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

FACULTY OF ENGINEERING AND TECHNOLOGY

OUTCOME BASED EDUCATION

Curriculum and Syllabus

B.Tech (Chemical Engineering)
Part Time

Regulations - 2022

Department of Chemical Engineering

VISION

Generating knowledge and developing technology through quality research in frontier areas of chemical engineering and interdisciplinary fields.

MISSION

- **M1:** To provide high quality education experience that will prepare graduates to assure leadership position within chemical and associated industries.
- **M2:** To attain global recognition in research and train students for meeting the challenging needs of chemical industries and the society
- **M3:** Fostering industry – academic relationship for mutual benefits and growth.

QUALITY POLICY

We wish to foster a chemical engineering program coupled with research strength to acquire innovation and next generation techniques.

PROGRAM EDUCATIONAL OBJECTIVES [PEO's]

Graduates will be able to:

- **PEO 1**: Graduates pursue profession in chemical & allied engineering
- **PEO 2**: Graduates work in diversified team
- **PEO 3**: Graduates will pursue higher education & research

PROGRAM OUTCOMES

- **PO1 : Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
- **PO2: Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO3: Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
- **PO5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

- **PO6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **PO7: Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
- **PO8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **PO9: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO11: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

- **PO12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES [PSO's]

- **PSO 1 :** Graduates will apply knowledge in physics, chemistry and biology in the field of transfer processes for effective separation and purification of petrochemicals, pharmaceuticals and health care products
- **PSO 2 :** Graduates will automate and control processes by applying mathematics, process control, instrumentation, simulation and process modelling.
- **PSO 3 :** Graduates will design equipment for modern science applications

PEO WITH MISSION STATEMENT

	M1	M2	M3
PEO1	3	2	3
PEO2	3	3	3
PEO3	2	3	3

PEO-PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	3	3	3	3	2	3	3	2	3	2	2	-
PEO2	3	3	2	1	1	1	2	-	-	1	1	2
PEO3	3	3	3	3	1	1	3	2	3	2	3	3

PEO-PSO

	PSO1	PSO2	PSO3
PEO1	2	3	1
PEO2	3	2	1
PEO3	3	1	3

I SEMESTER								
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**	**Category**
1	EBMA22024	Mathematics I For Chemical Engineers	Ty	3	1/0	0/0	4	BS
2	EBCT22002	Mechanical Operations	Ty	3	1/0	0/0	4	PC
3	EBCE22ID4	Environmental Engineering	Ty	3	0/0	0/0	3	ID
4	EBCT22ET1	Fertilizer Technology	ETL	2	0/0	2/0	3	PC
PRACTICALS								
1	EBCT22L02	Mechanical Operation Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total: 15

II SEMESTER								
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**	**Category**
1	EBMA22025	Mathematics II For Civil and Chemical Engineers	Ty	3	1/0	0/0	4	BS
2	EBCS22ID1	Computer Application in Chemical Engineering	Ty	3	0/0	0/0	3	ID
3	EBCT22003	Chemical Process Calculation	Ty	3	0/0	0/0	3	PC
4	EBCT22004	Chemical Technology I	Ty	3	1/0	0/0	4	PC
PRACTICALS								
5	EBCT22ET2	Polymer Technology	ETL	2	0/0	2/0	3	PC

Credits Sub Total: 17

III SEMESTER								
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**	**Category**
1	EBBT22ID1	Bio-Chemical Principles	Ty	3	0/0	0/0	3	ID
2	EBCT22009	Chemical Technology II	Ty	3	0/0	0/0	3	PC
3	EBCT22006	Fluid Mechanics	Ty	3	0/0	0/0	3	PC
`4	EBCT22005	Chemical Engineering Thermodynamics I	TY	3	1/0	0/0	4	PC

Credits Sub Total: 13

IV SEMESTER								
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**	**Category**
1	EBCT22008	Chemical Engineering Thermodynamics II	Ty	3	1/0	0/0	4	PC
2	EBCT22007	Mass Transfer I	Ty	3	1/0	0/0	4	PC
3	EBCT22011	Heat Transfer	Ty	3	0/0	0/0	3	PC
4	EBCT22EXX	Programme Elective I	Ty	3	0/0	0/0	3	PE
PRACTICALS								
1	EBCT22L08	Heat Transfer Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total: 15

V SEMESTER								
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**	**Category**
1	EBCT22010	Mass Transfer II	Ty	3	1/0	0/0	4	PC
2	EBCT22012	Chemical Reaction Engineering I	Ty	3	0/0	0/0	3	PC
3	EBCT22014	Process Control And Dynamics	Ty	3	0/0	0/0	3	PC
4	EBCT22EXX	Programme Elective II	Ty	3	0/0	0/0	3	PE
PRACTICALS								
1	EBCT22L07	Chemical Reaction Engineering Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total: 14

VI SEMESTER								
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**	**Category**
1	EBCT22013	Safety in Chemical Process Industries	Ty	3	1/0	0/0	4	PC
2	EBCT22EXX	Programme Elective III	Ty	3	0/0	0/0	3	PE
3	EBCC22ID3	Total Quality Management	Ty	3	0/0	0/0	3	ID
4	EBCT22015	Chemical Reaction Engineering II	Ty	3	0/0	0/0	3	PC
PRACTICALS								
1	EBCT22I05	Project Phase – 1	IE	0	0/0	3/3	2	P

Credits Sub Total: 15

VII SEMESTER								
S.NO	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL**	**L**	**T / SLr**	**P/ R**	**C**	**Category**
1	EBCT22EXX	Programme Elective IV	Ty	3	0/0	0/0	3	PE
PRACTICALS								
1	EBCT22L11	Project Phase – II	Lb	0	0/0	12/12	8	P

Credits Sub Total: 11

CREDIT SUMMARY

Semester 1:15
Semester 2:17
Semester 3:13
Semester 4:15
Semester 5:14
Semester 6:15
Semester 7:11
Total : 100

PROGRAMME ELECTIVES- I							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty / Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**
1	EBCT22E01	Food Technology	Ty	3	0/0	0/0	3
2	EBCT22E02	Industry Pollution Prevention and Control	Ty	3	0/0	0/0	3
3	EBCT22E03	Chemistry of Polymer and Composite Materials	Ty	3	0/0	0/0	3

PROGRAMME ELECTIVES - II							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty/ Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**
1	EBCT22E04	Green Chemistry and Engineering	Ty	3	0/0	0/0	3
2	EBCT22E05	Modern Separation Processes	Ty	3	0/0	0/0	3
3	EBCT22E06	Renewable Energy Engineering	Ty	3	0/0	0/0	3

PROGRAMME ELECTIVES - III							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty/ Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**
1	EBCT22E07	Computational Fluid Dynamics	Ty	3	0/0	0/0	3
2	EBCT22E08	Frontiers Of Chemical Engineering	Ty	3	0/0	0/0	3
3	EBCT22E09	Industrial Management	Ty	3	0/0	0/0	3

PROGRAMME ELECTIVES - IV							
S.NO.	**SUBJECT CODE**	**SUBJECT NAME**	**Ty/ Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**
1	EBCT22E10	Drugs And Pharmaceutical Technology	Ty	3	0/0	0/0	3
2	EBCT22E11	Professional Ethics In Engineering	Ty	3	0/0	0/0	3
3	EBCT22E12	Industrial Instrumentation	Ty	3	0/0	0/0	3
4	EBCT22E13	Process Optimization	Ty	3	0/0	0/0	3

Note: cTy/Lb/ETL/IE: Theory/Lab/Embedded Theory and lab/Internal evaluation L/T/SLr/P/R/C: Lecture/Tutorials/Supervised Learning/Practical/Research/Credit HS:Humanities and Social Science,ES:Engg.Science.BS:Basic Science,PC:Program core, PE:Program Elective,OE:Open Elective,P:Project

Table 1:Credit Distribution Format

Components of Curriculum and Credit distribution for E&T Programmes

Course Component	Description	No. of Courses	Credits	Total	Credit Weightage (%)	Contact hours
Basic Science	Theory	2	8	8	8	120
	Lab					
	ETL					
Engineering Science	Theory					
	Lab					
	ETL					
Humanities and Social Science	Theory					
	Lab					
	ETL					
Program Core	Theory	14	49	58	58	890
	Lab	3	3			
	ETL	2	6			
Program Electives		4	12	12	12	180
Open Elective	Theory					
	Lab					
Inter-disciplinary	Theory	4	12	12	12	180
	Lab					
	ETL					
Skill Component						
Internship/Project		2	10	10	10	200
Others if any						
	TOTAL	**31**	**100**	**100**	**100**	**1570**

Table 2:

Revision/modification done in syllabus content:

S.No	Course(Subject) Code	Course (Subject) Name	Concept/ topic if any, removed in current curriculum	Concept/topic added in the new curriculum	% of Revision/ Modification done
1.	EBCT22013	Safety in Chemical Process Industries	-	Included in VI semester	20%
2.	Elective EBCT22E05/ EBCT22E04/ EBCT22E07/ EBCT22E12/	Modern Separation Processes, Green Chemistry and Engineering, Computational Fluid Dynamics, Industrial Instrumentation newly added			20%

Table3:

List of New courses/ value added courses//life skills/Electives/interdisciplinary /courses focusing on employability/entrepreneurship/skill development.

S. No	**New courses(Subjects)**	**Value added courses**	**Life skill**	**Electives**	**Inter Disciplinary**	**Focus on employability/entrepreneurship/skill development.**
1	EBCT22013/ Safety in Chemical Process Industries	-	✓	-	-	**Skill development.**

SEMESTER I (THEORY)

Subject Code: EBMA22024	Subject Name: Mathematics I for Chemical Engineers	Ty / Lb/ ETL	L	T / SLr	P/ R	C
	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) :

CO1	To understand the Basic concepts in Matrices
CO2	To understand the Basic concepts in Differential equations
CO3	To understand the Basic concepts in Analytic functions
CO4	To understand the Basic concepts in Complex Integration
CO5	To understand the Basic concepts in Fourier series

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	1	1	1	2	1	3
CO2	3	2	3	1	1	2	1	1	2	1	1	2
CO3	3	2	2	2	2	1	1	1	1	1	1	2
CO4	3	3	2	1	1	2	1	1	2	1	1	3
CO5	2	3	3	2	1	1	1	2	1	1	1	3

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3
CO2	3	3	3	3
CO3	3	3	3	3
CO4	3	3	3	3
CO5	3	3	3	3

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
	√											

Subject Code: EBMA22024	Subject Name: Mathematics I for Chemical Engineers	Ty / Lb/ ETL	L	T / SLr	P/ R	C
	Prerequisite: Nil	Ty	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).*

Subject Code:	**Subject Name : Mechanical Operations**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EBCT22002	**Prerequisite: Unit operations and processes**	**Ty**	**3**	**1/0**	**0/0**	**4**

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).*

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

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.
CO4	To determine the effectiveness and efficiency of separating equipments
CO5	To study design and construction of separating equipments

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**2**	**1**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**
CO2	**-**	**1**	**-**	**1**	**-**	**1**	**-**	**2**	**-**	**-**	**-**	**-**
CO3	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**-**
CO4	**1**	**2**	**-**	**2**	**-**	**2**	**-**	**2**	**3**	**-**	**1**	**-**
CO5	**1**	**-**	**1**	**-**	**2**	**-**	**2**	**3**	**-**	**2**	**-**	**1**

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**			
CO1	**3**	**2**	**1**	**-**			
CO2	**2**	**1**	**3**	**-**			
CO3	**1**	**2**	**3**	**-**			
CO4	**1**	**1**	**2**	**-**			
CO5	**2**	**1**	**1**				

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCT22002	Subject Name : Mechanical Operations	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Unit operations and processes	Ty	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.*

Subject Code: EBCE22ID4	Subject Name : Environmental Engineering	Ty/Lb/ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	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/ Internal evaluation

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.
CO4	To develop students analytical, computational and research skills through assignments, weekly presentations and modeling software.
CO5	To inculcate among students sensitivity towards social and corporate responsibilities

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	1	-	-	-	2	-	1
CO2	3	2	-	-	-	-	-	-	-	2	-	-
CO3	3	2	1	-	-	2	-	-	-	1	-	3
CO4	2	-	-	-	1	-	-	-	2	-	-	1
CO5	-	1	-	-		-	-	-	-	1	-	-

COs / PSOs	PSO1	PSO2	PSO3	PO4
CO1	3	3	3	-
CO2	3	3	3	-
CO3	3	3	3	-
CO4	2	1	1	-
CO5	2	3	1	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities	Program	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
		√										

Subject Code: EBCE22ID4	Subject Name : Environmental Engineering	Ty/Lb/ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	Ty	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 : Fertilizer Technology	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EBCT22ET1	Prerequisite: Basic science	ETL	2	0/0	2/0	3

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

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	Use the proper micronutrients to improve fertility of soil.
CO2	Use relevant fertilizer on the basic of different properties
CO3	Select the relevant manufacturing process for phosphatic fertilizers
CO4	Select the relevant manufacturing process for potassic fertilizers
CO5	Select proper micro-nutrient to produce bio-fertilizer

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	1	-	-	-	-	3	-
CO2	2	3	-	2	-	2	-	-	-	-	3	1
CO3	-	-	1	-	1	2	1	-	1	3	1	-
CO4	1	-	-	-	2	-	2	-	-	1	-	1
CO5	2	-	2	1	-	2	1	-	-	-	1	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	2	-	1
CO2	3	1	2	1
CO3	3	2	1	-
CO4	2	1	2	2
CO5	3	2	2	2

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code: EBCT22ET1	Subject Name : Fertilizer Technology	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Basic science	ETL	2	0/0	2/0	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.

SEMESTER I (PRACTICAL)

Subject Code: EBCT22L02	Subject Name : Mechanical Operation Lab	Ty/Lb/ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Mechanical operation theory	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/ Internal Evaluation

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	Thermal conductivity of insulation powder
CO2	Determination of emissivity of a grey body
CO3	Determination of overall heat transfer coefficients for a composite wall
CO4	Determination of steban beltzman constant
CO5	Determination of efficiency of a pin-fin apparatus to find using based convection

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	3	-	-	-	3	-	-	1
CO2	2	-	2	-	3	-	-	-	3	-	-	2
CO3	2	-	-	-	1	-	-	-	3	-	2	-
CO4	3	-	-	1	-	-	-	3	-	-	1	-
CO5	2	-	-	-	1	2	2	-	-	-	-	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	-
CO2	3	1	-	-
CO3	1	2	1	-
CO4	3	2	1	-
CO5	1	2	1	1

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code: EBCT22L02	Subject Name : Mechanical Operation Lab	Ty/Lb/ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Mechanical operation theory	Lb	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: EBMA22025	Subject Name : Mathematics II for 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 chemicalstudents.

COURSE OUTCOMES (COs) :

CO1	To understand the Basic concepts in Partial Differential equations
CO2	To understand the Basic concepts in One & Two dimensional Heat and Wave equations
CO3	To understand the Basic concepts in Laplace Transforms
CO4	To understand the Applications of Laplace Transforms
CO5	To understand the Basic concepts in Fourier Transforms

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	1	1	2	1	2	2	1	2
CO2	3	3	3	2	1	1	1	2	2	1	1	2
CO3	3	3	3	2	1	1	1	1	2	1	2	3
CO4	2	3	3	1	2	2	1	2	1	1	1	3
CO5	3	3	2	2	1	2	1	1	1	2	1	3

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	-
CO2	2	3	2	-
CO3	3	2	-	-
CO4	3	3	3	-
CO5	3	3	3	3

H/M/L indicates StrengthofCorrelation 3- High, 2- Medium,1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
	√											

Subject Code: EBMA22025	Subject Name : Mathematics II for Chemical Engineers	Ty / Lb/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Mathematics I	Ty	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: EBCS22ID1	Subject Name : Computer Applications in Chemical Engineering	Ty/Lb/ETL/IE	L	T/SLr	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/ Internal evaluation

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.
CO4	To analyze calculation of chemical engineering data
CO5	By using computer programming to manipulate simulation of chemical processing

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	1	-	-	-	-	1	1	-
CO2	3	3	-	-	3	-	3	-	-	1	3	-
CO3	1	1	-	-	3	-	-	-	-	2	1	-
CO4	3	-	2	2	-	3	-	-	2	-	-	2
CO5	2	2	-	-	2	-	3	1	-	1	2	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1
CO2	2	1	2	1
CO3	1	2	1	2
CO4	3	2	1	2
CO5	1	2	2	1

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCS22ID1	Subject Name : Computer Applications in Chemical Engineering	Ty/Lb/ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Computer Fundamentals	Ty	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:	Subject Name : Chemical Process Calculations	Ty/Lb/ETL/IE	L	T/SLr	P/R	C
EBCT22003	Prerequisite: General Chemistry & basic chemical reactions	Ty	3	0/0	0/0	3

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

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.
CO4	Learn to perform energy balance calculation
CO5	Student will learn different problems related to process industries and come up with appropriate solution

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO10	PO1 1	PO12
CO1	3	2	1	-	-	-	1	-	-	-	-	1
CO2	2	3	1	-	-	-	2	-	-	-	-	-
CO3	2	3	1	-	-	-	1	-	-	-	-	2
CO4	3	-	-	-	1	-	-	2	-	-	-	-
CO5	2	1	-	-	1	-	-	-	1	-	-	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	2	3	1	2
CO3	3	1	2	2
CO4	2	1	-	-
CO5	1	2	2	-

H/M/L indicates Strength of Correlation 3- High,2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCT22003	Subject Name : Chemical Process Calculations	Ty/Lb/ETL/IE	L	T/SLr	P/R	C
	Prerequisite: General Chemistry & basic chemical reactions	Ty	3	0/0	0/0	3

UNIT I UNITS, DIMENSIONS AND GAS CALCULATIONS 9Hrs

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 9Hrs

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 9Hrs

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 9Hrs

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 9Hrs

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: 45Hrs

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: EBCT22004	Subject Name : Chemical Technology I	Ty / Lb/ ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Engineering Chemistry – II	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/ Internal Evaluation

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.
CO4	Can describe various manufacturing processes used in chemical process industries
CO5	Can understand major engineering problems encountered in chemical process industries

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	2	-	-	-	-	2	-	1	-
CO2	3	2	-	-	-	-	-	-	3	-	-	-
CO3	1	3	-	-	-	1	-	-	3	-	-	2
CO4	2	1	-	1	-	-	-	2	-	-	2	-
CO5	1	-	1	-	-	-	-	1	-	-	1	-

COs /PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1
CO2	2	1	3	3
CO3	1	3	2	1
CO4	2	2	1	2
CO5	2	3	1	1

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCT22004	Subject Name : Chemical Technology I	Ty / Lb/ ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Engineering Chemistry – II	Ty	3	1/0	0/0	4

UNIT I INTRODUCTION 12Hrs

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 12Hrs

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 12Hrs

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 12Hrs

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 12Hrs

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: 60Hrs

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 II (PRACTICAL)

Subject Code: EBCT22ET2	Subject Name: Polymer Technology	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Engineering chemistry 1	ETL	2	0/0	2/0	3

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

OBJECTIVE:

- To enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers.

COURSE OUTCOMES (COs) : (3- 5)

CO1	At the end of this course, the student would be able to demonstrate knowledge and understanding on the principles related to the synthesis and characterization of polymers.
CO2	Understand the techniques and their characteristics/limitations of synthesis of polymers.
CO3	Understand the structure-processing-property relationship of polymers.
CO4	Understand and apply the various processing and manufacturing techniques.
CO5	Understand the basic issues involved in polymer blends, composites and nano-composites.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	1	-	-	-	-	2	-	3
CO2	2	-	-	-	2	-	-	1	-	3	-	2
CO3	2	2	1	2	-	2	-	3	-	-	3	-
CO4	1	2	-	3	-	-	2	-	2	1	-	3
CO5	2	-	3	-	2	-	2	-	3	-	2	2

COs /PSOs	PSO 1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	-	-
CO3	3	2	2	-
CO4	-	1	1	2
CO5	2	2	1	3

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code: EBCT22ET2	Subject Name: Polymer Technology	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Engineering chemistry 1	ETL	2	0/0	2/0	3

UNIT I INTRODUCTION 12Hrs

History of Macromolecules – structure of natural products like cellulose, rubber,proteins – concepts of macro molecules – Staudinger's theory of macromolecules – difference between simple organic molecules and macromolecules.

UNIT II ADDITION POLYMERIZATION 12Hrs

Chemistry of Olefins and Dienes – double bonds – Chemistry of free radicals –monomers – functionality – Polymerization: Initiation – types of initiation – free radical polymerization – cationic polymerization – anionic polymerization – coordination polymerization – industrial polymerization – bulk, emulsion,
suspension and solution polymerization techniques – Kinetics – Copolymerization concepts.

UNIT III CONDENSATION POLYMERIZATION 12Hrs

Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity – polycondensation – kinetics of polycondensation- Carother's equation – Linear polymers by polycondensation– Interfacial polymerization – crosslinked polymers by condensation – gel point.

UNIT IV MOLECULAR WEIGHTS OF POLYMERS 12Hrs

Difference in molecular weights between simple molecules and polymers –number average and weight average molecular weights – Degree of polymerization and molecular weight – molecular weight distribution – Polydispersity – molecular weight determination. Different methods – Gel Permeation Chromatography – Osmometry, Light Scattering.

UNIT V TRANSITIONS IN POLYMERS 12Hrs

First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures –crystallinity in polymers – effect of crystallization – in polymers – factors affecting crystallization crystal nucleation and growth – relationship between Tg
and Tm – Relationship between properties and crystalline structure.

Total No. of Hours: 60Hrs

TEXT BOOKS:

1. Billmeyer.F.W.,Jr, Text Book of Polymer Science, Ed. Wiley-Interscience,1984.
2. Seymour.R.B., and Carraher.C.E., Jr., Polymer Chemistry, 2nd Ed., Marcel Dekker, 1988.
3. Gowariker.V.T., Viswanathan.N.V., and Sreedar.J., Polymer Science, Wiley Eastern Ltd., 1988.

REFERENCES*:*

1. Joel,R.F Polymer Science and Technology, Eastern Economy Edition,1999.

SEMESTER III (THEORY)

Subject Code:	Subject Name : Bio-Chemical Principles	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EBBT22ID1	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/ Internal Evaluation

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	To impart knowledge on design and operation of fermentation processes with all its prerequisites.
CO2	To endow the students with the basics of microbial kinetics, metabolic stoichiometry, energetics and product formation involved in bioprocess technology
CO3	To apply engineering principles to systems containing biological catalysts to meet the needs of the society.
CO4	Convert the promises of molecular biology and genetic engineering into new processes to make bio-products in economically feasible way.
CO5	Discuss the significance of material and energy balance for bioprocess technology.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	2	-	-	3	-	-	-	-	1
CO2	2	-	2	-	-	-	1	-	-	2	-	-
CO3	3	1	1	-	-	-	-	2	-	-	1	-
CO4	2	-	-	-	1	-	-	-	2	-	-	1
CO5	2	2	3	-	-	-	2	-	1	-	1	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	1	2				
CO2	2	1	1	2				
CO3	3	1	1	2				
CO4	2	1	2	1				
CO5	2	1	2	1				

H/M/L indicates Strength of Correlation 3- High, 4- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code:	Subject Name : Bio-Chemical Principles	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EBBT22ID1	Prerequisite: Engineering mathematics, physics, stoichiometric concepts, chemistry	Ty	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: EBCT22009	Subject Name : Chemical Technology II	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Chemical Technology I	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/ Internal Evaluation

OBJECTIVE:

- To study process technologies of various organic and inorganic process industries.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Knowledge about pulp and paper technology.
CO2	Study of sugar,starch soap industries.
CO3	Study of petroleum and petrochemical industries.
CO4	Can determine process aspects like yield, byproducts formed, generation of waste
CO5	Can draw and explain process flow diagrams for a given process

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	2	1	1	3	-	-	1	-	1
CO2	2	-	2	-	2	-	1	-	2	2	-	2
CO3	1	1	-	1	2	-	-	-	2	-	3	-
CO4	2	2	2	-	-	2	-	2	3	2	-	1
CO5	3	1	3	2	-	1	2	1	-	1	2	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-
CO2	2	3	1	1
CO3	1	2	1	2
CO4	1	2	3	1
CO5	2	1	1	2

H/M/L indicates Strength of Correlation 3- High,2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCT22009	Subject Name : Chemical Technology II	Ty/Lb/ ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Chemical Technology I	Ty	3	0/0	0/0	3

UNIT I PULP AND PAPER INDUSTRIES 9Hrs

Wood and Wood extracts – Wood Chemicals - Cellulose derivatives, Manufacture of pulp – different processes of pulping – Manufacture of paper – Manufacture of Boards.

UNIT II SUGAR, STARCH INDUSTRIES & OILS, FATS, SOAPS & DETERGEN INDUSTRIES 9Hrs

Raw and refined sugar by products of sugar industries, starch and starch derivatives. Vegetable oils and animal fats, their nature, analysis and extraction methods, hydrogenation of oils, fatty acids and alcohols, waxes, soaps, synthetic detergents.

UNIT III PETROLEUM AND PETROCHEMICAL INDUSTRIES 9Hrs

Petroleum refining, physical and chemical conversion products, lubricating oils, petrochemical precursors, methane, olefins, acetylenes and aromatics and products obtained from them by various UNIT processes.

UNIT IV RUBBER AND POLYMERS 9Hrs

Monomers – Thermosetting and Thermoplastic materials – General properties and applications of Resins – polymerization processes – different types - Natural rubber; Synthetic rubber such as SBR, NBR,CR - Fundamental methods of processing of synthetic Rubbers.

UNIT V SYNTHETIC FIBRE AND FILM INDUSTRIES 9Hrs

Natural and synthetic fibres – properties of - Poly amides – manufacture of Nylon 6. 6. Polyesters Fibers – manufacturer of – Cellulosic fibres – Viscose Rayon production manufacture of films - cellulose Acetate, PVC, Polyesters – polyethylene.

Total No.of Hours: 45Hrs

TEXT BOOKS:

1. Austin, G.T., "Shreve's Chemical Process Industries ", Fifth Edition, McGraw-Hill International Book Co, Singapore, 1984.

2. Dryden, C.E., "Outlines of Chemical Technology ", Edited and Revised by Gopala Rao. M. and M.Sittig, Second edition, Affiliated East-West press, 1993.

REFERENCES:

1. Kent, J.A.(ed), " Riggel's Hand Book of Industrial Chemistry ", Van Nostrant Reinhold, 1974.

2. CHEMTECH 1-4, Chemical Engineering Education Development Centre I.I.T., Madras 1975-78

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Subject Code: EBCT22006	Subject Name : Fluid Mechanics Prerequisite:	Ty/Lb/ETL/IE Ty	L 3	T / S.Lr 0/0	P/ R 0/0	C 3

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

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	To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.
CO2	To introduce fundamental aspects of fluid flow behavior
CO3	To identify derivation of basic equations of fluid mechanics and apply
CO4	Able to demonstrate boundary layer concepts
CO5	To estimate performance parameters of a given Centrifugal and Reciprocating pump.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	2	-	-	-	1	1
CO2	3	1	-	3	-	1	-	-	-	-	3	2
CO3	2	3	-	-	-	-	3	-	-	-	3	2
CO4	1	-	-	-	2	1	-	3	-	-	-	-
CO5	2	-	-	-	1	-	-	-	2	-	-	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	3
CO2	2	1	2	1
CO3	2	1	1	3
CO4	3	2	-	-
CO5	2	1	-	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCT22006	Subject Name : Fluid Mechanics	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	Ty	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.*

Subject Code: EBCT22005	Subject Name : Chemical Engineering Thermodynamics I	Ty / Lb/ ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Classical thermodynamics	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/ Internal Evaluation

OBJECTIVE:

- To understand the theory and applications of classical thermodynamics, thermodynamic properties, equations of state, methods used to describe and predict phase equilibria.

COURSE OUTCOMES (COs) : (3- 5)

CO1	To understand and be able to use the first law of thermodynamics for open and closed systems, to set up energy balances for steady- and unsteady-state processes and to solve them for simple and classic cases.
CO2	To understand and be able to use the second law of thermodynamics, to set up entropy balances for steady- and unsteady-state processes and to solve them for simple and limiting cases to establish bounds for solutions to engineering problems.
CO3	Students, at the end of the course will be able to comprehend the fundamental concepts of enthalpy, entropy, internal energy and free energy.
CO4	Students, at the end of the course will be able to use volumetric equations of state to estimate saturation pressure of pure components.
CO5	Students, at the end of the course will be able to use the concept of thermodynamic consistency of vapor-liquid equilibrium data through Gibbs-Duhem equation and test consistency of data.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PO1 2
CO1	2	1	-	2	-	-	-	-	2	-	1	-
CO2	3	2	-	-	-	2	-	-	3	-	-	2
CO3	2	1	1	-	-	-	-	2	-	2	2	1
CO4	3	-	1	-	2	-	-	3	-	-	1	-
CO5	2	2	-	2	1	1	1	-	1	1	-	2

COs / PSOs	PSO1	PSO2	PSO3	PSO 4
CO1	3	1	1	2
CO2	2	1	3	3
CO3	2	1	1	1
CO4	3	2	1	1
CO5	1	1	1	2

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives						
				√								

Subject Code: EBCT22005	Subject Name : Chemical Engineering Thermodynamics I	Ty / Lb/ ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Classical thermodynamics	Ty	3	1/0	0/0	4

UNIT – I FUNDAMENTAL CONCEPTS IN THERMODYNAMICS 12Hrs
Introduction – systems – surrounding – thermodynamic property – heat – work – energy forms

UNIT – II FIRST LAW OF THERMODYNAMICS 12Hrs
First law of thermodynamics - batch systems – open systems – applications – chemical reactions

UNIT - III SECOND LAW OF THERMODYNAMICS 12Hrs
Second law -carnot's principle – reversible – irreversible processes – entropy –criterion for reversible – irreversible – entropy balance

UNIT - IV REFRIGERATION AND LIQUEFACTION 12Hrs
Heat engines – refrigeration – cycles.

UNIT – V THERMODYNAMIC PROPERTIES OF FLUIDS 12Hrs
Fluids – state equations – ideal gas – actual gas equations – application.

Total No of periods: 60Hrs

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

REFERENCES

1. Hougen, O.A., Watson, K.M., and Ragatz, R.A., " ChemicalProcess 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. ",
4. Wiley, 1989.
***5.** Kyle, B.G., " Chemical and Process Thermodynamics 2nd edn. ", Prentice Hall of India Pvt.Ltd., 1990.*

SEMESTER IV (THEORY)

Subject Code: EBCT22008	Subject Name : CHEMICAL ENGINEERING THERMODYNAMICS-II	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: design chemical process plants.	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/ Internal Evaluation

OBJECTIVE:

- To provide knowledge of thermodynamic properties of real fluids and mixtures to design chemical process plants.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Students, at the end of the course will be able to describe the concept of non-ideal behavior of mixtures, activity coefficients.
CO2	Students, at the end of the course will be able to use models for liquid phase non-ideality of mixtures with multiple levels of complexity and capability including predictive models.
CO3	Students, at the end of the course will be able to describe phase equilibria such as gas-liquid, liquid-liquid, solid-liquid with thermodynamic framework and correlate data and estimate properties.
CO4	Students, at the end of the course will be able to use the concept of chemical reaction equilibrium in ideal gas reactions in thermodynamic terms.
CO5	Students, at the end of the course will be able to describe nonideal gas, liquid, solid and multiphase chemical reaction equilibria and predict equilibrium conversions.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	2	1	1	3	-	-	1	-	1
CO2	2	-	2	-	2	-	1	-	2	2	-	2
CO3	1	1	-	1	2	-	-	-	2	-	3	-
CO4	2	2	2	-	-	2	-	2	3	2	-	1
CO5	3	1	3	2	-	1	2	1	-	1	2	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-
CO2	2	3	1	1
CO3	1	2	1	2
CO4	1	2	3	1
CO5	2	1	1	2

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

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

Subject Code: EBCT22008	Subject Name : CHEMICAL ENGINEERING THERMODYNAMICS-II	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: design chemical process plants.	**Ty**	**3**	**1/0**	**0/0**	**4**

UNIT – I APPLICATION OF THERMODYNAMICS TO GAS EQUATIONS 12Hrs

Partial derivaties–exact differentials – Maxwells relations – thermodynamic – properties equation – application to actual gas equation.

UNIT - II FUGACITY CORRELATIONS 12Hrs

Residual properties – fugacity – fugacity coefficient - correlation

UNIT – III SOLUTION THERMODYNAMIC THERORY 12Hrs

Solutions – actual – ideals – excess free energy – activity – activity coefficients – correlations

UNIT - IV V.L.E FROM EQUATION OF STATES 12Hrs

V.L.E correlation – data generation – result – gas – liquid system – Henry's law – liquid – liquid , liquid – solid gas – solid equilibrium.

UNIT - V CHEMICAL REACTION EQUILIBRIA 12Hrs

Chemical reaction equilibrium – equilibrium constant – calculations

Total No of Hrs: 60Hrs

TEXT BOOKS

1. *Smith , J.M., Van Ness, H.C., " Introduction to Chemical Engineering Thermodynamics ", Kogakushai 1976.*
2. *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..*
2. *Dodge, B.F., "ChemicalEngineering Thermodynamics ", McGraw-Hill, 1*
3. *Sandler, S.I., "Chemical and Engineering Thermodynamics ", 2nd Edition., Wiley.*

Subject Code: EBCT22007	Subject Name : Mass Transfer-I	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	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/ Internal Evaluation

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	Understand the basic concepts of diffusion in gases, liquids and solids
CO2	Apply principles of mass transfer to predict transfer coefficients
CO3	To determine NTU, HTU,HETP and height of packed bed used for Humidification operations
CO4	To find time required for drying and to understand the operation of various types of drying equipments
CO5	To estimate process of nuclei formation, theories and operation of crystallization

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	3	-	2	-	3	-	1	1	-
CO2	2	-	-	1	-	-	-	-	-	3	-	1
CO3	3	-	-	-	-	-	-	1	-	-	2	-
CO4	2	-	-	-	1	-	-	-	2	-	-	1
CO5	3	-	-	-	-	1	-	-	2	-	-	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	-	-
CO3	3	2	-	-
CO4	2	1	1	-
CO5	3	1	2	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCT22007	Subject Name : Mass Transfer-I	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Engineering mathematics, physics, stoichiometric concepts, chemistry	Ty	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 conditions Diffusivity measurement and prediction, multi-component 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 multi-component 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 9Hrs 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 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.*
   Foust, A.S.Wenzel, L.A., Clump, C.W.,Naus, L., and Anderson, L.B., "Principles of UNIT

Subject Code: EBCT22011	Subject Name : Heat Transfer	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Basic maths & material energy balance	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/ Internal Evaluation

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.
CO4	Design double pipe heat exchangers, shell and tube heat exchangers, plate heat exchangers
CO5	Solve problems in various heat transfer heat equipment such as evaporators, furnace.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	3	-	-	-	-	-	2	2
CO2	1	2	-	-	-	-	2	-	-	-	3	2
CO3	2	3	-	-	1	-	-	-	-	-	3	2
CO4	3	1	1	2	-	-	-	1	-	2	3	3
CO5	3	3	-	-	-	-	-	2	-	-	2	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	3
CO2	1	2	3	2
CO3	3	2	1	3
CO4	2	1	2	3
CO5	3	2	1	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

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

Subject Code: EBCT22011	Subject Name : Heat Transfer	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Basic maths & material energy balance	Ty	3	0/0	0/0	3

UNIT I BASIC PRINCIPLES AND CONDUCTION 9Hrs

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 9Hrs

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 9Hrs

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 9Hrs

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 9Hrs

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: 45Hrs

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: EBCT22L08	Subject Name : Heat Transfer Lab	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Transfer by conduction	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/ Internal Evaluation

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	Determine the overall heat transfer coefficient for a composite slab
CO3	Estimate heat transfer coefficients in condensation, boiling and effectiveness of heat pipe
CO4	Estimate heat transfer coefficients in forced convection, free convection and determine effectiveness of heat exchangers

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	-	1	-	-	3	2	1
CO2	2	-	3	3	-	-	3	3	3	-	-	-
CO3	1	-	-	2	-	-	-	-	-	--	1	-
CO4	2	3	-	-	-	-	-	-	-	-	-	2
CO5	3	-	-	-	-	-	-	-	2	-	-	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	-	-
CO3	2	1	3	-
CO4	3	2	1	-
CO5	1	1	2	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code: EBCT22L08	Subject Name : Heat Transfer Lab	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Transfer by conduction	Lb	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/ IE	L	T / S.Lr	P/ R	C
EBCT22010	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/ Internal Evaluation

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)

CO 1	The concept of Equilibrium in all separation operations should be clear.
CO 2	Able to design Distillation columns
CO 3	Working of Extraction, adsorption, Leaching equipments
CO 4	Able to choose Economical separation
CO 5	Understand working & principles of membranes

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	3		-	-	3	1	2	-	-
CO2	3	-	-	-	-	-	-	2	1	1	-	2
CO3	3	2	3	-	-	-	1	-	-	-	2	-
CO4	3	3	2	2	-	-	-	2	-	-	3	-
CO5	2	-	-	1	-	2	-	3	-	1	-	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4			
CO1	3	2	1	3			
CO2	3	1	3	3			
CO3	2	1	2	2			
CO4	3	1	2	3			
CO5	3	3	2	1			

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCT22010	Subject Name : Mass Transfer II	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Basic mathematics & energy & material balance	Ty	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.

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

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

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

6. 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 I	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EBCT22012	Prerequisite: Equations thermodynamics	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/ Internal Evaluation

OBJECTIVE:

- To apply knowledge from calculus, differential equations thermodynamics, general chemistry, and material and energy balances to solve reactor design problems.
- To examine reaction rate data to determine rate laws, and to use them to design chemical reactors
- To simulate several types of reactors in order to choose the most appropriate reactor for a given need.
- To design chemical reactors with associated cooling/heating equipment

COURSE OUTCOMES (COs) : (3- 5)

CO1	Basic concept for thermodynamics and first law can be understood, PVT behavior of fluids and ideal gas processes can be analysed.
CO2	Develop rate laws for homogeneous reactions
CO3	Design of ideal reactors for single and complex reactions
CO4	Develop skills to choose the right reactor among single, multiple, recycle reactor, etc. schemes.
CO5	Design of non-isothermal reactors and the heat exchange equipment required.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO 2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO1 1	PO12
CO1	1	-	3	3	-	3	3	-	2	1	-	3
CO2	2	2	-	-	2	-	1	-	2	-	1	3
CO3	3	-	2	-	-	1	-	2	-	-	3	-
CO4	2	1	-	1	-	2	-	2	-	3	1	1
CO5	3	-	-	-	3	-	-	3	-	-	1	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-
CO2	2	1	-	1
CO3	2	-	2	1
CO4	2	3	3	-
CO5	2	1	1	3

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

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

Subject Code:	Subject Name : Chemical Reaction Engineering I	Ty/Lb/ETL/IE	L	T / S.Lr	P/R	C
EBCT22012	Prerequisite: Equations thermodynamics	Ty	3	0/0	0/0	3

UNIT – I REACTION KINETICS 9Hrs

Law of mass action, rate equation, elementary, non-elementary reactions and their mechanisms, theories of reaction rate and temperature dependency, analysis of experimental reactor data, evaluation of rate equation, integral and differential analysis for constant variable volume system, fitting of data complex reaction mechanism.

UNIT – II IDEAL REACTORS 9Hrs

Design for homogeneous systems, batch, stirred tank and tubular flow reactor, design of reactors for multiple reactions, combination reactor system, size comparison of reactors.

UNIT - III CHOICE OF REACTORS 9Hrs

Factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield problems, consecutive, parallel and mixed reactions, recycle.

UNIT - IV HEAT EFFECTS IN REACTORS 9Hrs

Isothermal and non isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate heat input and constant heat transfer coefficient, operation, batch and continuous reactors, optimum temperature progression.

UNIT - V REACTOR STABILITY AND REACTION EQUILIBRIA 9Hrs

Criteria for stability of reactors, limit cycles and oscillating reaction, parameter sensitivity. Equilibrium in chemically reactive systems, evaluation of reaction equilibrium constant, effect of temperature on equilibrium, application to system involving gaseous components, computation of equilibrium composition.

Total No of Hrs: 45Hrs

TEXT BOOKS:

1. Smith.J.M.,"Chemical Engineering Kinetics ", McGraw-Hill Third Edition.

REFERENCES:

1. Levenspiel.O, "Chemical Reaction Engineering ", John Wiley, Second Edition.

Subject Code:	Subject Name : Process Control And Dynamics	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EBCT22014	Prerequisite: Engineering Chemistry I & II, Engineering Mathematics III & IV	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/ Internal Evaluation

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	Analyse PID controllers and more advanced controllers to achieve desired performance & Understand various controller designs, and methods of controller tuning.
CO3	Design a control strategy for key unit operations (reactor, distillation column, etc)
CO4	Understand working principles of basic instruments available for flow, pressure, level and temperature measurement
CO5	Design of feedback control systems using frequency response techniques.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	-	-	2	-	3	1	-	1
CO2	2	-	-	3	-	3	-	-	3	1	-	2
CO3	3	2	3	2	-	-	-	-	2	-	2	3
CO4	2	1	2	-	-	-	-	2	-	-	2	3
CO5	3	3	3	-	-	2	2	-	3	3	3	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	2	1	3	3
CO3	3	3	2	-
CO4	2	3	2	-
CO5	2	1	3	2

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code:	Subject Name : Process Control And Dynamics	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EBCT22014	Prerequisite: Engineering Chemistry I & II, Engineering Mathematics III & IV	Ty	3	0/0	0/0	3

UNIT I RESPONSE OF FIRST ORDER SYSTEM 9Hrs

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 9Hrs

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 9Hrs

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 9Hrs

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 processe

UNIT V ADVANCED CONTRO SYSTEM 9Hrs

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: 45Hrs

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*

SEMESTER V (PRACTICAL)

Subject Code: EBCT22L07	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/ Internal Evaluation

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	Design chemical reactors optimally, using minimum amount of data
CO3	Design experiments in a judicious way to get the required data, if not available
CO4	Fix some problems related to operability and productivity
CO5	Maintain and operate a process in a safe manner, Increase capacity and/or selectivity and/or safety by improving/changing the reactor type/sequence

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	-	1	-	-	-	2	-	-	3
CO2	2	3	-	3	-	-	3	-	3	-	2	-
CO3	1	-	-	-	-	2	-	-	2	-	-	3
CO4	3	-	1	-	-	-	1	1	-	-	-	1
CO5	2	2	-	-	2	1	1	1	-	2	1	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	2	2	1	-				
CO2	3	1	2	1				
CO3	2	1	2	1				
CO4	3	1	1	2				
CO5	2	2	2	1				

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code: EBCT22L07	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

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: EBCT22013	Subject Name : Safety In Chemical Process Industries	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Chemical Reaction Engineering	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/ Internal Evaluation

OBJECTIVE:

- To study process technologies of various organic and inorganic process industries.

COURSE OUTCOMES (COs) : (3- 5)

CO1	To impart the principles of safety in chemical process operations.
CO2	To educate the students the importance of safety procedures and safety regulations in chemical industries.
CO3	Ability to understand the manufacturing of various inorganic and organic chemicals
CO4	Ability to understand the process flow diagram and various process parameters
CO5	Ability to identify and solve engineering problems during production

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1	1	1	1	3	3	2	1
CO2	1	1	1	1	2	2	2	1	2	1	2	1
CO3	2	1	1	1	3	2	3	1	2	1	1	2
CO4	2	1	2	1	1	1	2	2	2	1	2	2
CO5	1	1	1	2	2	1	2	1	2	1	2	3

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2
CO2	1	1	1	-
CO3	1	1	2	2
CO4	1	2	2	1
CO5	2	2	2	1

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCT22013	Subject Name : Safety In Chemical Process Industries	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Chemical Reaction Engineering	Ty	3	1/0	0/0	4

UNIT I INTRODUCTION 12Hrs

Safety in industries – need for development – importance of safety consciousness in Indian Chemical Industry – social environmental setup – Tolerance limit of the society – Psychological attitude towards safety programmes.

UNIT II SAFETY PROGRAMMES 12Hrs

Elements of safety programmes – Effective realization – Economic and social benefits – Effective communication training at various levels of production and operation.

UNIT III SAFETY PERFORMANCE 12Hrs

Appraisal – Effective steps to implement safety procedures – Periodic inspection and study of plant layout and constant maintenance – Periodic advice and checking to follow safety procedures – proper selection and replacement of handling equipments – personal protective equipment.

UNIT IV ACCIDENTS 12Hrs

Industrial accidents – accident costs – identification of accident spots – remedial measure – identification and analysis of causes of injury to men and machines – accident prevention – accident proneness – vocational guidance, fault free analysis – Fire prevention and fire protection.

UNIT V HEALTH HAZARDS AND LEGAL ASPECTS 12Hrs

Health hazards – occupational – Industrial health hazards – health Standards and rules – safe working environments – parliamentary legislation – Factories act – Labor Welfare Act – ESI Act – Workmen Compensation Act.

Total No of Hrs: 60Hrs

TEXT BOOK

1. *William Handley, Industrial Safety Hand Book, Mc Graw-Hill Book Company, 2nd edition, 1969.*
2. *Fawatt, H.H and Wood, W.S., Safety and Accident Prevention in Chemical operation, Interscience, 1965.*

REFERENCE

1. Heinrich, H.W, Dan Perterson, P.E and Nester Rood, Industrial Accident Prevention, McGraw- Hill, 1980.
2. Blake, R.P., Industrial Safety, PHI, III ed, 1963.

Subject Code:	Subject Name: Total Quality Management	T y/ Lb/ETL	L	T / SLr	P/ R	C
EBCC22ID3	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: The student will earn:

- To acquaint the students with the basic concept of Total Quality (TQ)
- To understand the customers' expectations and plan TQM accordingly
- To give understand International Quality Certification Systems – ISO 9000 and other standards
- To understand concepts related to quality of services in contemporary environment

COURSE OUTCOMES (COs) :

CO1	Understand the Quality Policies (Level 2)
CO2	Understand the Concepts of Total Quality Management (Level 2)
CO3	Apply Total Quality Management tools in Industry (Level 3)
CO4	Apply the Modern tools of Quality Control (Level 3)
CO5	Acquiring knowledge about Modern Trends and Concepts in Manufacturing Management(Level 2)

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	3	3	-	-	3	3	2	3	2
CO2	-	3	2	-	-	3	-	3	2	3	-	2
CO3	3	2	-	2	2	-	3	2	-	2	2	2
CO4	-	-	3	3	3	-	3	2	2	2	2	2
CO5	3	3	3	3	3	3	-	2	3	2	2	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	-	2	3	3
CO2	-	2	3	3
CO3	-	2	3	3
CO4	-	2	3	3
CO5	-	2	3	3

H/M/L indicates Strength of Correlation 3- High,2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			

Subject Code: EBCC22ID3	Subject Name: Total Quality Management	T y/ Lb/ETL	L	T / SLr	P/ R	C
	Prerequisite: Nil	Ty	3	0/0	0/0	3

UNIT– I QUALITY POLICY, PLANNING AND MANAGEMENT 9Hrs

Evolution of quality as a strategy- Definitions of quality, Quality Philosophies of Deming, Crosby and Miller, Service Vs product Quality, Customer focus, Quality and Business performance leadership for quality management, Quality planning, Designing for Quality and Manufacturing for Quality, Vision, Mission statements and Quality policy.

UNIT – II BASIC CONCEPTS F TOTAL QUALITY MANAGEMENT 9Hrs

Total Quality management- TQM models, human and system Components, Continuous Improvement Strategies, Deming wheel, Internal External Customer concept, Customer satisfaction Index, Customer retention, Team work and team building, Empowerment, TQM culture, Quality Circle, 5S principle, Top Management commitment.

UNIT – III QUALITY MANAGEMENT TOOLS 9Hrs

Quality management tools - Principles and applications of quality Function deployment, Failure Mode and Effect Analysis (FMEA), Taguichi Techniques, Basic tools- Statistical techniques and graphical tools and diagrams.

UNIT - IV VARIOUS CONCEPTS OF QC TECHNIQUES 9Hrs

Modern QC techniques - Japanese Production Related Techniques: Just in time (JIT) – Quality circles – Total productive maintenance (TPM) – Kaizen – Kanban – 5S concepts – Toyota production systems – JIDOKA – ANDON etc. Concepts on quality management systems (QMS – ISO 9000 – 2000) – Environmental Management Systems (EMS – ISO – 14000)

UNIT- V MODERN TREND AND CONCEPTS IN MANUFACTURING MANAGEMENT 9Hrs

Modern Trend and Concept in Manufacturing Management: Business processes reengineering (BPR) – Lean / flexible – manufacturing systems – Six sigma concepts. Quality Leadership- Quality Awards –Quality Tools- Quality Function Deployment.

Total No of Periods: 45Hrs

REFERENCES BOOKS:

1. *Jill A. Swift, Joel E.Ross and Vincent K.Omachonu, Peinciples of Total Quality, St.Lucie Press, US, 1998.*
2. *Samuel K.Ho, TQM, An integrated approach, kogan page India Pvt Ltd, 2002*
3. *Dale H.N Bester field et al, Total Quality management, Pearson Education Asia, 2001*
4. *RoseJ.E. Total Quality Management Kogan page India Pvt Ltd, 1993.*
5. *Mullar Max,' Essentials of Materail Management,Amacom*

Subject Code: EBCT22015	Subject Name : Chemical Reaction Engineering II	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Basic maths, chemistry & material energy balance	Ty	3	0/0	0/0	3

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

OBJECTIVE:

- To apply the knowledge of material energy balances, mass transfer and chemical reaction engineering for solving problems involving heterogeneous reaction systems.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Ability to distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information.
CO2	Design of ideal reactors for single and complex reactions
CO3	Develop rate laws for heterogeneous reaction
CO4	Design of reactors for non-catalytic and catalytic reactions.
CO5	Design of towers for gas–liquid operations with and without chemical reaction

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	1	1	-	1	-	1
CO2	1	3	-	3	-	-	2	3	-	-	2	-
CO3	2	1	1	-	-	-	-	-	-	1	-	-
CO4	2	-	-	-	-	2	-	-	-	3	-	-
CO5	1	-	2	-	-	-	-	1	-	-	-	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	2
CO2	3	2	1	3
CO3	2	1	2	3
CO4	3	1	2	1
CO5	3	1	1	2

H/M/L indicates Strength of Correlation 3- High,2 - Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EBCT22015	Subject Name : Chemical Reaction Engineering II	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Basic maths, chemistry & material energy balance	Ty	3	0/0	0/0	3

UNIT - I NON-IDEAL REACTORS 9Hrs

The residence time distribution as a factor performance; residence time functions and relationship between themin reactor; basic models for non-ideal flow; conversion in non-ideal reactors.

UNIT - II HETEROGENEOUS PROCESS AND SOLID CATALYSIS 9Hrs

Rate equations for heterogeneous reactions nature of catalysis, adsorption isothermal and rates of adsorption, desorption and surface reaction analysis of rate equation and rate controlling steps, surface area and pore-volume distribution, catalyst preparation.

UNIT - III GAS-SOLID CATALYTIC REACTORS 9Hrs

Diffusion within catalyst particle effective thermal conductivity mass and heat transfer within catalyst pellets; Effective factors, Thiele Modulus, fixed bed reactors.

UNIT - IV GAS-SOLID NON-CATALYTIC REACTORS 9Hrs

Models for explaining the kinetics; volume and surface models; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes, fluidised and static reactors.

UNIV – V GAS-LIQUID REACTIONS 9Hrs

Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants; application of film penetration and surface renewal theories; Hatta number and enhancement factor for first order reaction, tower reactor design.

Total No of Hrs: 45Hrs

TEXT BOOK

1. Fogler. H.S., "Elements of Chemical reaction engineering" 3rd edition, Prentice Hall of India Pvt. Ltd., 1999 (Indians Reprint 2003)

REFERENCES

1. Levenspiel , O; " Chemical Reaction Engineering ", 2nd Edition, John Wiley, 1972.
2. Smith J.M., "Chemical Engineering Kinetics", 3rd edition, McGraw-Hill, New York, 1981.

SEMESTER VI (PRACTICAL)

Subject Code: EBCT22I05	Subject Name : PROJECT PHASE -I	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Practical Knowledge of Basic Chemical Engineering Concepts	IE	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	3	3	3	3	2	3	3	1	2	2	3	3
CO2	3	3	3	3	3	3	3	2	2	2	3	3
CO3	2	3	3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	3	2	2	2	3	3	3	3

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	3				
CO2	3	3	3	2				
CO3	3	2	1	3				
CO4	3	3	3	2				

H/M/L indicates Strength of Correlation 3- High,2- Medium, 1-Low

Category	Basic Sciences	Engineering	Humanities and Social	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code: EBCT22I05	Subject Name : PROJECT PHASE -I	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Practical Knowledge of Basic Chemical Engineering Concepts	IE	0	0/0	3/3	2

Students are expected to do the Project in a group of 3 to 4 students. Theyshould identify the area/topic of the Project and should collect the literatures related to the project. Students intending to do Industrial projects will approach the industries with the support of the university, identify the industrial problem and finalize the project. In case of Industrial projects apart from Industry guide, a guide has to be appointed by the department. At the end of the Semester the students should submit their Project Phase - I report to the Department and Viva -Voce examination will be conducted by the examiners duly appointed by the Head of the department.

SEMESTER VII (PRACTICAL)

Subject Code: EBCT22L11	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	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	3	3	3	3	2	3	3	1	2	2	3	3
CO2	3	3	3	3	3	3	3	2	2	2	3	3
CO3	2	3	3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	3	2	2	2	3	3	3	3

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3
CO2	3	3	3	2
CO3	3	2	1	3
CO4	3	3	3	2

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

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

Subject Code: EBCT22L11	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

o make the students to make use of the knowledge and skill developed during their four years of study and to apply them for making an innovative product/process for the development of society and industries.

Students are expected to do a Project work either in an Industry or at the University in the field of relevant Engineering /inter-disciplinary /multi-disciplinary area in a group of 3 or 4 students. The work to be carried out in Phase II should be continuation of Phase I. Each group will be allotted a guide based on the area of Project work. In case of industrial Project external guide has to be allotted from Industry. Inter disciplinary/multi-disciplinary project can be done with students of different disciplines as a group. Monthly reviews will be conducted during the semester to monitor the progress of the project by the project review committee. Students have to submit the Project thesis at the end of the semester and appear for the Project Viva-Voce examination conducted by the examiners duly appointed by the Controller of Examination. In case of industrial project certificate in proof has to be included in the report along with the bonofide certificate.

PROGRAMME ELECTIVES - I

Subject Code: EBCT22E01	**Subject Name: Food Technology**	**Ty / Lb/ ETL/IE**	**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.
CO4	Identify important species of pathogenic microbes and describe factors that affect their growth in various types of food.
CO5	Analysis of food related hazards and HACCP method.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**-**	**1**	**-**	**-**	**-**	**2**	**-**	**3**	**-**	**1**	**-**
CO2	**2**	**-**	**1**	**-**	**1**	**-**	**3**	**-**	**-**	**-**	**1**	**2**
CO3	**3**	**-**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**1**	**-**
CO4	**2**	**-**	**1**	**-**	**1**	**-**	**3**	**-**	**-**	**-**	**1**	**2**
CO5	**3**	**-**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**1**	**-**

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**				
CO1	**3**	**2**	**1**	**3**				
CO2	**2**	**1**	**3**	**3**				
CO3	**3**	**3**	**3**	**1**				
CO4	**2**	**1**	**3**	**3**				
CO5	**1**	**2**	**3**	**1**				

H/M/L indicates Strength of Correlation 3- High, 2- Medium,1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E01	Subject Name: Food Technology	Ty / Lb/ ETL/IE	L	T / SLr	P/ R	C
	Prerequisite: Chemistry and Microbiology	Ty	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 P RODUCTION 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: EBCT22E02	Subject Name: Industry Pollution Prevention And Control	Ty / Lb/ ETL/IE	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/ Internal Evaluation

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.
CO4	Design gravity settling chamber, cyclones, electrostatic precipitator, fabric filters and absorbers for air pollution control.
CO5	Identify the best way to dispose, minimize or utilize haradous solid waste from chemical industries and understand the ethical issues and societal impact of releasing pollutants in environment.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	2	3	-	-	-	-	2
CO2	3	2	2	2	-	1	3	-	-	-	-	2
CO3	3	2	2	3	-	2	3	-	-	-	-	2
CO4	3	3	2	3	-	1	3	-	-	-	-	2
CO5	1	1	1	1	-	1	3	3	-	-	-	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	1	3				
CO2	2	1	3	3				
CO3	2	3	3	1				
CO4	2	3	2	1				
CO5	3	2	1	3				

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E02	Subject Name: Industry Pollution Prevention And Control	Ty / Lb/ ETL/IE	L	T / SLr	P/ R	C
	Prerequisite: Chemistry and Microbiology	Ty	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: EBCT22E03	Subject Name: Chemistry of Polymer And Composite Materials	Ty / Lb/ ETL/IE	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/ Internal evaluation

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	Identify and understand the basic mechanical behaviour of composite materials and make sound prediction on the likely behaviour of new combinations of materials
CO2	Apply the choices made for using certain types of composites in certain applications with reference to composite properties.
CO3	Demonstrate a practical understanding of composite properties and fabrication techniques, and to be able to make realistic suggestions for the evaluation of composite behaviour, where appropriate.
CO4	Analyse the micromechanical properties of fibre reinforced composites.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	-	2	-	2	-	3	-	1	2
CO2	2	1	1	-	1	1	3	-	2	-	3	1
CO3	3	-	2	-	2	-	2	-	2	-	1	3
CO4	3	-	1	-	2	-	2	-	3	-	1	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	3
CO2	2	1	2	3
CO3	2	3	3	1
CO4	2	3	1	2

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E03	Subject Name: Chemistry of Polymer And Composite Materials	Ty / Lb/ ETL/IE	L	T / SLr	P/ R	C
	Prerequisite: Chemistry	Ty	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*

PROGRAMME ELECTIVES - II

Subject Code:	**Subject Name: Green Chemistry and Engineering**	**Ty/Lb/ETL\ IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EBCT22E04	**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/ Internal Evaluation

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.
CO4	Utility and modification of processes to have green and better environmental protective aspect

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO2	**3**	**2**	**1**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**1**
CO3	**2**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**3**	**-**	**-**	**-**
CO4	**3**	**-**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**				
CO1	**2**	**1**	**3**	**3**				
CO2	**3**	**3**	**2**	**1**				
CO3	**3**	**2**	**1**	**1**				
CO4	**3**	**3**	**2**	**1**				

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E04	Subject Name: Green Chemistry and Engineering	Ty/Lb/ETL\ IE	L	T / S.Lr	P/ R	C
	Prerequisite: Nil	Ty	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: EBCT22E05	Subject Name: Modern Separation Processes	T y/ Lb/ ETL/IE	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/ Internal Evaluation

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	Design various components of equipment used in advanced separation processe
CO3	Compare various options and select an appropriate process for a particular separation
CO4	Describe and discuss principles of various advanced separation processes based on membranes, chromatography, distillation, extractions.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	-	2	-	-	-	-	1
CO2	2	-	-	-	-	-	3	-	-	-	2	-
CO3	3	-	-	-	2	-	-	-	-	-	-	2
CO4	2	-	-	-	-	1	-	-	-	-	2	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	-	-
CO3	3	2	-	-
CO4	2	1	-	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E05	Subject Name: Modern Separation Processes	T y/ Lb/ ETL/IE	L	T / SLr	P/ R	C
	Prerequisite: Advanced separation	Ty	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: EBCT22E06	Subject Name: Renewable Energy Engineering	Ty / Lb/ ETL/IE	L	T / SLr	P/ R	C
	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/ Internal evaluation

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	Make interpretation about the energy sources.
CO2	Comprehend the energy and energy types.
CO3	Make interpretation about the solar energy.
CO4	Explain the solar energy power plants.
CO5	Make interpretation about the geothermal energy

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	3	-	-	-	2	-	-	3
CO2	2	3	-	1	-	-	-	-	3	-	1	-
CO3	1	-	-	-	-	1	-	-	-	2	-	-
CO4	3	-	-	-	-	2	-	-	2	-	-	-
CO5	2	-	-	-	-	1	-	1	-	-	-	

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	-	-
CO3	1	2	3	-
CO4	3	2	1	-
CO5	1	2	-	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E06	Subject Name: Renewable Energy Engineering	Ty / Lb/ ETL/IE	L	T / SLr	P/ R	C
	Prerequisite: conversion technologies	Ty	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.

PROGRAMME ELECTIVES - III

Subject Code: **EBCT22E07**	**Subject Name: Computational Fluid Dynamics**	**T y/ Lb/ ETL/IE**	**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/ Internal Evaluation

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	Provide the student with a significant level of experience in the use of modern CFD software for the analysis of complex fluid-flow systems.
CO3	Improve the student's research and communication skills using a self-directed, detailed study of a complex fluid-flow problem and to communicate the results in written form.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**-**	**-**	**3**
CO2	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**
CO3	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**	**-**

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**				
CO1	**2**	**2**	**-**	**-**				
CO2	**3**	**1**	**-**	**-**				
CO3	**2**	**1**	**-**	**-**				
CO4	**3**	**2**	**-**	**-**				

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Programme Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E07	Subject Name: Computational Fluid Dynamics	T y/ Lb/ ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Basic Mathematics and fluid mechanics	Ty	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 unsteady 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 Finite Volume 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", arosa Publishing 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: EBCT22E08	Subject Name : Frontiers of Chemical Engineering	T y/ Lb/ETL/IE	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/ Internal Evaluation

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 understanding the frontier area in chemical engineering
CO3	To gain knowledge of latest development in chemical science and engineering
CO4	To emphasize emerging to ends in research and development
CO5	To get overview of multi disciplinary fields

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	3	-	-	-	2	-	-	3
CO2	2	3	-	1	-	-	-	-	3	-	1	-
CO3	1	-	-	-	-	1	-	-	-	2	-	-
CO4	3	-	-	-	-	2	-	-	2	-	-	-
CO5	2	-	-	-	-	1	-	1	-	-	-	

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	-	-
CO3	1	2	3	-
CO4	3	2	1	-
CO5	1	2	-	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E08	Subject Name : Frontiers of Chemical Engineering	T y/ Lb/ETL/IE	L	T /S.Lr	P/ R	C
	Prerequisite: Chemical product design	Ty	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: EBCT22E09	Subject Name: Industrial Management	T y/ L/b ETL/IE	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 Internal Evaluation

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 Management (s) professional.
CO2	Develop attitude for continuous learning.
CO3	Analyses industrial management problem and solve them
CO4	Learn about financial and growth management, analyse problem and solve them

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	2	-	2	-	-	-	1
CO2	2	-	-	-	-	2	-	-	-	3	-	-
CO3	2	-	-	-	2	-	-	2	-	-	-	2
CO4	2	-	2	-	2	-	-	-	2	2	1	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	-	-
CO3	3	1	-	-
CO4	2	1	-	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium,1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E09	Subject Name: Industrial Management	T y/ L/b ETL/IE	L	T / SLr	P/ R	C
	Prerequisite: Basic Management	Ty	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 BehaviorLearning 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.

PROGRAMME ELECTIVES - IV

Subject Code:	**Subject Name: Drugs And Pharmaceutical Technology**	**T y/ L/b ETL/IE**	**L**	**T / SLr**	**P/ R**	**C**
EBCT22E10	**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/ Internal Evaluation

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	Emphasis on the mechanism of the action of different inorganic and oraganic compound.
CO3	Knowledge on the method of preparation of different drugs.
CO4	Classification of drug categories with examples under different agents.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**-**	**-**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**1**
CO2	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**-**
CO3	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**			
CO1	**3**	**2**	**-**	**-**			
CO2	**2**	**1**	**-**	**-**			
CO3	**3**	**2**	**-**	**-**			
CO4	**2**	**1**	**-**	**-**			

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E10	Subject Name: Drugs And Pharmaceutical Technology	T y/ L/b ETL/IE	L	T / SLr	P/ R	C
	Prerequisite: Engineering Chemistry	Ty	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, BailliereTindall, 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., 197*5.

Subject Code: EBCT22E11	Subject Name: Professional Ethics in Engineering	Ty / Lb/ ETL/IE	L	T / SLr	P/ R	C
	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/ Internal evaluation

OBJECTIVE:

- To enable the students to create 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	Distinguish between ethical and non ethical situations
CO2	Practice moral judgment in condition of dilemma
CO3	Relate the code of ethics in social experimentation
CO4	Develop concepts based on moral issues and enquring

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	-	2	-	-	1	-	1
CO2	2	-	-	-	-	-	3	-	-	-	2	-
CO3	3	-	-	-	2	-	-	-	2	-	-	2
CO4	2	-	1	-	-	1	-	-	-	-	2	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	2	3
CO3	3	2	-	-
CO4	2	1	-	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					√							

EBCT22E11	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 Autonomy – Kohlberg'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: EBCT22E12	Subject Name: Industrial Instrumentation	Ty / Lb/ ETL/IE	L	T / SLr	P/ R	C
	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 and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

COURSE OUTCOMES (COs) : (3- 5)

CO1	To know basic of Instrumentation
CO2	To know about sensors
CO3	Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field.
CO4	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	3	-	-	1	-	-	-	1	-	3	-	-
CO2	2	-	-	1	-	-	2	-	-	-	-	1
CO3	3	-	-	-	-	3	-	-	2	-	1	-
CO4	2	3	1	-	-	2	-	-	-	-	2	-

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	-	-
CO3	3	1	2	-
CO4	2	3	1	-

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	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EBCT22E12	Subject Name: Industrial Instrumentation	Ty / Lb/ ETL/IE	L	T / SLr	P/ R	C
	Prerequisite: Moral science and general English	Ty	3	0/0	0/0	3

UNIT I **5Hrs**

Introduction – Variables, UNITs & standards of measurement, Measurementterms – characteristic. Data Analysis.

UNIT II **12Hrs**

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 Moisturesystem, Humidity Measurement, Moisture measurement system, Rheological system, Viscosity measurement, Radiation system, Nuclear radiationinstrumentation.

UNIT III **10Hrs**

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.

Subject Code:	Subject Name : Process Optimization	T y/ Lb/ ETL/IE	L	T / S.Lr	P/ R	C
EBCT22E13	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/ Internal evaluation

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	• Define the structure of optimization problems, define the essential properties of optimization problems.
CO3	Explain general solution methods of optimization problems, Define optimization models, explain building up of optimization models.
CO4	• Define objective function; define solution tecniques of objective function.
CO5	• Define linear programming, explain solution tecniques of linear programming

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	2	-	2	-	-	-	1
CO2	2	-	-	-	-	2	-	-	-	3	-	-
CO3	2	-	-	-	2	-	-	2	-	-	-	2
CO4	2	-	2	-	2	-	-	-	2	2	1	1
CO5	3	-	-	-	-	2	-	2	-	-	-	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	-
CO2	3	1	3	-
CO3	2	1	2	-
CO4	3	2	1	-
CO5	1	2	3	-

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project		
					√						

Subject Code: EBCT22E13	Subject Name : Process Optimization	T y/ Lb/ ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: PCE	Ty	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

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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.