Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Sardar Beant Singh State University, Gurdaspur(Pb)

Department of Chemical Engineering

Scheme

for

B.Tech. (Chemical Engineering)

2020 Batch Only

Department of Chemical Engineering
B.Tech. Chemical Engineering
3rd Semester (Second Year)
(Revised Scheme for 2020 Batch)

Total Contact Hours= 26

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	BTME-18309	Engineering & Solid Mechanics	3	1	0	40	60	100	4
2.	BTAC-18302	Chemistry-II	3	1	0	40	60	100	4
3.	BTCH-18303	Water Conservation and Management	3	1	0	40	60	100	4
4.	BTBS-18305	Biology	3	0	0	40	60	100	3
5.	BTCH-18304	Plant Utilities	3	1	0	40	60	100	4
6.	BTCH-18305	Fluid Mechanics	3	1	0	40	60	100	4
7.	BTCH-18306	Chemical Engineering Lab-I	0	0	3	30	20	50	1
8.	CHMC-I	Environmental Sciences	-	-	-	-	-	-	-
	TOTAL		18	05	03	270	380	650	24

**New subject introduced in third semester in Scheme of 2018 Batch in place of Thermodynamics-I, and Material and Energy Balance that already studied in the Second semester of 2020 Batch .*

Department of Chemical Engineering

B.Tech. Chemical Engineering

Scheme of Syllabi (2020 Only)

4th Semester (Second Year) -Scheme

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-18401	Heat Transfer	3	1	0	40	60	100	4
2.	BTCH-18402	Mass Transfer-I	3	1	0	40	60	100	4
3.	BTCH-18403	Thermodynamics-II	3	1	0	40	60	100	4
4.	BTCH-18404	Materials Science	3	0	0	40	60	100	3
5.	BTHS-18901	Fundamentals of Management for Engineers	3	0	0	40	60	100	3
6.	BTCH-18405	Numerical Methods in Chemical Engineering	3	0	0	40	60	100	3
7.	BTCH-18406	Numerical Methods in Chemical Engineering Lab	0	0	2	30	20	50	1
8.	BTCH-18407	Chemical Engineering Lab-II	0	0	3	30	20	50	1
Total			**18**	**3**	**5**	**300**	**400**	**700**	**23**

Department of Chemical Engineering

B.Tech. Chemical Engineering

Scheme of Syllabi (2020 Only)

5th Semester (Third Year) -Scheme

Total Contact Hours= 23

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	BTCH-18501	Chemical Reaction Engineering-I	3	1	0	40	60	100	4
2.	BTCH-18502	Mass Transfer-II	3	1	0	40	60	100	4
3.	BTCH-18XXX	DE-I	3	0	0	40	60	100	3
4.	BTXX-18XXX	OE-I	3	0	0	40	60	100	3
5.	BT HS-18902	Entrepreneurship and Project Management	3	0	0	40	60	100	3
6.	BTCH-18506	Chemical Engineering Lab-III	0	0	3	30	20	50	1
7.	BTCH-18507	Particle & Fluid Particle Processing	3	0	0	40	60	100	3
8.	CHMC-II	Constitution of India/Essence of Indian Traditional Knowledge	-	-	-	-	-	-	-
Total			**18**	**2**	**3**	**270**	**380**	**650**	**21**

Department of Chemical Engineering

B.Tech. Chemical Engineering

Scheme of Syllabi (2020 Only)

6th Semester (Third Year) -Scheme

Total Contact Hours= 23

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	BTCH-18601	Chemical Reaction Engineering-II	3	1	0	40	60	100	4
2.	BTCH-18602	Process Technology & Economics	3	0	0	40	60	100	3
3.	BTCH-18XXX	DE-II	3	0	0	40	60	100	3
4.	BTCH-18603	Process Control	3	1	0	40	60	100	4
5.	BTHS-18903	Human Resource Management	3	0	0	40	60	100	3
6.	BTCH-18604	Chemical Engineering Lab -IV	0	0	3	30	20	50	1
7.	BTXX-18XXX	OE-II	3	0	0	40	60	100	3
Total			**18**	**2**	**3**	**270**	**380**	**650**	**21**

Department of Chemical Engineering

B.Tech. Chemical Engineering

Scheme of Syllabi (2020 Only)

7th Semester (Fourth Year) -Scheme

Total Contact Hours= 22

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	BTCH-18XXX	DE-III	3	0	0	40	60	100	3
2.	BTCH-18701	Design & Simulation Lab	0	0	3	30	20	50	1
3.	BTCH-18702	Instrumentation & Control Lab	0	0	3	30	20	50	1
4.	BTCH-18XXX	DE - IV	3	0	0	40	60	100	3
5.	BTXX-18XXX	OE-III	3	0	0	40	60	100	3
6.	BTXX-18XXX	OE-IV	3	0	0	40	60	100	3
7.	BTCH-18703	Process Plant Design	0	0	4	30	20	50	2
8.	BTCH-18704	Summer Internship	0	0	0	-	100	100	3
Total			**12**	**0**	**10**	**250**	**400**	**650**	**19**

Department of Chemical Engineering

B.Tech. Chemical Engineering

Scheme of Syllabi (2020 Only)

8th Semester (Fourth Year) -Scheme

Total Contact Hours= 00

Sr. No.	Course Code	Course Title	Hours per week			Marks Distribution		Total Marks	Credit
			L	T	P	Internal	External		
1.	BTCH-18801	Industrial Training	0	0	0	200	200	400	12
Total			**0**	**0**	**0**	**200**	**200**	**400**	**12**

For Batch 2020 Only

Revised Department Electives subjects (Chemical Engineering -as per 2018 Scheme)

Departmental Elective I (5th Semester)

Sr No	Course Code	Course name	Hours Per week			Credits
			L	T	P	
1	BTCH-18952	Sustainability Engineering	3	0	0	3
2	BTCH-18953	Interfacial Engineering	3	0	0	3
3	BTCH-18957	Environmental Pollution and Control	3	0	0	3

Departmental Elective II (6th Semester)

Sr No	Course Code	Course name	Hours Per week			Credits
			L	T	P	
1	BTCH-18954	Nano Science and Nanotechnology	3	0	0	3
2	BTCH-18955	Advanced Separation Processes	3	0	0	3
3	BTCH-18956	Polymer Science and Engineering	3	0	0	3

Departmental Elective III (7th Semester)

Sr No	Course Code	Course name	Hours Per week			Credits
			L	T	P	
1	BTCH-18958	Renewable Energy	3	0	0	3
2	BTCH-18962	Petroleum Refining Engineering	3	0	0	3

Departmental Elective IV (7th Semester)

Sr No	Course Code	Course name	Hours Per week			Credits
			L	T	P	
1	BTCH-18959	Transport Phenomena	3	0	0	3
2	BTCH-18960	Petrochemical Technology	3	0	0	3
3	BTCH-18963	Optimization Methods	3	0	0	3

For Batches 2018 , 2019 (Academic Autonomous Status vide letter No. F22-1/2014 (AC) and 2020 Batch

Open Electives (Chemical Engineering)

Departmental Open Elective I (5th Semester)

Sr No	Course Code	Course name	Hours Per week			Credits
			L	T	P	
1	BTCH-18970	Corrosion Engineering	3	0	0	3
2	BTCH-18971	New & Renewable Energy Sources	3	0	0	3

Departmental Open Elective II (6th Semester)

Sr No	Course Code	Course name	Hours Per week			Credits
			L	T	P	
1	BTCH-18972	Environment Impact Assessment	3	0	0	3
2	BTCH-18973	Hydrocarbon Engineering	3	0	0	3

Departmental Open Elective III (7th Semester)

Sr No	Course Code	Course name	Hours Per week			Credits
			L	T	P	
1	BTCH-18975	Polymer Reactor Design	3	0	0	3
2	BTCH-18977	Petro-Chemical Technology	3	0	0	3

Departmental Open Elective IV (7th Semester)

Sr No	Course Code	Course name	Hours Per week			Credits
			L	T	P	
1	BTCH-18974	Bio-Chemical Engineering	3	0	0	3
2	BTCH-18976	Plant Utilities	3	0	0	3

BTME-18309 Engineering and Solid Mechanics

L T P
3 1 0

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

Course Objective:

The main objective of this course is to develop in the student the ability to analyze any engineering problem in a simple and logical manner with the help of free body diagrams and then to apply the basic principles of mechanics to solve the problem. The students should develop skills to apply equilibrium equations of statics to various problems to determine reactions and also could determine centre of gravity and moment of inertia of various bodies. Students would be introduced to the basic concepts of mechanics of deformable materials.

1 Force and Force Equilibrium

Force, System of forces, Coplanar concurrent & non-concurrent force, Non-coplanar concurrent & non-concurrent force, Couples and resultant of force systems, Equilibrium of force system (two and many force system), Lamiôs theorem, General equations of equilibrium for rigid-body, Rigid body constraints, Concept of free-body diagrams, Resultant moment of forces, Varingnonôs theorem and its applications, Numerical Problems. (6)

2 Friction

Types of friction, Limiting friction, Static and dynamic friction, Laws of dry friction, Determination of coefficient of sliding friction, Rolling resistance, Force of friction on a wheel when a force is applied & when acted upon by torque, Motion of bodies on inclined plane, wedge friction, screw jack. (5)

3 Centroid, Centre of Gravity and Moment of Inertia

Center of Gravity and Center of Mass for a Body, Centroid of simple figures from first principle, Centroid of composite sections, Area moment of inertia, Moment of inertia of plane sections from first principles, Parallel and perpendicular axes theorem of Moment of inertia, Moment of inertia of standard sections and composite sections, Mass moment of inertia of cylinder, cone and sphere. (7)

4 Review of Particle Dynamics

Rectilinear motion with uniform and variable acceleration, Displacement, velocity and acceleration of connected bodies, Equations of dynamic equilibrium, Analysis of motion of elevators and motion of pulleys. Plane curvilinear motion with components of motion as rectangular components, Normal & tangential components, Collision of elastic bodies; Direct central impact, Nature of impact and the coefficient of restitution. (7)

5 Introductions to Kinetics of Rigid Bodies

Basic terms, General principles in dynamics, Plane motion of a rigid body, Relation between the translatory and rotary motion of a body in plane motion, DôAlembertôs Principle in plane motion, Instantaneous centre of rotation in plane motion and simple problems. (6)

6.Mechanics of Solids : Concept and philosophy of stress and strain, Longitudinal and lateral strain, Normal stress (tensile and compressive), shear stress, Youngôs modulus of elasticity, Modulus of rigidity, Bulk modulus, Poissonôs ratio, Relations among elastic constants. Stress strain curve for ductile and brittle material, Yield point, Elastic limit, Ductility, True stress and true strain. Elongation of uniform bar due to application of external load with and without self weight. Temperature stresses in composite bar. Strain energy and resilience, Modulus of resilience, (7)

Books Recommended:

- Engineering Mechanics ï Irving H. Shames, PHI Publications
- Engineering Mechanics ï U.C.Jindal, Galgotia Publications
- Tayal A.K. Engineering Mechanics,Umesh Publications
- Bansal R.K. A Text Book of Engineering Mechanics, Laxmi Publications
- Engineering Mechanics By R S Khurmi,S Chand Publications
- Andy Ruina and Rudra Partap, Introduction to Statics and Dynamics,Oxford University Press.
- Strength of Material by S S Rattan ,Tata McGraw Hill Education Private Limited
- Strength of Material by Sadhu Singh. Khanna Publishers.

BTAC-18302 Chemistry-II

L T P
3 1 0

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

(i) Polymers

Types and mechanism of polymerization (free radical, cationic and anionic). Average molecular weights; Determination of molecular weight by number average method. Crystallinity, melting point and glass transition. Copolymerization. Elastomers-structure, applications. Conducting polymers and applications. Synthesis, properties and uses of PE, PVC, PMMA, formaldehyde resins, melamine-formaldehyde-urea resins. Adhesives, adhesive mechanism and applications. Composites: characteristics, types and applications. (10)

(ii) Surfactants and Lubricants

Methods of preparation, cleaning mechanism. Critical micelle concentration and its determination by surface tension. Hydrophobic and hydrophilic interactions. Micelles and reverse micelles. Detergents. Lubricants-physical and chemical properties,type sand mechanism of lubrication. Additives of lubricants and freezing points of lubricants. (8)

(iii) Corrosion

Thermodynamic overview of electrochemical processes. Reversible and irreversible cells. Chemical and electrochemical corrosion and mechanism of corrosion. Factors affecting corrosion. Protection of corrosion. (9)

(iv) Nanochemistry

Introduction; Materials self assembly; Molecular vs materials self assembly; Self assembly materials; Two dimensional assemblies; Mesoscale self assembly; Coercing colloids; Nanocrystals; Nanoscale materials. (8)

(v) Environmental and green chemistry

Air, water and noise pollution. Optimum levels of pollution. Significance and determination of COD and BOD. Greenhouse effect and global warming. e-Waste. Concept of green chemistry; Twelve principles with emphasis on the concept of atom economy; the use of alternative feedstock; Use of innocuous reagents in natural processes; Alternative solvents; Design of safer chemicals; Designing alternating reaction methodology. Microwave and ultrasonic radiation in green synthesis- Minimizing energy consumption. (10)

Books

(1) Introduction to Nanoscience, by S. M. Lindsay
(2) A Textbook of Engineering Chemistry, by Shashi Chawla
(3) Engineering Chemistry, by P. C Jain and M. Jain
(4) Advanced Polymer Chemistry, by M. Chanda
(5) A Textbook of Environmental Chemistry, by O. D. Tyagi and M. Mehra

BTCH-18303 WATER CONSERVATION AND MANAGEMENT

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

Course Objectives:

1.To have an increased awareness among students on issues in areas of water conservation.
2.To understand the importance of water conservation in different area.
3.To know the important of water audit.
4.To establish a clear understanding of the role of water quality and testing.

Course Contents:

1.Introduction : Water cycle, Water Storage, Water Quality (6L)

2.Water Conservation Technologies : (8L)
Rain water harvesting, Better Irrigation practices **,**Contour farming, Drip irrigation ,Mulching.

3.Water Management: (14L)
Water quality, controlling use and quality of water, water flow measurement, water quality control, testing water salinity, preserving water quality, minimizing evaporation, Water Sanitation.

4.Water Audit & Conservation :
In homes, water conservation in the work place, Water conservation in agriculture; Water conservation in process industry; Water conservation in construction industry; Water conservation in service industry. (8L)

Course Outcomes:

The student will be able to:
1.Understand the importance of water cycle and water storage.
2.Students will learn about water quality , its quality control and testing.
3.Learn about various techniques for water conservation.
4.Learn about water audit and its advantages.

Suggested Books:

1. Elements of Water Pollution Control Engineering, OP Gupta, Khanna Publishing House, Delhi.
2. Water Supply and Sanitary Engineering, Rangwala, Charotar Publications.

BTCH-18304 PLANT UTILITIES

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

L	T	P
3	1	0

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

1.Introduction:Importance of Process utilities in Chemical Plant. (3L)

2.Steam: Boilers- classification , various types, construction, boiler mountings & accessories, properties of steam tables, Mollier Diagram. (5L)

3.Power Generation: Internal Combustion Engines- classification, two- stroke, four stroke petrol & diesel engine, valve timing diagram, carburetor, Combustion Phenomena . (7L)

4.Refrigeration: Air refrigeration cycles, vapour compression cycle, P-H diagram, liquefactions processes. (5L)

5.Compressed Air and Vacuum:

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

6.Water: Cooling water, cooling towers, raw water, DM water, soft water. (3L) .

7.Waste Disposal: Plant sewer system and waste disposal (3L)

Course Outcomes:

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

1.About various sources of plant utilities like steam, power, water etc .

2.The students will also learn functioning of different types of steam generators, compressors, blowers for handling air and inert gases.

3. Students will learn about various types of refrigeration cycles.

4.Students will learn about various uses of water in the plants.

Suggested Books:

1. Yadav B, Thermodynamics & Heat Engines, Central Publishing House, Allahabad, 2000.

2. Vasandani, Treatise on Heat Engines, 4th edition, Metropolitan Book Co. Pvt Ltd, New Delhi, 2008

3. Lyle O, The efficient Use of Steam, Her Majestyôs Stationary Office, London, 1974.

4.Baasal W D, Preliminary Chemical Engineering Plant Design, 2nd edition, New York, 1989.

BTBS-18305 Biology

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

L T P
3 1 0

Objective: Students will be introduced to the basics of biology such as cell structure and functions, inheritance & evolution, basic concepts of genetics, and an introduction to microbiology. So that they can use technology for the betterment of life on this planet.

Unit–I Introduction to living world: Diversity of life, major prokaryotes- monera, eubacteria and eukaryotic kingdoms- Protista, Fungi, Plantae, and Animalia. (6L + 1T)

Unit–II Biochemistry: Metabolism (Catabolism: oxidation reactions and Anabolism: reduction reactions), ATP, Bioenergetics: cellular respiration and photosynthesis. (12L + 3T)

Unit–III Genetics: Basic principles of Mendel, molecular genetics, structure and function of genes and chromosomes, Central dogma, Replication, Transcription and Translation, introduction to recombinant DNA technology and its applications including genetically modified foods and organisms. (12L + 3T)

Unit–IV Cell Biology: Macromolecules: carbohydrates, lipids, water, aminoacids, proteins, nucleic acids, cell membrane, organelles: mitochondria, ribosomes, golgi appratus, endoplasmic reticulum, cytoskeleton, cell-signaling, cell division: mitosis, meosis, differentiation, motility. (12L + 3T)

Unit–V Microbiology: Host-microbe interactions, physiology, ecology, diversity, and virology, microbial diseases and preventions, Antibiotics production with major examples, types of vaccines and important examples. (6L +2T)

Course Outcomes:

1. Get insight into basic biology as a science
2. Outlining the diversity and evolution
3. Organization and fundamental principles of living systems
4. Principle behind recombinant technology

Suggested Books:

1. Biology Fundamental Principles by Balaji S Thorat and Sumit M Raut
2. Lehlinger's Principles of Biochemistry
3. Microbiology by Prescott

BTCH 18305 FLUID MECHANICS

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

Course Objectives: This course is designed for the undergraduate chemical engineering students to develop an understanding of the behaviour of fluids at rest or in motion and the subsequent effects of the fluids on the boundaries.

Introduction : Introduction to fluids, Continuum hypothesis, Liquid & their properties, Viscosity, Newtonôs law of viscosity. **(3L+1T)**

Fluid Statics : Pascalôs law, Absolute & Gauge pressure, Hydro static paradox, Manometry, Forces on horizontally submerged bodies. **(3L+1T)**

Kinematics of Fluid Flow: Introduction to various types of flows, path line, stream line, Stream function, Vorticity and Circulation, flow nets. **(3L+1T)**

System and Control Volume Approach: Euler's equation of motion, Bernoulli equation and applications, Head loss in pipe flow, Moody diagram. **(5L+2T)**

Flow Measurements : Transportation of fluids - pumps, selection and design of pumps **(3L+1T)**

Diffrential Analysis: Mass and momentum balances, Navier-Stokes equation, Unidirectional flow, Viscous flow, Stokes law, Skin drag and pressure drag. **(5L+2T)**

Potential Flow: Potential function, streamlined and bluff bodies. **(3L+1T)**

Boundry Layer Theory: Drag and lift force on immersed body, dimensional analysis of lift and drag. **(5L+2T)**

Dimentional and Similitude Analysis (3L+1T)

Introduction to Compressible Flows: Blowers and compressors. **(3L+1T)**

COURSE OUTCOMES:

1. This course will develop analytical abilities related to fluid flow.
2. It is expected that students will be able to have conceptual understanding of fluids and their properties.
3. It is expected that students will be able to apply the analytical tools to solve different types of problems related to fluid flow in pipes, design the experiments effectively and do the prototype studies of different types of machines and phenomenon.

SUGGESTED BOOKS:

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

BTCH-18306 CHEMICAL ENGINEERING LAB-I

Internal Marks: 30 **L T P**

External Marks: 20 **0 0 3**

Total Marks: 50

1. Characteristic curves of a centrifugal pump.
2. Determination of stability of a floating body.
3. Verification of Bernoulli's equation for flow process.
4. Measurement of flow by a venturimeter.
5. Measurement of flow by an orifice meter.
6. Measurement of flow by a Rotameters.
7. Measurement of flow by a V-notch in an open channel.
8. Measurement of losses in various fitting and valves.
9. Measurement of losses due to contraction and expansion.
10. Measurement of losses due to variation in cross section/ shapes.
11. Verification of laminar/ turbulent flow regime in a flow process
12. Study of valves and fittings.

CHMC-I ENVIRONMENTAL SCIENCES

Internal Marks: 00 **L T P**

External Marks: 00 **2 0 0**

Total Marks: 00

COURSE OBJECTIVES : To think across and beyond existing disciplinary boundaries, mindful of the diverse forms of knowledge and experience that arise from human interactions with the world around them.

Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness. **(2L)**

Natural Resources: Introduction and types of natural Resources and associated problems, use and over exploitation of resources. **(3L)**

Ecosystem and Biodiversity: Concept and types of Ecosystem, Structure and functions of ecosystem , producers , consumers and decomposers , ecological pyramids , Introduction to biodiversity, levels of biodiversity, values of biodiversity, importance (uses) of biodiversity, Hot spots of biodiversity, Threats to biodiversity, Conservation of biodiversity (in situ and ex situ techniques). **(4L)**

Environmental Pollution: Introduction, definition, sources, effects and control measures of Air pollution , Water pollution , Soil pollution , Marine pollution , Noise pollution, Thermal pollution. Nuclear hazards.Solid waste Management: Types , sources, causes and effects of solid wastes, Methods of solid waste disposal. **(4L)**

Disaster Management : Introduction ,characteristics and types of Disasters, Causes, effects and control measures of Floods, earthquake, cyclone and landslides. **(2L)**

Global Environment Issues: Concept of sustainable development,Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation, Climate change, Global warming (Green house effect) , Acid rain ,Ozone layer depletion, Wasteland reclamation. **(3L)**

Legislation for Environmental Protection : Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of pollution) Act, Environment Protection Act, Wildlife Protection Act , Forest Conservation Act, their objectives and salient features. **(2L)**

Environment and Human Population: Population growth, Population explosion, Environment and human health, Human Rights, Value Education, Environmental ethics, Role of Information Technology in Environment and human health. **(4L)**

COURSE OUTCOMES :

1. Understand the scope and importance of environmental science.
2. Identify different types of environmental pollution and its management.
3. Develop the awareness about global environmental issues.
4. Understand the concept and benefits of Green Building & Smart Cities.
5. Understand the concept of 3Rôs & its application.

Suggested Text Books

1. Sawyer CN, McCarty PL and Parkin GF, Chemistry for Environmental Engineering and Science, McGraw Hill (2003)

2. Bharucha, E., Textbook of Environmental Studies, Universities Press (2005).

3. Chapman, J.L. and Reiss, M.J., Ecology-Principles and Application, Cambridge University Press (LPE) (1999).

4. Joseph, B., Environmental Studies, Tata McGraw-Hill (2006).

BTCH-18401 HEAT TRANSFER

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

COURSE OBJECTIVES : The objective of the course is to introduce to students about basic of Heat transfer, its 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 and rating of heat exchangers with and without phase change.

Heat Transfer Fundamental : Mode of Heat Transfer ,Conduction Fourier's law, Thermal diffusivity & Heat Transfer Coefficient. Differential Equations of Heat Transfer and Special forms .Thermal conductivity of materials. Unsteady State Heat Transfer . **(5L+1T)**

Conductive Heat Transfer : One Dimensional Problems (one dimensional heat conduction through plane and composite structures having plane wall, spherical & cylindrical geometry), Heat transfer from extended surfaces ,two and three dimensional problems ,Insulation**. (5L+2T)**

Convective Heat Transfer : Free and forced convection, Concept of thermal boundary layer, dimensional analysis, Analogies and Correlations. **(6L+3T)**

Introduction to Radiative Heat Transfer Radiation: Definition of emissivity, 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. **(3L+1T)**

Basic of Heat Transfer with phase change : Condensation and Boiling heat transfer: Introduction to boiling ,Introduction to condensation , Dropwise and Filmwise condensation of pure and mixed vapours, Convective, Nucleate & Film boiling. **(3L+1T)**

Design of Heat Transfer equipment: Heat exchangers -Construction and working of double pipe heat exchanger, plate type heat exchanger, Shell and Tube heat exchanger ,Concept of LMTD temperature correction factor for shell & tube exchangers, fouling factors, overall heat transfer coefficient . **(8L+3T)**

Evaporators: Various types of evaporators- Standard vertical tube evaporator, basket type vertical evaporator, forced circulation evaporator and horizontal tube evaporators. Single effect evaporators and multi-effect evaporators and its various types of feed arrangements, boiling point elevation, capacity and economy of evaporators. **(6L+1T)**

COURSE OUTCOMES:

This course is expected to acquaint the students:-

1. About Various Mode of Heat transfer ,Steady state and Unsteady heat Transfer.
2. Empirical Correlation for Free and Forced Convection ,Dimensional Numbers .
3. Thermal Boundary Layer ,Condensation and Boiling Phenomenon.
4. Various types of Heat exchange Equipments, Boilers, Condensors, Evaporator.
5. Industrial Application of Heat Exchange equipments.
6. Identify, formulate, and solve industrial engineering problems using different equations studied .

Suggested Books:

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. Principle of Heat Transfer ,D.Srinivasan,New Age International Publishers.

BTCH-18402 MASS TRANSFER-I

Internal Marks: 40 **L T P**

External Marks: 60 **3 1 0**

Total Marks: 100

COURSE OBJECTIVES : The purpose of this course is to introduce the undergraduate students with the most important separation equipments in the process industry, and provide proper understanding of unit operations.

Introduction: Importance and classification of mass transfer operations in Chemical Engineering. **(4L)**

Diffusion: Mass balance in simple situations, diffusion through solids, liquids & gases, Constitutive laws of diffusion ,unsteady state diffusion. **(8L+3T)**

Interphase Mass Transfer : Theories of Mass transfer, Convective mass transfer, interphase mass transfer and mass transfer coefficients, mass transfer correlations , Equilibrium stages and transfer units: number and height of transfer units, stage efficiency. **(10L+4T)**

Gas Absorption: Gas absorption plate and packed column design; reactive absorption . **(6L+1T)**

Humidification Operations: humidification operations and water cooling operations. Dehumidification Equipments: water cooling towers & spray chambers, Rate of drying curves, through circulation drying, Continuous drying, Types of dryers. **(8L+2T)**

COURSE OUTCOMES :
1. Students will learn about the diffusional mass transfer
2. Operation of cooling tower will be clearly understood
3. Operation of Dryer will be understood
4. Student will understand the mechanism of crystallization and absorption

Suggested Text Books

1. Binay K.Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice Hall of India,2007
2. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.
3. E.D. Cussler, Diffusion - Mass Transfer in Fluid Systems, Cambridge
4. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.

Suggested References Books

1. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

BTCH-18403 THERMODYNAMICS -II

Internal Marks: 40 **L T P**

External Marks: 60 **3 1 0**

Total Marks: 100

COURSE OBJECTIVES : To introduce the concepts of fugacity, activity coefficient, vapour-liquid equilibrium and reaction equilibrium. Introduction to molecular thermodynamics.

Introduction: Review of first and second law of thermodynamics . **(2L)**

Solution Thermodynamics: Fundamental property relationships,chemical potential as a criterion for phase equilibrium, partial properties, ideal gas solution, fugacity and fugacity coefficient for a pure species, fugacity and fugacity coefficient for species in a solution, excess properties, Lewis rendall rule. **(8L+3T)**

Solution thermodynamics application: liquid phase properties from VLE, activity and activity coefficient, dependence of activity and activity coefficient on temperature and pressure, models for Gibbs free energy, heat effects and property change on mixing. **(7L+2T)**

Vapour-liquid equilibrium: Phase rule duhem's theorem, gamma-Phi formulation of VLE, dew point and bubble point calculations, Raoult's law and modified raoult's law, VLE from K-value correlations, flash calculations. **(6L+3T)**

Liquid-Liquid Equilibria: Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria, Solid-Gas Equilibria. **(6L+2T)**

Chemical Reaction Equilibria: Reaction coordinate, application of equilibrium criteria to chemical reactions, standard gibbs free energy and the equilibrium constant relation, effect of temperature on equilibrium constant, evaluation of equilibrium constants, relation of equilibrium constant to composition for single phase reactions and liquid phase reactions, equilibrium conversions for single reactions, reactions in heterogenous system, phase rule and duhem's theorem for reacting systems. V**(7L+2T)**

COURSE OUTCOMES :

1. Learning thermodynamics cycles, making cycle calculations by using basic thermodynamics principles.
2. Learning how to apply laws of thermodynamics on ideal gas mixtures.
3. Analyzing varied humidified air processes like air conditioning by using basic formulas and diagrams.
4. 4. Having opinion about social and environmental effects of thermodynamic applications.

Suggested Text Books

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, ñIntroduction to Chemical Engineering thermodynamicsò, 7th edition, McGraw-Hill International Edition,2005.

Suggested References Books

1. S.Sandler, ñChemical, Biochemical and Engineering Thermodynamicsò, 4th edition,Wiley,India.
2.Y.V.C.Rao, ñChemical Engineering Thermodynamicsò, University Press, Hyderabad,1997.
3.K.V.Narayan, A Text book of Chemical Engineering Thermodynamics, Prentice Hall of India Private Limited.,New Delhi.

BTCH-18404 MATERIAL SCIENCE

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

COURSE OBJECTIVES: The objective of the course will be to give the students a basic introduction to the different classes of materials relevant to engineering in general, and Chemical Engineering in particular. The intent of the course will be to relate the underlying molecular structure of the materials to their physical and chemical properties, and their processing and performance characteristics.

Introduction to Materials: Bonding between atoms: metallic bonding, ionic bonding, covalent bonding, Vander Waals bond, thermal expansion, elastic modulus and melting point of materials, Role of materials selection in design, structure-property-processing-performance relationships. **(3L)**

Structure of Materials: Miller indices of directions and planes, packing of atoms inside solids, close-packed structures, structure of ceramics, ionic solids, glass and polymers, density of various materials. **(3L)**

Imperfections in Solids : Vacancies, equilibrium concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults. **(3L)**

Strength of Materials : Yield strength, tensile strength and ductility of materials: stress strain behavior of metals, ceramics and polymers, tensile test, plastic deformation, necking, creep behavior and fatigue. **(4L)**

Semi-crystalline Materials : Classification, structure and configuration of ceramics, polymers, copolymers, liquid crystals and amphiphiles. **(7L)**

Non-Crystalline/Amorphous Materials: Silicates, glass transition temperature, viscoelasticity. **(4L)**

Polymer Nano-composite Materials: Nanocomposites, role of reinforcement-matrix interface strength on composite behavior, Corrosion, Degradation and Recycling **(7L)**

Biomaterials: Material related to catalyst such as zeolites, silica etc. and other selected materials . **(2L)**

Introduction to Experimental Techniques: XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties. **(3L)**

COURSE OUTCOMES

1. Students will have a fair understanding of hard and soft materials, including polymers and composites.

2. All materials characterization, properties and use in engineering applications.

Suggested Books

1. V. Raghavan Materials Science and Engineering: A First Course, 5th Edition Prentice Hall India, 2004.
2. S. Upadhyaya and A. Upadhyaya, Material Science and Engineering, Anshan Publications, 2007.

Suggested Reference Books

1. R. A. L Jones, Soft Condensed Matter, Oxford University Press, 2002.
2. William D. Callister, David G. Rethwisch Materials Science and Engineering: An Introduction, Wiley Publisher.
3. B. S. Mitchell An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, John Wiley & Sons, 2004.

BTHS-18901 Fundamentals of Management for Engineers

Credit: 3

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

Unit 1. Definition, functions, and significance of Management. Levels of management, Douglas Mc Gregor Theory X and Theory Y. Difference between management and Administration.

Unit 2. Evolution of Management, thought, approaches of management. principles of Henry Fayol and F.W Taylor.

Unit3. Planning and organization nature, objectives and significance of planning, types and steps of planning. Span of control. Methods and types of training, Various organizational structures. Formal and informal organizations.

Unit 4. Concept of motivation, theories of motivation - Maslow need hierarchy theory & Herzberg two factor theory, Concepts of leadership and styles. Steps of Controlling .

Books Recommended:-

1. General Management - C.B. Gupta Sultan Chand

2. Principal and Practice of management- L.M. Prasad Sultan Chand

3. Essential of Management -Koontz & O, Donnel Tata Mc Graw

4. Essential Of Management ï Koontz and Weihrich Tata Mc Graw 5. Management : James Stoner, R Edward Freeman, Daniel R. Gilbert, Jr. Prentice Hall of India

BTCH- 18405 NUMERICAL METHODS IN CHEMICAL ENGINEERING

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

COURSE OBJECTIVES: This course is aimed at providing the students with knowledge about the numerical solutions to various mathematical expressions that they may come across in Chemical Engineering 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: Approximation and Concept of Error & Error Analysis **(3 L)**

Linear Algebraic Equations: Methods like Gauss elimination, LU decomposition and matrix inversion, Gauss-Siedel method, Chemical engineering problems involving solution of linear algebraic equations **(5 L)**

Root finding methods for solution on non-linear algebraic equations: Bisection, Newton- Raphson and Secant methods, Chemical engineering problems involving solution of non-linear equations **(5 L)**

Interpolation and Approximation: Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression **(5 L)**

Numerical integration: Trapezoidal rule, Simpsonôs rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation and integration. **(7 L)**

Ordinary Differential Equations: Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs. **(11 L)**

COURSE OUTCOMES:

1. To learn the application of Numerical methods and its application in chemical industry
2. To understand the concept of errors and their significance in numerical methods.
3. To learn different numerical methods used for solution of linear and non linear equations
4. To learn how different type of Chemical Engg. problems can be solved by using different methods (ODE/Integration).

Suggested Books:

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

BTCH-18406 NUMERICAL METHODS IN CHEMICAL ENGINEERING (P)

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

PRACTICAL DESCRIPTION [No. of turns (2 hrs)]

1. Introduction to use of computers for numerical calculations (1 practical turn)

2. Solution of linear algebraic equations using Gauss elimination, Gauss-Siedel etc. (2 practical turns)

3. Solution of a non-linear equations using bracketing and Newton-Raphson method. (2 practical turns)

4. Interpolation and Approximation(2 practical turns)

5. Numerical integration(2 practical turns)

6. Euler method (1 practical turn)

7. Runge-Kutta methods for ODEs (2 practical turns)

8. Solution of system of ODEs using simple methods (1 practical turn)

9. Solution of simple PDEs (2 practical turns)

Total :15 practical turns

BTCH-18407 CHEMICAL ENGINEERING LAB-II

Internal Marks: 30 **L T P**

External Marks: 20 **0 0 3**

Total

Marks: 50

Objective:

The objective of this course is to calculate heat transfer coefficient for different types of heat transfer equipments along with heat losses for various devices like vertical cylinder by natural convection, to determine thermal conductivity of different materials .Student will learn about double pipe heat exchanger and perform calculation for heat exchanger. Student will perform experiments based on conduction , convection and radiation principles.

PRACTICAL DESCRIPTION

1. To determine the thermal conductivity of insulating powder.
2. To determine the heat transfer resistance and thermal conductivity through composite wall .
3. To determine the thermal conductivity of Metal Bar (Brass).
4. To find the heat transfer coefficient of heat loss by vertical cylinder by natural convection.
5. To find heat transfer coefficient loosing heat by forced convection to air flowing through it for different air flow rates & heat flow rates.
6. To find heat transfer coefficient for parallel flow and counter flow for double pipe heat exchanger.
7. To study and determine the heat transfer through lagged pipe.
8. To determine the Steafan Boltzman's constant with Stefan Boltzman apparatus.
9. To study the emissivity of a test plate with the help of emissivity measurement apparatus.
10. To study the temperature distribution and determine the heat transfer rate for an unsteady state system. 11.To determine the super thermal conductivity of heat and to compare its working with best conductor i.e., Cu pipe and SS pipe.

5th Semester (Third Year-Curriculum)

BTCH-18501 Chemical Reaction Engineering-I

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

L	T	P
3	1	0

Course Objectives: The course is designed to understand the basic concepts basic Concepts of Kinetics and Rate Laws • Design and Rating of Ideal Reactors including heat effects • Interpretation of Rate data • Design and Rating of Reactors involving multiple reactions including heat effects • Analysis of Non-ideal flow Behavior in Reactors .

Content:

1. Kinetics of Homogenous Reactions: (7L+3T)

Reactions and reaction rates Stoichiometry, extent of reactions, conversion, Selectivity Reaction rate fundamentals - elementary reaction sequences, steady state approximation and rate limiting step theory.

2. Material Balance: (5L+1T)

Ideal reactors , generalized material balance, design equations, graphical interpretation .

3. Design of reactors: (8L+2T)

Sizing and analysis of ideal batch, mixed (CSTR), plug flow and recycle reactors - solving design equations for constant and variable density systems, reactors in series and parallel .

4. Interpretation of data: (7L+2T)

Analysis and correlation of experimental kinetic data - data collection & plotting, linearization of rate equations, differential and integral method of analysis.

5.Design for Parallel Reactions: (7L+2T)

Multiple reactions - conversion, selectivity, yield, series, parallel, independent and mixed series-parallel reactions.

6. Basics of Non Ideal Flow: (3L+1T)

RTD theory and analysis of non-ideal reactors.

Expected Course Outcomes: Students will be able to

1. Understand reaction kinetic and design chemical reactors involving mass and energy balance.
2. Fix some problems related to operability and productivity.
3. Operate reactors in a safe manner for single and multiple reactions .
4. Analyze the non-ideality in the reactors.

Suggested Reference Books:

1.Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, John Wiley & Sons

2 Elements of Chemical Reaction Engineering by H. Scott Fogler, , Prentice Hall

3.Chemical Reactor Analysis and Design Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, John Wiley & Sons, Incorporated, 2010

4. Peacock D.G., Richardson J.F., Chemical Engineering ï Volume 3, 3rd Ed., Butterworth Heinemann, 1994

5. Walas S.M., Reaction Kinetics for Chemical Engineer, 3rd Ed., McGraw Hill Book Co, Inc.

BTCH-18502 Mass Transfer -II

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

L	T	P
3	1	0

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

Course Contents:

1.Distillation: (10L+4T)

Vapor-liquid equilibria, Raoultôs Law and Daltonôs law, relative volatility, Flash distillation, Differential distillation, Continuous Rectification- Binary system, Steam distillation, Multistage tray tower- McCabe-Thiele method, Ponchon-Savarit method, Underwood and Fenskeôs equations, Total reflux, minimum and optimum reflux ratios, multiple feeds and side streams, principles of azeotropic and extractive distillation,

2.Liquid-liquid extraction: (7L+3T)

Extraction equipment: rotating disc contractor, scheibel extractor, pulsed column extractor, podbilniak extractor. Equilibrium diagram. Choice of solvent. Single stage and multistage counter-current extraction with/without reflux.

3.Leaching: (6L+2T)

Leaching equipment: Rotocel extractor, Kennedy extractor, Bollman extractor, continuous horizontal extractor and equilibrium. Single stage and multistage cross current and counter current leaching.

4.Adsorption: (8 L+2T)

Types, nature of adsorbents, Adsorption equilibria- single species- Langmuir, Freundlich isotherms, Adsorption operations ï single stage and multi stage.

5.Crystallization: (5 L+1T)

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

Expected Course Outcomes: At the end of the course the student will be able to :

1.Understand the concept of Distillation & can estimate the number of stages for distillation.

2.Solve problems related to mass transfer operation.

3.Understand the concept of adsorption .

4.Estimate the factors involved in Crystallization process and learn different types of mass transfer equipments .

Suggested Reference Books:

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

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

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

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

BTCH-18XXX Core Department Elective -I *

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

L	T	P
3	0	0

BTCH-18XXX Open Elective -I *

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

L	T	P
3	0	0

*Detail Syllabus content is at the end of the syllabus

BTHS-18902 Entrepreneurship and Project Management

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

Contents:

Unit1: Entrepreneurship definition, classification of Entrepreneur, Features of Entrepreneurship, Need and importance of Entrepreneurship and Scope of Entrepreneurship in India. (9L)

Unit2:Entrepreneurship:Skills and characteristics, Technical, Business, Marketing, Personal Entrepreneurial skills, Project characteristics, Project life cycle phases. (9L)

Unit3: Market and Demand Analysis, Collection of market survey, characteristics of market, Demand Forecasting, Market Planning, Product mix, Performance appraisal methods . (9L)

Unit4: Project Management, Steps in Project Management, Job description of Project Manager, Constraints of project Management, Feasibility study, Steps in feasibility study. (9L)

Suggested Reference Books:

1.Chandra, P. (2002). Projects Planning,Analysis,Selection,Financing,Implementation and Review. New Delhi: Tata McGraw-Hill.

2.Gray F.Clifford, L. W. (2008). Project Management The Managerial Process. McGraw Hill

BTCH-18506 Chemical Engineering Lab-III

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

Course Objective :

Chemical Engineering lab provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses. This particular lab focuses mass transfer and Chemical Reaction Engg . The objective of the course is to provide knowledge about experiments for finding liquid hold up, critical moisture content, mass transfer coefficients, yield of crystal, Residence time distribution, rate kinetics in different types of reactors .

*Minimum 8 Experiments to be conducted

Contents:

1.To find out the critical moisture content of the given material and to find out the equations for constant and falling rate period of drying.
2.Determination of liquid hold up in a packed column.
3.To find the mass transfer coefficient for the vaporization of organic vapor to air.
4.To study the Rayleigh's equation for batch distillation column .
5.To find the yield of crystals using batch crystallizer
6.To study liquid-liquid extraction in a packed column.
7.Study of Rate kinetics using an isothermal batch reactor.
8.Study of Rate kinetics using an isothermal flow reactor PFR/CSTR
9.To find the residence time distribution for PFRs of different lengths.
10.To find the residence time distribution for Packed bed reactor

Course Outcomes : Students will be able to:

1.Learn how to experimentally verify various theoretical principles , Develop experimental skills & Visualize practical implementation of chemical engineering equipment.
2.Students will be able to perform experiments for finding liquid hold up in packed column, critical moisture contents, mass transfer coefficients .
3. Students will be able to perform experiments for finding rate kinetics for batch reactors and plug flow reactors, and finding residence time distribution in PFR and Packed bed reactor.

BTCH-18507 Particle and Fluid-Particle Processing

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

Objectives: Objective of this course is 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, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. The course is concluded with an introduction to colloidal systems, soft materials and nano-particles.

Contents :

1. Introduction: (3L)
Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes.

2. Solid particle characterization: (5L)
Particle size, shape and their distribution; Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area.

3. Packed bed: (3L)
Void fraction, superficial velocity, channeling, Ergun equation and its derivation, Darcyôs law and permeability, Blaineôs apparatus.

4. Fluidization: (8L)
Fluidized bed, minimum fluidization velocity, pressure drop. Types of fluidization: Particulate fluidization, Bubbling fluidization, Classical models of fluidization, Circulating fluidized beds, Applications of fluidization.

5. Separation of solids from fluids: Introduction. (2L)
6. Sedimentation: Free Settling, hindered settling, design of settling tanks. (3L)
7. Filtration: Concepts, design of bag filters, design of electrostatic filters. (3L)
8. Size reduction, milling, laws of communition, classification of particles. (3L)
9. Transport of fluid-solid systems: pneumatic and hydraulic conveying. (3L)
10. Introduction to nanoparticles: (3L)
Properties, characterization, synthesis methods, applications.

Expected Course Outcomes:

1Students will be able to develop an understanding about different mechanical operations.

2.The course will develop analytical abilities related to solid particles & packed beds.

3.It is expected that students will be able to have conceptual understanding about different filtration & other separation processes.

4.Students will be able to apply the analytical tools to solve different types of problems related to transportation of fluids.

5.Students will be able to develop an understanding about different types of nano-particals.

Suggested Reference Books

1. McCabe, W., Smith, J. and Harriott, P. Unit Operations of Chemical Engineering, 6th edition., McGraw Hill.
2. Coulson and Richardsonôs Chemical Engineering, Vol. 2, Butterworth-Heinemann, Fifth edition 2002.
3. Vollath, D. Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Ed., Wiley, 2013.

CHMC-II Constitution of India

Internal Marks: 0 **L T P**
External Marks: 0 **2 0 0**
Total Marks: 00

Credit:00

OBJECTIVES:

- To know about Indian constitution.
- To know about central and state government functionalities in India.
- To know about Indian society.

UNIT I : INTRODUCTION
Historical Background ï Philosophical foundations of the Indian Constitution ï Fundamental Rights ï Right to certain freedom under Article 19. ï Fundamental Duties ï Citizenship ï Right to Equality-Right to life and Personal Liberty under Article 21. (9L)

UNIT II : STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT
Union Government ï Structures of the Union Government and Functions ï President ï National Emergency-President Rule ï Prime Minister ï Financial Emergency- Cabinet ï Parliament ï Supreme Court of India. (9L)

UNIT III : STRUCTURE AND FUNCTION OF STATE GOVERNMENT
State Government ï Structure and Functions ï Governor ï Chief Minister ï Cabinet ï State Legislature ï Judicial System in States ï High Courts and other Subordinate Courts. (9L)

UNIT-IV: STRUCTURE AND FUNCTION OF LOCAL GOVERNMENT

Districtôs Administration head- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj. (9L)

TEXTBOOKS:

1.Durga Das Basu, ñIntroduction to the Constitution of India ñ, Prentice Hall of India, New Delhi.
2.R.C.Agarwal, (1997) ñIndian Political Systemò, S.Chand and Company, New Delhi.
3.Maciver and Page, ñ Society: An Introduction Analysis ñ, Mac Milan India Ltd., New Delhi.
4.K.L.Sharma, (1997) ñSocial Stratification in India: Issues and Themesò, Jawaharlal Nehru University, New Delhi.

6th Semester (Third Year)-Syllabus
BTCH-18601 Chemical Reaction Engineering -II

L T P
3 1 0

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

Course Objectives:

This course teaches the principles of Basic concepts of Catalysis ,Kinetic and Mechanistic aspects of Catalysts .The course objective also include design and Rating of catalytic reactors ,design aspects of Gas-Liquid Reactors . It also includes the use of mass transfer and heat transfer principles as applicable to heterogeneous reactions and their application to reactor design.

Course Contents:

1. **Catalysis**: (3 L)

Introduction to Catalysis, homogeneous and heterogeneous catalysis. Preparation and characterization of catalysts, Deactivation of Catalysts .

2.**Adsorption**: (3 L+2T)

Physical and chemical adsorption, Adsorption isotherms, Langmuir Hinshelwood rate equations and parameter estimation. Determination of BET surface area and pore volume of the Catalyst .

3.**Kinetic of fluid -particle Reactions** : (6 L+2T)

Kinetics of solid catalyzed gas phase reaction.

4.**Laboratory reactors** : (3 L+2T)

Laboratory reactors for catalytic gas solid reactions. Design concepts.

5.**Diffusion through Porous catalyst particles** : (8L+2T)

Mass transfer, Diffusion and Chemical reactions in catalysts, Effectiveness factor for pore diffusion resistance through a single cylindrical pore, Significance of Thiele modulus, Effects of external mass transfer and heat transfer, Effectiveness factor. Design aspects of catalytic reactors.

6.**Fluid Solid Non Catalytic Reactions:** (6 L+1T)

Non-catalytic gas-solid reactions, different model for gas-solid reactions.

7.**Kinetics and Design of Fluid-Fluid Reactions**: (8L+2T)

Gas liquid reactions, film and penetration theories, , Interface behavior for liquid-phase reaction, Regimes for different reaction kinetics for liquid-liquid reactions, Determination of reaction rate & tower height based on film and penetration theories, Concept of Enhancement factor & Hatta Number , gas-liquid reactors.

Expected Course Outcomes : At the end of the course, the student would be able to

1. Explain the fundamentals of reaction mechanism and kinetics.
2. Analyze the mechanism of non catalytic gas-liquid reactions.
3. Understand Phenomenon of Adsorption and its application.
4. Understand the working of a catalyst in a given chemical reaction.

Suggested Reference Books :

1.Smith J.M., Chemical Engineering Kinetics, 3rd Ed., McGraw Hill, 1981.
2.Levenspiel O., Chemical Reaction Engineering, 3rd Ed., John Willey, 2004.
3.Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry, 2001.
4.Fogler H. S., Elements of Chemical Reaction Engineering, 4th Ed., Prentice Hall, 2006 7. Carberry, J.J. Chemical and Catalytic Reaction Engineering, McGraw Hill, New York, 197
5.Walas S.M., Reaction Kinetics for Chemical Engineer, 3rd Ed., McGraw Hill Book Co, Inc.

BTCH-18602 Process Technology and Economics

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

Objectives:

To familiarize students with manufacturing aspects of industrially relevant chemicals. This course is also enable the students to learn an economic analysis of different technologies or operations based on understanding of various costs involved, Balance sheet , Depreciation and profitability.

Course Contents :

1.Inorganic Chemicals: (10 L)

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of inorganic chemicals, such as: inorganic acids, chlor-alkali, ammonia, fertilizers, etc.

2.**Petroleum Refining** : (8L)

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for Petroleum refining and cracking operations, syngas and hydrogen.

3.PetrochemicalsTechnology : (12 L)

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of Petrochemicals: C1, C2, C3, C4, etc., benzene, toluene, xylene and other petrochemicals from these basic building blocks.

4 Fuels: (4 L)

Industrially relevant fuels, coal, coal based chemicals and fuels.

5.**Utilities:** (3L)

Common utilities such as electricity, cooling water, steam, hot oil, refrigeration and chilled water

5.Cost Estimation : (6 L)

Introduction to project cost and cost of production, Various components of cost of production and their estimation, Various components of project cost and their estimation. Estimation of working capital.

6.Analysis of Projects: (3 L)

Analysis of working results project: Balance sheets, Project financing, concept of interest, time value of money, depreciation. Profitability Analysis of Projects.

Expected Course Outcomes: At the end of the course, the students will be able to:

1. Can describe various manufacturing processes used in chemical process industries
2. Can understand major engineering problems encountered in chemical process industries.
3. Perform economic analysis for process to calculate equipment cost, and profitability for process.
4.Understand fundamental concepts of investment ,financial statement ,Depreciation.

Suggested Reference Books:

1.Shreveôs Chemical Process Industries, George T. Austin, McGraw-Hill International Editions Series, 1984
2.Drydenôs Outlines of Chemical Technology, M. Gopala Rao, Marshall Sittig, East West Press, 1997
3.Chemical Project Economics, Mahajani V. V. and Mokashi S M., MacMillan India Ltd. 2005
4.Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013.
5.Peters M.S. , Timmerhaus K.D., Plant Design and Economics for Chemical Engg., 5th Ed., Tata McGraw Hill, 2005.

BTCH-18XXX Department Elective -II *

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

L	T	P
3	0	0

*Detail Syllabus content is at the end of the syllabus

BTCH-18603 Process Control

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

Course Objective : Introduce the fundamentals of process control with applications using P, PI, and PID controllers. The course will teach the students about mathematical models based on transfer function approach for single loop systems, how to obtain dynamic response of open loop and closed loop systems, stability analysis in transient and frequency domains, and controller tuning methods. The course would end with more advanced concepts like feed-forward control, ratio control, model-predictive control, ratio control, dead-time compensation, etc.

Course Contents:

1 Introductory Concepts: (4 L+1T)

Need for control and automation, control logic, servo and regulatory control, block diagrams, control structures (feedback vs. feed forward), process and instrumentation diagrams.

2.Laplace Transform: (4 L+2T)

Laplace transforms, solution of ODEs using Laplace transform.

3.Linear Open Loop Systems : (5 L+2T)

Transfer function approach, response of first order systems: step, impulse and sinusoidal response, first order systems in series.

4 Higher Order System: (4 L+1T)

Second order systems, higher order systems, transportation lag and dead time .

5 .Linear closed loop systems: (8 L+3T)

Linear closed loop systems, development of block diagrams, classical feedback controllers.
Final control element (control valves), block diagram reduction techniques .
Closed loop response, servo and regulatory problems.

6.Stability Analysis : (8 L+3T)

Stability analysis, Routh stability criterion, Root locus diagrams (rule based).
Introduction to frequency response, Bode diagrams, Nyquist plots, Bode and Nyquist stability criterion.

7.Introduction to advanced controllers: cascade control, feed forward control, ratio control. (3L)

Course Outcomes:

Students will be able to
1.Understand the importance of process dynamics (unsteady state operation)
2.Students will understand different types of controller.
3.Tune a controller to Stability and disturbances or manage operating point transitions.
4.Student will learn about block diagram and other advanced control system.

Suggested Books :

1. Coughanowr, D. R., LeBlanc, S. ñProcess Systems Analysis and Controlò, 3rd edition, McGraw-Hill (2008).
2. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. ñProcess Dynamics and Controlò, 2nd edition, John Wiley (2003)
3. Stephanopoulos, G. ñChemical Process Control: An Introduction to Theory and Practiceò, Pearson Education (1984)

BTHS-18903 Human Resource Management

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

Content:

1 .Introduction:
Introduction to Human Resource Management and its definition, functions of Human Resource Management & its relation to other managerial functions. Nature, Scope and Importance of Human Resource Management in Industry, Role & position of Personnel function in the organization. (10L)

2. Procurement and Placement:
Process of Human Resource Planning; Methods of Recruitment; Types tests and interviewing, Selection and its procedure Meaning and Importance of Placement and Induction. (8L)

3.Training & Development:
Difference between training and development; Principles of Training, Performance Appraisal, Career Development & Planning. (8L)

4. Job analysis & Design:
Job Analysis: Job Description & Job Description, Job Specification. (4L)

5. Job Satisfaction:
Job satisfaction and its importance; Motivation, Factors affecting motivation, introduction to Motivation Theory; Workers ' Participation, Quality of work life. (6L)

Suggested Books:

1. T.N.Chhabra- Human Resource Management (Dhanpat Rai & Co.)
2. Lowin B. Flippo - Principles of personnel Management (Mc Graw-Hill)
3. R.C. Saxena - Labour Problems and social welfare (K.Math & Co.)
4. A Minappa and M. S. Saiyada - Personnel Management (Tata Mc. Graw-Hill)

BTCH-18604 Chemical Engineering Lab-IV

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

Course Objective :

Chemical Engineering lab provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses. It also serves as a bridge between theory and practice. This particular lab focuses on Process Technology and Environment .The objective of the course is to provide knowledge about experiments for finding acid value , specification value ,TDS, dissolved solids, Alkalinity ,BOD,COD, hardness etc.

Minimum 8 Experiments to be performed.

1.To perform proximate analysis of a given sample of Coal .
2.To determine the acid value of an oil/fat.
3.To determine the saponification value of an oil/fat.
4.To determine the Iodine value of an oil.
5.To determine the optimum dose of coagulant for waste water using Jar test apparatus.
6.To find Alkalinity of Given water sample.
7.Determination of TDS and TSS of a water sample.
8.To find hardness of given sample water.
9.Determination of COD of a water sample.
10.Determination of BOD of a water sample.

Course Outcomes ::

1. Students will be able to learn how to experimentally verify various theoretical principles ,
2.Students will be able to perform experiments for finding acid value , specification value, Alkalinity.
3. Students will be able to perform experiments for finding BOD,COD, hardness.
4. Students will be able to perform experiments for finding TDS, dissolved solids.

BTCH-18XXX Open Elective -II *

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

L	T	P
3	0	0

*Detail Syllabus content is at the end of the syllabus

7th Semester (Fourth Year)-Syllabus

BTCH-18XXX Department Elective -III *

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

*Detail Syllabus content is at the end of the syllabus

BTCH -18701 Design & Simulation Lab

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

L	T	P
0	0	3

Course Objectives: To introduce students to use of software packages such as CHEMCAD, MATLAB, COMSOL for simulation, and also analyzing flow sheets.

Contents:

1. Introduction to Software Packages
2 Setting up models for simulation
3 Steady State simulation using CHEMCAD, Flow sheeting concepts (sequential modular, equation oriented)
4 Dynamic simulation using MATLAB
5 CFD simulations using COMSOL, geometry & meshing

Practical Description (examples may be drawn from Fluid Flow, Heat Transfer, Reaction Engineering, Process Control)

Course Outcomes :

Students will be able to:
1.Solve chemical engineering problems using advanced programming software
2.Use simulation software's like Chem-CAD & COMSOL
3.Analyse the techno-economic feasibility of chemical manufacturing facility.

BTCH-18702 INSTRUMENTATION & CONTROL LABORATORY

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

L	T	P
0	0	3

Course Objectives: To introduce students to use of measuring instruments for stability, and also analyzing dynamic response of process system.

Minimum 8 Experiments to be performed.

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

Course Outcomes:
Students will be able to :
1.Solve chemical engineering stability problem using hardware & software.
2.Use various measuring instruments & their control.
3.Analyse the first & second order problem of chemical process system.
4.Students will learn to control interacting liquid level system.

BTCH-18XXX Department Elective –IV*

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

L	T	P
3	0	0

BTCH-18XXX Open Elective –III*

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

L	T	P
3	0	0

BTCH-18XXX Open Elective -IV *

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

L	T	P
3	0	0

*Detail Syllabus content is at the end of the syllabus

BTCH-18703 Process Plant Design

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

L	T	P
0	0	4

Course Objective : The course will enable the students to:

1. Familiarize standard symbols of process flow diagrams.
2. Learn basic symbols used instrumentation diagrams.
3. Impart the knowledge mechanical aspects of pressure vessel design
4. Translate mechanical design specifications in to fabrication drawings for plant erection.

Contents:

1.Selection, Preparation , Specification sheet for a centrifugal Pump.
2.Design of piping and piping networks.
3.Process Design of double pipe Heat exchanger, Shell and Tube Heat Exchanger.
4.Process Design of Condensers, Distillation Column.
5.Mechanical Design of Process Equipment: Introduction, Classification of pressure vessels, Pressure vessel Codes and Standard .
6.Design Considerations: Design Pressure, Design Temperature, Materials of construction, Weld joint efficiency, corrosion allowance, Design loads.
7.Flow Sheets symbols, Instrumentation symbols, Process Flow Diagram and factors for Plant location .

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

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

1. Design equipments involved in industrial operation/Processes.
2. Demonstrate process from process flow diagrams.
3. Explain the different control strategies employed in the process from the instrumentation diagrams and Flow diagram.
4. State the IS Codes used in the mechanical design.

Suggested Books:

1. Brownell and Young, Process Equipment Design, Wiley Interscience, 1959.Gulf Publication, 1996
2. Bhattacharya, R.C., An Introduction to Chemical Equipment Design- Mechanical Aspects, 1st Ed., CBS Publication, 1998
3. Mahajani V.V., Umarji S.B., Joshiôs Process Equipment Design, 4th Ed., Macmillan Indian Ltd., 2009
4. Coulson, Richardson & Sinnott R.K., Chemical Engineering Volume-6 ï an Introduction to Chemical Engineering Design, 4th Ed., Elseveir Butterworth Heinemann, 2005

BTCH-18704 Summer Internship

Internal Marks: 00
External Marks: 100
Total Marks: 100

L	T	P
0	0	0

Each student will be required to submit a report after the completion of Industrial training. The reports will be assessed by teachers in-charge of the training. The student has to appear in external Viva- Voce examination.

8th Semester (Fourth Year)-Syllabus

BTCH-18801 Industrial Training

Internal Marks: 200
External Marks: 200
Total Marks: 400

L	T	P
0	0	0

Each student will be required to submit a report after the completion of Industrial / institutional training. The reports will be assessed by teachers in-charge of the training. The student has to appear in internal and external Viva- Voce examination.

Department Electives

BTCH-18952 Sustainability Engineering

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

L	T	P
3	0	0

Course Objectives

1.To have an increased awareness among students on issues in areas of sustainability
2.To understand the role of engineering and technology within sustainable development;
3.To know the methods, tools, and incentives for sustainable product-service system development
4.To establish a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic problems.

Content:

1. Introduction to Sustainability : (7 L)
Introduction, Need and concept of sustainability, Social environmental and economic sustainability concepts. Sustainable development, Challenges for Sustainable Development. Multilateral environmental agreements and Protocols - Clean Development Mechanism (CDM), Environmental legislations in India - Water Act, Air Act.

2.Natural resources and their pollution : (8 L)
Air Pollution, Effects of Air Pollution; Water pollution- sources, Sustainable wastewater treatment, Solid waste - sources, impacts of solid waste, Zero waste concept, 3 R concept. Global environmental issues-Resource degradation, Climate change, Global warming, Ozone layer depletion, Regional and Local Environmental Issues. Carbon credits and carbon trading, carbon foot print.

3.Environmental management : (5 L)
Environmental management standards, ISO 14000 series, Life Cycle Analysis (LCA) - Scope and Goal, Bio-mimicking, Environment Impact Assessment (EIA) - Procedures of EIA in India.

4.Basic concepts of sustainable habitat: (6 L)
Green buildings, Green chemistry, green materials for building construction, material selection for sustainable design, green building certification, Methods for increasing energy efficiency of buildings.

5.Energy sources: (5 L)
Basic concepts-Conventional and non-conventional, solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans, Geothermal energy.

6.Technology and sustainable development : (5 L)
Green Engineering, Sustainable Urbanization, sustainable transportation, industrialization and poverty reduction; Social and technological change, Industrial Ecology, Industrial symbiosis.

Course outcomes:

Students will be :

1. Able to understand the different types of environmental pollution problems and their sustainable solutions.
2. Able to work in the area of sustainability for research and education.
3.Able to understand and manage various environmental issues.
4.Having a broader perspective in thinking for sustainable practices by utilizing the engineering knowledge and principles gained from this.

Course Reference Books:

1.Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3.Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998

BTCH-18953 Interfacial Engineering

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

L	T	P
3	0	0

Course Objectives:

The objective of the course to introduce students about Fundamental engineering aspects of fluid-fluid and fluid-solid interfaces and its applications , about rheology of fluids, about emulsion preparation and characterization techniques.

Contents :

1.**Introduction to the engineering of interfaces**:

Definitions of fluid-fluid and fluid-solid interfaces; Occurrence of interfaces in science and engineering; Overview of industrial applications of various interfacial phenomena; Colloidal materials; Properties of colloidal systems; Experimental characterization of colloidal dispersions, Colloid Interaction and flocculation. (8L)

2.Capillary phenomenon :

Surface and interfacial Tension. Surface free energy , Surface tension for curved interfaces, Measurement of Surface tension, Interfacial Tension, Contact angle and wetting phenomenon. (5L)

3.Adsorption:

Fluid-fluid and fluid-solid interfaces and Film formation ; Adsorption of surfactants; Brunauer-Emmett- Teller theory of adsorption; Adsorption hysteresis: Flotation. (7L)

4.Interfacial rheology and transport processes: (8L)

About reheology of fluids ,Surface shear viscosity; Surface dilatational viscosity; Interfacial turbulence; Motion of drops in a liquid; Thin liquid films; Stability of thin liquid film; Black films.

5.**Emulsions**: (8L)

Preparation, characterization and applications; Ostwald ripening; Flocculation and coalescence; Microemulsions: characterization and properties; Stability of microemulsions; Foams: preparation, characterization and stability; Structure of foams.

Course Outcomes:

Students will be able:

1.Identify the primary influences on interfacial behavior.

2. Recognize the role of interfaces play in engineering systems .

3. Analyze the forces affecting the behavior of interfaces.

4. Identify means of improving engineering designs by modifying interfacial properties.

Suggested books:

1.Adamson, A. W. and Gast, A. P.,Physical Chemistry of Surfaces, John Wiley, New York, 1997.

2.Ghosh, P.,Colloid and Interface Science, PHI Learning Pvt Ltd., New Delhi, 2009.

3.Hiemenz, P.C. and Rajagopalan, R., Principles of Colloid and Surface Chemistry, Marcel 4.Dekker, New York,

1997. Stokes, R. J. and Evans, D. F.,Fundamentals of Interfacial Engineering, Wiley-VCH, New York, 1997.

BTCH-18954 Nano Science and Nanotechnology

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

L	T	P
3	0	0

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

1.Introduction:

Terminologies, History & Scope of Nano technology . (3L)

2.Characterization & Fabrication:

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

3.Self assembly: (6 L)

Supra-molecular & dimension Control in Nanostructure, thermodynamics and coded self assembly.

4.Biomaterials:

DNA & Nanomaterials, Bio-nanocomposites, Biometrics, molecular motor (6L)

5.Nanoelectronics and Molecular computing:

Molecular wires, Nan wires, Nan tubes, Molecular switch, Molecular logic gates and molecular storage devices, DNA Computing Quantum Computing. (6L)

Course outcomes: At the end of the course the students will be able:

1. Explain the characteristics of nonmaterial's, nanodevices and nanostructures
2. Identify various characterization and Fabrication Techniques of nonomaterials.
3. Elucidate the applications of nanotechnology in nanoelectronics.

Suggested Books:

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

BTCH-18955 Advanced Separation Processes

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

L	T	P
3	0	0

Course Objective:

To understand the governing mechanisms and driving forces of various advanced separation processes and to perform process and design calculations for advanced separation processes.

1.Membrane Separation Processes: (9L)

Fundamentals ,Materials ,Types and properties of membranes, Membrane modules, Transport mechanism in membrane process. Bulk Flow, Liquid Diffusion in Pores, Gas Diffusion, Nonporous Membranes, Solution-Diffusion for Liquid Mixtures, Solution-Diffusion for Gas Mixtures.

2.Ultrafiltration: (8L)

Ultra filtration modules and applicability, Fundamentals of reverse osmosis, Osmotic pressure, Relation between chemical potential and osmotic pressure, Factors affecting the performance of reverse osmosis plant, Advantages, disadvantages and application of reverse osmosis process.

3.Chromatographic Separations: (10L)

Theory of chromatographic separation, Selectivity or separation factor, Efficiency of chromatographic system, Types of chromatography, Liquid chromatography, Liquid-solid chromatography, Advantages and disadvantages of chromatographic separations.

4.Gas Separation:

Different techniques of gas separations and their applications. (5L)

5.Surfactant based separation processes: (4L)

Centrifugal separation processes ; supercritical fluid extraction: Ion- Exchange , Dialysis.

Course outcomes (COs): The students will be able to:

1. Apply modern separation techniques in various applications.
2. Analyze novel membranes process for intended application.
3. Understand chromatography and dialysis based separation processes.
4. Understand the concept of ultrafiltration and its application.

Suggested Books:

1. Seader J.D., Ernet J. Henlay, and Keith, D., Separation Process Principles,Wiley (2010).
2. King, C.J., Separation Processes, Tata McGraw - Hill Publishing Co., Ltd. (1982).
3.Osadar, V., and Nakagawa, I.,Membrance Science and Technology, Marcel Dekkar (1992).
4.Schoew, H.M., New Chemical Engineering separation Techniques,Interscience Publishers (1972).

BTCH-18956 POLYMER SCIENCE AND ENGINEERING

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

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

Contents:

1. Introduction to Polymers: Global scenario of polymer industry, Present status of polymer industry in India, Classification of polymers, polymerization process, Kinetics of step growth and chain growth polymerization, polymerization techniques: Bulk, Solution, Suspension and Emulsion Polymerization. (6L)

2.**Molecular Weight and size of Polymers**:Number average and weight average molecular weight, Significance of molecular weight, determination of molecular weight, viscosity method, light scattering method, gel permeation chromatography method. (5L)

3.**Polymer Properties and their Testing :**

Glass transition temperature and associated properties, Tensile strength & impact strength and their determination, softening point, heat distortion dielectric and power factor. (4L)

4.**Synthesis & Properties of commercial polymers**:

Manufacture, processing and properties of resins and fibre forming polymers such as phenol formaldehyde, epoxy resins and silicon polymers, LDPE, HDPE, polypropylene, polyvinyl chloride, polystyrene, and polyamides Nylon6 and Nylon66. (6L)

5. **Introduction to rubber and elastomers** : (6L)

Natural & synthetic rubber, Buna S, Buna N, Butyl rubber, neoprene, Thiokol, polyurethane, Fillers, accelerators, activators, antioxidants & other additives, mastication & compounding, vulcanization theory & technology.

6. **Polymer Degradation** : Thermal, Mechanical and by ultrasonic waves, photo degradation, heat energy radiation, oxidation and hydrolysis. (3L)

7. **Polymer Processing** : Compression moulding, injection moulding, blow moulding, extrusion, and calendaring. (6L)

Course Outcomes: Students will :

1 Understand different types of Polymers, Polymerization Process and Techniques.
2 Understand relationship between Number and Weight average molecular weight
3 Understand manufacturing and properties of different types of Polymers
4. Understand various types of Polymer testing methods.

Suggested Books:

1.Gowariker V.L., Viswanathan N.V. and Sreedhar J., Polymer Science, 1st Ed., New Age International
2.Ghosh P., Polymer Science & Technology of Plastics & Rubber, 3rd edition, Tata McGraw Hill, New Delhi, 2010
3.Billmeyer F.W., Text Book of Polymer Science, 3rd edition, John Wiley
4. Sinha R., Outlines of Polymer Technology - Manufacture of Polymers, PHI

BTCH-18957 ENVIRONMENTAL POLLUTION AND CONTROL

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

Course Objectives: The course aims at giving the students an insight into the environmental issues related to chemical process industries in terms of their impact on land, water and air and the possible mitigation techniques to reduce this effect for sustainably.

1.Introduction:
Ambient air and water standards, principle sources of pollution, Interrelationship between energy and environmental pollution, Prevention of environmental pollution through conservation . (3L)

2. Air Pollution: Definition and scales of concentration of air pollution, Classification and properties of Air Pollutants, Sources of Air Pollutants, Photochemical Smog, Effects of air pollution on human health, animals, vegetation and materials. (7L)

3. Aspects of Air Pollutant Dispersion :
Tempters Lapse rate and stability, Adiabatic lapse rate, Atmospheric stability, Temperature inversions. Types Plume Behavior, Atmospheric dispersion of air pollutants. (6L)

4. Air Pollution Sampling and Measurements :
Ambient air sampling: Grab sampling, Sedimentation (dust fall jar) and High Volume Filtration (The Hi-Volume sampler) Stack sampling and Particulate sampling. (4L)

5. Air Pollution Control Methods and Equipments : Source correction methods & cleaning of gas effluents, Collection efficiency Equipment, Gravitational settling chamber, Cyclone Separator, Fabric Filters, Electrostatic Precipitators, Wet collectors (Scrubbers). (7L)

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

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

8. Solid Waste :
Sources and classification of solid waste, Methods of collection, Disposal methods: Open dumping, Sanitary Landfill, Incineration and compositing Recovery and recycling. (3L)

Course Outcomes: The theory should be taught in such a manner that students are able to acquire different learning out comes in cognitive and affective domain to demonstrate following course outcomes.

1.Quantify and analyze the pollution load.

2 .Analyze/design of suitable treatment for wastewater

3 .Model the atmospheric dispersion of air pollutants.

4 .Selection and design of air pollution control devices.

Suggested Books:

1.Perkins H. C., Air Pollution, McGraw Hill, N.Y., 1974 E.P. Popov, Mechanics of Materials-(SI Version), Prentice Hall India.
2. Rao C.S., Environmental Pollution Control Engineering, 2nd Edition, New Age International Pvt. Ltd., 2006.
3.Metcalf and Eddy, Waste-Water Engineering, 4thEdition, Tata McGraw Hill, 2007.
4.Mahajan S. P., Pollution Control in Process Industries, McGraw Hill, 2008

BTCH-18958 RENEWABLE ENERGY

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

L	T	P
3	0	0

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

Contents:

1. Introduction : Global and Indian scenario, sources, Energy conservation, types of NCES with applications. (3L)

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

3. Geothermal and Wind Energy: Resources, types of wells, methods of harnessing the energy, Wind Energy: Sources and potentials, horizontal and vertical axis, wind mills, wind regime analysis and evaluation of wind mills. (8L)

4. Biomass and Biofuels: Recycling of agricultural waste, anaerobic/ aerobic digestion and types of biogas digesters; gas yield, and combustion characteristics of bio gas, design of biogas system for heating, Introduction to Biofuels such as biodiesel, ethanol, bio-butanol etc., their production and present status.(9L)

5. Ocean and Tidal Energy : OTEC, settling of OTEC plants, thermodynamic cycles, Tidal Energy: Potential and conversion technique, mini hydel power plants and their economics. (6L)

Course Outcomes:

1.Students will be able to develop an understanding about different types of energies.
2.The course will develop analytical abilities related to solar energy production & consumption.
3.It is expected that students will be able to have conceptual understanding about geothermal, wind energy & bio-fuels.
4.Students will be able to understand the production of different energies.

Suggested Books

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

BTCH-18959 TRANSPORT PHENOMENA

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

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

Contents :

1.Momentum Transport :

Introduction to Transport Phenomena, Formulation of transport problems from nature, Newtonôs law of Viscosity, Generalization of Newton's Law of Viscosity, Effect of Temperature and Pressure on Viscosity, Molecular theory of Viscosity of Gases at Low density, Molecular theory of Viscosity of Liquids Convective Momentum Transport, Non Newtonian Fluids. Vector and Tensor Analysis: Basic concepts . (4L)

Shell Momentum Balances and Velocity distributions in Laminar Flow, Flow of Falling film, Inclined Parallel plate, Flow through Circular tube, Hagen -Poiseuille equation, Flow through an Annulus, Couette viscometer. (6L)

Principles of conservation of mass and momentum, continuity equation, equations of motion, Bernoulli Equation, Navier-Stokes equations. Equation of mechanical energy, Equation of angular momentum equation of change in substantial derivative. (5L)

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

2. Energy Transport :

Shell energy balances and temperature distributions in solids and laminar flow, Principle of conservation and equation of energy. Fourier's law, Thermal conductivity and mechanism of energy transport, Effect of Temperature and Pressure on Thermal Conductivity. (3L)

Heat Conduction with an electrical heat source, Heat Conduction with an viscous heat source, Heat conduction through Composites walls, Composite cylindrical pipe, Heat conduction in a cooling fin. Free and Forced Convection, Heat transfer coefficients for forced convection in tubes. (7L)

3. Mass Transport :

Diffusivity and the mechanisms of mass transport, Fick's Law of Binary diffusion, Effect of Temperature and Pressure on Diffusivity. Theory of ordinary diffusion in gases at low density, Theory of ordinary diffusion in liquids. Basics of mass transport, mechanisms, and mass and molar fluxes . (4L)

Mass and Molar Transport by convection: Definition of concentrations, velocities and fluxes. Diffusion through stagnant gas film, Equimolar counter diffusion, Diffusion in a falling liquid film. Interphase mass transport, Definition of Transfer coefficients in Two Phases, mass transfer coefficients-individual and overall. Introduction to the concept of heat and mass transfer coefficients, Analogy between momentum, heat and mass transfer. Unsteady-state momentum, heat and mass transport, formulation of basic equations and similarity transform method . (10L)

Course Outcomes: The theory should be taught in such a manner that students are able to acquire different learning out comes in cognitive and affective domain to demonstrate following course outcomes.

1. Identify transport properties and analyze the mechanisms of momentum, energy and mass transport.
2. Formulate the differential forms of the equations of change for momentum, heat and mass transfer problems for steady-state and unsteady flows.
3. Students will be able to understand the concept of fluid flow, heat transfer and mass transfer problems, and

solve problems combining these transport phenomena.
4.Students will be able to understand the application of Momentum ,Energy and Heat transfer in engineering application.

Suggested Books:

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

BTCH-18960 PETROCHEMICAL TECHNOLOGY

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

L	T	P
3	0	0

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

1. Introduction :

Petro chemicals; Definition, History, importance and growth potential of the field. (3L)

2.Petrochemical Feed stocks : Raw material for petrochemical industries. Production of olefin containing gases-their purification and separation processes. (7L)

3.Processes for petrochemical feed stocks: Naphtha cracking, steam reforming, xylene isomerization, synthesis gas. (8L)

4.Manufacture of important petrochemicals and their uses, properties:

Methanol, Ethylene oxide, Ethylene glycol, Isopropanol, Acrylic acid, Butadiene, Acetic acid, Poly-vinyl chloride, LDPE, HDPE, Phenol formaldehyde resin, urea formaldehyde resin, Propylene oxide, Nylon 6, Nylon 66, Polyethylene terephthalate, Styrene Butadiene Rubber, Fertilizers: ammonia, urea. Carbon Black, Synthetic Detergents. (15L)

Concepts of quality and environmental pollution control in petrochemical industries. (3L)

Course Outcomes:

1.The students will learn about the basics of petrochemical technology.

2. The students will learn various manufacturing process for widely used petrochemicals.

3.The students will learn about various types of petrochemical feed stocks.

4.The students will learn about uses of various petrochemicals products.

Suggested Books :

1. Rao B.K. B, Modern Petroleum Refinery Processes, 5th edition, Oxford & IBH Publishing Co. Pvt. Ltd., 2009

2. Rao B. K. B., ñA textbook on Petrochemicalsò 5thEdition, Khanna publisher, 2010.

3. Waddone, A.C., Chemicals from Petroleum, John Murry, 1988

4. Top Chev, A.V. Synthetic Materials from Petroleum, Pergammon Press, 1982

BTCH-18962 PETROLEUM REFINING ENGINEERING

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

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

1.Introduction to petroleum industry:

World petroleum resources, petroleum industry in India. Brief review of petroleum origin, its composition and classification. Exploration: Meaning, methods of exploration. Drilling: Concept of drilling, various drilling operations e.g. cable drilling, rotary drilling, directional drilling. Transportation of crudes and their products. (9L)

2.Crude pre-treatment and methods of evaluation/ Crude processing: (12L)

Desalting and stabilization of crude. Process description of a typical simple distillation, fractional distillation, atmospheric distillation, vacuum distillation, crude oil distillation.Methods of evaluation: ASTM, TBP and EFV distillation. Properties and specifications of petroleum products such as LPG, gasoline, naphtha, kerosene, diesel oils, lubricating oils, waxes.

3.Conversion Process:

Cracking, Thermal cracking, visbreaking, coking, catalytic cracking, reforming, alkylation, polymerization, isomerization and hydro processing. (7L)

4.Separation Processes:

Sweetening: Doctorôs sweetening process, copper chloride sweetening process, merox sweetening process. Solvent extraction: Edeleanu process. Solvent dewaxing: Chilling and pressing, Ketone dewaxing, Propane dewaxing, Urea dewaxing. Deasphalting: Propane deasphalting process. Safety and pollution considerations in refineries. (8L)

Course Outcomes: The students will learn about :

1. Introductory information about petroleum and refinery.

2.The history of refinery development and composition of petroleum.

3.The refinery products, test methods and petroleum properties.

4.Recognize the characteristics of petroleum refinery process and the distillation processes.

Suggested Books:

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

BTCH-18963 OPTIMIZATION METHODS

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

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

1.Introduction: Engineering application of optimization, Design variables, constraints, objective function, variable bounds, statement and formulation of an optimization problem, Examples of chemical engineering Optimization problems, Classification of optimization problems, different optimization algorithms. Optimal Point: Local optimal point, global optimal point and inflection point. **(**3L)

2. Single variable optimization techniques: Optimality criterion, Bracketing method (Bounding phase method). Region elimination methods (Internal halving, Fibonacci search method, Golden section method). Point estimation method (Successive quadratic estimation methods). Gradient-based methods (Newton-Raphson method, Bisection method, Secant, Cubic search method.) Root finding using optimization techniques. (10 L)

3.Multivariable optimization techniques: Optimality criterion ï Hessian Matrix and its use in optimization, Unidirectional search method. Direct search method (Evolutionary method, Hooke-Jeeves Pattern Search method, Powell's conjugate direction method) , Gradient-based methods (Steepest descent method, Newton's method, Marquardt's methods). (10L)

4.Constrained optimization algorithms:

Kuhn - Tucker conditions, Transformation method (penalty function method) , Direct search for constrained minimization (variable elimination method, complex search method. (10 L)

5. Linear programming: Linear programming problems, Degeneracy, Simplex method of linear programming dual phase simplex method. (3L)

Course Outcomes:

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

1. Apply the knowledge of optimization to formulate the problems of Chemical Engineering.
2. Analyze the optimization criterion for solving problems.
3. Apply different methods of optimization and to suggest a technique for specific problem.
4. Apply simplex method for linear optimization problems.

Suggested Books:

1. Deb K., Optimization for Engg. Design Algorithms and Examples, Prentice Hall of India, 2005.
2. Edgar T.I. & Himmelblau D.M., Lasdon L.S., Optimization of Chemical Processes, McGraw Hill, 2001.
3. Rao S.S., Engineering Optimization Theory and Practice, 4 th Ed., John Wiley and Sons, 2009.
4. Ray W.H., &Szekely J., Process Optimization with Applications to Metallurgy & Chemical Engg. Wiley Interscience, 1973.

Department Open Electives

BTCH-18970 Corrosion Engineering

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

OBJECTIVE:

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

1.Basic Concepts: (3)

Corrosion Engineering, Definition of corrosion, Corrosion Damage

2.Corrosion Principles: (4)

Corrosion rate expressions, Electrochemical Aspects, Polarization, Passivity, Environmental Effects

3.Forms of Corrosion : (12)

Galvanic corrosion: EMF and Galvanic series, Environmental Effects, Prevention and Beneficial applications

Crevice Corrosion:

Environmental effects, Mechanism and Prevention

Pitting: Pit Shape and Growth, Autocatalytic nature of Pitting, Solution composition, Evaluation and prevention

Inter granular Corrosion: Austenitic Stainless steels, Weld Decay, Control for Austenitic Stainless Steels

Selective Leaching: Dezincification: Characteristics, Mechanism and Prevention

Erosion Corrosion: Erosion Corrosion, Factors which effect Erosion Corrosion, Combating erosion Corrosion

Stress Corrosion: Crack morphology, Stress Effects, Environmental and Metallurgical factors, Classification of Mechanisms, Methods of Prevention

Hydrogen Damage: Characteristics, Environmental Factors and Prevention.

4.**Materials:** (6)

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

5.**Corrosion Prevention** : (4)

Materials Selection, Alteration of Environment, Cathodic and Anodic Prevention, Coatings

6. **Passivity :** (2)

Basic concepts of passivity; Properties of passive films

7.**High Temperatures Corrosion :** (5)

Mechanisms and Kinetics: Pitting- Bedworth Ratio, Electrochemical and Morphological Aspects of Oxidation. Oxidation Kinetics, Effect of Alloying, High Temp Materials, Corrosion in acidic and alkaline process streams.

Course Outcomes:

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

1. Understand the electrochemical and metallurgical behavior of corroding systems.

2. Apply the electrochemical and metallurgical aspects of combating different forms of corrosion.

3. Select or choose the testing procedures for corroding systems.

4. Evaluate the polarization behavior of corroding systems.

Suggested Books :

1.Fontana, Mars.G., ñCorrosion Engineeringò, McGraw-Hill. 2.Jones, D.A., ñPrincipal and Protection of Corrosionò, Prentice-Hall 3.Unling, H.H., Corrosion Control, John Wiley & Sons, 1971

4.Rajagopalan , K S. Corrosion and its prevention, Chemical Engineering Education Development Centre, IIT Madras, 1975

BTCH -18971 NEW & RENEWABLE ENERGY SOURCES

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

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

1. Introduction:

Global and Indian scenario, sources, Energy conservation, types of NCES with applications. (4L)

2. Solar Energy:

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

3.Geothermal & Wind Energy:

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

4. Biomass & Biofuels :

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

5. Ocean & Tidal Energy:

OTEC, settling of OTEC plants, thermodynamic cycles, Tidal Energy: Potential and conversion technique, mini hydel power plants and their economics. (6L)

COURSE OUTCOMES :The students will be able to :

1.Understand the need of energy conversion and the various methods of energy storage.

2. Able to explain the field applications of Renewable energy sources.

3. Able to identify Winds energy as alternate form of energy and to know how it can be tapped.

4. Illustrate the concepts of Direct Energy Conversion systems & their applications.

Suggested Books:

1. Rai G D, Non-Conventional Energy Sources, 4th edition, Khanna Publishers, 2009 .

2. Kumar Ramesh, Udayakumar K., Anandakrishnan M., Renewable Energy Technologies: Ocean Thermal Energy Conversion and Sustainable Energy Options, Narosa Publication, 1997

3. Desai Ashok V, Jhirad D., Munasinghe M., Non-Conventional Energy, New Age International, 1990

4. Sukhatme S. P., Solar Energy: Principles of Thermal Collection and Storage, 3rd Edition, Tata McGraw-Hill Education, 2008

BTCH-18972 ENVIRONMENT IMPACT ASSESSMENT

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

Course Objective :

The objective of this course to provide knowledge to students to identify, predict and evaluate the economic, environmental and social impact of development activities. Also objective is to provide information on the environmental consequences for decision making and to promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

1.Introduction :

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

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

3.Environmental Domain and Its Divisions: Parametric analysis, environmental indices and indicators, operational framework, rapid and comprehensive EIA . (6L)

4.Impact Assessment Methodologies: Tools and methods to identify, predict, and evaluate different types of impacts, models and expert systems and professional judgments. (8L)

5.Environmetal Management Plan: Principles, elements of approach and measures used for mitigating the impacts, anticipated environmental impacts and mitigation measures. EIA Case Studies of Process Industries. (8L)

Course Outcomes:

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

1.Learn on prediction and assessment of environmental impacts due to developmental activities.
2.Understand the concepts on various environmental impact assessment methodologies.
3.Familiar with regulations pertinent to environmental problems
4.Describe general environmental impact problems, meteorological definitions.

RECOMMENDED BOOKS:

1. Sadler, B. and McCabe, M., Environmental Impact Assessment: Resource Manual, UNEP (2002).
2. Canter, R.L., Environmental Impact Assessment, Tata McGraw-Hill (1981).
3. A K Srivastava, Environment impact Assessment, APH Publishing, 2014.
4.John Glasson, Riki Therivel & S Andrew Chadwick ñIntroduction to EIAò University College London Press Limited, 2011
5. Larry W Canter, ñEnvironmental Impact Assessmentò, McGraw Hill Inc. , New York, 1995.

BTCH-18973 Hydrocarbon Engineering

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

Course Objective :

ÅTo understand the properties and the significance of petroleum fractions.
ÅTo understand the various petroleum refinery processes
ÅTo understand various parameters for measuring the quality of petroleum products.

Course Contents:

1.Scope and Purpose of Refining

Global and Indian refining scenario, Petroleum refining industry in India practice and prospects, Separation and Conversion processes etc. (3L)

2.Refinery Distillation Processes

Desalting, Process description of typical crude distillation, Fractional distillation, Vacuum distillation, Flooding, Weeping, Entrainment, Setting of cut point, Crude assay analysis, ASTM, TBP EFV Distillation etc. (8L)

3.Fuel Refining and Lube Refining

Cracking, Coking, Reforming, Alkylation, Isomerisation, Polymerization, and Sweetening etc. Solvent extraction, De-waxing, Propane deasphalting etc. (6L)

4.Hydro processing

Hydro cracking, Hydro treating, Hydro desulphurization (3L)

5.Oil and Gas separators

Principal of separation, Types of separators, their description. Various control and vessel internals, Oil and gas gravitational separator, Vertical two and three phase separator, Horizontal three phase separator etc.

6.Quality Monitoring of Petroleum Products (16L)

API gravity, Flash point, Fire point, Smoke point, Aniline point, Carbon residue, Kinetic viscosity, Pour point, freezing point, octane number, Cetane number, Viscosity index, Diesel index Calorific value, Characterization factor, Cloud Point, Vapour lock index, Carbon hydrogen ratio, Calculated ignition index, Calculated carbon aromaticity index, U.O.P Characterization factor, Conrad son carbon residue, Water and sediment content etc. Storage and Transportation of Petroleum and their Products

COURSE OUTCOMES: At the end of the course the students will be able to :

1. Under the concepts and importance Distillation process in refinery.
2. Understand various refining and cracking processes.
3. Understand various downstream activities performed in oil and gas industry.
4. Learn about parameters to measure the quality of petroleum products.

Suggested Books

1.Nelson W. L., ñPetroleum Refinery Engineeringò, Mc Graw Hill Book Co., (1985).

2.Watkins R. N., ñPetroleum Refinery Distillationò, Gulf Publishing Co.

3.Gary J. H., Handwork G. E., ñPetroleum Refining Technology and Economicsò, Marcel Dekker, Inc., (2001).

4.Jones D. S. J., ñElements of Petroleum processingò, John Wiley & Sons, (1995).

5.Waquier J. P., ñPetroleum Refiningò Vol. I &II,Technip, (1995)

Rao, B.K., Modern Petroleum Refining Processes, 5th Edition, Oxford & IBH Publishing Co., 2009

BTCH-18974 Biochemical Engineering

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

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

Course Contents:

1. Biochemistry :

Structure and function of carbohydrates, lipids, amino acids and peptides, nucleic acid and nucleotides, proteins, enzymes. (5L)

2. Classification of microorganisms:

Morphological structural and biochemical characteristics of prokaryotes and eukaryotes. Microbial nutrients and growth media. Microbial reproduction and growth. (6L)

3. Kinetics & Sterilization:

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

4.Mass transfer and microbial respiration: Mass transfer resistance, physical and enzymatic considerations, critical value of dissolved oxygen concentration, respiration of mycelial pellet. (7L)

5.Aeration & Agitation: Bubble aeration and mechanical agitation Single bubbles, series of bubbles, power number versus Reynolds number, decrease of power requirement in aeration. Cardinal rules for Fermentor design, materials of construction. (8L)

Course Outcomes:

Student will be able to :

1. Understand the basic fundamental principles and concept for biological and bio processing .
2. Understand classification of microorganism and its growth .
3. Understand the kinetic of microorganism.
4. Fermentor design aspects.

Suggested Books:

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

BTCH-18975 Polymer Reactor Design

L T P
3 0 0

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

Course Objectives:

Students will learn about various Polymerization techniques, different types of reactors for polymerization reactions. The students will learn about reactors design steps and various factors for design .

Contents:

1.**Introduction to Polymer** : (3L)

A brief introduction to various type of polymers, polymerization methods and their importance

2.**Polymer Reactor**: (3L)

Definition, types application-fields.

3.**Polymer Reactor Design :** (5L)

Meaning, general design procedure .

4.**Reaction 4.Engineering of step growth polymerization** : (7L)

Introduction, analysis of semi batch reactors, MWD of ARB polymerization in homogeneous continuous flow stirred-tank reactors (HCSTRs) advanced stage of polymerizatiom, similarity solution of step growth polymerization in films with finite mass transfer.

5.Reaction engineering of chain growth polymerization; (6L)

Introduction, design of tubular Reactors, copolymerization, solution of equations describing isothermal radical polymerization.

6**.Emulsion polymerization**: (6L)

Introduction emulsion polymerization in homogeneous continuous flow stride tank reactors (HCSTRSs).

7.**Detailed Design of ideal batch reactor** for the prodution of Phenol-formaldehyde (novolac) starting from phenol & formaldehyde as raw materials. (6L)

Course Outcomes:

Students will be able:

1.Understand different types of polymerization reactions.
2. Understand the role of reactors in polymerization reactions.
3.Understand how to design reactors for various polymerization reactions.
4.Understand effect of parameters in polymerization reactions.

Suggested Books:

1. ñFundamentals of Polymersò Anil Kumar and Rajesh K. Gupta McGraw Hill,1998.
2. ñFundamentals of Polymer Science and Engineeringò, Anil Kumar and K. Gupta listed Tata McGraw HillNew Delhi, 1978.
3. ñElements of Chemical Reaction Enggò, H. Scott , Fogler (PHI)

BTCH-18976 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

Course Content:

1.**Introduction** :

Importance of Process utilities in Chemical Plant. (3L)

2.Steam: Boilers- classification , various types, construction, boiler mountings & accessories, properties of steam tables, Mollier Diagram. (5L)

3.Power Generation: Internal Combustion Engines- classification, two- stroke, four stroke petrol & diesel engine, valve timing diagram, carburetor, Combustion Phenomena . (7L)

4.Refrigeration:

Air refrigeration cycles, vapour compression cycle, P-H diagram, liquefactions processes. (5L)

5.Compressed Air and Vacuum:

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

6.Water: Cooling water, cooling towers, raw water, DM water, soft water . (3L)

7.Waste Disposal: Plant sewer system and waste disposal. (3L)

Course Outcomes:

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

1.About various sources of plant utilities like steam, power, water etc .

2.The students will also learn functioning of different types of steam generators, compressors, blowers for handling air and inert gases.

3. Students will learn about various types of refrigeration cycles.

4.Students will learn about various uses of water in the plants.

Suggested Books:

1. Yadav B, Thermodynamics & Heat Engines, Central Publishing House, Allahabad, 2000.

2. Vasandani, Treatise on Heat Engines, 4th edition, Metropolitan Book Co. Pvt Ltd, New Delhi, 2008

3. Lyle O, The efficient Use of Steam, Her Majestyôs 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

6.Perry R. H. Green D. W. ñPerryôs chemical Engineerôs Handbookò, McGraw Hill, New York, 2007.

L	T	P
3	0	0

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

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

1.Introduction of Petrochemicals :

Petro chemicals; Definition, History, importance and growth potential of the field. (3L)

2.Petrochemical Feed stocks

Raw material for petrochemical industries. Production of olefin containing gases-their purification and separation processes. (7L)

3.Processes for petrochemical feed stocks

Naphtha cracking, steam reforming, xylene isomerization, synthesis gas. (8L)

4.Manufacture of important petrochemicals and their uses, properties:

Methanol, Ethylene oxide, Ethylene glycol, Isopropanol, Acrylic acid, Butadiene, Acetic acid, Poly-vinyl chloride, LDPE, HDPE, Phenol formaldehyde resin, urea formaldehyde resin, Propylene oxide, Nylon 6, Nylon 66, Polyethylene terephthalate, Styrene Butadiene Rubber, Fertilizers: ammonia, urea. Carbon Black, Synthetic Detergents. (15L)

5.**Concepts of quality and environmental pollution control in petrochemical industries.** (3L)

Course Outcomes:

1.The students will learn about the basics of petrochemical technology.
2. The students will learn various manufacturing process for widely used petrochemicals.
3.The students will learn about various types of petrochemical feedstocks.
4.The students will learn about uses of various petrochemicals products.

Suggested Books :

1. Rao B.K. B, Modern Petroleum Refinery Processes, 5th edition, Oxford & IBH Publishing Co. Pvt. Ltd., 2009
2. Rao B. K. B., ñA textbook on Petrochemicalsò 5thEdition, Khanna publisher, 2010.
3. Waddone, A.C., Chemicals from Petroleum, John Murry, 1988
4. Top Chev, A.V. Synthetic Materials from Petroleum, Pergammon Press, 1982
5. Astle M.J., Synthetic Materials from Petroleum, Pergammon Press