3
5.	BTCH-	Open Elective-IV	3	0	0	40	60	100	3
6.	BTCH-702B	Process Optimization & Simulation Lab	0	0	3	30	20	50	1
7.	BTCH-703B	Instrumentation & Control Lab	0	0	3	30	20	50	1
8.	BTCH-704B	Chemical Process Plant Design	1	0	2	30	20	50	3
Total			**16**	**1**	**8**	**290**	**360**	**650**	**21**

For Batches 2018 & Onwards
Academic Autonomous Status vide letter No. 22-1/2015(AC)

Shaheed Bhagat Singh State Technical Campus, Ferozepur Punjab
Department of Chemical Engineering
B.Tech. Chemical Engineering
Scheme of Syllabi (2018 Onwards)
8th Semester (Fourth Year) -Curriculum

Total Contact Hours= 00

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
	BTCH-801B	Summer Industry internship Project				200	200	400	12
Total=			**0**	**0**	**0**	**200**	**200**	**400**	**12**

3rd Semester
BTCH-301B Engineering and Solid Mechanics

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

Objectives: Students would be introduced to fundamentals of Engineering Mechanics with emphasis on force systems. Second part of the course would be an introduction to Solid Mechanics, and students would be introduced to basic concepts of mechanics of deformable media: concept of stress tensor, strain tensor, strain rates, constitutive relations, and applications to one/two dimensional problems.

Rigid body kinematics: (4 hrs)
Translation and rotation, relative motion, angular velocity, Laws of motion, (Euler's Axioms), General motion of a rigid body, General relative motion.

Simple Stresses & Strains: (6 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.

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. Shear Force and Bending Moment diagram.

Theory of Bending: (6 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

Analysis of Structures: (4 hrs)
Trusses, Equivalent force systems, Resultant forces, Linear and Angular Momentum, Free Body Diagrams, Equilibrium of rigid bodies, distributed forces.

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: (4 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 ratio, and conditions. Derivations of Euler's formula for elastic-buckling load, equivalent length,Rankine-Garden empirical formula.

BOOKS RECOMMENDED:

1. Timoshenko, S., Young D.H. , Sukumar P., Rao J. V. Engineering Materials 5th Edition, McGraw Hill Education.

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

Course outcomes

Students will be able to:

1. Understand the basic concepts of rigid body kinematics.
2. Understand the concept of stress and strain at a point and stress analysis in various machine elements like thin cylinder, sphere, spring, beams and shafts.
3. Tackle the problems related to shearing Force, bending moment, slope and deflections in different types of beams subjected to various types of loadings.
4. Apply the knowledge of various theories of failures to design the various structural components subjected to different types of loadings.
5. Understand the concept of buckling of slender, long columns subjected to axial loads and be able to solve problems related to columns and struts.

BTCH-302B Thermodynamics-I

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

Objectives: This course covers the application of thermodynamic principles to chemical engineering problems. It involves principles and application of first, second and third laws of thermodynamics.

Introduction **(4 hrs)**
Scope of thermodynamics, Dimensions and Units, Temperature, Pressure, Work, Energy and Heat.

Energy conservation & first law of thermodynamics: **(6 hrs)**
State functions; Equilibrium; Phase Rule; Reversible process; Constant P, V, T processes; Mass and energy balances for open systems.

Phases: **(8 hrs)**
Phase transitions, PVT behaviour; description of materials – Ideal gas law, Vander Waals, virial and cubic equations of state; Reduced conditions & corresponding states theories; correlations in description of material properties and behaviour.

Heat effects: **(4 hrs)**
Latent heat, sensible heat, Standard heat of formation, reaction and combustion, flame temperature, Enthalpy for phase change etc.

Second law of thermodynamics: **(10 hrs)**
Statement of Second law of thermodynamics, Heat engines, Carnot's theorem, Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work. Throttling process, Joule-Thomson coefficient, Third law of thermodynamics and its applications

Thermodynamic property of fluids: **(4 hrs)**
Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties.

Thermodynamics of Process: **(6 hrs)**
Application of thermodynamics to flow processes-pumps, compressors and turbines, Thermodynamic analysis of Steam power plants and Rankine cycle.

Carnot refrigerator: **(6 hrs)**
Vapor-compression cycle; Absorption refrigeration; Heat pump, Liquefaction processes of gases.

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, PHI, 1972.
4. M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8th Edition, Willey .

Course outcomes

Students should be able to

1. Apply the concept of Ist, IInd and the IIIrd laws of thermodynamics.
2. Apply mass and energy balances to closed and open systems.
3. Apply the heat effects to various sensible heat and latent heat processes.
4. Evaluate the properties of Gases, concept of non-ideal gases and its governing correlations.
5. Solve problems involving liquefaction, refrigeration and different power cycles.

BTCH-303B Transport Phenomena

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

Objective: This course introduces the student to the rigorous formulation of transport problems using the conservation principles and flux expressions, and identifies the similarities and differences among the transport processes for momentum, heat and mass. The main focus of the course is on microscopic treatment of transport problems, with particular emphasis on proper use of dimensional analysis and scaling arguments.

Review: (8 hrs)
Basic concepts of vector & tensor analysis and introduction to transport phenomena. Formulation of transport problems from nature, concept of boundary layer, laminar and turbulent flows.
Basics of Transport phenomena: (10 hrs)
Basics of mass, energy and momentum transport. Newton's law of viscosity, Fourier's Law of heat conduction and Fick's law of diffusion.
Shell balances: (10 hrs)
Shell energy balance and shell mass balance for solving specific problems of transport of momentum, heat and mass in laminar flow or in solids in one dimension.
One dimensional transport problems: (8 hrs)
Development of general differential equations, one-dimensional steady state and unsteady state problems of momentum, heat and mass transfer.
Interphase transport: (6 hrs)
Interphase transport of Momentum, heat and mass and dimensionless correlations for each one of them.
Transport Analysis: (6 hrs)
Emphasis on analogies between momentum, heat and mass transfer with respect to transport mechanism and governing equations.

BOOKS RECOMMENDED:
1. Bird R.B., Stewart, W.E. and Lightfoot, E.N., Transport Phenomena, 2nd Ed., John Wiley& Sons, 2005.
2. Geankoplis C.J., Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed., Prentice Hall, 2003
3. Weity, J.R. Wilson, R.E. and Wicks, C.E., Fundamentals of Momentum Heat and Mass Transfer, 4thEd., John Wiley & Sons.
4. Bennett.C.O. and Myres J.E., Momentum Heat and Mass Transfer, 3rd Ed., McGraw Hill, 1982.

COURSE OUTCOMES
The students are able to:
1. Demonstrate the knowledge momentum, heat, mass transport and vector & tensor analysis.
2. Simplify the momentum transport problems using shell balances.
3. Apply the conservation principles for the microscopic analysis of the given situation and solve the same for heat transport.
4. Apply the conservation principles for the microscopic analysis of the given mass transport situation and solve the same.
5. Analyse the given situation on macroscopic scale for transport of momentum, heat and mass and their analogies.

BTCH-304B Material & Energy Balance Computations

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.

1. Introduction to Chemical Engineering Calculations: **(8 hrs)**
Units & Dimensions, Conversion of units, Mole concept, Basic Concept, Stoichiometric and composition relationship, limiting-excess- reactant, conversion and yield, "basis" of calculations Degrees of Freedom.

2. 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, stage-wise and continuous operations in systems with or without chemical reaction.

3. Energy Balance: **(14 hrs)**
Review: Standard heat of formation and combustion, standard heat of reaction, problems using Hess Law. open and closed system, heat capacity, calculation of enthalpy changes Heat balances for non reacting processes and reaction processes. Theoretical flame temperature, Adiabatic reaction temperature, flame temperature, combustion calculation.

4. Gases, Vapors, Liquids and Solids: **(6 hrs)**
Equations of state, Vapor pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot, Raoult's law, Crystallization, Dissolution.

5. Humidity: **(4 hrs)**
Saturation, humid heat, humid volume, dew point, humidity chart and its use.

BOOKS RECOMMENDED:

1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., Pearson India Education Services, 2015.
2. Bhatt, B. I., Vora, S. M., "Stoichiometry", Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2004.
3. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons, 2000
4. Hougen, O. A., Watson, K. M., Ragatz, R. A., "Chemical Process Principles, Part-I Material & Energy Balances", Second Edition, CBS Publishers & Distributors, 2004
5. Venkataramani, V., Anantharaman, N., Begum, K. M. Meera Sheriffa, "Process Calculations" , Second Edition, Prentice Hall of India.
6. Sikdar, D. C., "Chemical Process Calculations", Prentice Hall of India.

COURSE OUTCOMES

Students would be able to:-

1. Demonstrate the knowledge of basic Chemical Engineering Calculations involving units & dimensions, stoichiometry and degree of freedom analysis.
2. Apply material balance on Chemical Engineering processes with & without chemical reaction.
3. Apply thermophysics and thermochemistry-laws for applying energy balance on Chemical Engineering processes.
4. Be familiar with equations of state and properties of gases and liquids, including phase transition, crystallization and dissolution operations.
5. Comprehend the concept of humidity and usage of psychometric charts.

BTCH-305B Fluid mechanics

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 **(8 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 **(6 hrs)**
Momentum Balance, Continuity equation, Bernoulli's Equations, Navier Stokes Equations, Derivation and Application,
Dimensional Analysis of Fluid Flow: **(4 hrs)**
Problems using Rayleigh method and Buckingham π method, Dimensionless numbers and their significance
Flow of Incompressible Fluids **(8 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

Students would be able to:-

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-306B Environmental Sciences (Mandatory Non-credit course)

External Marks: 60	**L**	**T**	**P**
Internal Marks: 40	**2**	**0**	**0**
Total Marks: 100			

Objective: The course provides a basic understanding of concept of multidisciplinary nature of Environmental Science & basic problems of exploitation & environmental effects of using Natural Resources. It provides an ability to identify threats to Bio-diversity, relationship among Social-issues, human population and their potential solutions. An awareness about causes, effects & control measures of various types of environmental Pollution.

Part A

Introduction: **(2 hrs)**

Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness.

Natural Resources: **(2 hrs)**

Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.

Ecosystems: **(2 hrs)**

Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity.

Environmental Pollution: **(6 hrs)**

Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster Management : Floods, earthquake, cyclone and landslides.

PART B

Social Issues and the Environment: **(8 hrs)**

Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution) Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.

Human Population and the Environment: **(4 hrs)**

Population growth, variation among nations. Population explosion - Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health. Case studies.

BTCH-307B Chemical Engineering Lab-I

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

LIST OF EXPERIMENTS

PART A

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.

PART B

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's 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.

At least five experiments should be conducted from each part.

COURSE OUTCOMES:

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

1. Demonstrate the working of a centrifugal pump.
2. Demonstrate practical understanding of Bernoulli's equation
3. Determine coefficient of discharge of fluids by Venturimeter, Orifice meter and V-notch etc
4. Demonstrate practical understanding of friction losses due to various fitting and valves, contraction and expansion or due to variation in cross section/ shapes.
5. Demonstrate practical understanding of determination of yield points, tensile strength compressive strength and ultimate strength
6. Present results in form of written reports.

BTCH-308B Training-I
(Mandatory Non-credit course)

External Marks: 4 0
Internal Marks: 6 0
Total Marks: 100

Grade Satisfactory- Pass
Unsatisfactory-Fail 60

Each student will be required to submit a report after the completion institutional Workshop training. The reports will be assessed by Workshop in-charge. Students have to appear in Viva-Voce examination. Students have to secure passing marks in both and internal and external to secure them a Satisfactory grade.

BTCH-401B 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 and analyse simple radiation heat transfer problems, condensation and boiling.
5. Perform the analysis of heat transfer processes involved in evaporation and heat exchangers

BTCH-402B Mass Transfer-I

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

Objective: The objective of this course is to present the principles of mass transfer and their application to separation and purification processes. The concept of diffusion, mass transfer coefficients and gas-liquid mass transfer operations is developed.

Introduction **(2 hrs)**
Importance and classification of mass transfer operations in Chemical Engineering.
Diffusion: **(8hrs)**
Diffusion in gases and liquids, Fick's First law of diffusion, Mass balance in simple situations - with and without chemical reaction.
Diffusion in solids, diffusion through porous solids and polymers, unsteady state diffusion
Interphase Mass transfer: **(10 hrs)**
Theories of Mass transfer, Individual and overall mass transfer coefficients, Convective mass transfer, Mass Transfer correlations, Analogies between Mass, momentum and Heat transfer
Mass balance in co-current and counter-current operation, Concept of operating line, Multi-stage counter current operations, Concept of ideal stage, Stage efficiencies– local, overall and Murphree efficiency.

Gas- Liquid Operations
Gas absorption: **(8 hrs)**
Solubility of gases, ideal solutions, Roult's law & Henry's law, choice of solvent, Co-current & counter current operations, Calculation of stages, Absorption factor A, stripping, Non-isothermal absorption, Reactive Absorption.
Distillation: **(12 hrs)**
x-y & H-x-y diagrams, Flash vaporisation and condensation. Differential distillation, Batch distillation, Rayleigh equation, Binary fractionation, Steam distillation, Use of open steam, Azeotropic distillation, McCabe-Thiele and Ponchon-Savarit method, Total reflux, minimum and optimum reflux ratios, Efficiency. Introduction to multi-component distillation. partial condensers and total condensers
Design of G/L Equipments **(8 hrs)**
Introduction to column design - Stagewise and continuous contact equipments, HTU and NTU concepts
Design of plate and packed absorption columns, stripping columns and Distillation Column

BOOKS RECOMMENDED:

1. Treybal Robert E., Mass Transfer Operations, 3rd Ed., McGraw Hill, 2001.
2. Sherwood T. K., Pigford R.L., Wilke C.R., Mass Transfer, Chemical Engineering Series, McGraw Hill, 1975.
3. Backhurst J.R., Harker J.H., Coulson J.F., Richardson J.M., Chemical Engineering – Volume 1, 6th Ed., Butterworth Heinemann, 1999
4. Skelland, A.H.P, Diffusional Mass Transfer, Kreiger Pub. Co., 1985.
5. McCabe, Warren L., Smith, Julian C. and Harriot, P., Unit Operations of Chemical Engg., 7th Ed., McGraw Hill, 2005

COURSE OUTCOMES

The students would be able to:

1. Apply the concepts of Diffusion and various laws governing diffusion in solids, liquids & gases.
2. Apply the concept of mass transfer coefficients and analogies
3. Analyze processes involving Gas absorption/ Stripping.
4. Demonstrate the knowledge of distillation operations and analyze problems.
5. Apply the concepts for design of stagewise & continuous-contact columns.

BTCH-403B THERMODYNAMICS-II

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

Prerequisite: The students should have studied Thermodynamics-I 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: **(6 hrs)**
Review of 1st,2nd and 3rd Law of thermodynamics and its engineering applications, Clapeyron equation for estimating vapour pressures.

Solution Thermodynamics **(14 hrs)**
Fundamental property relationships, free energy and chemical potential, partial molar properties, ideal solution and excess properties, dependence of chemical potential on temperature and pressure. Definition of fugacity and fugacity coefficient of pure species and species in solution, Fugacity and its calculations. Dependence of fugacity on temperatures and pressure. Gibbs-Duhem equation

Phase Equilibria: **(12 hrs)**
Solution behaviour of real liquids and solids. Activity and activity coefficients. Variation of activity co- efficient with temperature and composition. Activity coefficients of electrolytes. Standard states. Properties of mixing. Application of Gibbs-Duhem equation to vapour- liquid equilibria, Ideal solutions (Lewis-Randall Rule).

Vapor-liquid equilibrium: **(6 hrs)**
Phase rule, simple models for VLE (UNIFAC/ UNIQUAC) and LLE, VLE by modified Raoult's law; VLE from K-value correlations; Flash calculations.

Chemical Equilibria: **(10 hrs)**
Equilibrium constant in terms of measurable properties, variations of equilibrium constant with temperature and pressure. Adiabatic reactions. Gibbs phase rule for reacting systems, equilibria in heterogeneous reactions. Multi-reaction equilibria.

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.
3. Apply the knowledge of phase equilibria to chemical engineering problems.
4. Apply thermodynamics principles to VLE and LLE.
5. Apply Chemical Equilibria for solution to problems involving more than one phase and chemical reactions.

BTCH-404B Materials Science

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

Prerequisite: The students should have studied Chemical Process Industries as a prerequisite to study this course

Objective: 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 equipments being used in a particular processing technology.

Crystal Structure: **(5 hrs)**
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.

Mechanical, Thermal and Electrical Properties: **(5 hrs)**
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.

Ferrous Metals: **(5 hrs)**
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).

Non Ferrous Metals: **(3 hrs)**
Aluminium, cobalt, copper, lead, magnesium, nickel, tin and zinc their properties and uses.

Alloys: **(4 hrs)**
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.

Ceramics: **(3 hrs)**
Definition of ceramic, clay: properties of clay, earthen wares and stonewares, uses of stonewares.

Glass: **(2 hrs)**
Definition, classification, composition, types and properties of glass.

Refractories **(3 hrs)**
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.

Polymers & Composites: **(4 hrs)**
Classification of polymers, Properties and engineering usage of Nylon-66, polyesters, polycarbonates, polyurethanes, PVC, polypropylene, polymer composites.

Novel Materials: **(2 hrs)**
Introduction to nano materials and biomaterials and their uses.

BOOKS RECOMMENDED:

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.

COURSE OUTCOMES

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

1. Demonstrate the fundamental concepts of crystal structure.
2. Demonstrate the basic knowledge of ferrous and non-ferrous materials and advanced materials like nano-materials and biomaterials.
3. Distinguish the structure, properties and uses of various types of engineering materials like polymers, metals and ceramics.
4. Demonstrate the knowledge of phase diagrams and their relation to the material properties.
5. Make judicious choice among a range of materials, for various Chemical Engineering applications.

BTCH-405B Numerical Methods in Chemical Engineering

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

Objective: 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: (3 hrs)
Introduction to Numerical methods and its significance in chemical engineering, Classification of errors, significant digits and numerical stability.
Linear Algebraic Equations: (6 hrs)
Cramer's rule, Gauss Elimination and LU Decomposition, Gauss-Jordan elimination, Gauss-Seidel and Relaxation Methods.
Non-Linear Algebraic Equations: (9 hrs)
Single variable successive substitutions (Fixed Point Method), Multivariable successive substitutions, single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.
Eigen values and Eigen vectors of Matrices: (4 hrs)
Fadeev Leverrier's Method, Power Method.
Function Evaluation: (13hrs)
Least squares curve-fit (Linear Regression), Newton's interpolation formulae (equal intervals), Newton's Divided Difference Interpolation Polynomial, Langrangian Interpolation Unequal intervals. Extrapolation Technique of Richardson and Gaunt.
Numerical Differentiation, Numerical Integration or Quadratures (Trapezoidal, Simpson's1/3 and 3/8 rules)
Ordinary Differential Equations (ODE-IVPs) and partial differential Equations: (8 hrs)
Finite element method – Galerkin's mehod, Finite difference Technique,
Euler's method, Runge-Kutta method,
Laplace Transforms: (5 hrs)
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.

BOOKS RECOMMENDED:

1. Gupta S.K., Numerical Methodsfor Engineers, 2nd Ed., New Age International Publishers, 2009
2. Grewal B.S., Higher engineering mathematics,43rd Ed., Khanna Publishers, 2014.
3. Jain M.K., Iyengar SRKand Jain R.K., Numerical Methods for Scientific and Engineering Computation, New Age International.
4. Finlayson, B.A. Nonlinear Analysis in Chemical Engineering, McGraw Hill, New York, 1980.
5. Villadsen J., and Michelsen, M.L. Solution of Differential Equation Models by Polynomial Approximation, Prentice Hall, N.J.,1978.

6. Rice R.G., Do Duong D., Applied Mathematics and Modelling for Chemical Engineers, John Wiley & Sons, Inc, 1995.
7. Sastry S.S., Introductory Methods of Numerical Analysis, 4th Ed., PHI.
8. Kreyszig, E., Advanced Engineering Mathematics, Eighth edition, John Wiley, New Delhi.

COURSE OUTCOMES

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

1. Apply numerical methods to obtain solutions of linear and non-linear algebraic equation.
2. Derive and apply numerical methods for various mathematical operations and tasks, such as interpolation, differentiation and integration.
3. Evaluate eigen values and eigen vectors of matrices and demonstrate understanding and implementation of numerical solution algorithms applied to ODE-IVPs and PDEs.
4. Apply Laplace Transform technique to the solution of linear ODEs and simultaneous ODEs.

HASS-II (HSMC-*)**

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

Any one subject from AICTE proposed list of Humanities, Social Science including Management Courses (HSMC).

HPY-303 APPLICATIONS OF PSYCHOLOGY IN EVERYDAY LIFE

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

COURSE TOPICS:

Unit 1: (4hrs)
Introduction: Nature and fields.

Unit 2: (6hrs)
Psychology in industries and organizations: Job analysis; fatigue and accidents; consumer behaviour.

Unit 3: (8hrs)
Psychology and mental health: Abnormality, symptoms and causes psychological disorders.

Unit 4: (8hrs)
Psychology and Counselling: Need of Counselling, Counsellor and the Counselee, Counselling Process, Areas of Counselling.

Unit 5: (10hrs)
Psychology and social behaviour: Group, group dynamics, teambuilding, Prejudice and stereotypes; Effective Communication, conflict and negotiation.

Text
1. Schultz, D. & Schultz, S.E. (2009). Psychology and Work Today (10th ed.). New Jersey: Pearson/Prentice Hall.
2. Butcher J. N., Mineka S., & Hooley, J. M. (2010). Abnormal psychology (14th ed.). New York: Pearson
3. Gladding, S. T. (2014). Counselling: A comprehensive profession. New Delhi: Pearson Education
4. Aronson, E., Wilson, T. D., & Akert, R. M. (2010). Social Psychology (7th Ed.). Upper Saddle River, NJ: Prentice Hall.

COURSE OUTCOMES
The students would be able to
1) Apply different applications of psychology in industries and organizations,
2) Resolve different social issues, workplace issues, and behavioural issues, and
3) Apply the knowledge gained from this course for enhancing their own personal and professional work life
4) To improve the mental health through counselling.
5) Understand group dynamics and team-work and also to develop ability for effective conflict management .

BTCH-406B Numerical Methods in Chemical Engineering Lab

LIST OF PROGRAMs

1. Introduction to use of Software Packages: Matlab for numerical calculations. (2 practical turn)
2. Solution of linear algebraic equations using Gauss elimination, Gauss-Siedel etc. (1 practical turns)
3. Solution of a non-linear equations using bracketing and Newton-Raphson method (1practical turn)
4. Newton forward /backward, Lagrange's interpolation and Approximation (2 practical turns)
5. Numerical integration using Trapezoidal rule, Simpson's 1/3 rule. (1 practical turns)
6. Numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods. (2 practical turns)
7. Solution of (IVPs) ODE's using Euler, Predictor-corrector and Runge-Kutta methods (2 practical turn)
8. Solution of simple (BVPs) using finite difference technique (1 practical turns)

Suggested Text Books

1. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.

Suggested References Books

1. S.C. Chapra & R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.
2. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
3. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.
4. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.

Course Outcomes

Students will be able to

1. Use programming languages to solve chemical engineering problems involving Linear and non-linear equations.
2. Use programming languages to solve chemical engineering problems involving ODEs and PDEs.
3. Use programming languages to solve chemical engineering problems involving numerical integration and interpolation.
4. To present their results in written form of report.

BTCH-407B Chemical Engineering Lab-II (Thermo & HT lab)

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.
11. To determine the partial molar volume for liquid solution.
12. To validate Ist law of Thermodynamics.

COURSE OUTCOMES

Students will be able to develop the following skills/understanding upon the successful completion of this course:

1. Measure heat transfer coefficients of different flow geometries for different heat transfer conditions.
2. Measure the heat losses and effect of insulation during the heat transfer.
3. Perform the operation of different heat transfer equipments.
4. Measure partial molar properties and validate laws of thermodynamics.
5. To present their results in written form of report.

5th Semester
BTCH-501B Chemical Reaction Engineering-I

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 reactions.

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: **(6 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: **(10 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-502B Mass Transfer-II

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

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

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

Simultaneous Heat & Mass Transfer (14 hrs)

Drying of solids:

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

Humidification operations:

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

Dehumidification Equipments: water cooling towers & spray chambers

Membrane Separations: (6hrs)

Types of membranes, permeate flux for ultra filtration, concentration polarization, partial rejection of solutes, microfiltration, reverse osmosis and electro-dialysis.

Liquid-liquid extraction: (10 hrs)

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

Leaching: (8 hrs)

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

Adsorption: (6 hrs)

Types, nature of adsorbents, Adsorption equilibria- single species- Langmuir, Freundlich isotherms, Adsorption operations –single stage and multi stage, Fixed bed absorbers, breakthrough

Crystallization: (4 hrs)

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

BOOKS RECOMMENDED:

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

8. Holland, Charles D., Fundamentals and Modelling of Separation Processes, Prentice Hall, Inc. New Jersey.

COURSE OUTCOMES

The students would be able to

1. Apply the concepts of mass transfer to the analysis of drying and humidification.
2. Analyse extraction and leaching operations.
3. Analyse the mass transfer operations of adsorption and crystallization.
4. Analyse the mass transfer operation of membrane separation

BTCH-503B Particle & Fluid Particle Processing

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

Objective: To introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle fluid interactions are important. The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc..

Characterization and Handling of Solids: (6 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.
Screening: Capacity and Effectiveness of a screen, calculation of average size of particles in mixture by screen analysis, types of screens.

Agitation and Mixing: (6 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, mixing index, axial 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.

Filtration: (6 hrs)
Classification of filtration: Cake filtration, Clarifying filters, liquid clarification, Gas cleaning, Cross flow Filtration, micro filtration
Filtration Equipment: Centrifuges and their selection.

Settling: (6 hrs)
Motion of particles through fluids: Terminal velocity, hindered settling, Stoke's law, Richardson-Zaki equation.
Gravity settling processes: Classifiers, clarifiers, thickeners, flocculation, rate of sedimentation
Centrifugal Settling processes: Principles of centrifugal sedimentation, cyclones, hydroclones, tubular, disk and nozzle discharge centrifugal sludge separators, Centrifugal classifiers.

Flow through Packed Beds (2 hrs)
Ergun equation, Kozeny-Carman equation, Blaine's apparatus.

Fluidization: (4 hrs)
Fluidization and fluidized bed, conditions for fluidization, minimum fluidization velocity, types of fluidization, expansion of fluidized beds and particulate fluidization, continuous fluidization, industrial applications.

Suggested Text Books

1. McCabe, W., Smith, J. and Harriott, P. Unit Operations of Chemical Engineering, 6th edition., McGraw Hill.
2. Coulson and Richardson's Chemical Engineering, Vol. 2, Butterworth-Heinemann, Fifth edition 2002.

Suggested References Books

1. Rhodes, M. J., Introduction to Particle Technology, 2nd edition, John Wiley, Chichester ; New York, 2008.
2. Allen, T., Powder Sampling and Particle Size Determination, Elsevier, 2003.
3. Masuda, H., Higashitani, K., Yoshida, H., Powder Technology Handbook, CRC, Taylor and Francis, 2006.
4. Vollath, D. Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Ed., Wiley, 2013.

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-504B Chemical Engineering lab-III (Mass Transfer lab)

External Marks: 20	**L**	**T**	**P**
Internal Marks: 30	**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. Determinations of liquid hold up in a packed column.
3. To find the mass transfer coefficient for the vaporisation of organic vapour to air.
4. To verify the Rayleigh's equation for batch distillation.
5. To find the height equivalent to a theoretical plate and height of a transfer unit for the packed distillation column under total reflux.
6. To find the yield of crystals using batch crystallizer
7. To find the efficiency of rotary drier using a granular solid
8. To find the efficiency of a distillation column.
9. To study the adsorption characteristics and plot adsorption isotherm.
10. To find the yield of a natural oil by leaching from biomass.
11. To study liquid-liquid extraction in a packed column.
12. To determine mass transfer coefficient from a wetted wall column.

COURSE OUTCOMES

Students will be able to develop the following skills/understanding upon the successful completion of this course:

1. Apply the fundamental concepts of mass transfer and use those concepts to real engineering problems.
2. Apply the concepts of diffusion and various laws governing diffusion in solids, liquids & gases.
3. Operate equipments based upon processes involving Gas absorption, drying of solids, adsorption, crystallization, Distillation, Liquid-liquid extraction and leaching
4. To present their results in written form of report

BTCH-505B Constitution of India/Essence of Indian Traditional Knowledge

External Marks: 60	**L T P**
Internal Marks: 40	**2 0 0**
Total Marks: 100*	

*** Satisfactory/Unsatisfactory grade is awarded based upon passing marks scored by the student.**

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21

BTHU-501B HASS-III (Project Management)

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

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 as well as to build entrepreneurship skills .

Small Scale Industries: (8 Hrs.)

Definition of Small and Medium enterprises ,Product Range, Relative merits and demerits of SSI and large/medium industries, Characteristics of SSI, Classification and its Importance and advantages.

Growth of SSI: (12 Hrs.)

Present status of small scale industry in the country, Trends of growth in India and abroad, Export Potential of SSI, Marketing mechanism of SSI, Future Growth fields of SSI, Problems of SSI, Industry- Academia R&D Regimes in IITs, CSIR etc., Patent Ecosystem in India , Science Parks.

Policies Governing SSI: **(6 Hrs.)**

Resolutions of 1956 and 1977, New Policies for small and Tiny sector, Govt. Incentives, Finance of SSI, Taxation Benefits , Turnkey and other projects , Registration process of SSI.

Feasibility Report Preparation of SSI: **(4 Hrs.)**

Market Analysis, Financial Analysis, Technical Analysis , Economic Analysis , Ecological Analysis and Legal and Administrative Analysis.

Entrepreneurship: **(6 Hrs.)**

Definition of Entrepreneur, Characteristics of Entrepreneurs, Classification of Entrepreneurs, Institutions in Aid of Entrepreneurship development.

BOOKS RECOMMENDED:

1. Geoffery G. Mcredity, Nerson, 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. Desai V., Small Scale Industries and Entrepreneurship Development, Himalaya Publishing House, 2017.
4. Aswathappa, Factory Organisation and Management, Himalya Publishing House.
5. Bhojwani Ramesh, Small, Medium & Large Scale Industries Vol. I & II , Small industry Research Institute Delhi

Course outcomes

Students should be able to

1. Understand the detailed concept of Small Scale Industry (SSI).
2. Analyse and understand the Growth of SSI at Indian and Global level.
3. Understand the policies governing SSI.
4. Apply the knowledge of feasibility report to various SSI.
5. Understand and apply the concept of Entrepreneurship

(Dept. Electives)
BTCH-511B Optimization Techniques

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

Prerequisite: The students should have studied Numerical Methods in Chemical Engg. as a prerequisite to study this course

Objective: 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.

Introduction: **(8 hrs)**
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, Optimality criterion.

Single variable Optimization Techniques: **(8 hrs)**
1. Bracketing method (Bounding phase method).
2. Region elimination methods (Internal halving method, Fibonacci search method, Golden section search method).
3. Point estimation method (Successive quadratic estimation methods).
4. Gradient-based methods (Newton-Raphson method, Bisection method, Secant, Cubic search method.)
5. Root finding using optimization techniques.

Multivariable Optimization Techniques: **(8 hrs)**
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)

Constrained Optimization Algorithms: **(7 hrs)**
1. Kuhn - Tucker conditions
2. Transformation method (penalty function method)
3. Direct search for constrained minimization (variable elimination method, complex search method.)

Linear Programming: **(5 hrs)**
Linear programing problems, Degeneracy, Simplex method of linear programming, dual phase simplex method.

BOOKS RECOMMENDED:

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, 4th 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.

COURSE OUTCOMES

At the end of this course, students will be able to:

1. Formulate optimization problem and interpret the results of a model and present the insights (sensitivity, duality etc.)
2. Perform analysis and optimization of a given single variable, constrained and unconstrained problems using various optimization techniques.
3. Analyze and optimize a given multivariable, constrained and unconstrained problems using various optimization techniques.
4. Optimize linear programming problem.

BTCH-512B Plant Utilities

External Marks: 60	**L T P**
Internal Marks: 40	**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: **(6 hrs)**
Boilers- classification, various types, construction, boiler mountings & accessories, properties of steam-tables, Mollier Diagram.

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

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

Compressed Air and Vacuum: **(12 hrs)**
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.

Water: **(3 hrs)**
Cooling water, cooling towers, raw water, DM water, soft water.

Waste Disposal: **(3 hrs)**
Plant sewer system and waste disposal.

BOOKS RECOMMENDED:

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-512B Enzyme technology

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

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.

Immobilised Enzyme Reactions: **(8 hrs)**

Techniques of enzyme immobilisation-matrix entrapment, ionic and cross linking, column packing; Analysis of mass transfer effects of kinetics of immobilised 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.

Mass transfer Effects in Immobilised Enzyme Systems: **(12 hrs)**

Analysis of film and Pore diffusion Effects on kinetics of immobilised enzyme reactions; Formulation of dimensionless groups and calculation of Effectiveness Factors Reactor design and analysis for immobilized enzyme reactors

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.

Enzyme Biosensors: **(6 hrs)**

Applications of enzymes in analysis; Design of enzyme electrodes and case studies on their application as biosensors in industry, healthcare and environment.

BOOKS RECOMMENDED:

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.