Dr. M.G.R.
EDUCATIONAL AND RESEARCH INSTITUTE
(Deemed to be University)
Maduravoyal, Chennai - 600 095. Tamilnadu. India.
(An ISO 9001 : 2015 Certified Institution)

CURRICULUM AND SYLLABUS

(2018 REGULATION)

BACHELOR OF TECHNOLOGY

CHEMICAL ENGINEERING

(PART TIME)

DEPARTMENT OF CHEMICAL ENGINEERING

I SEMESTER							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BMA18024	Mathematics I For Chemical Engineers	Ty	3	1/0	0/0	4
2	BCE18I04	Environmental Engineering	Ty	3	0/0	0/0	3
3	BCT18007	Mechanical Operations	Ty	3	1/0	0/0	4
4	BCT18ET1	Fertilizer Technology	ETL	1	0/1	3/0	3
PRACTICALS*							
1	BCT18L03	Mechanical Operation Lab	Lb	0	0/0	3/0	1

Credits Sub Total:15

II SEMESTER							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BMA18025	Mathematics II For Civil and Chemical Engineers	Ty	3	1/0	0/0	4
2	BCS18I03	Computer Application In Chemical Engineering	Ty	3	0/0	0/0	3
3	BES18001	Basic Electrical & Electronics Engineering	Ty	2	0/1	0/0	3
4	BCT18ET3	Petroleum Technology	ETL	1	0/1	3/0	3
5	BCT18005	Chemical Technology	Ty	3	0/0	0/0	3

Credits Sub Total: 16
TOTALCREDITS: 31

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R :Research
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab*Internal evaluation

III SEMESTER							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BBT18I01	Bio-Chemical Principles	Ty	3	0/0	0/0	3
2	BCT18008	Chemical Process Calculation	Ty	3	1/0	0/0	4
3	BCT18006	Fluid Mechanics	Ty	3	0/0	0/0	3
4	BCT18ET4	Chemical Process Equipment Design & Drawing Lab	ETL	1	0/1	3/0	3

Credits Sub Total: 13

IV SEMESTER							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BCT18003	Chemical Engineering Thermodynamics	Ty	3	0/0	0/0	3
2	BCT18013	Mass Transfer-I	Ty	3	1/0	0/0	4
3	BCT18009	Heat Transfer	Ty	3	1/0	0/0	4
4	BXX18EXX	Elective 1	Ty	3	0/0	0/0	3
PRACTICALS*							
1	BCT18L08	Heat Transfer Lab	Lb	0	0/0	3/0	1

Credits Sub Total: 15

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R :Research
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab*Internal evaluation

V SEMESTER							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BCT18014	Mass Transfer II	Ty	3	1/0	0/0	4
2	BCT18010	Chemical Reaction Engineering	Ty	3	1/0	0/0	4
3	BCT18E13	Industrial Instrumentation	Ty	3	0/0	0/0	3
4	BXX18EXX	Elective 2	Ty	0	0/0	0/0	3
PRACTICALS*							
1	BCT18L11	Chemical Reaction Engineering Lab	Lb	0	0/0	3/0	1

Credits Sub Total: 15

VI SEMESTER							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BCT18004	Process Control And Dynamics	Ty	3	1/0	0/0	4
2	BXX18EXX	Elective 3	Ty	1	0/2	1/1	3
3	BMG18001	Total Quality Management For Chemical Engineers	Ty	3	0/0	0/0	3
4	BCT18011	Transport Phenomena	Ty	3	0/0	0/0	3
PRACTICALS*							
1	BCT18L12	Project Phase -I	Lb	0	0/0	3/3	2

Credits Sub Total: 15

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R :Research
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab*Internal evaluation

VII SEMESTER							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BXX18EXX	Elective-4	Ty	0	0/0	0/0	3
PRACTICALS*							
1	BCT18L13	Project Phase -II	Lb	0	0/0	12/12	8

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R :Research
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab*Internal evaluation

CREDIT SUMMARY

Semester : 1 : 15
Semester : 2 : 16
Semester : 3 : 13
Semester : 4 : 15
Semester : 5 : 15
Semester : 6 : 15
Semester : 7 : 11
Total Credits : 100

ELECTIVES –SEMESTER 4							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BCT18E01	Food Technology	Ty	3	0/0	0/0	3
2	BCT18E02	Industry Pollution Prevention and Control	Ty	3	0/0	0/0	3
3	BCT18E03	Chemistry of Polymer and Composite Materials	Ty	3	0/0	0/0	3

ELECTIVES –SEMESTER 5							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BCT18E04	Green Chemistry and Engineering	Ty	3	0/0	0/0	3
2	BCT18E05	Modern Separation Processes	Ty	3	0/0	0/0	3
3	BCT18E06	Renewable Energy Engineering	Ty	3	0/0	0/0	3

ELECTIVES –SEMESTER 6							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BCT18E07	Computational Fluid Dynamics	Ty	3	0/0	0/0	3
2	BCT18E08	Frontiers of Chemical Engineering	Ty	3	0/0	0/0	3
3	BCT18E09	Industrial Management	Ty	3	0/0	0/0	3
4	BCT18E10	Drugs And Pharmaceutical Technology	Ty	3	0/0	0/0	3

ELECTIVES – SEMESTER 7							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**
1	BCT18E11	Professional Ethics In Engineering	Ty	3	0/0	0/0	3
2	BCT18E13	Process Optimization	Ty	3	0/0	0/0	3

SEMESTER I (THEORY)

Subject Code:	Subject Name: Mathematics I for Chemical Engineers	Ty / Lb/ ETL	L	T / SLr	P/ R	C
BMA18024	Prerequisite: Nil	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Labp

OBJECTIVE:

- The aim of this course is to introduce the concepts of Matrices, Analytic functions and, Fourier series to chemical students.

COURSE OUTCOMES (COs) : (3- 5)

CO1	To understand the basic concepts in P.D.E & its application.
CO2	To understand the basic concepts in analytic for complex integral.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	-	-	M	-	-	M	-	H	-	L
CO2	H	M	-	-	-	-	-	L	-	-	-	H

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	H	-	-
CO2	M	H	-	-

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
	√											

BMA18024	MATHEMATICS I FOR CHEMICAL ENGINEERS	3	1/0	0/0	4

UNIT I MATRICES 12Hrs

Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values – Cayley - Hamilton theorem (without proof) – Orthogonal reduction pof a symmetric matrix to Diagonal form.

UNIT II DIFFERENTIAL EQUATIONS 12Hrs

Linear differential equations of second order with constant coefficients – Euler's equation – Simultaneous equations of first order with constant coefficients.

UNIT III ANALYTIC FUNCTIONS 12Hrs

Analytic functions – Cauchy Riemann equations in Cartesian and Polar form – Properties of analytic functions – Construction of analytic functions – Simple Transformations – Standard transformations : w = z2, w = ez, w = sin z, w = cosh z – Bilinear transformations.

UNIT IV COMPLEX INTEGRATION 12Hrs

Cauchy's integral theorem (without proof) – Cauchy's integral formulae (without proof) – Taylor's and Laurent's series (without proof) – Singularities: Types – Residues – Cauchy's residue theorem (without proof) – Evaluation of real integrals by Contour Integration (excluding poles on real axis)

UNIT V FOURIER SERIES 12Hrs

Dirichlet's conditions – General Fourier series – Half range Sine & Cosine series – Parseval's identity – Harmonic Analysis.

Total no. of Hours: 60Hrs

TEXT BOOKS:

1. *Veerarajan T., Engineering Mathematics (for first year), Tata McGraw Hill Publishing Co., (2007).*

2. *Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw Hill Publishing Co., (2005).*

REFERNCES*:*

1. *Singaravelu, Transforms and Partial Differential Equations, Meenakshi Agency, (2009).*

2. *Kreyszig E., Advanced Engineering Mathematics (9 th ed.), John Wiley & Sons, (2011).*

3. *Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, (2012).*

Subject Code: BCE18I04	Subject Name : Environmental Engineering	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Nil	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE :

- To impart knowledge in fundamental theory and design of conventional water treatment facilities.
- To impart knowledge in fundamental theory and design of conventional wastewater treatment facilities.
- To impart knowledge on the principles used to design advanced wastewater treatments.

COURSE OUTCOMES (COs) : (3- 5)

CO1	An insight into the structure of drinking water supply and waste water systems, including water transport, treatment and distribution.
CO2	An understanding of water quality and waste water criteria and standards, and their relation to public health.
CO3	The ability to design and evaluate water supply and waste water project alternatives on basis of chosen.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	-	-	L	-	-	-	M	-	L
CO2	H	M	-	-	-	-	-	-	-	M	-	-
CO3	H	M	L	-	-	M	-	-	-	M	-	H

COs / PSOs	PSO1	PSO2	PSO3	PO4
CO1	H	H	H	-
CO2	H	H	H	-
CO3	H	H	H	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
		√										

BCE18I04	**ENVIRONMENTAL ENGINEERING**	**3**	**0/0**	**0/0**	**3**

UNIT I PLANNING FOR WATER SUPPLY SYSTEMS 9Hrs

Scope of environmental engineering – role of environmental engineer – Public water supply systems – objectives – design period – population forecasting – water demand – sources of water – sources selection – water quality – characterization – sources of wastewater –estimation of storm runoff.

UNIT II WATER TREATMENT 9Hrs

Screening - types of screening - plain sedimentation – sedimentation with coagulation – settling & flotation

- filtration – disinfection.

UNIT II SEWAGE TREATMENT – PRIMARY TREATMENT 9Hrs

Objectives – unit operations & processes – principles, functions and design of screen, grit chambers and primary sedimentation tanks.

UNIT IV SEWAGE TREATMENT – SECONDARY TREATMENT 9Hrs

Secondary treatment – activated sludge process and trickling filter; other treatment methods – stabilization ponds and septic tanks – advances in sewage treatment.

UNIT V SEWAGE DISPOSAL AND SLUDGE MANAGEMENT 9Hrs

Methods – dilution – self purification of surface water bodies – oxygen sag curve – land disposal – sewage farming – deep well injection – soil dispersion system. Thickening – sludge digestion – biogas recovery - drying beds – conditioning and dewatering – sludge disposal.

Total No of Hours: 45Hrs

TEXT BOOKS:

1. *Garg, S.K., Environmental Engineering, Vols. I &II, Khanna Publishers, New Delhi, 1994*
2. *C.S.Shah, Water Supply And Sanitation, Galgotia Publishing Company, New Delhi, 1994*

REFERENCES:

1. *Manual on Water Supply And Treatment, Ministry Of Urban Development, Government Of India, New Delhi, 1999.*
2. *Manual on sewerage and sewage treatment, CPHEEO, Ministry Of Urban Development, Government Of India, New Delhi, 1993.*
3. *H.S.Peavy, D.R.Rowe and George Tchobanoglous, Environmental Engineering, Mcgraw-Hill Book Company, New Delhi, 1995.*

Subject Code:	Subject Name : Mechanical Operations	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18007	Prerequisite: PCC	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE :

- To provide knowledge of particle size analysis, size reduction, storage of solids, particle mechanics, sedimentation and floatation, flow through packed beds, fluidization, filtration, fluid-solid conveying.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Ability to know about properties of solids.
CO2	To understand the process and equipment.
CO3	To select suitable size reduction equipment.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	-	-	L	-	-	-	-	M	L
CO2	M	L	H	-	-	-	M	-	L	-	L	H
CO3	L	M	H	-	H	-	-	-	-	-	M	H

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	H	M	L	-				
CO2	M	L	H	-				
CO3	L	M	H	-				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Lo

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18007	**MECHANICAL OPERATIONS**	**3**	**1/0**	**0/0**	**4**

UNIT I PARTICLE CHARACTERISTICS AND SIZE ANALYSIS 12Hrs

General characteristics of solids, their behavior under different external forces, agglomeration, techniques for size analysis.

UNIT II SIZE REDUCTION 12Hrs

Laws of size reduction classification of equipment, methods of size reduction, disintegration, preparation of colloids.

UNIT III MECHANICAL SEPARATIONS 12Hrs

Screening and Screening equipment, effectiveness of screens, gravity settling, sedimentation, thickening, centrifugal separation, impingement methods, industrial dust removing equipment with special reference to electrostatic and magnetic separators, heavy media separations, floatation.

UNIT IV FILTRATION, MIXING AND AGITATION 12Hrs

Theory of filtration, Batch and continuous filters, centrifuges, membrane and ultra filtration. Equipment for blending and kneading, dispersion, power for agitation, correlations.

UNIT V STORAGE AND CONVEYING OF SOLIDS 12Hrs

Conveyors, elevators, pneumatic conveying, Different methods for storage of solids.

Total No.of Hours: 60Hrs

TEXT BOOK:

1. *McCabe,W.L, Smith J.C and Harriot, P., " UNIT Operations in Chemical Engineering ", McGraw-Hill, Fourth Edition, 1984.*

REFERENCES:

1. *Coulson, J.M., Richardson, J.F., "Chemical Engineering ", Volume 2, Third Edition, Pergamon Press, 1977.*

SEMESTER I (PRACTICAL)

Subject Code:	Subject Name : Fertilizer Technology	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18ET1	Prerequisite: PCC	ETL	1	0/1	3/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.

COURSE OUTCOMES (COs) : (3- 5)

CO1	At the end of this course, the students would know about the manufacturing techniques of fertilizers and design the equipments in fertilizer industry.
CO2	To do all calculations.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	-	-	-	L	-	-	-	-	H	-
CO2	M	H	-	-	-	M	-	-	-	-	H	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	M	-	-
CO2	H	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
							√					

BCT18ET1	**FERTILIZER TECHNOLOGY**	**1**	**0/1**	**3/0**	**3**

UNIT I NITROGENOUS FERTILISERS 9Hrs

Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate,urea and calciumammonium nitrate; ammonium chloride and their methods ofproduction, characteristics and specifications, storage and handling.

UNIT II PHOSPHATIC FERTILISERS 9Hrs

Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers – groundrock phosphate; bone meal-single superphosphate, triple superphosphate, triplesuperphosphate, thermal phosphates and their methods of production, characteristics and specifications.

UNIT III POTASSIC FERTILISERS 9Hrs

Methods of production of potassium chloride, potassium sulphatetheircharacteristics and specifications.

UNIT IV COMPLEX AND NPK FERTILISERS 9Hrs

Methods of production of ammonium phosphate, sulphated ammoniumphosphate, nitrophosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.

UNIT V MISCELLANEOUS FERTILISERS 9Hrs

Mixed fertilizers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers,controlled release fertilizers.

Total No of Hours: 45Hrs

TEXT BOOKS:

1. *"Handbook of fertilizer technology", Association of India, New Delhi, 1977.*
2. *Menno, M.G.; "Fertilizer Industry - An Introductory Survey", HigginbothamsPvt. Ltd., 1973.*

REFERENCES:

1. *Sauchelli, V.; "The Chemistry and Technology of Fertilizers", ACSMONOGRAPH No. 148, Reinhold Publishing Cor. New York, 1980.*
2. *Fertiliser Manual, "UNITed Nations Industrial Development Organisation",UNITed Nations, New York, 1967.*
3. *Slack, A.V.; Chemistry and Technology of Fertilisers, Interscience, New York, 1966*

PRACTICAL EXERCISE

1. Prepare chart for fertilizer classification with chemical formula and nutrient content.
2. Estimate nutrient content (% N, %P2O, % K2O) in different fertilizers from their chemical formula.
3. Estimate percentage of Nitrogen in Ammonium chloride by back titration.
4. Estimate percentage of Nitrogen in DAP by Kjeldhal's method.
5. Prepare potassium sulphate and potassium chloride.

SUGGESTED STUDENT ACTIVITIES

1. Following is the list of proposed student activities. These could be individual or group-based.
2. Prepare course/topic based presentations using internet .
3. Make a report on fertilizer plants in India/Tamil Nadu with their capacity of production and technology being used.
4. Participate in MCQ/Quiz.

SPECIAL INSTRUCTIONAL STRATEGY (IF ANY)

1. Show video/animation films about fertilizer production plants.
2. Arrange Visit to nearby fertilizer production plant.
3. Arrange expert lectures.

Arrange MCQ/Quiz arrange in normal term period.

Subject Code:	Subject Name : Mechanical Operation Lab	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18L03	Prerequisite: ESS	Lb	0	0/0	3/0	1

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- In this course, the students will learn characterization of solids, size reduction, techniques of solid – fluid separation and mixing.

COURSE OUTCOMES (COs) : (3- 5)

CO1	The students would understand about solids, their characterization, handling and the various processes involving solids.
CO2	And do all calculation

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	-	-	-	H	-	-	-	H	-	-	L
CO2	M	-	M	-	H	-	-	-	H	-	-	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	M	-	-
CO2	H	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

–Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
							√					

BCT18L03	**MECHANICAL OPERATION LAB**	**0**	**0/0**	**3/0**	**1**

1. Jaw crusher
2. Crushing rolls
3. Ball mill
4. Size analysis by sieving
5. Size analysis by sub-sieving
6. Filter press
7. Leaf filter
8. Cyclone separator
9. Sedimentation
10. Elutriator
11. Rotary Drum filter
12. Effectiveness of screens

*** Minimum 10 experiments shall be offered**

SEMESTER II (THEORY)

Subject Code: BMA18025	Subject Name : Mathematics II for Civil and Chemical Engineers	Ty / Lb/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Mathematics I	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- The aim of this course is to introduce the concepts of Partial differential equations and, Transform methods for chemical students.

COURSE OUTCOMES (COs) : (3- 5)

CO1	To understand the basic concepts in analytic for complex integral.
CO2	To do all calculation

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	M	-	-	H	-	-	-	-	H	H
CO2	M	H	-	L	-	-	H	-	L	-	-	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	M	-	-
CO2	H	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
	√											

BMA18025	**MATHEMATICS II FOR CIVIL AND CHEMICAL ENGINEERS**	**3**	**1/0**	**0/0**	**4**

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12Hrs

Formation of PDE by eliminating arbitrary constants and eliminating arbitrary functions – Solutions of standard types of first order equations – Lagrange's equation – Linear partial differential equations of second and higher order with constant coefficients.

UNIT II APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12Hrs

Classification of second order linear partial differential equations – Solutions of one dimensional wave equation, one-dimensional heat equation – Steady state solution of two dimensional heat equation (Cartesian coordinates only) – Fourier series solutions.

UNIT III LAPLACE TRANSFORMS I 12Hrs

Transforms of simple functions – Properties of Transforms – Inverse Transforms – Transforms of Derivatives and Integrals.

UNIT IV LAPLACE TRANSFORMS II 12Hrs

Periodic functions – Initial and final value theorems – Convolution theorem – Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficients.

UNIT V FOURIER TRANSFORM 12Hrs

Statement of Fourier integral theorem – Fourier transform pairs – Fourier Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's theorem.

Total no. of Hours: 60Hrs

TEXT BOOKS:

1. Veerarajan T., Engineering Mathematics (for first year), Tata McGraw Hill Publishing Co., (2007).
2. Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw Hill Publishing Co., (2005).

REFERENCE*:*

1. Singaravelu, Transforms and Partial Differential Equations, Meenakshi Agency, (2009).
2. Kreyszig E., Advanced Engineering Mathematics (9 th ed.), John Wiley & Sons, (2011).
3. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, (2012).

Subject Code: BCS18I03	Subject Name : Computer Applications in Chemical Engineering	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Computer fundamentals	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To gain knowledge based on various programming languages applied for chemical technology.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Select appropriate computer applications to store and retrieve data.
CO2	Disseminate given information in basic and advanced PC applications..
CO3	Identify and apply digital/computer fundamentals.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	-	L	-	-	-	-	L	L	-
CO2	M	M	-	-	-	-	M	-	-	L	H	-
CO3	L	L	-	-	H	-	-	-	-	M	L	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	M	L	M	L				
CO2	M	L	M	L				
CO3	L	M	L	M				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCS18I03	**COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING**	**3**	**0/0**	**0/0**	**3**

UNIT I INTRODUCTION TO PROGRAMMING LANGUAGES 9Hrs

Evaluation of Programming Languages - C, C++ and Java, Review on Windows operating system. Application Program : introduction to Word, Power point

UNIT II INTRODUCTION TO C PROGRAMMING 9Hrs

Introduction to C Programming - data types - constants - Variables - Expressions – Operators – input and output functions – Control Statements – Looping statements. Functions -Definition –Types of Function, Arrays - types of Array- Files handling.

UNIT III SPREAD SHEETS 9Hrs

Creating – opening and saving files – working with worksheets – entering data – editing – formatting – printing – formulae –Charts - Application in Density, molecular weight, mole and percentage compositions, Empirical and Molecular formula calculations, Heat of mixing, Gas laws, Vapour pressure, Chemical Kinetics calculations.

UNIT IV SPREAD SHEETS (DATA ANALYSIS) 9Hrs

Application in data processing, Statistical analysis of data, Regression. Analysis of variance, Interpolation, Graphical representations of various Chemical Engineering.

UNIT V FORTRAN 9Hrs

Syntax – Mathematical and logical operation – Looping – Conditional statements – function – sub function – Simple application Programs.

Total No.of Hours: 45Hrs

TEXT BOOK

1. Ashok N.Kamthane ,Programming with ANSI and Turbo C , Pearson Education, 2006
2. E. Joseph Billo, "Excel® for Chemists- A Comprehensive Guide", John Wiley & Sons, 3rd Edition

REFERENCE BOOKS:

1. B.W. Kernighan and D.M.Ritchie, The C Programming Language, 2nd Edition, PHI, 1988

2. Kanetkar Y., Let us C, BPB Pub., New Delhi, 1999.
3. Jerry, O., Breneman, G.L. Spreadsheet Chemistry, Prentice Hall, Englewood Cliffs, 1991.

Subject Code : BES18001	Subject Name : BASIC ELECTRICAL & ELECTRONICS ENGINEERING	Ty/Lb/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite : ESC	Ty	2	0/1	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory / Lab / Embedded Theory and Lab

OBJECTIVES :

- Understand the concepts of circuit elements, circuit laws and coupled circuits.
- Acquire knowledge on conventional &non conventional energy production.
- Gain information on measurement of electrical parameters.
- Identify basic theoretical principles behind the working of modern electronic gadgets.
- Demonstrate digital electronic circuits and assemble simple devices.

COURSE OUTCOMES (Cos) : (3 – 5)
Students completing the course were able to

CO1	Students understand Fundamental laws and theorems and their practical applications
CO2	Predict the behavior of different electric and magnetic Circuits.
CO3	Identify conventional and Non-conventional Electrical power Generation, Transmission and Distribution.
CO4	Identify & Apply schematic symbols and understand the working principles of electronic devices
CO5	Analyze basics of digital electronics and solving problems and design combinational circuits

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H							M	L
CO2	H	H	H	M	M		M				M	
CO3	H	M	H	M	H		M		M			L
CO4	H	M		M			M				M	L
CO5	H	M	H	M	H				M		M	L

H/M/L indicates strength of correlation H – High, M – Medium, L – Low

Category	Basic Sciences	Engg Sciences	Humanities & Social Sciences	Program core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skills	Soft Skills
		√							

BES18001	BASIC ELECTRICAL & ELECTRONICS ENGINEERING	2	0/1	0/0	3

UNIT I ELECTRIC CIRCUITS 9Hrs

Electrical Quantities – Ohms Law – Kirchhoff's Law – Series and Parallel Connections – Current Division and Voltage Division Rule - Source Transformation – Wye (Y) – Delta (Δ) , Delta (Δ) – Wye (Y) Transformation – Rectangular to Polar and Polar to Rectangular.

UNIT II MACHINES & MEASURING INSTRUMENTS 9Hrs

Construction & Principle of Operation of DC motor & DC Generator – EMF equation of Generator – Torque Equation of Motor – Construction & Principle of operation of a Transformer – PMMC – Moving Iron types of meter – Single Phase Induction Type Energy Meter.

UNIT III BASICS OF POWER SYSTEM 9Hrs

Generation of Electric Power (Thermal, Hydro, Wind and Solar) – Transmission & Distribution of Electric Power – Types of Transmission & Distribution Schemes – Representation of Substation.

UNIT IV ELECTRON DEVICES 9Hrs

Passive Circuit Components-Classification of Semiconductor-PN Junction Diode-Zener diode- Construction and Working Principle –Applications--BJT-Types of configuration-JFET.

UNIT V DIGITAL SYSTEM 9Hrs

Number System – Binary, Decimal, Octal, Hexadecimal – Binary Addition Subtraction, Multiplication & Division– Boolean Algebra – Reduction of Boolean Expressions – Logic Gates - De-Morgan's Theorem , Adder – Subractor.

Total no of Periods : 45Hrs

TEXT BOOKS

1. *D P Kothari, I J Nagrath, Basic Electrical Engineering, Second Edition, , Tata McGraw-Hill Publisher*
2. *A Course In Electrical And Electronic Measurements And Instrumentation,A.K. Sawhney, publisher DHANPAT RAI&CO*
3. *Text Book of Electrical Technology: Volume 3: Transmission, Distribution and Utilization,B.L.Theraja, A.K.Theraja, publisher S.CHAND*
4. *Morris Mano, M. (2002) Digital Logic and Computer Design. Prentice Hall of India*
5. *Millman and Halkias1991, Electronic Devices and Circuits , Tata McGraw Hill,*

REFERENCES

1. *R.Muthusubramanian, S.Salivahanan, K A Muraleedharan, Basic Electrical, Electronics And Computer Engineering, Second Edition, ,Tata McGraw-Hill publisher.*

SEMESTER II (PRACTICAL)

Subject Code:	Subject Name : Petroleum Technology	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18ET3	Prerequisite: PCC	ETL	1	0/1	3/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To make the students understand petroleum engineering principles, their application to petroleum and natural gas manufacturing problems.

COURSE OUTCOMES (COs) : (3- 5)

CO1	At the end of this practical course, the student would have a thorough understanding of skills in Petroleums.
CO2	And do all calculations.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	L	-	-	H	-	-	L	-	-	M
CO2	M	-	H	-	M	-	-	-	M	-	-	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	-
CO2	M	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
							√					

BCT18ET3	PETROLEUM TECHNOLOGY	1	0/1	3/0	3

UNIT I INTRODUCTION 9Hrs

Refinery products – Refinery Feeds – Crude distillation – Coking and thermal process.

UNIT II CATALYTIC CRACKING 9Hrs

Catalytic Cracking - Catalytical hydro cracking – Hydro processing and Reused processing hydro treating.

UNIT III CATALYTICAL 9Hrs

Reforming and isomerization alkylation and polymerization – Product blending –Supporting processes.

UNIT IV LUBRICIATING 9Hrs

Lubriciating oil blending stocks petrochemical feed stocks.

UNIT V COST EVALUATION 9Hrs

Cost Evaluation – Economic evaluation of petroleum reused and refineries.

Total No. of Hours: 45Hrs

TEXT BOOKS:

1. Petroleum Refining: Technology and economics CRC Press V Edition 2007J.CH Garry, Hardward G.E and M.J.Kaiser.

REFERENCES*:*

1. Modern Petroleum Technology Upstream Vol I A.G. Lucas Hurley Edition, 2002

PRACTICAL EXERCISE

Classification of fuels: G/L/S
Automotive Fuels Bharat Standards II III & IV

SUGGESTED STUDENT ACTIVITIES

Solid Fuels: Characterization
- Coal
- Biomass
- Residue from Refinery
- Plastic waste
- Municipal domestic waste

Combustion of Fuels :
- Basic equation, air requirement norms for excess air.
- Heating value : GHV/LHV Calculations for mixture of components.
- Wobbe number for Gaseous Fuels definition and significance.
- Burners : Gas/Liquid/Hydrogen.
- Flue gas composition, Dew point calculations.
- Treatment of flue gas to meet local standards, Carbon Credit.

Subject Code:	Subject Name : Chemical Technology	Ty / Lb/ ETL	L	T / S.Lr	P/ R	C
BCT18005	Prerequisite: Basic science	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To introduce history, importance and components of chemical engineering, concepts of unit operations and unit processes. Currents scenario of chemical & allied process industries.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Student will be able to explain the basic history, current issues, and trends in process industries. This shall give them first hand information about the environment in industries and prepare them well for industries
CO2	The students are informed about some basic industries with the help of process diagrams, material of construction used, chemical and physical processes involved including the equipments used, their safety precautions in design and operation.
CO3	This shall give them first hand information about the environment in industries and prepare them well for industries.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	-	M	-	-	-	-	M	-	L	-
CO2	H	M	-	-	-	-	-	-	H	-	-	-
CO3	L	H	-	-	-	L	-	-	H	-	-	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4			
CO1	H	L	L	M			
CO2	M	L	H	H			
CO3	L	H	M	L			

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18005	**CHEMICAL TECHNOLOGY**	**3**	**0/0**	**0/0**	**3**

UNIT I INTRODUCTION 9Hrs

Chemical processing, the role of chemical engineers in process industries, importance of block diagrams and flow charts, UNIT operations, UNIT processes, process utilities sand economics, industrial safety and pollution, outline plant and equipment design, process control and instrumentation.

UNIT II FERTILIZER CHEMICALS 9Hrs

Growth elements, Function, Nitrogenous fertilizers, Ammonium sulfate, Ammonium Nitrate and Urea, Phosphatic fertilizers, single and triple superphosphate, Ammonium phosphate, Nitro phosphate, Potassium Fertilizers, Potassium Chloride, Potassium Nitrate and phosphate, Compound fertilizers and bio-fertilizers. PHOSPHORUS INDUSTRIES: Phosphate rock, benefaction, phosphoric acid-phosphate. NITROGEN INDUSTRIES: Synthesis ammonia and nitric acid. AGRICHEMICAL INDUSTRIES: Insecticides, pesticides, herbicides, plant nutrients and regulators

UNIT III INDUSTRIAL CHEMICALS - I 9Hrs

EXPLOSIVES AND PROPELLANTS INDUSTRIES: Explosives, types and characteristics, industrial and military explosives, propellants for rockets. SURFACE COATING INDUSTRIES: Paints, pigments, varnishes, lacquers, industria, and marine coatings. PHOTOGRAPHIC CHEMICALS: Photographic chemicals, manufacture of films, plates and papers, recovery. INDUSTRIAL GASES: Synthetic gas, natural gas, carbon dioxide sulphur-di-oxide, acetylene, helium and argon, hydrogen, oxygen, nitrogen.

UNIT IV INDUSTRIAL CHEMICALS - II 9Hrs

CHOLORO - ALKALI INDUSTRIES: Soda ash and sodium bicarbonate, Chlorine and caustic soda; bleaching powder and related bleaching agents, hydrochloric acid.SULPHUR AND SULPHURIC ACID INDUSTRIES: Mining and manufacturing of Sulphur, recovery of sulphur from polluting gases, sulphur trioxide and sulphuric acid.ELECTROLYTIC AND ELECTROTHERMAL INDUSTRIES: Abrasives, Carborondum, Calcium Carbide, Aluminium and Magnesium.

UNIT V INDUSTRIAL CHEMICALS - III 9Hrs

WATER IN INDUSTRY: Role of water treatment methods for industrial and domestic use, recovery of waste water, water conditioning.MARINE CHEMICALS: Sodium chloride, By-products of common salt industry, value added product.NUCLEAR INDUSTRIES: Production of uranium, thorium and zirconium from ores and minerals, separation of isotopes, waste disposal.

Total No of Hours: 45Hrs

TEXT BOOKS

1. *Austin, G.T. Shreve, " Chemical Process Industries ", Fifth Edition,McGraw Hill International Book Co., Singapore, 1984.*
2. *Dryden, C.E., " Outlines of Chemicals Technology ", Edited andRevised by Gopala Rao, M. and Sitting, M., Second Edition,Affiliated East-West Press, 1993.*

SEMESTER III (THEORY)

Subject Code:	Subject Name : Bio-Chemical Principles	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BBT18I01	Prerequisite: Engineering mathematics, physics, stoichiometric concepts, chemistry	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To understand the theory and applications of classical thermodynamics, thermodynamic properties, equations of state, methods used to describe and predict phase equilibria.
- To provide knowledge of thermodynamic properties of real fluids and mixtures to design chemical process plants.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Basic concept for thermodynamics and first law can be understood.
CO2	PVT behavior of fluids and ideal gas processes can be analysed.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	M	-	-	H	-	-	-	-	L
CO2	M	-	-	-	-	-	L	-	-	M	-	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	H	-	-
CO2	M	H	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BBT18I01	**BIO-CHEMICAL PRINCIPLES**	**3**	**0/0**	**0/0**	**3**

UNIT I OVERVIEW OF FERMENTATION PROCESSES 9Hrs

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes.

UNIT II RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS 9Hrs

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods

UNIT III STERILIZATION KINETICS 9Hrs

Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of sterilization equipment - batch and continuous.

UNIT IV METABOLIC STOICHIOMETRY AND ENERGETICS 9Hrs

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

UNIT V KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 9Hrs

Modes of operation - batch, fed batch and continuous cultivation. Simple unstructured kinetic models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics - leudeking-piret models, substrate and product inhibition on cell growth and product formation.

Total No. of Hrs: 45Hrs

TEXT BOOKS:

1. *Bailey and Ollis, " Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.), 1986.*
2. *Shule and Kargi, " Bioprocess Engineering ", Prentice Hall, 1992.*

REFERENCES:

1. *Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications.*
2. *Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.*
3. *Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc*

Subject Code:	Subject Name : Chemical Process Calculations	Ty / Lb/ETL	L	T / S.Lr	P/ R	C
BCT18008	Prerequisite: General Chemistry & basic chemical reactions	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- This course brings together the concepts of engineering and economics for chemical plant design and optimization and also composition of mixtures.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Units and dimensions.
CO2	Material balance and Energy balance calculation for all chemical processes.
CO3	Calculation for batch and continuous processes applied to solution of problems in chemical process industries.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO 4	PO5	PO 6	PO7	PO8	PO9	PO10	PO1 1	PO12
CO1	H	M	L	-	-	-	L	-	-	-	-	L
CO2	M	H	L	-	-	-	M	-	-	-	-	-
CO3	M	H	L	-	-	-	L	-	-	-	-	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4			
CO1	H	H	H	M			
CO2	M	H	L	M			
CO3	H	L	M	M			

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18008	CHEMICAL PROCESS CALCULATIONS	3	1/0	0/0	4

UNIT I UNITS, DIMENSIONS AND GAS CALCULATIONS 12Hrs

Basic and derived UNITs, use of model UNITs in calcualtions, Methods of expression, compositions of mixture and solutions. Ideal and real gas laws - Gas constant - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT II MATERIAL BALANCE 12Hrs

Stoichiometric principles, Application of material balance to UNIT operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

UNIT III HUMIDITY AND SATURATION 12Hrs

Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

UNIT IV FUELS AND COMBUSTION 12Hrs

Determination of Composition by orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur bearing compounds.

UNIT V THERMO PHYSICS AND THERMOCHEMISTRY 12Hrs

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy. Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems with and without chemical reaction. - unsteady state energy balances.

Total No of Hours: 60Hrs

TEXT BOOKS:

1. *Bhatt, B.L., Vora, S.M., " Stoichiometry ", Tata McGraw-Hill, 1976.*
2. *Himmelblau, D.M., " Basic Principles and Calculations in Chemical Engineering ",EEE Sixth Edition, Prentice Hall Inc., 2003 (with CD containing programmes and problems).*

REFERENCES*:*

1. *Process Calculation for Chemical Engineering, Second Revised Edition, Chemical Engineering Education Developement Centre, I.I.T., Madras, 1981*
2. *Process Calculations, Venkataramani, V and Anantharaman, N, Prentice Hall of India Pvt. Ltd. 2007*

Subject Code:	Subject Name : Fluid Mechanics	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18006	Prerequisite: maths & science	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To understand basic concept of fluid flow and its application to chemical process industries including pipe flow, fluid machinery and agitation & mixing.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Ability to understand the fluid particle system and fluid properties.
CO2	Study analytical solutions to variety of simplified problems.
CO3	Apply concept of mass, momentum and energy conservation to flows.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	-	-	-	M	-	-	-	L	L
CO2	M	L	-	H	-	L	-	-	-	-	H	M
CO3	H	M	-	-	-	-	H	-	-	-	H	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	H	M	L	H				
CO2	M	L	M	L				
CO3	M	L	L	H				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18006	**FLUID MECHANICS**	**3**	**0/0**	**0/0**	**3**

UNIT I INTRODUCTION **9Hrs**

Concept of fluid - the fluid as a continuum - properties of a fluid –density -viscosity –surface tension – heat capacity – vapour pressure.

UNIT II FLUID STATICS **9Hrs**

Application to manometry – Floatation – gravity settling – centrifugal separation – acceleration.

UNIT III FLOW OF FLUIDS **9Hrs**

Bernoullis theorem and application – laminar flow – turbulent flow – pressure drop – Newtonian and non-newtonian flow.

UNIT IV COMPRESSIBLE FLUID FLOW **9Hrs**

Mach no – nozzle flow – flow of fluid through packed bed – fluidization.

UNIT V INDUSTRIAL PIPING **9Hrs**

Valves – fluid moving machinery – pumps – characteristics of centrifugal pump – other types of pumps – compressors – work – blowers of pumps

Total No of periods: 45Hrs

TEXT BOOKS:

1. *Noel de Nevers, " Fluid Mechanics for Chemical Engineers ", Second Edition, McGraw-Hill, 1991.*
2. *McCabe,W.L, Smith J.C and Harriot .P.," UNIT Operations in Chemical Engineering ", McGraw-Hill, Sixth Edition 2000.*

REFERENCES:

1. *Chemical engineering hand book by Perry.*
2. *White, F.M., " Fluid Mechanics ", 4th Edition, McGraw-Hill Inc., 1999.*

SEMESTER III (PRACTICAL)

Subject Code:	Subject Name : Chemical Process Equipment Design & Drawing Lab	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18ET4	Prerequisite: Chemical Process Equipment Design	ETL	1	0/1	3/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: To study the design principles of various chemical process equipments and to draw them with appropriate dimensions.

COURSE OUTCOMES (COs) : (3- 5)

CO1	At the end of this practical course, the student is capable of performing the design calculation of various chemical process equipments.
CO2	To do all calculations.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	-	-	-	-	L	-	-	H	-	-	H
CO2	M	-	H	-	-	-	H	-	-	L	-	H

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	M	M	-	-				
CO2	H	L	-	-				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
							√					

BCT18ET4	**CHEMICAL PROCESS EQUIPMENT DESIGN & DRAWING LAB**	**1**	**0/1**	**3/0**	**3**

UNIT – I **9Hrs**

Design of storage vessels for non-volatile and volatile fluids – design of pressure vessels – design of vessel supports.

UNIT – II **9Hrs**

Design of Heat Exchangers – Double pipe – shell & tube – finned tube – plate heat exchangers – design of evaporators – single & multi effect.

UNIT – III **9Hrs**

Design of mass transfer operation equipment – Absorber – Distillation column – Plate and packed columns.

UNIT – IV **9Hrs**

Design of Dryers – Rotary – Spray dryers – cooling towers

UNIT – V **9Hrs**

Design of Agitated vessels – filters – cyclones

Total No of periods: 45Hrs

(All Tables/Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.)

1. Fundamental principles, equations, general design and drawing considerations of cooling towers, evaporators and driers.
2. Heat exchangers, condensers and reboilers.
3. Distillation columns- sieve tray, and bubble cap tray columns and packed column.
4. Equipments for absorption and adsorption of gases.
5. Equipments for liquid-liquid extraction and solid-liquid extraction.

SEMESTER IV (THEORY)

Subject Code: BCT18003	Subject Name : Chemical Engineering Thermodynamics	Ty/Lb/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Engineering mathematics, physics, stoichiometric concepts, chemistry	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To understand the theory and applications of classical thermodynamics, thermodynamic properties, equations of state, methods used to describe and predict phase equilibria.
- To provide knowledge of thermodynamic properties of real fluids and mixtures to design chemical process plants.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Basic concept for thermodynamics and first law can be understood.
CO2	PVT behavior of fluids and ideal gas processes can be analysed.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	M	-	-	H	-	-	-	-	L
CO2	M	-	-	-	-	-	L	-	-	M	-	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	H	-	-
CO2	M	H	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18003	CHEMICAL ENGINEERING THERMODYNAMICS	3	0/0	0/0	3

UNIT I INTRODUCTION 7Hrs

Systems – surroundings – heat, work ,energy; first ,second and third law of thermodynamics, applications-heat engines, refrigeration, liquefaction .

UNIT II PURE FLUIDS 9Hrs

Fluids-state equations-ideal gas-actual gas-fugacity coefficient-activity-residual properties-exact differentials-fundamental energy property relation-maxwell's equation-heat capacity relation-entropy relationship-gibbs- helmholtz equations.

UNIT III SOLUTION THERMODYNAMICS 11Hrs

Partial molar properties-properties of solutions-determination of pmp-chemical potential- fugacity/ fugacity coefficient of solutions-lewis-randasl rule-ideal/real solutions- raoult's and henry's law- activity/activity coefficient of solutions-gibbsduhem equation-property change of mixing-excess properties.

UNIT IV PHASE EQUILIBRIA 11Hrs

Criteria for phase equilibrium-stability criteria-phase equilibria in single component system, multicomponent system-phase rule for non reacting systems-v.l.e at high pressure-non ideal solution v.l.e margules/vandar equations-consistency tests for v.l.e data.

UNIT V CHEMICAL REACTION EQUILIBRIA 7Hrs

Definition-stoichiometric number-extent of reaction-criteria for reaction equilibria-equilibrium constant-relations-effects of temp and pressure-other factors influencing reaction equilibria-phase rule for reacting system.

Total No.of Hours: 45Hrs

TEXT BOOKS:

1. *Smith, J.M., and Van Ness, H.C., "Introduction to Chemical Engineering Thermodynamics", Kogakushai 1976.*
2. *Narayanan K.V" A text book of chemical engineering thermodynamics" Prentice Hall of India pvt. Ltd 2001.*
3. *Kyle, B.G., "Chemical and Process Thermodynamics 2nd edn. "Prentice Hall of India Pvt.Ltd., 1990.*

REFERENCES:

1. *Hougen, O.A., Watson, K.M., and Ragatz, R.A., " Chemical Process Principles Part II, Thermodynamics ", John Wiley 1970.*
2. *Dodge, B.F., "Chemical Engineering Thermodynamics ", McGraw-Hill, 1960.*
3. *Sandler, S.I.,"Chemical and Engineering Thermodynamics 2nd edn.", Wiley, 1989.*
4. *Kyle, B.G., "Chemical and Process Thermodynamics 2nd edn.", Prentice Hall of India Pvt.Ltd., 1990.*

Subject Code:	Subject Name : Mass Transfer-I	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18013	Prerequisite: Engineering mathematics, physics, stoichiometric concepts, chemistry	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- The purpose of this course istointroduce the undergraduate students with them Ostimportant separation equipments in the process industry.

COURSE OUTCOMES (COs) : (3- 5)

CO1	To provide proper understanding of UNIT operations..
CO2	

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	M	-	L	H	-	-	-	-	L
CO2	M	-	M	-	-	-	L	-	M	M	-	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	H	-	-
CO2	M	H	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18013	MASS TRANSFER-I	3	1/0	0/0	4

UNIT I DIFFUSION 12Hrs

Molecular and eddy diffusion in gases and liquids, steady state diffusion under stagnant and laminar flow onditions Diffusivity measurement and prediction, multicomponent diffusion, diffusion in solids and its applications.

UNIT II MASS TRANSFER COEFFICIENTS 12Hrs

Concept of mass transfer coefficients, mass transfer under laminar and turbulent flow past solids, boundary layers, mass transfer at fluids surfaces correlation of mass transfer coefficients, JD,HTU,and NTU concepts, theories of mass transfer and their applications, interphase mass transfer and over all mass transfer coefficients in binary and multicomponent systems, application to gas-liquid and liquid-liquid systems.

UNIT III HUMIDIFICATION AND AIR CONDITIONING 12Hrs

Basic concepts, psychrometric chart construction, Humidification and dehumidification operations, design calculations, cooling tower principle and operation, types of equipment, design calculation.

UNIT IV DRYING 12Hrs

Theory and mechanism of drying, drying characteristics of materials, batch and continuous drying, calculation for continuous drying, drying equipment, design and performance of various drying equipments.

UNIT V CRYSTALLISATION 12Hrs

Nuclei formation and crystal growth, theory of crystallisation, growth coefficients and the factors affecting these in crystallisation, batch and continuous industrial crystallisers, principle of design of equipment.

Total No of periods: 60Hrs

TEXT BOOKS

1. Treybal, R.E., " Mass Transfer Operations ", McGraw-Hill Kogakusha, 1980.
2. McCabe, W.L., Smith, J.C., and Harriot, P., "UNIT Operations in Chemical Engineering ", McGrawHill Edn, 1993.

REFERENCES

1. Roman Zarzytci, AndrzaiChacuk, " Absorption: Fundamentals and Application ", Pergamon Press, 1993.
2. skelland, A.H.P., " Diffusional Mass Transfer ", Krieger, Malabar FL (1985).Strigle (jr), R.F., " Packed Tower Design and Applications ", Second Edition, Gulf Publishing Company, USA., 1994.
3. Coulson, J.M., Richardson, J.F., "Chemical Engineering" Vol. I, Pergamon Press, 1977.
4. Foust, A.S.Wenzel, L.A., Clump, C.W.,Naus, L., and Anderson, L.B., "Principles of UNIT Operations",Second Edition, Wiley, 1980.

Subject Code:	Subject Name : Heat Transfer	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18009	Prerequisite: Basic maths & material energy balance	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries.

COURSE OUTCOMES (COs) : (3- 5)

CO1	To impart knowledge on heat conduction, convection and radiation phenomena.
CO2	To impart knowledge on application of heat transfer principles in heat exchanger design.
CO3	To impart knowledge on the principles of evaporation and evaporator design.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	-	-	H	-	-	-	-	-	M	M
CO2	L	M	-	-	-	-	M	-	-	-	H	M
CO3	M	H	-	-	L	-	-	-	-	-	H	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	L	H
CO2	L	M	H	M
CO3	H	M	L	H

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18009	HEAT TRANSFER	3	1/0	0/0	4

UNIT I BASIC PRINCIPLES AND CONDUCTION 12Hrs

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Mean temperature difference. Concept of heat conduction - Fourier's law of heat conduction - one dimensional steady state heat conduction equation for flat plate, hollow cylinder, hollow sphere - Heat conduction through a series of resistances - Analogy between flow of heat and flow of electricity - Thermal conductivity measurement; effect of temperature on thermal conductivity; conduction through liquids.

UNIT II FILM COEFFICIENTS AND THEIR APPLICATION 12Hrs

Individual and overall heat transfer coefficients and the relationship between them - Conduction with heat source - Two dimensional steady state conduction - Analytical and graphical methods - Transient heat conduction.

UNIT III CONVECTION 12Hrs

Concept of heat transfer by convection - Natural and forced convection - Application of dimensional analysis for convection - Equations for forced convection under laminar, transition and turbulent conditions - Equations for natural convection - Heat transfer from condensing vapours, heat transfer to boiling liquids - Influence of boundary layer on heat transfer - Heat transfer to molten metals - Heat transfer in packed and fluidised beds.

UNIT IV HEAT EXCHANGERS 12Hrs

Parallel and counter flow heat exchangers - Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer UNIT - Chart for different configurations - Fouling factors and wilson's plot - Design of various types of heat exchangers - Design of furnaces - Design of condensers, - Design of tubular reactors.

UNIT V RADIATION AND EVAPORATION 12Hrs

Concept of thermal radiations - Black body concept - Stefan Boltsman's law -concept of grey body – radiation between surfaces. Types of evaporation - single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation.

Total No of Hours: 60Hrs

TEXT BOOKS:

1. *McCabe, W.L., Smith, J.C., and Harriot, P., "UNIT Operations in Chemical Engineering ", McGraw-Hill Recent Edn.*
2. *BinayK.Dutta "Heat Transfer Principles and Applications", Prentice Hall of India, 2001.*
3. *Kern, D.Q., " Process Heat Transfer ", McGraw-Hill - Revised adition.*

REFERENCES*:*

Coulson, J.M., Richardson, J.F., "Chemical Engineering ", Vol.I.,Pergamon and ECBPRACTICAL

SEMESTER IV (PRACTICAL)

Subject Code:	Subject Name : Heat Transfer Lab	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18L08	Prerequisite: Heat Transfer	Lb	0	0/0	3/0	1

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To enable the students to learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger.

COURSE OUTCOMES (COs) : (3- 5)

CO1	At the end of this course, the students would have knowledge in various heat transfer methodology in process engineering and to design heat transfer equipments such as furnace, boilers, heat exchangers evaporation.
CO2	To do all calculations.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	H	-	-	L	-	-	H	M	L
CO2	M	-	H	H	-	-	H	-	H	-	-	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	-
CO2	M	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
							√					

BCT18L08	**HEAT TRANSFER LAB**	**0**	**0/0**	**3/0**	**1**

1. Thermal Conductivity measurement
2. Emissivity mesurement
3. Stefan-Boltzmann Constant verification
4. Thermocouple calibration
5. Natural Convection
6. Forced Convection
7. Parallel Flow Double Pipe Heat Exchanger
8. Counter Flow Double Pipe Heat Exchanger

SEMESTER V (THEORY)

Subject Code:	Subject Name : Mass Transfer II	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18014	Prerequisite: Basic mathematics & energy & material balance	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To teach the students different separation techniques and also to know the design of a distillation column.
- To understand the calculations involved In liquid-liquid extraction and solid liquid extraction.

COURSE OUTCOMES (COs) : (3- 5)

CO1	To study diffusion phenomenon in various mass transfer theories.
CO2	To study Humidification operation, drying operation and adsorption.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	-	-	H		-	-	H	L	M	-	-
CO2	H	-	-	-	-	-	-	M	L	L	-	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	L	H
CO2	H	L	H	H

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18014	**MASS TRANSFER II**	**3**	**1/0**	**0/0**	**4**

UNIT I ABSORPTION 12Hrs

Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stagewise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; multicomponent absorption; mechanism and model of absorption with chemical reaction; thermal effects in absorption process.

UNIT II DISTILLATION 12Hrs

Vapour-liquid equilibria, Raoult's law and deviations from ideality, methods of distillation; fractionation of binary and multicomponent system; design calculations by McCabe-Thiele and ponchon-Savarit, methods; continuous contact distillation tower (packed tower) design; extractive and azeotropic; distillation low pressure distillation; steam distillation.

UNIT III LIQUID-LIQUID EXTRACTION 12Hrs

Equilibrium in ternary systems; equilibrium stagewise contact calculations for batch and continuous extractors, differential contact extraction equipment - spray, packed and mechanically agitated contactors and their design calculations; pulsed extractors, centrifugal extractors.

UNIT IV SOLID-LIQUID EXTRACTION (LEACHING) 12Hrs

Solid-liquid equilibria; leaching equipment-batch and continuous types; calculation of number of stages.

UNIT V ADSORPTION, ION EXCHANGEAND MISCELLANEOUS SEPARATION PROCESSES 12Hrs

Theories of adsorption of gases and liquids; industrial adsorbents, adsorption equipment for batch and continuous operation; design calculation of ion-exchange resins; principle of ion-exchnage; industrial equipment. Membrane separation process; solid and liquid membranes; concept of osmosis; reverse osmosis; electrodialysis; their applications; foam separation process; Thermal and sweep diffusion process.

Total No. of Hrs: 60Hrs

TEXT BOOKS

1.R.E.Treybal, " Mass Transfer Operations ", McGraw-Hill, Kogakusha, 1980.

2.W.L McCabe J.C.Smith, and Harriot. P., " UNIT Operations of Chemical Engineering ", sixth edition McGraw-Hill. International Edition, 2001.

REFERENCES

1, C.Judson King " Separation Processes ", Tata McGraw-Hill 1974.

2. A.H.P.Skelland, " Diffusional Mass Transfer ", Krieger, Malapur, FL (1985).

3. Roman Zarfyki and Andrzej Chacuk, " Absorption Fundamentals and Applications", Pergamon Press, 1993.

4. P.Wankat" Equilibrium Stage Separations ", Prentice Hall, 1993.

5. R.F.Strigle (jr), Packed Tower Design and Application, 2nd Edn Gulf Publishing company U.S.A. 1994.

Subject Code:	Subject Name : Chemical Reaction Engineering	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18010	Prerequisite: Basic maths, chemistry & material energy balance	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To apply knowledge from calculus differential equations, thermodynamics and material and energy balances to solve reactor design problems and simulate several types of reactor in process industries.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Develop rate loss for homogeneous reactions
CO2	Design of ideal reactors for single and complex reactions
CO3	Develop rate loss for heterogeneous reactions

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	-	-	-	L	L	-	-	-	L
CO2	L	H	-	H	-	-	M	H	-	-	-	-
CO3	H	M	-	-	-	-	L	L	-	-	-	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	H	L	M
CO2	H	M	L	H
CO3	L	M	H	H

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18010	**CHEMICAL REACTION ENGINEERING**	**3**	**1/0**	**0/0**	**4**

UNIT I REACTION KINETICS 12Hrs

Law of Mass Action, Rate Equation, Elementary, Non-Elementary Reactions-Their Mechanism, Theories Of Reaction Rate And Temp Dependency, Analysis Of Experimental Data-Evaluation Of Rate Equation Integral And Differential Analysis For Constant/Variable Volume Systems.

UNIT II HOMOGENEOUS REACTIONS 12Hrs

Batch, Stirred Tank Reactor Design, Choice Of Reactors, Optimum Yield And Conversion, Isothermal, Non Isothermal Reaction, Adiabatic Reactors, Rates Of Heat Exchange, Criteria For Stability Of Reactors, Equilibrium Constant-Evaluation, Effect Of Temperature

UNIT III HETEROGENEOUS REACTIONS-(NON CATALYTIC). 12Hrs

Rate Equations, Analysis Of Rate Equation, Rate Controlling Steps, Models For Explaining Kinetics, Volume And Surface Models, Controlling Resistances &Rate Controlling Steps; Time For Complete Conversion In Static And Fluidized Bed Reactors, Absorptions With Chemical Reactions, Mass Transfer Co Efficient& Kinetic Constants, Hatta Number, Enhancement Factor For First Order Reaction

UNIT IV HETEROGENEOUS REACTIONS- CATALYTIC REACTIONS 12Hrs

Adsorption Isotherms, Rates Of Adsorption/Desorption, Surface Reaction, Rate Controlling Steps Surface Area And Pore Volume Distribution-Diffusion Within Catalyst Particles, Mass And Heat Transfer Within Catalyst Particles, Effectiveness Factors-Internal & Overall; Thiele Modulus

UNIT V NON IDEAL REACTORS 12Hrs

Definition, Cause For Deviation From Identity, Concept Of Residence Time Distribution RTD E-Curve, F-Curve, Their Inter Relationship, Basic Model Tanks In Series Model, Conversion Relationships In Non-Ideal Reactors.

Total No of Hours: 60Hrs

TEXT BOOKS

1. Levenspiel.O, " Chemical Reaction Engineering ", John Wiley, Second Edition, 1972.
2. Fogler. H.S., "Elements Of Chemical Reaction Engineering" 3rd Edition, Prentice Hall Of India Pvt. Ltd., 1999 (Indians Reprint 2003)

REFERENCES

1. Smith.J.M., " Chemical Engineering Kinetics ", Mcgraw-Hill Third Edition, 1981.
2. Levenspiel , O; " Chemical Reaction Engineering ", 2nd Edition, John Wiley, 1972.

Subject Code:	Subject Name: Industrial Instrumentation	Ty / Lb/ ETL	L	T / SLr	P/ R	C
BCT18E12	Prerequisite: Basic electrical and electronics	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field.
CO2	Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	L	-	-	-	L	-	H	-	-
CO2	M	-	-	L	-	-	M	-	-	-	-	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	-
CO2	M	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E12	INDUSTRIAL INSTUMENTATION	3	0/0	0/0	3

UNIT I **5Hrs**

Introduction – Variables, UNITs & standards of measurement, Measurement terms – characteristic. Data analysis.

UNIT II **10Hrs**

Process Variables Measurement–Temperature systems– Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters, Vacuum measurement, Resonant wire pressure Transducer, Flow system –Differential producers, Variable area flow meters, Velocity, vortex, mass, ultrasonic & other flow meters, positive displacement flow meters, Open –channel flow measurements, Force systems, Strain gauges Humidity Moisture system, Humidity Measurement, Moisture measurement system, Rheological system, Viscosity measurement, Radiation system, Nuclear radiation instrumentation.

UNIT III **12Hrs**

Analytical instrumentation – Analysis instruments, Sample conditioning forprocess analyzers, X-ray Analytical methods, Quadrupole mass spectrometry,Ultra violet Absorption Analysis, Infra red process analyzers, Photometricreaction product analysers Oxygen analyzers, Oxidation – reduction potential lmeasurements, pH measuring systems, Electrical conductivity and Resistivitymeasurements, Thermal conductivity, gas analysis, Combustible, Total hydrocarbon, and CO analyzer, Chromatography.

UNIT IV **9Hrs**

Fundamentals of Automatic process control – Control algorithms-Automaticcontrollers – Electronic controllers - Electric controllers (Traditional) – Hydrauliccontrollers – Fluidics - Programmable controllers.

UNIT V **9Hrs**

Sensors, Transmitters and control valves - Pressure, Flow, Level, Temperatureand Composition sensors, Transmitters, Pneumatic and electronic controlvalves, Types, Actuator, accessories, Instrumentation symbols and Labels.

TOTAL No. of Hrs: 45Hrs

TEXTBOOKS:

1. *Fribance, "Industrial Instrumentation Fundamentals" ,Mc Graw Hill Co. Inc.New York 1985*
2. *Eckman D.P. "Industrial Instrumentation", Wiley Eastern Ltd., 1989.*
3. *Considine D M and Considine G D "Process Instruments Controls"Handbook 3rd Edition, McGraw – Hill Book Co., NY, 1990.*
4. *Scborg D E,.Edgar T.F and Mellichamp D.A, "Process Dynamics andControl" John Wiley 1989.*

REFERENCES:

1. *Ernest Doebelin, Measurement systems, McGraw – Hill Book, Co., NY,1975.*
2. *Astrom K.J., Bjonwittenmark, Computer controlled systems, Prentice- Hallof India, New Delhi 1994.*
3. *Cartis Johnson, Process Control Instrumentation Technology, Prentice-Hallof India, New Delhi 1993.*

SEMESTER V (PRACTICAL)

Subject Code: BCT18L11	Subject Name : Chemical Reaction Engineering Lab	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Chemical Reaction Engineering	Lb	0	0/0	3/0	1

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To impart knowledge on design of reactors.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Students would get a sound working knowledge on different types of reactors.
CO2	To do all calculations.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	-	L	-	-	-	M	-	-	H
CO2	M	H	-	H	-	-	H	-	H	-	M	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	M	-	-
CO2	H	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
							√					

BCT18L11	CHEMICAL REACTION ENGINEERING LAB	0	0/0	3/0	1

1. Kinetic studies in a batch reactor
2. Kinetics in a plug flow reactor
3. Kinetics in a PFR followed by a CSTR
4. RTD in a PFR
5. RTD in a packed bed
6. RTD in CSTRs in series
7. Combined Reactor
8. Packed Bed Reactor
9. Adiabatic Reactor
10. Catalytic Reactor
11. Kinetics in Semi-batch Reactor

***Minimum 10 experiments shall be offered.**

SEMESTER VI (THEORY)

Subject Code: BCT18004	Subject Name : Process Control And Dynamics	Ty/Lb/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Engineering Chemistry I & II, Engineering Mathematics III & IV	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To gain the knowledge of process instruments & understand dynamic modeling of a physical process using first principles.
- To design various control schemes and to apply the control system in various processes.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Develop fundamental and empirical models for dynamic processes & Implement dynamic models with or without controllers.
CO2	Analyses PID controllers and more advanced controllers to achieve desired performance & Understand various controller designs, and methods of controller tuning.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	H	-	-	H	-	M	L	-	L
CO2	M	-	-	H	-	H	-	-	H	L	-	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	L	L
CO2	M	L	H	H

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18004	**PROCESS CONTROL AND DYNAMICS**	**3**	**1/0**	**0/0**	**4**

UNIT I RESPONSE OF FIRST ORDER SYSTEM 12Hrs

Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems in Laplace transformation, application. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics, transfer function for chemical reactors and dynamics.

UNIT II THE CONTROL SYSTEM 12Hrs

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulator problems, Transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, transient response of closed-loop control systems and their stability.

UNIT III CLOSED LOOP TRANFER FUNCTIONS 12Hrs

Introduction to frequency response of closed-loop systems, control system design by frequency, Bode diagram, stability criterion, Nyquist diagram; Tuning of controller settings.

UNIT IV CONTROLSYSTEM DESIGN BY FREQUENCY RESPON 12Hrs

Controller mechanism, introduction to advanced control systems, cascade control, feed forward control, control of distillation towers and heat exchangers, introduction to microprocessors and computer control of chemical process.

UNIT V ADVANCED CONTRO SYSTEM 12Hrs

Principles of measurements and classification of process control instruments, measurements of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity and consistency, p^H, concentration, electrical and thermal conductivity, humidity of gases, composition by physical and chemical properties and spectroscopy.

Total No of Hours: 60Hrs

TEXT BOOKS:

1. *Patranabis .D, Principles of Process control, II edition, Tata McGraw Hill Publishing Co Ltd., 1981.*
2. *PeterHarriott, Processcontrol, Tata McGraw Hill Publishing Co., Reprint 2004.*

REFERENCES:

1. *Thomas, E.Marlin, Process Control, 2nd Edn, McGraw Hills International Edn 2000.George Stephanopoulos, Chemical Process Control, Prentice Hall of India 2003.*
2. *Norman H.CEAGLSKE, Automatic process control for chemical engineers, John Wiley & Sons, Japan*

Subject Code: BMG18001	Subject Name: Total Quality Management For Chemical Engineers	T y/ Lb/ETL	L	T / SLr	P/ R	C
	Prerequisite: Quality control and quality engineering	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To introduce the main principles of business and social excellence.
- To generate knowledge and skills of students to use models and quality management methodology for the implementation of total quality management in any sphere of business and public sector.

COURSE OUTCOMES (COs) :

CO1	Help to apply appropriate techniques in identifying customer needs.
CO2	Measure the cost of poor quality and process effectiveness and efficiency.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	M	L	L	H	H	H	M	H
CO2	M	M	M	-	M	L	-	H	-	-	H	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4			
CO1	H	M	L	H			
CO2	M	L	H	H			

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BMG18001	**TOTAL QUALITY MANAGEMENT FOR CHEMICAL ENGINEERS**	**3**	**0/0**	**0/0**	**3**

UNIT I INTRODUCTION 9Hrs

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT II TQM PRINCIPLES 9Hrs

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

UNIT III STATISTICAL PROCESS CONTROL (SPC) 9Hrs

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV TQM TOOLS 9Hrs

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

UNIT V QUALITY SYSTEMS 9Hrs

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

Total No. of Hours: 45Hrs

TEXT BOOK:

1. *Dale H.Besterfiled, et at., Total Quality Management, Pearson Education Asia, 1999 (Indian reprint 2002).*

REFERENCES

1. *JaesR.Evans& William M.Lidsay, The Management and Control of Quality, (5th Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).*
2. *Feigenbaum.A.V. "Total Quality Management, McGraw Hill, 1991.*
3. *Oakland.J.S. "Total Quality Management Butterworth – Hcinemann Ltd., Oxford. 1989.*
4. *Narayana V. and Sreenivasan, N.S. Quality Management – Concepts and Tasks, New Age International 1996.*
5. *Zeiri. "Total Quality Management for Engineers Wood Head Publishers, 1991*

Subject Code:	Subject Name : Transport Phenomena	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18011	Prerequisite: Mass transfer, Heat transfer	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE :

- This course will provide the fundamentals to solve real life problems involving transports of Momentum, energy and mass in biological, mechanical and chemical systems using a unified approach.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understanding of transport processes.
CO2	Ability to develop steady and time dependent solutions along with their limitations.
CO3	Ability to analyze industrial problems along with appropriate boundary conditions.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	-	H	-	-	-	-	L	-	M	-	H
CO2	L	-	L	-	-	H	-	-	-	M	-	L
CO3	L	-	H	-	-	-	-	-	-	M	-	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	M	L	M	M				
CO2	M	M	H	M				
CO3	H	H	H	L				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

BCT18011	**TRANSPORT PHENOMENA**	**3**	**0/0**	**0/0**	**3**

UNIT I PHILOSOPHY AND FUNDAMENTALS OF TRANSPORT PHENOMENA 9Hrs

Importance of transport phenomena; analogous nature of transfer process; basic concepts, conservation laws; continuous concept, field, reference frames, substantial derivative and boundary conditions; methods of analysis; differential, integral and experimental methods.

UNIT II TRANSPORT BY MOLECULAR MOTION 9Hrs

Phenomenological laws of transport properties,Newtonian and non Newtonian fluids; rheological models; theories of transport properties of gases and liquids; effect of pressure and temperature.

UNIT III ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW 9Hrs

General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical; forced and free convection; mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection.

UNIT IV EQUATIONS OF CHANGE AND THEIR APPLICATIONS 9Hrs

Conservation laws and equations of change; Development of equations of continuity motion and energy in single multi components systems in rectangular co-ordinates and the forms in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change, scale factors; applications in scale-up

UNIT V TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW ANALOGIES BETWEEN TRANSPORT PROCESSES 9Hrs

Turbulents phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow overflat surface. ANALOGIES BETWEEN TRANSPORT PROCESSES: Importance of analogy; development and applications of analogies between momentum and mass transfer; Reynolds, Prandtl, Von Karman and Colbum analogies

Total No of Hours: 45Hrs.

TEXT BOOKS:

1. *R.B. Bird, W.E. Stewart and E.W.Lighfoot, "Transport Phenomena", John Wiley, 1978*
2. *Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena", McGraw-Hill International Edn 1988.*

REFERENCE*:*

1. *L.S.Sissom, and D.R.Pitts, "Elements of Transport Phenomena", McGraw-Hill, New York, 1972.*
2. *R.W.Fahien, "Elementary Transport Phenomena", McGraw-Hill, New York, 1983.*
3. *J.R. Welty, R.W. Wilson, and C.W.Wicks, "Fundamentals of Momentum Heat and Mass Transfer", 2nd Edn. John Wiley, New York, 1973.*

SEMESTER VI (PRACTICAL)

Subject Code:	Subject Name : Project Phase -1	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18L12	Prerequisite: Practical Knowledge of Basic Chemical Engineering Concepts	Lb	0	0/0	3/3	2

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- The objective of the Main Project is to culminate the academic study and provide an opportunity to explore a problem or issue, address through focused and applied research under the direction of a faculty mentor.
- The project demonstrates the student's ability to synthesize and apply the knowledge and skills acquired to real-world issues and problems.
- This project affirms the students to think critically and creatively, find an optimal solution, make ethical decisions and to present effectively.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Apply the knowledge and skills acquired in the course of study addressing a specific problem or issue.
CO2	To encourage students to think critically and creatively about societal issues and develop user friendly and reachable solutions.
CO3	To refine research skills and demonstrate their proficiency in communication skills
CO4	To take on the challenges of teamwork, prepare a presentation and demonstrate the innate talents.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M	H	H	L	M	M	H	H
CO2	H	H	H	H	H	H	H	M	M	M	H	H

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	H	M	H
CO2	H	H	H	M

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
							√					

BCT18L12	**PROJECT PHASE -1**	**0**	**0/0**	**3/3**	**2**

During the first term the students are required to:

1. Define the research problem.
2. Write a research proposal, which should contain –

a. Project title
b. Introduction
c. Origin of the problem
d. Literature review of research and development at national & international level
e. Significance of the problem
f. Objective
g. Methodology
h. Details of collaboration (if any)

3. Carry out *preliminary* experimental investigations or product design or process design etc.
4. Summarize the results (if any).

Criteria for Project Design:

1. Projects suggested by the staff on the basis of collected industrial problem.
2. Projects to cater to development of infrastructure of the department.
3. Projects to cater to preparation for application for funding agents.
4. Projects to cater to obtaining relevant data for doctoral programme.
5. Projects to recalibrate and standardize existing equipment.
6. Projects to establish relevant instrumentation and analytical procedures.
7. Projects to give students an opportunity if they suggest an innovative / alternate approach to the existing solution.

SEMESTER VII (PRACTICAL)

Subject Code: BCT18L13	Subject Name : Project Phase II	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Project Phase – 1	Lb	0	0/0	12/12	8

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Projects to establish relevant instrumentation and analytical procedures.
CO2	Projects to give students an opportunity if they suggest an innovative / alternate approach to the existing solution.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	H	-	M	-	-	H	-	-	L
CO2	M	M	-	H	-	H	-	-	H	-	-	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	H	M	H
CO2	H	H	H	M

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
							√					

BCT18L13	**PROJECT PHASE II**	**0**	**0/0**	**12/12**	**8**

Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry.
Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, outside the department, in industries/Research labs for which proportional weightage will be given in the final assessment

The above phase I project may be continued or a separate project can be assigned depending upon the students interest.

Criteria for Project Design:

1. Projects suggested by the staff on the basis of collected industrial problem.
2. Projects to cater to development of infrastructure of the department.
3. Projects to cater to preparation for application for funding agents.
4. Projects to cater to obtaining relevant data for doctoral programme.
5. Projects to recalibrate and standardize existing equipment.
6. Projects to establish relevant instrumentation and analytical procedures.
7. Projects to give students an opportunity if they suggest an innovative / alternate approach to the existing solution

SEMESTER IV (ELECTIVE)

Subject Code: BCT18E01	Subject Name: Food Technology	Ty / Lb/ ETL	L	T / SLr	P/ R	C
	Prerequisite: Chemistry and Microbiology	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation, food poisoning, food related hazards and safety, and transportation.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understanding the various causes of food deterioration and food poisoning.
CO2	Identification of appropriate processing, preservation, and packaging method.
CO3	Analyze product quality and effect of processing technique on it.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	L	-	-	-	M	-	H	-	L	-
CO2	M	-	L	-	L	-	H	-	-	-	L	M
CO3	H	-	L	-	-	-	M	-	-	-	L	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	H	M	L	H				
CO2	M	L	H	H				
CO3	M	H	H	L				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E01	**FOOD TECHNOLOGTY**	**3**	**0/0**	**0/0**	**3**

UNIT I AN OVERVIEW 9Hrs

General aspects of food industry world food needs and Indian situation.

UNIT II FOOD CONSTITUENTS, QUALITY AND DERIVATIVE FACTORS 9Hrs

Constituents of food quality and nutritive aspects food additives standards deteriorative factors and their control.

UNIT III GENERAL ENGINEERING ASPECTS AND PROCESSING METHODS 9Hrs

Preliminary processing methods conversion and preservation operations.

UNIT IV FOOD PRESERVATION METHODS 9Hrs

Preservation by heat and cold dehydration concentration drying irradiation microwave heating sterilization and pasteurization fermentation and pickling packing methods.

UNIT V PRODUCTION AND UTILISATION OF FOOD PRODUCTS 9Hrs

Cereal grains pulses vegetables; fruits; spices fats and oils bakery confectionery and chocolate productssoft and alcoholic beverages dairy products meat poultry and fish products.

Total No. of Hours: 45Hrs

TEXT BOOKS:

1. *Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, The AVI publishing Co., West port 1967.*
2. *Potter N.N., Food Science, The AVI publishing Co., Westport, 1963.*

REFERENCES:

1. *Heldman D.R., Food Process Engineering, The AVI publishing co., 1975.*
2. *Charm S.E., The Fundamentals of Foods Engineering, The AVI Publishing Co., Westport, 1966*

Subject Code: BCT18E02	Subject Name: Industry Pollution Prevention And Control	Ty / Lb/ ETL	L	T / SLr	P/ R	C
	Prerequisite: Chemistry and Microbiology	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation, food poisoning, food related hazards and safety, and transportation.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understanding the various causes of food deterioration and food poisoning.
CO2	Identification of appropriate processing, preservation, and packaging method.
CO3	Analyze product quality and effect of processing technique on it.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	L	-	-	-	M	-	H	-	L	-
CO2	M	-	L	-	L	-	H	-	-	-	L	M
CO3	H	-	L	-	-	-	M	-	-	-	L	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	H	M	L	H				
CO2	M	L	H	H				
CO3	M	H	H	L				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E02	**INDUSTRY POLLUTION PREVENTION AND CONTROL**	**3**	**0/0**	**0/0**	**3**

UNIT I **INTRODUCTION** **9Hrs**

Industrial activity and environment, industrialization and sustainable development indicators of sustainability-sustainability strategies-Barriers to sustainability- Pollution prevention in achieving sustainability

UNIT II **POLICIES AND REGULATIONS** **9Hrs**

Prevention vs control of industrial pollution-Environment policies and Regulations to encourage pollution prevention 143 CHEM-Engg&Tech-SRM-2013

UNIT III **ENVIRONMENTAL CONTAMINANTS** **9Hrs**

Environment friendly chemical processes-Properties of environmental contaminants - Regulations for clean environment and implications for industries

UNIT IV **LIFE CYCLE ASSESSMENT** **9Hrs**

Life cycle assessment and pollution prevention economics-Design for the environment-International environmental standards-Environmental technology assessment.

UNIT V **INDUSTRIAL APPLICATIONS OF POLLUTION PREVENTION** **9Hrs**

Water,energy and reagent conservation-residuals management-Economic recovery and recycling of wastes. Industrial applications of pollution prevention, Life cycle assessment, waste audits and technology assessments

Total No. of Hours: 45Hrs

TEXT BOOK

1. Bishop .P, "Pollution Prevention: Fundamentals and Practice", McGraw Hill International Edn., McGraw Hill Book Co., Singapore, 2000.
2. Roy T.K. (Editor), "Chemical Technology for better Environment", Allied Publishers Ltd., Chennai, 1998.

REFERENCES

1. Freeman. H.M , "Industrial Pollution Prevention Hand Book", McGraw Hill, 1995. 2. James G. Mann and Y.A.Liu, "Industrial Water Reuse and Waste Water Minimization", McGraw Hill, 1999

Subject Code: BCT18E03	Subject Name: Chemistry of Polymer And Composite Materials	Ty / Lb/ ETL	L	T / SLr	P/ R	C
	Prerequisite: Chemistry	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To enable the students to understand the mechanism of polymerization, various techniques of polymerization, characterization of polymers by molecular weight, reactions and degradation of polymers.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Will develop knowledge in polymerization techniques
CO2	Will be aware about chemical reaction of polymers
CO3	Will be able to determine the molecular weight of the polymer

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	L	-	M	-	M	-	H	-	L	M
CO2	M	L	L	-	L	L	H	-	M	-	L	M
CO3	H	-	L	-	-	-	M	-	M	-	L	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	H	M	L	H				
CO2	M	L	H	H				
CO3	M	H	H	L				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E03	**CHEMISTRY OF POLYMER AND COMPOSITE MATERIALS**	**3**	**0/0**	**0/0**	**3**

UNIT I FUNDAMENTAL CONCEPTS OF POLYMER 9Hrs

Introduction, classification of polymer, nomenclature, trade and common name of polymer, monomers and functionality concept of monomers (with example), concept of cross linking and isomerism, general applications of polymer.

UNIT II SOLVENTS, FILLERS AND ADDITIVES 9Hrs

Solvents: Introduction, Classification, types of solvents, types of solutions, method of finding chain length, demixing, flexible chains, particle size & shape, compatibility, phase transition, ternary systems. **Fillers**: Introduction, types of fillers, particle geometry, organic fillers, cellulosic, fibers, and inorganic fillers, applications. **Additives**: Introduction, plasticizers, classification, effect on chemical properties & stability, flexibilizers, release agents, antioxidants, applications.

UNIT III POLYMERIZATION PATHWAY 9Hrs

Step polymerization, chain polymerization, anionic polymerization, cationic polymerization, free radical polymerization (with kinetics), and ring opening polymerization.

UNIT IV POLYMER SYNTHESIS 9Hrs

Synthesis and applications of polystyrene, polyvinyl acetate, nylon-6, nylon-66, polyvinyl chloride, unsaturated polyvinyl chloride, chlorinated polyvinyl chloride, teflon, poly (3- hydroxybutyrate-co- 3-hydroxyvalerate)(PHBV), polyethylene terephthalate, poly glyptal, polymethyl methacrylate, poly urethane, neoprene, phenol formaldehyde, urea formaldehyde, melamine formaldehyde, epoxy resins, poly propylene, High-density polyethylene, low- density polyethylene.

UNIT V COMPOSITE MATERIALS 9Hrs

Introduction and industrial applications of composites,**Fiber Reinforced Composites (FRC):** introduction, importance and properties, manufacture of fiber fabric, manufacture of fiber preforms, Forming processes, Bladder moulding, Compression moulding, Autoclave and vacuum bag, Mandrel wrapping, Wet layup, Chopper gun, Filament winding, Pultrusion, Resin transfer moulding, Carbon fibre, Aramid fibre material, Kevlar.Introduction, example and application of Particle Reinforced Composites (PRC).

Total No. of Hours: 45Hrs

REFERENCE BOOKS:

1. *A Textbook of Polymers – Vol I & II, M. S. Bhatnagar, S. Chand Publication*
2. *Plastic Materials – John Brydson, Elsevier Publication*
3. *Polymer Science & Technology – Joel Fried, PHI*
4. *Introductory Polymer Chemistry, G. S. Misra, New Age International*
5. *Polymer Science, G. Govariker, New Age International*

SEMESTER V (ELECTIVE)

Subject Code:	Subject Name: Green Chemistry and Engineering	Ty/Lb/ETL	L	T / S.Lr	P/ R	C
BCT18E04	Prerequisite: Nil	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To make the students aware of global environmental issues, concepts behind pollution prevention, environmental risks, green chemistry, methods to evaluate environmental costs and life cycle assessments.

COURSE OUTCOMES (COs) :

CO1	Explain how Green chemistry and sustainability relates to problems of societal concern.
CO2	Analyze a process and identify how it may be made more environmentally friendly/sustainable/green.
CO3	Integrate, synthesize, and apply knowledge of the relationship between science and technology and societal issues in both focused and broad interdisciplinary contexts.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L	H	-	-	-	-	-	M	-	-
CO2	H	M	L	H	-	-	H	-	-	-	-	L
CO3	M	H	H	H	L	-	-	-	H	-	-	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	L	H	H
CO2	H	H	M	L
CO3	H	M	L	L

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E04	**GREEN CHEMISTRY AND ENGINEERING**	**3**	**0/0**	**0/0**	**3**

UNIT I ENVIROMENTAL ISSUES 9Hrs

Overview of Major Environmental Issues, Global Environmental Issues. Air Quality Issues. Water Quality Issues, Ecology, Natural Resources, Description of Risk. Value of Risk Assessment in the Engineering Profession. Risk-Based Environmental Law. Risk Assessment Concepts. Hazard Assessment. Dose- Response. Risk Characterization.

UNIT II POLLUTION PRAVENTION 9Hrs

Pollution Prevention- Pollution Prevention Concepts and Terminology. Chemical Process Safety. Responsibilities for Environmental Protection. Environmental Persistence. Classifying Environmental Risks Based on Chemical Structure.Exposure Assessment for Chemicals in the Ambient Environment.

UNIT III GREEN CHEMISTRY 9Hrs

Green Chemistry. Green Chemistry Methodologies. Quantitative/Optimization-Based Frameworks for the Design of Green Chemical Synthesis Pathways.Green Chemistry Pollution Prevention in Material Selection for Unit Operations.Pollution Prevention for Chemical Reactors. Pollution Prevention for Separation Devices. Pollution Prevention Applications for Separative Reactors. Pollution Prevention in Storage Tanks and Fugitive Sources.

UNIT IV ESTIMATION OF ENVIROMENTAL EFFECTS 9Hrs

Process Energy Integration. Process Mass Integration. Case Study of a Process Flow sheet- Estimation of Environmental Fates of Emissions and Wastes.

UNIT V ENVIROMENTAL EVALUATIONS 9Hrs

Magnitudes of Environmental Costs. A Framework for Evaluating Environmental Costs. Hidden Environmental Costs. Liability Costs. Internal Intangible Costs.External Intangible Costs. Introduction to Product Life Cycle Concepts. Life-Cycle Assessment. Life-Cycle Impact Assessments. Streamlined Life-Cycle Assessments. Uses of Life-Cycle Studies.

Total No. of Hours: 45Hrs

TEXT BOOKS:

1. *Allen, D.T., Shonnard, D.R, Green Engineering: Environmentally Conscious Design of Chemical Processes. Prentice Hall PTR 2002.*
2. *MukeshDoble and Anil Kumar Kruthiventi, Green Chemistry and Engineering, Elsevier, Burlington, USA, 2007.*

Subject Code: BCT18E05	Subject Name: Modern Separation Processes	T y/ Lb/ ETL	L	T / SLr	P/ R	C
	Prerequisite: Advanced separation	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To enable the students to learn the principle and technical concept of advanced separation processes.

COURSE OUTCOMES (COs) : (3- 5)

CO1	The students would fully understand key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, limiting cases, efficiency and mass transport effects.
CO2	To do all calculation.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	H	-	-	M	-	-	-	-	L
CO2	M	-	-	-	-	-	H	-	-	-	M	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	-
CO2	M	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E05	**MODERN SEPARATION PROCESSES**	**3**	**0/0**	**0/0**	**3**

UNIT I **BASICS OF SEPARATION PROCESS** **9Hrs**

Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

UNIT II **MEMBRANE SEPARATIONS** **9Hrs**

Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic- Hybrid process and Biological Membranes.

UNIT III **SEPARATION BY ADSORPTION** **9Hrs**

Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

UNIT IV **INORGANIC SEPARATIONS** **9Hrs**

Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.

UNIT V **OTHER TECHNIQUES** **9Hrs**

Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management,Industrial Effluent Treatment by Modern Techniques.

Total No. of Hours: 45Hrs

REFERENCES*:*

1. King, C. J., "Separation Processes", Tata McGraw Hill, 1982.83
2. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley,New York, 1987.
3. Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar,1992.

Subject Code:	Subject Name: Renewable Energy Engineering	Ty / Lb/ ETL	L	T / SLr	P/ R	C
BCT18E06	Prerequisite: Conversion Technologies	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- This course helps the students to understand the importance, availability, conversion technologies of renewable energy resources and its applications.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Various aspects of solar energy and utilization.
CO2	Familiarize other renewable energy sources.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	-	H	-	-	-	M	-	-	H
CO2	M	H	-	L	-	-	-	-	H	-	L	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	-
CO2	M	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E06	**RENEWABLE ENERGY ENGINEERING**	**3**	**0/0**	**0/0**	**3**

UNIT I INTRODUCTION 9Hrs

World energy status, Current energy scenario in India, Environmental aspects of energy utilization, Environment - Economy - Energy and Sustainable development,energy planning.classification of Energy resources, Advantages and disadvantages of Non-Conventional source of energy, Renewable energy resources - potentials -achievements – applications.

UNIT II SOLAR ENERGY 9Hrs

Basic concepts, Solar thermal systems – Flat plate and concentrating collectors, Solar passive space - Solar heating and cooling techniques – Solar desalination –Solar Pond - Solar cooker - Solar dryers-Solar furnaces - Solar pumping, Solar 139 CHEM-Engg&Tech-SRM-2013 green house- Solar thermal power plant – Solar photo voltaic conversion – Solar cells – PV applications

UNIT III WINDENERGY 9Hrs

Introduction-Background-Availability- wind power plants , Power from the wind,Wind energy conversion systems, site characteristics, Wind turbines types –Horizontal and vertical axis-design principles of wind turbine, Magnus effect-Performance.Wind energy Applications – New developments - Safety and environmental aspects.

UNIT IV BIOMASS ENERGY 9Hrs

Biomass – usable forms- composition- fuel properties – applications, Biomass resources, Biomass conversion technologies - direction combustion - pyrolysis –gasification -anaerobic digestion, Bioethanol and Biodiesel Production – Recent developments.Energy farming, Biogas technology - Family biogas plants,Community and institutional biogas plants – design consideration – applications**.**

UNIT V OTHER RENEWABLE ENERGY SOURCES 9Hrs

Tidal energy – Wave energy – Open and closed OTEC Cycles – Small hydro –Geothermal energy Fuel cell technology - types, principle of operation –applications.Hydrogen energy production - Storage system.

Total No. of Hours: 45Hrs

TEXT BOOK:

1. Rai. G.D. "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 1999.
2. Sukhatme.. S.P. "Solar Energ", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
3. "Renewable energy sources of conversion technology": Bansal..N.K Manfred Kleen Man and Michael Meliss, TMH Publicatio

REFERENCES:

1. Kothari. P, K C, Singal and Rakesh Ranjan, " Renewable EnergySources and Emerging Technologies ", PHI Pvt. Ltd.,New Delhi, 2008
2. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, OxfordUniversityPress, U.K, 1996.
3. Twidell. J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK,1986.
4. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990.

SEMESTER VI (ELECTIVE)

Subject Code: BCT18E07	Subject Name: Computational Fluid Dynamics	T y/ Lb/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Basic Mathematics and Fluid Mechanics	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To make the students to demonstrate competence in setting up computational fluid dynamics models for some Industrially important applications. This technical competence in building and conducting CFD simulations is a skill.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Upon completing the course, the student should have a Hands-on experience with a commercial CFD program.
CO2	

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	-	-	L	-	-	-	H	-	-	H
CO2	M	H	-	-	-	-	-	-	H	H	-	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	M	-	-
CO2	H	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E07	**COMPUTATIONAL FLUID DYNAMICS**	**3**	**0/0**	**0/0**	**3**

UNIT I CONSERVATION LAWS AND TURBULENCE MODELS 9Hrs

Governing equations of fluid flow and heat transfer –mass conservation, momentum and energy equation, differential and integral forms, conservation and non-conservation form. Characteristics of turbulent flows, time averaged Navier Strokes equations, turbulence models-one and two equation, Reynolds Stress, LES and DNS.

UNIT II FINITE DIFFERNCE APPROXIMATION 9Hrs

Mathematical behaviour of PDE, finite difference operators, basic aspects of discretization by FDM, explicit and implicit methods, error and stability analysis.

UNIT III FINITE VOLUME METHOD 9Hrs

Diffusion problems – explicit and implicit time integration Convection-diffusion problems – properties of discretisation schemes, central, upwind, hybrid, QUICK schemes Solution of discretised equations.

UNIT IV FLOW FIELD COMPUTATION 9Hrs

Pressure velocity coupling, staggered grid, SIMPLE algorithm, PISO algorithm for steady and unstead y flows.

UNIT V GRID GENERATION 9Hrs

Physical aspects, simple and multiple connected regions, grid generation by PDE solution, grid generation by algebraic mapping.

Total No. of Hours: 45Hrs

TEXT BOOKS:

1. Anderson, J. D., "Computational Fluid Dynamics: The Basics with Applications", McGraw-Hill,1995.
2. Fletcher, C. A. J., "Computational Techniques for Fluid Dynamics", Springer Verlag, 1997.
3. Versteeg, H.K. and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The FiniteVolume Method", Pearson Education Ltd., 2007.

REFERENCES*:*

1. Chung T.J Computational Fluid Dynamics Cambridge University Press,2003.
2. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", arosaPublishing House, New Delhi,2001.
3. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw – Hill Publishing Company Ltd. 1998.
4. Subas, V. Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
5. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier Stock Equation", Pineridge Press Limited, U.K.,1981.

Subject Code: BCT18E08	Subject Name : Frontiers of Chemical Engineering	T y/ Lb/ETL	L	T /S.Lr	P/ R	C
	Prerequisite: Chemical product design	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To enable the students to understand the chemical product design and available renewable energy resources.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Upon completing the course, the student should have a Hands-on experience with a commercial CFD program.
CO2	To do all calculation.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	-	M	-	-	-	L	-	-	-	-	H
CO2	M	-	-	-	-	H	-	-	-	M	-	H

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	M	-	-
CO2	H	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E08	**FRONTIERS OF CHEMICAL ENGINEERING**	**3**	**0/0**	**0/0**	**3**

UNIT I PROCESS INTENSIFICATION 9Hrs

Novel reactor configurations combination of reaction and separation use of different energy fields, lab on a chip.

UNIT II CHEMICAL PRODUCT DESIGN 9Hrs

Scope and importance identification of needs and specifications sources of ideas and screening ideas selection of product idea process development for product manufacture specialty chemical manufacture economic aspects.

UNIT III RENEWABLE ENERGY 9Hrs

Hydrogen production, Hydrogen economy, Fuel Cell Technology, biofuel cells and bio-hydrogen, solar energy.

UNIT IV MATERIALS ENGINEERING 9Hrs

Polymers and composites, ceramics and glasses, colloidal dispersions and nanoparticles, thin films and electronic materials.

UNIT V BIOENGINEERING 9Hrs

Biomechanics, biotransport and biomaterials, biomolecular and cellular engineering, drug discovery and development.

Total No. of Hours: 45Hrs

TEXT BOOKS:

1. Keil, F. J., Modeling of Process Intensification Wiley-VCH Verlag GmbH & Co. KGaA2007

2. Cussler, E.l. and Moggridge, G.D., "Chemical product design" Cambridge University Press, Cambridge, 2001

3. Hoffmann,P, Tomorrow's energy: hydrogen, fuel cells, and the prospects for a cleaner planet, MIT Press, Sabon, 2002.

REFERENCES:

1. Mitchell, B.S., An introduction to materials engineering and science for chemical and materials engineers, John Wiley and Sons Inc., New Jersey,2004

Subject Code: BCT18E09	Subject Name: Industrial Management	T y/ L/b ETL	L	T / SLr	P/ R	C
	Prerequisite: Basic Management	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To provide an opportunity to learn basic management concepts essential for business.

COURSE OUTCOMES (COs) : (3- 5)

CO1	At the end of this course, the students would have knowledge on the basic management principles to become Managements professional.
CO2	To do all calculation.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	-	-	M	-	M	-	-	-	L
CO2	M	-	-	-	-	H	-	-	-	H	-	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	-
CO2	M	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E09	INDUSTRIAL MANAGEMENT	3	0/0	0/0	3

UNIT I INTRODUCTION 9Hrs

Management - Definition – Functions – Evolution of Modern Management –Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization – Individual Ownership – Partnership – Joint Stock Companies – Co-operative Enterprises – Public Sector Undertakings, Corporate Frame Work – Share Holders – Board of Directors – Committees – Chief Executive –Trade Union.

UNIT II FUNCTIONS OF MANAGEMENT 9Hrs

Planning – Nature and Purpose – Objectives – Strategies – Policies and Planning Premises – Decision Making – Organizing – Nature and Process – Premises – Departmentalization – Line and staff – Decentralization – Organizational culture, Staffing - selection and training – Placement –Performance appraisal – Career Strategy – Organizational Development. Leading – Managing human factor – Leadership – Communication, Controlling - Process of Controlling – Controlling techniques, productivity and operations management – Preventive control, Industrial Safety.

UNIT III ORGANIZATIONAL BEHAVIOUR 9Hrs

Definition – Organization – Managerial Role and functions – Organizational approaches, Individual behaviour – causes – Environmental Effect – Behavior and Performance, Perception – Organizational Implications. Personality Contributing factors - Dimension – Need Theories – Process Theories – Job Satisfaction, Learning and Behavior Learning Curves, Work Design and approaches.

UNIT IV GROUP DYNAMICS 9Hrs

Group Behavior – Groups – Contributing factors – Group Norms, Communication – Process – Barriers to communication – Effective communication, leadership – formal and informal characteristics – Managerial Grid – Leadership styles – Group Decision Making – Leadership Role in Group. Decision, Group Conflicts – Types – Causes – Conflict Resolution – Inter group relations and conflict, Organization centralization and decentralization – Formal and informal – Organizational Structures – Organizational Change and Development – Change Process – Resistance to Change – Culture andEthics.

UNIT V MODERN CONCEPTS 9Hrs

Management by Objectives (MBO), Management by Exception (MBE), Strategic. Management - Planningfor Future direction – SWOT Analysis – Information technology in management – Decisions support system – Business Process. Re-engineering (BPR) – Enterprises Resource Planning (ERP) – Supply Chain Management (SCM) – Activity Based Management (ABM).

Total No. of Hours: 45Hrs

TEXT BOOKS:

1. Herald Knottz and Heinz Weihrich, 'Essentials of Management', TataMcGraw Hill Education Pvt. Ltd., 2010.85

2. Stephen P. Robbins, 'Organization Behaviour', Pearson Education Inc., 13 edition, 2010.

REFERENCES*:*

1. Ties, AF, Stoner and R.Edward Freeman, 'Management' Prentice Hall of India Pvt. Ltd. New Delhi 110 011, 1992

2. Joseph J, Massie, 'Essentials of Management' Prentice Hall of India Pvt. Ltd. 1985.

3. P.C. Tripathi & P.N. Reddy, 'Principles of Management', TataMcGraw Hill,2006.

Subject Code: BCT18E10	Subject Name: Drugs And Pharmaceutical Technology	T y/ L/b ETL	L	T / SLr	P/ R	C
	Prerequisite: Engineering Chemistry	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To give the students an understanding of the poly technical nature of engineering and drug discovery in the Pharmaceutical industry involving Chemical Engineering.

COURSE OUTCOMES (COs) : (3- 5)

CO1	At the end of this course, the students would have knowledge on the basic management principles to become management(s) professional.
CO2	To do all calculation.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	-	-	M	-	M	-	-	-	L
CO2	M	-	-	-	-	H	-	-	-	H	-	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	-
CO2	M	L	-	-

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCCT18E10	DRUGS AND PHARMACEUTICAL TECHNOLOGY	3	0/0	0/0	3

UNIT I INTRODUCTION 9Hrs

Development of drugs and pharamaceutical industry; organic the rapeuticagents uses and economics.

UNIT II DRUG METABOLISM AND PHARMACO KINETICS &MICROBIOLOGICAL AND ANIMAL PRODUCTS 9Hrs

Drug metabolism; physico chemical principles; pharma kinetics-action of drugson human bodies. Antibioticsgram positive, gram negative and broad spectrumantibiotics; hormones

UNIT III IMPORTANT UNIT PROCESSES AND THEIR APPLICATION 9Hrs

Chemical conversion processes; alkylation; carboxylation; condensation andcyclisation; dehydration, esterification, halogenation, oxidation, sulfonation;complex chemical conversions fermentation.

UNIT IV MANUFACTURING PRINCIPLES & PACKING AND QUALITYCONTROL 9Hrs

Compressed tablets; wet granulation; dry granulation or slugging; advancementin granulation; direct compression, tablet presses formulation; coating pills;capsules sustained action dosage forms; parential solutions, oral liquids;injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control.

UNIT V PHARMACEUTICAL PRODUCTS & PHARMACEUTICALANALYSIS 9Hrs

Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives;external antiseptics; antacids and others. Analytical methods and tests forvarious drugs and pharmaceuticals – spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pHmetry.

TOTAL No. of Hrs: 45Hrs

TEXT BOOK:

1. Rawlines, E.A.; " Bentleys Text book of Pharmaceutics ", III Edition, BaillereTindall, London, 1977.

REFERENCES:

1. Yalkonsky, S.H.; Swarbick. J.; " Drug and Pharamaceutical Sciences ", Vol.I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. "Remingtons Pharmaceutical Sciences ", Mack Publishing Co., 1975.

SEMESTER VII (ELECTIVE)

Subject Code:	Subject Name: Professional Ethics in Engineering	Ty / Lb/ ETL	L	T / SLr	P/ R	C
BCT18E11	Prerequisite: Moral science and general English	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To enable the students to create an awareness on Engineering Ethics andHuman Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field.
CO2	Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	-	-	L	-	-	-	L	-	H	-	-
CO2	M	-	-	L	-	-	M	-	-	-	-	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	H	M	-	-				
CO2	M	L	-	-				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E11	**PROFESSIONAL ETHICS IN ENGINEERING**	**3**	**0/0**	**0/0**	**3**

UNIT I HUMAN VALUES 9Hrs

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civicvirtue – Respect for others – Living peacefully – Caring – Sharing – Honesty –Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS 9Hrs

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry –Moral dilemmas – Moral AutonomyKohlberg's theory – Gilligan's theory –Consensus and Controversy – Models of professional roles.Theories about right action – Self interest – Customs and Religion – Uses of Ethical Theories

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9Hrs

Engineering as Experimentation – Engineers as responsible Experimenters –Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9Hrs

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis andReducing Risk Respect for Authority – Collective Bargaining – Confidentiality– Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES 9Hrs

Multinational Corporations – Environmental Ethics – Computer Ethics –Weapons Development – Engineers as Managers – Consulting Engineers –Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

Total No. of Hours: 45Hrs

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, NewJersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education,New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001

Subject Code:	Subject Name : Process Optimization	T y/ Lb/ ETL	L	T / S.Lr	P/ R	C
BCT18E13	Prerequisite: PCE	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To expose the students with various mathematical methods for numerical analysis and use of software tools

COURSE OUTCOMES (COs) : (3- 5)

CO1	Through this course, the students would have learnt about the systems of equations, probability statistics, error analysis and programming concepts using various software tools.
CO2	

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	-	L	-	-	-	-	-	H	-
CO2	M	H	H	-	-	-	H	-	-	-	H	H

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	M	M	M	-
CO2	H	L	H	-

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

BCT18E13	**PROCESS OPTIMIZATION**	**3**	**0/0**	**0/0**	**3**

UNIT I OPTIMISATION 15Hrs

Introduction; formulation of objective functions; fitting models to data classification of functions; necessary and sufficient conditions for optimum unimodal, multimodal functions; analytical methods lagrange multiplier methods.

UNIT II NUMERICAL METHODS 15Hrs

Unimodel functions; newton's quasi newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; random, grid. Hooke's nelder and mead methods; Powell's technique; indirect methods gradient and conjugate gradient methods; secant methods.

UNIT III LINEAR AND NON-LINEAR PROGRAMMING APPLICATIONS 15Hrs

Review on basic concepts of LP formulations; Simplex methods; Integer,quadratic, geometric and dynamic programming. Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale systems.

Total No. of Hours: 45Hrs

TEXT BOOKS:

1. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes", McGraw-Hill II Edition 2001.
2. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimisation", John Wiley, II Edition 2006

REFERENCES*:*

1. Biles, W.E., Swain, J.J.; "Optimisation and Industrial Experimentation", Inter Science, New York, 1980.
2. Seinfeld, J.H.; Lapidus, L; "Process Modelling, Estimation and Identification"Prentice Hall, Englewood Cliffs, New Jersey, 1974.
3. Beveridge, C.S.; Schechter, R.S.; "Optimisation: Theory and Practice", McGraw-Hill Book Co., New York, 1970.