MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC, NBA & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Curriculum/Syllabus

Programme Code : CH

Programme Name : B.Tech-Chemical Engineering

Regulation : R-2016

MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, Accredited by NAAC & NBA, Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dt, Tamil Nadu.

Ph. No.: 04287-220837

Email: principal@mec.edu.in.

MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC, NBA & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

INSTUTION VISION &MISSION

INSTUTION VISION

To be a Centre of Excellence in Engineering, Technology and Management on par with International Standards.

INSTUTION MISSION

- To prepare the students with high professional skills and ethical values
- To impart knowledge through best practices
- To instill a spirit of innovation through Training, Research and Development
- To undertake continuous assessment and remedial measures
- To achieve academic excellence through intellectual, emotional and social stimulation

INSTUTIONMOTTO

Rural upliftment through Technical Education.

MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC, NBA & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

DEPARTMENT VISION & MISSION

DEPARTMENT VISION

Knowledge and solutions for a changing world and to emerge as a global leader in the area of technical education commensurate with the dynamic global scenario for the benefit of mankind.

DEPARTMENT MISSION

- Mentor academic and technical education in the graduate level improvement.
- Enable graduates to leadership positions within chemical and other associated industries.
- Create platform to disseminate research and development.

MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC, NBA & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

DEPARTMENT PROGRAM EDUCATIONAL OBJECTIVES, PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

PROGRAM EDUCATIONAL OBJECTIVES

The Chemical Engineering Graduates should be able to

PEO1: To understand and implement the basic engineering ideas on chemical engineering.

PEO2: To enhance the knowledge about problem solving ability in working areas like industries, research and relevant field.

PEO3: To allow the students to enroll in various membership and career bodies, and aid them to get advancements in their era.

PEO4: To provide awareness about multidisciplinary like environmental, ethical and develop communicatively strong one.

PROGRAM OUTCOMES

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, and fundamental engineering things, to solve the complex chemical engineering problems.
2. **Problem Analysis:** An ability to analyze complex engineering problems, as well as or process to meet desired needs.
3. **Design/Development solutions:** An ability to design and conduct experiments, as well as to analyze and interpret data as required.
4. **Conduct investigations of complex problems:** An ability to communicate effectively to precede valid conclusions.
5. **Modern tool usage:** Modeling to complex engineering activities with an understanding of professional and ethical responsibility.
6. **The engineer and society:** An ability to function on multidisciplinary teams to get to assess societal, health, safety, legal and cultural issues.
7. **Environment and sustainability**: To Understand the impact of the professional Engineering solutions in global and societal context for sustainability.

8. **Ethics:** Apply ethical in engineering and commit to lifelong learning as professional ethics.
9. **Individual and team work:** Function effectively as an individual, leads to knowledge of contemporary issues.
10. **Communication:** To communicate effectively on complex situations in various field related to chemical engineering by oral and written communication.
11. **Project management and finance:** To demonstrate and create principles to deal the manage projects and in multidisciplinary environments.
12. **Lifelong learning:** An ability to recognize the need for being in independent and allow to learning of technological change.

PROGRAM SPECIFIC OUTCOMES

PSO1: Gain and apply knowledge of basic engineering, mathematics, physics, and chemistry and chemical engineering courses for the benefit of society.

PSO2: Acquire the skills to design, analyze and innovative physiochemical, biological processes, including the hazards associated with these processes.

PSO3: To follow the rules and regulations, control and operate chemical processes within permissible standards.

MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

Estd. 2000

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu

B.Tech. – Chemical Engineering

GROUPING OF COURSES

Humanities and Social Sciences [HS]

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1.	16SHA01	Technical English	HS	5	3	2	0	4
2.	16SHA02	Communicative English	HS	7	3	0	4	5
3.	16SHA03	Business English	HS	5	3	2	0	4
4.	16SHA04	Basics of Japanese	HS	5	3	2	0	4
5.	16SHA05	Functional Japanese	HS	5	3	2	0	4
6.	16SHA06	Basics of German	HS	5	3	2	0	4
7.	16SHA07	Functional German	HS	5	3	2	0	4
8.	16SHA08	Principles of Management and Engineering Ethics	HS	3	3	0	0	3

Basic Sciences [BS]

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1.	16SHB01	Matrices, Calculus and Differential Equations	BS	5	3	2	0	4
2.	16SHB02	Complex Variables, Laplace Transforms and Vector Calculus	BS	5	3	2	0	4
3.	16SHB03	Transforms and Partial Differential Equations	BS	5	3	2	0	4
4.	16SHB04	Random Processes	BS	5	3	2	0	4
5.	16SHB05	Probability and Queuing Theory	BS	5	3	2	0	4
6.	16SHB06	Numerical Methods	BS	5	3	2	0	4
7.	16SHB07	Statistics and Numerical Methods	BS	5	3	2	0	4
8.	16SHB08	Discrete Mathematics	BS	5	3	2	0	4
9.	16SHB09	Operations Research	BS	5	3	2	0	4
10.	16SHB21	Engineering Physics	BS	6	2	0	4	4
11.	16SHB22	Material Science	BS	3	3	0	0	3
12.	16SHB23	Physics for Electrical Engineering	BS	3	3	0	0	3

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

13.	16SHB24	Physics for Mechanical Engineering	BS	3	3	0	0	3
14.	16SHB31	Engineering Chemistry	BS	5	3	0	2	4
15.	16SHB32	Environmental Science and Engineering	BS	3	3	0	0	3

Engineering Science [ES]

Sl. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/ Week			C
					L	T	P	
1.	16CHC01	Fundamentals of Computing and Programming	ES	6	2	0	4	4
2.	16CHC02	Advanced C Programming	ES	6	2	0	4	4
3.	16CHC03	Basic of Civil and Mechanical Engineering	ES	4	4	0	0	4
4.	16CHC04	Basics of Electrical and Electronics Engineering	ES	3	3	0	0	3
5.	16CHC05	Engineering Graphics	ES	4	0	0	4	2
6.	16CHC06	Engineering Practices for Mechanical Sciences	ES	4	0	0	4	2
7.	16CHC07	Electrical Drives and Controls	ES	5	3	2	0	4
8.	16CHC08	Engineering Mechanics	ES	5	3	0	2	4
9.	16CHC09	Microprocessors and Microcontrollers	ES	5	3	0	2	4
10.	16CHC10	Object Oriented Programming	ES	5	3	0	2	4
11.	16CHC11	Biomechanics	ES	6	2	0	4	4
12.	16CHC12	Measurements and instruments	ES	3	3	0	0	3
13.	16CHC13	Renewable Energy sources	ES	3	3	0	0	3
14.	16CHC14	Fundamentals of Nano science	ES	3	3	0	0	3
15.	16CHC15	Production Processes	ES	3	3	0	0	3
16.	16CHC16	Organic Chemistry	ES	5	3	0	2	4
17.	16CHC17	Physical chemistry	ES	5	3	0	2	4

Professional Core [PC]

Sl. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/ Week			C
					L	T	P	
1.	16CHD01	Mechanics of Solids	PC	5	3	2	0	4
2.	16CHD02	Fluid Mechanics	PC	5	3	0	2	4
3.	16CHD03	Chemical Engineering Thermodynamics I	PC	5	3	2	0	4
4.	16CHD04	Chemical Engineering Thermodynamics II	PC	5	3	2	0	4
5.	16CHD05	Chemical Process Calculations	PC	5	3	0	2	4
6.	16CHD06	Instrumental Methods of Analysis	PC	5	3	0	2	4
7.	16CHD07	Mechanical Operations	PC	5	3	0	2	4

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

8.	16CHD08	Heat transfer	PC	5	3	0	0	3
9.	16CHD09	Chemical Reaction Engineering I	PC	5	3	0	2	4
10.	16CHD10	Mass Transfer – I	PC	5	3	0	2	4
11.	16CHD11	Material Technology for Process Industries	PC	5	3	2	0	4
12.	16CHD12	Process Dynamics and Control	PC	5	3	2	0	4
13.	16CHD13	Mass Transfer -- II	PC	5	3	0	0	3
14.	16CHD14	Chemical Reaction Engineering II	PC	5	3	2	0	4
15.	16CHD15	Process Modeling and Simulation	PC	5	3	0	3	4
16.	16CHD16	Total Quality Management	PC	5	3	0	0	3
17.	16CHD17	Transport Phenomena	PC	5	3	2	0	3
18.	16CHD18	Chemical Process Plant Safety	PC	5	3	0	0	3
19.	16CHD19	Process Equipment Design Laboratory	PC	3	0	0	2	1

Professional Elective [PE]

Sl. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/ Week			C
					L	T	P	
1.	16CHE01	Enzyme Engineering	PE	3	3	0	0	3
2.	16CHE02	Petroleum Refining and Petrochemicals	PE	3	3	0	0	3
3.	16CHE03	Food Technology	PE	3	3	0	0	3
4.	16CHE04	Polymer Technology	PE	3	3	0	0	3
5.	16CHE05	Disaster Management	PE	3	3	0	0	3
6.	16CHE06	Air Pollution and Control	PE	3	3	0	0	3
7.	16CHE07	Waste Water Treatment	PE	3	3	0	0	3
8.	16CHE08	Electrochemical Engineering	PE	3	3	0	0	3
9.	16CHE09	Modern Separation Techniques	PE	3	3	0	0	3
10.	16CHE10	Optimization of Chemical Processes	PE	3	3	0	0	3
11.	16CHE11	Environmental Engineering	PE	3	3	0	0	3
12.	16CHE12	Process Plant Utilities	PE	3	3	0	0	3
13.	16CHE13	Fermentation Engineering	PE	3	3	0	0	3
14.	16CHE14	Pulp and Paper Technology	PE	3	3	0	0	3
15.	16CHE15	Energy Technology	PE	3	3	0	0	3
16.	16CHE16	Drugs and Pharmaceutical Technology	PE	3	3	0	0	3

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Au
Rasipuram, Namakkal Dist 637 40

Employability Enhancement Courses [EEC]

Sl. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/ Week			C
					L	T	P	
1.	16CHF01	Project work – Phase-I	EEC	6	0	0	6	3
2.	16CHF02	Project work – Phase-II	EEC	30	0	0	30	15
3.	16CHF03	Comprehension	EEC	4	0	0	4	2
4.	16CHF04	Design Project	EEC	4	0	0	4	2
5.	16CHF05	Interpersonal Skills / Listening and Speaking	EEC	2	0	0	2	1

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (A...
Rasipuram, Namakkal Dist 637 4...

	MUTHAYAMMAL ENGINEERING COLLEGE (Approved by AICTE, accredited by NAAC, NBA & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R - 2016

Department	Chemical Engineering
Programme	B.Tech. - Chemical Engineering

SEMESTER – I

Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit	Contact Hrs
				L	T	P	C	
1.	16SHA01	Technical English	HS	3	2	0	4	5
2.	16SHB01	Matrices, Calculus and Differential Equations	BS	3	2	0	4	5
3.	16SHB22	Material Science	BS	3	0	0	3	3
4.	16CHC03	Basic of Civil and Mechanical Engineering	ES	4	0	0	4	4
5.	16SHB31	Engineering Chemistry	ES	3	0	0	4	3
6.	16CHC01	Fundamentals of Computing and Programming	ES	0	0	4	4	6
7	16CHC05	Engineering Graphics	ES	4	0	0	2	2
Total Credits							**25**	

	MUTHAYAMMAL ENGINEERING COLLEGE (Approved by AICTE, accredited by NAAC, NBA & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R - 2016

Department	Chemical Engineering
Programme	B.Tech. - Chemical Engineering

SEMESTER – II

Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit	Contact Hrs
				L	T	P	C	
1.	16SHA08	Principles of Management and Engineering Ethics	HS	3	0	0	3	3
2.	16SHB02	Complex Variables, Laplace Transforms and Vector Calculus	BS	3	2	0	4	5
3.	16SHB32	Environmental Science and Engineering	BS	3	0	0	3	3
4.	16CHC02	Advanced C Programming	ES	2	0	4	4	6
5.	16SHB21	Engineering Physics	BS	2	0	4	4	6
6	16SHA02	Communicative English	HS	3	0	4	5	7
7	16CHC06	Engineering Practices For Electrical Sciences	ES	0	0	4	2	4
Total Credits							**25**	

Chairman
Board of Studies
Department of Chemical Engi
Muthayammal Engineering College
Rasipuram, Namakkal Dist 63

	MUTHAYAMMAL ENGINEERING COLLEGE (Approved by AICTE, accredited by NAAC, NBA & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R - 2016

Department	Chemical Engineering
Programme	B.Tech. - Chemical Engineering

SEMESTER – III

Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit	Contact Hrs
				L	T	P	C	
1.	16SHB03	Transforms and Partial Differential Equations	BS	3	2	0	4	5
2.	16CHC16	Organic Chemistry	ES	3	0	2	4	5
3.	16CHD01	Mechanics of Solids	PC	3	2	0	4	5
4.	16CHD02	Fluid Mechanics	PC	3	0	2	4	5
5.	16CHD03	Chemical Engineering Thermodynamics - I	PC	3	2	0	4	5
6.	16CHC07	Electrical Drives and Controls	ES	3	2	0	4	5
Total Credits							**24**	

	MUTHAYAMMAL ENGINEERING COLLEGE (Approved by AICTE, accredited by NAAC, NBA & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R - 2016

Department	Chemical Engineering
Programme	B.Tech. - Chemical Engineering

SEMESTER – IV

Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit	Contact Hrs
				L	T	P	C	
1.	16SHB06	Numerical Methods	BS	3	2	0	4	5
2.	16CHC17	Physical Chemistry	ES	3	0	2	4	5
3.	16CHD04	Chemical Engineering Thermodynamics - II	PC	3	2	0	4	5
4.	16CHD05	Chemical Process Calculations	PC	3	2	0	4	5
5.	16CHD06	Instrumental Methods of Analysis	PC	3	0	2	4	5
6.		Open Elective - I	OE	3	0	0	3	3
Total Credits							**23**	

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

	MUTHAYAMMAL ENGINEERING COLLEGE (Approved by AICTE, accredited by NAAC, NBA & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R - 2016

Department	Chemical Engineering
Programme	B.Tech. - Chemical Engineering

SEMESTER – V

Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit	Contact Hrs
				L	T	P	C	
1.	16CHD08	Heat Transfer	PC	3	0	2	4	5
2.	16CHD09	Chemical Reaction Engineering - I	PC	3	2	0	4	5
3.	16CHD10	Mass Transfer - I	PC	3	2	0	4	5
4	16CHD11	Material Technology for Process Industries	PC	3	2	0	4	5
5.	16CHD07	Mechanical Operations	PC	3	0	2	4	5
6.		Elective – I	PE	3	0	0	3	3
7.		Elective – II	PE	3	0	0	3	3
Total Credits							**26**	

	MUTHAYAMMAL ENGINEERING COLLEGE (Approved by AICTE, accredited by NAAC, NBA & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R - 2016

Department	Chemical Engineering
Programme	B.Tech. - Chemical Engineering

SEMESTER – VI

Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit	Contact Hrs
				L	T	P	C	
1.	16CHD18	Chemical Process Plant Safety	PC	4	0	0	3	4
2.	16CHD16	Total Quality Management	PC	3	0	2	4	5
3.	16CHD13	Mass Transfer – II	PC	3	0	0	3	3
4.		Elective – III	PE	3	0	0	3	3
5.		Elective – IV	PE	3	0	0	3	3
6.		Open Elective - II	OE	3	0	0	3	3
7	16CHF05	Interpersonal Skills / Listening and Speaking	EEC	0	0	2	1	2
8	16CHD19	Process Equipment Design Laboratory	PC	3	0	0	1	2
Total Credits							**21**	

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

	MUTHAYAMMAL ENGINEERING COLLEGE (Approved by AICTE, accredited by NAAC, NBA & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R - 2016

Department	Chemical Engineering
Programme	B.Tech. - Chemical Engineering

SEMESTER – VII

Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit	Contact Hrs
				L	T	P	C	
1.	16CHD12	Process Control	PC	3	0	2	4	5
2.	16CHD15	Process Modelling and Simulation	PC	3	2	0	4	5
3.	16CHD17	Transport Phenomena	PC	3	2	0	4	5
4.		Elective - V	PE	3	0	0	3	3
5.		Elective - VI	PE	3	0	0	3	3
6.		Open Elective - III	OE	3	0	0	3	3
		PRACTICAL						
7	16CHF01	Project work Phase I	EEC	0	0	6	3	6
Total Credits							**26**	

	MUTHAYAMMAL ENGINEERING COLLEGE (Approved by AICTE, accredited by NAAC, NBA & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R - 2016

Department	Chemical Engineering
Programme	B.Tech. - Chemical Engineering

SEMESTER – VIII

Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit	Contact Hrs
				L	T	P	C	
1.	16CHF02	Project work Phase II	EEC	0	0	24	12	24
Total Credits							**12**	

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

Total Credits: 182

Semester	I	II	III	IV	V	VI	VII	VIII	Total	%
Total	**25**	**25**	**24**	**23**	**26**	**21**	**26**	**12**	**182**	**100**
HS	4	8							12	7
BS	11	11	4	4					30	16
ES	10	6	8	4					28	15
PC			12	12	20	11	12		67	37
PE					6	6	6		18	10
EEC						1	5	12	18	10
OE				3		3	3		9	5

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD01 **MECHANICS OF SOLIDS** **L T P C**
3 2 0 4

COURSE OBJECTIVES:

- To develop understanding of the state of stresses and strains in structural components as a result of different loading conditions.
- To provide knowledge on shear force and bending moment for all statically determinate beams by recognizing the beam type, loading, shear and bending stress.
- To provide knowledge on deflection of determinate beam.
- To have knowledge on principal stress and strain and analysis of plane truss
- To understand the effect of torsion on shafts and springs.

COURSE OUTCOMES:

16CHD01.CO1 : Ability to realize the state of stresses and strains in structural components under tension, compression and shear.
16CHD01.CO2 : Ability to plot the shear force and bending moment diagrams for all the statically determinate beams
16CHD01.CO3 : Ability to analyze the deflection of determinate beam by different methods.
16CHD01.CO4 : Ability to determine principle stress, strain and analysis of plane truss.
16CHD01.CO5 : Ability to comprehend the behavior of members under pure torsion and spring.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD01.CO1	x	-	x	-	-	-	-	-	-	x	-	x	-	-	-
16CHD01.CO2	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16CHD01.CO3	x	-	x	-	-	-	-	-	-	x	-	x	-	-	-
16CHD01.CO4	x	-	x	-	-	x	x	-	-	x	-	x	x	-	-
16CHD01.CO5	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-

UNIT I STRESS AND STRAIN 9

Stress and strain at a point - Tension, Compression, Shear Stress – Hook's Law - Relationship among elastic constants - Stress Strain Diagram for Mild Steel - Ultimate Stress - Yield Stress - Factor of Safety - Thermal Stresses - Strain Energy due to Axial Force - Resilience - Stresses due to impact and Suddenly Applied Load - Compound Bars -Thin cylinder & shells

UNIT II SHEAR AND BENDING IN BEAMS 9

Beams and Bending - Types of loads, supports - Shear Force and Bending Moment Diagrams for statically determinate beam with concentrated load, UDL, uniformly varying load. Theory of Simple Bending - Analysis of Beams for Stresses - Stress Distribution at a cross Section due to bending moment and shear force for Cantilever, simply supported and overhanging beams with different loading conditions

UNIT III DEFLECTION 9

Double integration method - Macaulay's methods - Area moment method - Conjugate beam method for computation of slopes and deflections of determinant beams

UNIT IV PRINCIPAL STRESS AND STRAIN & ANALYSIS OF PLANE TRUSS 9

Plane stress - Principal stresses and maximum shear stress - Mohr's circle for plane stress - Determination of principal stresses and planes - plane strain - Applications of plane stress - Maximum stresses in beams- Spherical and deviatory components of stress tensor – Determination of principal stresses and principal planes-Truss-Methods of joints - method of sections.

UNIT V TORSION OF SHAFTS AND SPRING 9

Torsional deformations of a circular bar - Circular bars of linearly elastic materials – Non uniform torsion - Stresses and strains in pure shear - transmission of power by circular shafts - Stepped shafts - Shafts fixed at both ends - Strain energy in torsion and pure shear - Springs - Types - Helical and leaf springs - Stresses and deflection of springs.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist. 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rajput.R.K	Strength of Materials	S.Chand and Co, New Delhi	2015
2	Gambhir.M.L	Fundamentals of Solid Mechanics	PHI Learning Private Limited., New Delhi	2010

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Subramanian R	Strength of materials	Oxford University Press, New Delhi	2012
2	Ramamrutham S	Strength of Materials	Dhanpat Rai & Sons	2014
3	Bansal R.K	Strength of materials	Laxmi Publications, New Delhi	2014
4	William A. Nash	Theory and Problems of Strength of Materials	Schaum's Outline Series, Tata McGraw-Hill publishing co., New Delhi	2010
5	Srinath L.S	Advanced Mechanics of Solids	Tata McGraw-Hill Publishing Co., New Delhi	2017

WEB URLs:

1. https://nptel.ac.in/courses/105/104/105104160/
2. https://www.iitk.ac.in/me/research/specialization-areas/solid-mechanics-and-design/mechanics-of-solids
3. https://www.youtube.com/watch?v=B9lyGZzb_6M
4. https://www.youtube.com/watch?v=D6DTb4tXfOQ
5. https://www.youtube.com/watch?v=K9nl606I0W0

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonom
Rasipuram, Namakkal Dist 637

16CHD02 **FLUID MECHANICS** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To understand the basic properties of fluids.
- To get a basic knowledge of fluids in statics and dynamics.
- to gain knowledge about various losses in pipes and to impart knowledge on boundary layers.
- To learn about flow measurement and pumps.
- To select appropriate model and similitude in problem related to hydraulics.

COURSE OUTCOMES:

16CHD02.CO1 : Determine the various fluid properties.
16CHD02.CO2 : Impart knowledge on fluid in statics and dynamics.
16CHD02.CO3 : Determine the various losses in pipes and compute the energy and momentum thickness.
16CHD02.CO4 : Explain the processes involved in the flow measurement and pumps.
16CHD02.CO5 : Explain the various applications of similitude and model analysis.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD02.CO1	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
16CHD02.CO2	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
16CHD02.CO3	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
16CHD02.CO4	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
16CHD02.CO5	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-

UNIT I FLUID PROPERTIES 9

Definitions – Fluid and fluid mechanics – Dimensions and units – Fluid properties – density-specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillarity and surface tension.

UNIT II FLUID STATICS AND DYNAMICS 9

Fluid statics: concept of fluid pressure, absolute and gauge pressures-pressure measurements by manometers and pressure gauges. Classification of flows – Continuity equation (one, two and three dimensional forms) – Stream and potential functions – Flow nets –Fluid dynamics –equation of motion-Euler's equation along a streamline-Bernoulli's equation-applications-flow measurements.

UNIT III FLOW THROUGH PIPES AND BOUNDARY LAYER 9

Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions - Flow through a fixed and fluidized beds.

UNIT IV FLOW MEASUREMENT AND PUMPS 9

Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans.

UNIT V SIMILITUDE AND MODEL STUDY 9

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

LIST OF EXPERIMENTS

1. Viscosity measurement of non Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps (Centrifugal / Gear / Reciprocating)
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle

TOTAL: 30 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Bansal R.K	Fluid Mechanics and Hydraulic Machines	Laxmi Publications (P) Ltd.	2016
2	Modi P.N. and Seth S.M	Hydraulics and Fluid Mechanics	Standard Book House, NewDelhi	2011

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	John Finnemore, Joseph B and Franzini	Fluid Mechanics with Engineering Applications	McGraw-Hill Ltd	2014
2	Streeter, Victor L and Wylie, Benjamin E	Fluid Mechanics	McGraw- Hill Ltd	2013
3	Jain. A.K	Fluid Mechanics	Khanna Publishers	2013
4	Fox, Robert W and Macdonald, Alan T	Introduction to Fluid Mechanics	John Wiley & Sons	2011
5	Rajput R.K	A text book of Fluid Mechanics	S.Chand and Co	2010

WEB URLs:

1. www.britannica.com/science/fluid-mechanics
2. www.mcgill.ca/study/2014-2015/courses/mech-331
3. www.pipes.digital/docs
4. www.britannica.com/science/boundary-layer
5. www.springer.com/cda/content/document/cda.../9783319134758-c1.pdf?SGWID

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
[illegible]uram, Namakkal Dist 637 408

16CHD03 **CHEMICAL ENGINEERING THERMODYNAMICS I** **L T P C**
3 2 0 4

COURSE OBJECTIVES:

- To learn PVT behavior of fluids
- To understand laws of thermodynamics
- To provide knowledge on thermodynamic property relations and their application to fluid flow
- To have knowledge on thermodynamic formulations
- To understand the compression and expansion of fluids.

COURSE OUTCOMES:

16CHD03.CO1 : Ability to outline the terminology associated with engineering thermodynamics, apply the concepts of heat, work and energy conversion to calculate heat and work quantities for industrial processes and predict the properties of ideal and real mixtures based on thermodynamic principles.

16CHD03.CO2 : Ability to apply the basic concepts of first and second laws of thermodynamics for the design and analyze of the open and closed system in chemical process plants.

16CHD03.CO3 : Ability to predict the changes in the properties of real fluids undergoing changes in process plant equipments.

16CHD03.CO4 : Ability to use empirical correlations and experimental date to evaluate thermodynamic quantities that relate to the vapour - liquid or liquid-liquid equilibrium of ideal and non-ideal chemical mixtures.

16CHD03.CO5 : Ability to determine equilibrium constants, standard enthalpy, Gibbs free Energy and equilibrium compositions for single and multiple reaction systems.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD03.CO1	x	-	x	-	-	-	-	-	-	x	-	x	-	-	-
16CHD03.CO2	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16CHD03.CO3	x	-	x	-	-	-	-	-	-	x	-	x	-	-	-
16CHD03.CO4	x	-	x	-	-	x	x	-	-	x	-	x	x	-	-
16CHD03.CO5	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-

UNIT I Basic Concept of Thermodynamics **6**

Scope of thermodynamics; Definition of system, control volume, state and path function, equilibrium, reversibility, energy, work and heat, zeroth law, temperature scales.

UNIT II PVT behavior of Pure Substances **7**

PVT behavior of fluids; Mathematical representation of PVT behavior; Generalized compressibility factor correlation; Generalized equations of state.

UNIT III First and Second law of Thermodynamics **11**

Joule's experiment, internal energy, first law, energy balance for closed systems, mass and energy balance for open systems, Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume.

UNIT IV Thermodynamic Formulations **11**

Third law of thermodynamics, entropy from a microscopic point of view. Thermodynamic potentials – internal energy, Helmholtz free energy, Gibbs free energy, thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method, residual properties, thermodynamic property tables and diagrams.

UNIT V Compression, Expansion of Fluids **10**

Thermodynamic aspects and classification of compression process, equation for change of state of gases, work done calculation for different situations, factors affecting compressor performance, multistage compression, convergent divergent flow in nozzles, Ejectors.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
M...ammal Engineering College (Autonomous)
...Namakkal Dist 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Smith, J.M., Van Ness, H.C and Abbot M.M	Introduction to Chemical Engineering Thermodynamics	McGraw Hill	2003
2	Narayanan, K.V	A Textbook of Chemical Engineering Thermodynamics	Prentice Hall	2004

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kyle, B.G	Chemical and Process Thermodynamics	Prentice Hall	1990
2	Hougen, O.A., Watson, K.M., and Ragatz, R.A	Chemical Process Principles Part - II: Thermodynamics	John Wiley & Sons	1970
3	Sandler, S.I	Chemical and Engineering Thermodynamics	John Wiley International	1989
4	Rao .Y.V.C	Chemical Engineering Thermodynamics	United press (India) ltd.	1997
5	Merle Potter, Craig Somerton	Schaum's outline of Thermodynamics for Engineers	McGraw Hill	2009

WEB URLs:

1. https://nptel.ac.in/courses/103/101/103101004/
2. https://nptel.ac.in/courses/103/104/103104151/
3. https://www.classcentral.com/course/swayam-chemical-engineering-thermodynamics-12898
4. https://www.youtube.com/watch?v=aDXBo0FtALA&list=PLwdnzlV3ogoVnCnIfjDHng_8biZSUEYtK
5. https://www.youtube.com/watch?v=yVOzgBfsQI0&list=PLFW6lRTa1g80QsuYcFQZWrsn_PB987gn5

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 40.

16CHD04 **CHEMICAL ENGINEERING THERMODYNAMICS - II** **L T P C**
3 2 0 4

COURSE OBJECTIVES:

- To present thermodynamic principles from a Chemical Engineering viewpoint.
- To provide knowledge on behavior of fluids under PVT conditions
- To understand the concept of phase equilibria.
- To present the main advantage will be to deal with power production
- To provide knowledge on refrigeration processes.

COURSE OUTCOMES:

16CHD04.CO1 : Ability to analyze the properties of fluids
16CHD04.CO2 : Ability to understand the equilibrium of liquids
16CHD04.CO3 : Ability to determine the phase equilibria
16CHD04.CO4 : Ability to understand the chemical equilibrium concepts
16CHD04.CO5 : Ability to analyze the refrigeration concepts

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD04.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
16CHD04.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD04.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD04.CO4	-	x	x	x	-	-	-	-	-	x	-	x	-	x	-
16CHD04.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I PROPERTIES OF SOLUTIONS **9**

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, GibbsDuhem equation, excess properties of mixtures.

UNIT II PHASE EQUILIBRIA **9**

Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity, application of phase rule, vapour-liquid equilibrium, phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA **9**

Activity coefficient-composition models, thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

UNIT IV CHEMICAL REACTION EQUILIBRIA **9**

Definition of standard state, standard free energy change and reaction equilibrium constant, evaluation of reaction equilibrium constant, prediction of free energy data, equilibria in chemical reactors, calculation of equilibrium compositions for homogeneous chemical reactors, thermodynamic analysis of simultaneous reactions.

UNIT V REFRIGERATION **9**

Principles of refrigeration, methods of producing refrigeration, liquefaction process, co-efficient of performance, evaluation of the performance of vapour compression and gas refrigeration cycles

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Narayanan K.V	A Text Book of Chemical Engineering Thermodynamics	Prentice Hall of India	2007
2	Smith, J M., Van Ness H C and Abbot, M M	Introduction to Chemical Engineering Thermodynamics	McGraw-Hill	2005

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
[illegible]am, Namakkal Dist 637 40[illegible]

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rao, Y.V.C	Chemical Engineering Thermodynamics	University Press (India) Ltd	1997
2	Hougen, O.A., Watson, K.M., and Ragatz, R.A	Chemical Process Principles- Part II: Thermodynamics	John Wiley & Sons	1970
3	Sandler, S.I	Chemical and Engineering Thermodynamics	John Wiley International	1989
4	Kyle, B.G	Chemical and Process Thermodynamics	Prentice Hall	1990
5	Merle Potter, Craig Somerton	Schaum's outline of Thermodynamics for Engineers	McGraw Hill	2009

WEB URLs:

1. https://www.academia.edu/36635353/Chemical_Engineering_Thermodynamics_II_CHE_303_Course_Notes
2. https://catalog.k-state.edu/preview_course_nopop.php?catoid=24&coid=124602
3. https://www.youtube.com/watch?v=UFxLlEEmB58&list=PLvSNXOe4nVGq-DIlyuMHrrueMWw7tCJD8&index=2&t=0s
4. https://www.youtube.com/watch?v=IltERuQOW1o&list=PLvSNXOe4nVGq-DIlyuMHrrueMWw7tCJD8&index=4&t=0s
5. https://www.youtube.com/watch?v=pF7-Juf0VcI&list=PLvSNXOe4nVGq-DIlyuMHrrueMWw7tCJD8&index=6&t=0s

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD05 **CHEMICAL PROCESS CALCULATIONS** **L T P C**
3 2 0 4

COURSE OBJECTIVES:

- To acquire knowledge on laws of chemistry
- To develop its application to solution of mass balance equations.
- To understand the energy balance equations.
- To provide knowledge on for single and network of units.
- To provide knowledge on process simulators.

COURSE OUTCOMES:

16CHD05.CO1 : Ability to apply the principles of dimensional homogeneity to convert one form of unit to other equivalent forms in CGS, FPS. MKS and SI unit systems and apply fundamental gas laws to solve ideal gas problems.

16CHD05.CO2 : Ability to calculate the composition of a mixture in terms of mole fractions from a given composition expressed in terms of mass fractions or vice versa.

16CHD05.CO3 : Ability to compute the concentration, degree of saturation and dew point of vapour -gas mixture at the given temperature and pressure using humidity chart.

16CHD05.CO4 : Ability to formulate steady state material balance for the unit operations such as distillation, evaporation, mixing, extraction, drying and crystallization processes with recycle, by-pass and purge.

16CHD05.CO5 : Ability to practice the combined steady state material and Energy balance for simple processes like distillation, evaporation and combustion.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD05.CO1	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-
16CHD05.CO2	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-
16CHD05.CO3	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-
16CHD05.CO4	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-
16CHD05.CO5	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-

UNIT I **9**

Base and derived Units - Composition of Mixture and solutions - 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 **9**

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 **9**

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

UNIT IV **9**

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.

UNIT V **9**

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 burning compounds - Application of Process simulators in energy and material balance problems.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Bhatt, B.L., Vora, S.M	Stoichiometry	Tata McGraw-Hill	2004
2	Himmelblau, D.M	Basic Principles and Calculations in Chemical Engineering	Prentice Hall Inc	2003

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Felder, R. M. and Rousseau, R. W	Elementary Principles of Chemical Processes	John Wiley & Sons	2000
2	Hougen O A, Watson K M and Ragatz R A	Chemical process principles Part I	CBS publishers	1973
3	Narayanan. K.V. and Lakshmikutty.B	Stoichiometry and Process Calculations	Prentice-Hall of India	2006
4	Murphy, R.M	Introduction to Chemical Processes: Principles, Analysis, Synthesis	McGraw Hill International	2007
5	O'Connell, J. P., and Haile, J. M	Thermodynamics: Fundamentals for Applications	Cambridge University Press, Cambridge	2005

WEB URLs:

1. https://ceng.tu.edu.iq/ched/images/lectures/chem-lec/st1/c3/basic-1.pdf
2. https://nptel.ac.in/courses/103/103/103103165/
3. https://www.youtube.com/watch?v=R6DSN58odLk
4. https://www.youtube.com/watch?v=_ww0-IDidXM&list=PLwdnzlV3ogoXpDif2e93GJKoojj0SgvV0
5. https://www.youtube.com/watch?v=0k3SE16_bnU&list=PLyqSpQzTE6M-QFqMp7_FJ_NuGCXDuHqvf

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Au
Rasipuram, Namakkal Dist 63

16CHD06 **MECHANICAL OPERATIONS** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To impact knowledge in the field of particle characterization
- To acquire knowledge in the field of particle size reduction
- To develop understanding of the particle size separation
- To gain knowledge on filtration
- To understand the principles of mixing

COURSE OUTCOMES:

16CHD06.CO1 : Ability to calculate the Particle size, shape and surface area by both differential, cumulative analysis

16CHD06.CO2 : Ability to compute the power requirement for particle size reduction screen effectiveness by sieve analysis.

16CHD06.CO3 : Ability to determine the gravity settling velocity, settling time and calculate the thickener area

16CHD06.CO4 : Ability to calculate the pressure drop in filters, filter medium resistance and cake resistance

16CHD06.CO5 : Ability to estimate the power required by mixers using power number and Reynolds number

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD06.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
16CHD06.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD06.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD06.CO4	-	x	x	x	-	-	-	-	-	x	-	x	-	x	-
16CHD06.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I Particle Characterization and Measurement 9

General characteristics of solids, different techniques of size analysis- Static - Image analysis and Dynamic analysis - Light scattering techniques, shape factor, surface area determination, estimation of particle size. Advanced particle size analysis techniques. Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT II Particle Size Reduction and Size Enlargement 9

Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; Advanced size reduction techniques - Nano particle fabrication - Top down. approach - Bottom-up approach. Size enlargement - Importance of size enlargement, principle of granulation, briquetting, pelletisation, and flocculation. Fundamentals of particle generation.

UNIT III Particle Separation (Gas-Solid and Liquid-Solid System) 9

Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging

UNIT IV Filtration and Filtration Equipments 9

Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT V Mixing and Particle Handling 9

Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and Conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, Powder hazards, conveyer selection, different types of conveyers and their performance characteristics.

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	McCabe, W.L., Smith, J.C., and Harriot, P	Unit Operations in Chemical Engineering	McGraw-Hill	2005
2	Badger W.L. and Banchero J.T	Introduction to Chemical Engineering	Tata McGraw Hill	1997

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B	Principles of Unit Operations	John Wiley & Sons	1994
2	A. S. Foust, L. A. Wenzel, C. W. Clump, L. Naus, and L. B. Anderson	Principles of Unit Operations	John Wiley & Sons	1994
3	Coulson, J.M. and Richardson, J.F	Chemical Engineering Vol. II	Asian Books Pvt. Ltd	1998
4	Perry. R. H., Green. D. W., Perry's	Chemical Engineer's Handbook	McGraw-Hill, New York	2007
5	Narayanan. C.M., Bhattacharyya. B.C	Mechanical Operation for Chemical Engineers	Khanna Publisher	2005

WEB URLs:

1. https://nptel.ac.in/courses/103/107/103107123/
2. https://www.inspirenignite.com/vtu/mechanical-operations-syllabus-vtu-beb-tech/
3. https://www.youtube.com/watch?v=SdP3BbCt4Ak&list=PLwdnzlV3ogoX9tKDkHm6KD1zNnwR0PZOS
4. https://www.youtube.com/watch?v=K5vbIhUyqXU&list=PLvOh309NvHlGxEMlZ0kYdVXw8V3uMc5Uh
5. https://www.youtube.com/watch?v=ziz0UXcOBXI&list=PLvOh309NvHlG0EIcqA_F1ShakeyH49Pcx

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD07 **INSTRUMENTAL METHODS OF ANALYSIS** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To enable the students to have a fundamental knowledge about the Light spectrum, Absorption
- To expose students with electrical and electronic components used in the analytical instruments
- To learn and understand the principles and operation of different instrumentation techniques
- To acquire knowledge on the different chromatographic methods for separation of biological products
- To know the different molecular spectroscopic techniques and their analytical applications

COURSE OUTCOMES:

16CHD07.CO1 : Ability to analyze the function of electrical and optical component in analytical instruments and their calibration
16CHD07.CO2 : Ability to apply the spectroscopic techniques to identify, estimate and characterize analytes
16CHD07.CO3 : Ability to analyze the thermal behavior of materials using thermal analysis
16CHD07.CO4 : Ability to apply chromatographic and electrophoretic techniques to separate, purify and quantify molecules
16CHD07.CO5 : Ability to analyze different types of electrodes and electroanalytical techniques for sensing and quantifying analytes.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD07.CO1	x	x	-	-	x	-	-	-	-	x	-	x	x	-	x
16CHD07.CO2	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
16CHD07.CO3	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
16CHD07.CO4	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
16CHD07.CO5	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x

UNIT I INTRODUCTION TO SPECTROMETRY **9**

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements.

UNIT II MOLECULAR SPECTROSCOPY **9**

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence – Instrumentation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications.

UNIT III MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY **9**

Manufacture of Starch, Dextrin, Glucose and sucrose and manufacture of Ethyl alcohol, Acetic acid, Citric acid, Oxalic acid and Antibiotics (Penicillin). Materials for handling, storage and transportation.

UNIT IV SEPARATION METHODS **9**

General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography principles of GC and applications – HPLC- Capillary electrophoresis – Applications

UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY **9**

Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

LIST OF EXPERIMENTS

1. Precision and validity in an experiment using absorption spectroscopy .
2. Validating Lambert-Beer's law using KMnO4
3. Finding the molar absorbtivity and stoichiometry of the Fe (1,10 phenanthroline)3 using absorption spectrometry.
4. Finding the pKa of 4-nitrophenol using absorption spectroscopy.
5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxolate.
7. Estimation of SO4-- by nephelometry.
8. Estimation of Al3+ by Flourimetry.
9. Limits of detection using aluminium alizarin complex.
10. Chromatography analysis using TLC.
11. Chromatography analysis using column chromatography.

TOTAL: 30 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Skoog, D.A. F. James Holler, and Stanky, R.Crouch	Instrumental Methods of Analysis	Cengage Learning	2007
2	Willard, Hobart	Instrumental Methods of Analysis	CBS	1986

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Braun, Robert D	Introduction to Instrumental Analysis	Pharma Book Syndicate	1987
2	Ewing,G.W	Instrumental Methods of Chemical Analysis	McGraw-Hill	1985
3	Sharma, B.K	Instrumental Methods of Chemical Analysis: Analytical Chemistry	Goel Publishing House	1972
4	Haven, Mary C	Laboratory Instrumentation	John Wiley	1995
5	Arthur I. Vogel	Quantitative Inorganic Analysis including Elementary Instrumental Analysis	ELBS, Group	1989

WEB URLs:

1. http://nptel.ac.in/courses.php
2. http://nptel.ac.in/downloads/102103044/
3. http://nptel.ac.in/courses.php?disciplineId=102
4. https://www.youtube.com/watch?v=dAM0CVa8IkQ
5. https://www.youtube.com/watch?v=vrlR4oBslV8

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD08 **HEAT TRANSFER** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To develop understanding of conduction.
- To provide knowledge on convection.
- To provide knowledge on condensation.
- To have knowledge on evaporation
- To understand the concepts of heat exchangers.

COURSE OUTCOMES:

16CHD08.CO1 : Ability to solve one-dimensional steady state heat conduction problems for the rectangular, cylindrical and spherical composite walls.

16CHD08.CO2 : Ability to analyze the convection heat-transfer problems for laminar and turbulent flows in internal and external configurations, including the basics of the boundary layer concept.

16CHD08.CO3 : Ability to estimate the heat transfer co-efficient for film wise and drop wise condensation, boiling heat transfer using empirical correlations.

16CHD08.CO4 : Ability to apply fundamental laws of radiation to determine the heat transfer rate between two surfaces and apply the principles of evaporation to precisely calculate the energy requirement for single and multiple effect evaporators.

16CHD08.CO5 : Ability to estimate heat exchanger design parameters like heat transfer area.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD08.CO1	-	x	-	-	-	-	x	-	-	-	-	x	-	-	-
16CHD08.CO2	x	x	x	x	-	-	x	-	-	-	-	x	x	x	-
16CHD08.CO3	x	x	x	x	-	-	x	-	-	-	-	x	x	x	-
16CHD08.CO4	-	x	x	x	-	-	x	-	-	-	-	x	-	x	-
16CHD08.CO5	x	x	x	x	-	-	x	-	-	-	-	x	x	x	-

UNIT I **9**

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Fourier's law of heat conduction - one dimensional steady state heat conduction equation for flat plate, hollow cylinder, - Heat conduction through a series of resistances - Thermal conductivity measurement.

UNIT II **9**

Concepts of heat transfer by convection - Natural and forced convection, analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Coulburn analogy. Dimensional analysis in heat transfer.

UNIT III **9**

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.

UNIT IV **9**

Theory of evaporation - single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation. Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzmann law, Plank's law, radiation between surfaces.

UNIT V **9**

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

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

LIST OF EXPERIMENTS

1. Heat Transfer in a Double Pipe Heat Exchanger
2. Heat transfer in Shell and Tube Heat Exchanger
3. Heat Transfer in a Bare and Finned Tube Heat Exchanger
4. Heat transfer in composite wall
5. Heat transfer by Forced / Natural Convection
6. Heat Transfer by Radiation - Determination of Stefan Boltzmann constant
7. Heat Transfer by Radiation - Emissivity measurement
8. Heat transfer in Open Pan Evaporator
9. Heat transfer by Single effect evaporation / Multiple effect evaporation
10. Boiling Heat Transfer
11. Heat Transfer through Packed Bed

TOTAL: 30 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Holman, J. P	Heat Transfer	McGraw Hill	1997
2	Binay K. Dutta	Heat Transfer: Principles and Applications	Prentice Hall of India	2006

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kern, D.Q	Process Heat Transfer	McGraw-Hill	1999
2	McCabe, W.L., Smith, J.C., and Harriot, P	Unit Operations in Chemical Engineering	McGraw-Hill	2001
3	Coulson, J.M. and Richardson, J.F	Chemical Engineering vol. I	Asian Books Pvt. Ltd	1998
4	Ozisik, M. N	Heat Transfer: A Basic Approach	McGraw-Hill	1984
5	J. R. Welty	Fundamentals of Momentum, Heat and Mass Transfer	Wiley	2000

WEB URLs:

1. https://www.toppr.com/guides/physics/thermal-properties-of-matter/heat-transfer/
2. http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heatra.html
3. https://www.youtube.com/watch?v=rxTK_SvSmvs&list=PL1gyM10tgL1hK9666oGndGlWDQdpQzkY9
4. https://www.youtube.com/watch?v=kNZi12OV9Xc
5. https://www.youtube.com/watch?v=U72ueGTF7n8

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD09 **CHEMICAL REACTION ENGINEERING I** **L T P C**
3 2 0 4

COURSE OBJECTIVES:

- To understand the basics of chemical reactions.
- To provide knowledge on design of continuous reactors.
- To provide knowledge on Design of reactors for multiple reactions.
- To acquire knowledge on non-isothermal homogeneous reactor systems
- To have knowledge on non ideal reactors

COURSE OUTCOMES:

16CHD09.CO1 : Ability to formulate the rate equation from the stoichiometry and reaction mechanism for elementary and non-elementary reactions

16CHD09.CO2 : Ability to design batch, plug flow and continuous stirred tank reactors and choose the appropriate reactor or reactor combination based on qualitative and quantitative analysis for the specific reaction conditions

16CHD09.CO3 : Ability to analyze kinetic data and determine the components of the rate equation multiple reactions

16CHD09.CO4 : Ability to comprehend the behavior of Non-isothermal homogeneous reactor systems.

16CHD09.CO5 : Ability to compute precisely the moments of RTD using pulse tracer test data for the real reactors and estimate extent of non ideality of real reactors.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD09.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
16CHD09.CO2	x	x	x	x	-	-	-	-	-	x	x	x	x	x	-
16CHD09.CO3	x	x	x	x	-	-	-	-	-	x	x	x	x	x	-
16CHD09.CO4	-	x	x	x	-	-	-	-	-	x	x	x	-	x	-
16CHD09.CO5	x	x	x	x	-	-	-	-	-	x	x	x	x	x	-

UNIT I **9**

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

UNIT II **9**

Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, Equal sized CSTRs in series and parallel, Equal sized PFRs in series and parallel, size comparison of reactors.

UNIT III **9**

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

UNIT IV **9**

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

UNIT V **9**

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

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

LIST OF EXPERIMENTS

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Semi Batch reactor
3. Kinetic studies in a Plug flow reactor
4. Kinetic studies in a CSTR
5. Kinetic studies in a Packed bed reactor
6. Combined reactor studies in a PFR and CSTR
7. RTD studies in a PFR
8. RTD studies in a Packed bed reactor
9. RTD studies in a CSTR / CSTR in series
10. Study of temperature dependence of rate constant
11. Batch reactive distillation

TOTAL: 30 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Levenspiel O	Chemical Reaction Engineering	Wiley Eastern Ltd	2000
2	Smith, J.M	Chemical Engineering Kinetics	McGraw Hill	1981

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Fogler.H.S	Elements of Chemical Reaction Engineering	Prentice Hall of India	2000
2	Froment. G.F. & K.B.Bischoff	Chemical Reactor Analysis and Design	John Wiley and Sons	1979
3	E. Bruce Nauman	Chemical Reactor design, Optimization and Scaleup	McGraw Hill Inc	2002
4	Peter Harriot	Chemical Reactor Design	Marcel and Dekker Inc	2003
5	Hugo A. Jakobsen	Chemical Reactor Modeling: Multiphase Reactive Flows	Springer-Verlag	2008

WEB URLs:

1. https://nptel.ac.in/courses/103/108/103108097/
2. http://umich.edu/~elements/5e/lectures/index.html
3. https://www.youtube.com/watch?v=ANjzlZ_Zsak&list=PLbMVogVj5nJRrrhcrAIIJs1W0qgH5axqO
4. https://www.youtube.com/watch?v=DpLAsVcofao&list=PLwdnzlV3ogoUC9IWVOPTGqV5eEVNRAfGa
5. https://www.youtube.com/watch?v=WcHd7yFvp6Q&t=384s

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD10 **MASS TRANSFER I** **L T P C**
3 2 0 4

COURSE OBJECTIVES:

- To develop basics of mass transfer concepts.
- To provide knowledge on mass transfer coefficients.
- To provide knowledge on humidification.
- To have knowledge on drying
- To understand the concepts of crystallization.

COURSE OUTCOMES:

16CHD10.CO1 : Ability to estimate the mass transfer flux for molecular diffusion in fluids and measurement of diffusivity by pseudo diffusion model.
16CHD10.CO2 : Ability to analyze mass transfer theories to predict the mass transfer coefficients, develop the analogy between momentum, heat and mass transfer and draw the operating line for stage-wise operations.
16CHD10.CO3 : Ability to comprehend the humidification concepts
16CHD10.CO4 : Ability to analyze the batch and continues dryers.
16CHD10.CO5 : Ability to determine the kinetics of crystallization

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD10.CO1	-	x	x	x	-	x	-	-	-	x	-	x	-	x	-
16CHD10.CO2	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
16CHD10.CO3	-	x	x	x	-	x	-	-	-	x	-	x	-	x	-
16CHD10.CO4	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
16CHD10.CO5	-	x	x	x	-	x	-	-	-	x	-	x	-	x	-

UNIT I **9**

Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; diffusivity measurement and prediction; multi-component diffusion.

UNIT II **10**

Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stagewise and differential contractors.

UNIT III **9**

Humidification - Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

UNIT IV **9**

Drying- Equilibrium; classification of dryers; batch drying - Mechanism and time of cross through circulation drying, continuous dryers - material and energy balance; determination of length of rotary dryer using rate concept.

UNIT V **8**

Crystallization - Equilibrium, classification of crystallizers, mass and energy balance; kinetics of crystallization - nucleation and growth; design of batch crystallizers; population balance model and design of continuous crystallizers.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist. 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Treybal, R.E	Mass Transfer Operations	McGraw-Hill	1981
2	Geankoplis, C.J	Transport Processes and Unit Operations	Prentice Hall Inc	2003

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	McCabe, W.L., Smith, J.C., and Harriot, P	Unit Operations in Chemical Engineering	McGraw-Hill	2005
2	Coulson, J.M. and Richardson, J.F	Chemical Engineering Vol. I and II	Asian Books Pvt. Ltd	1998
3	J.D. Seader and E.J. Henley	Separation Process Principles	John Wiley	2006
4	Binay K. Dutta	Principles of Mass Transfer and Separation Processes	PHI Learning Ltd	2013
5	E.L. Cussler	Mass transfer in fluid systems	Cambridge university press	1984

WEB URLs:

1. https://nptel.ac.in/courses/103/103/103103035/
2. https://nptel.ac.in/courses/103/103/103103145/
3. https://www.youtube.com/watch?v=Yc2eSffzhBI&list=PLwdnzlV3ogoVX_S_8DyKa7RudEazDL0o_
4. https://www.youtube.com/watch?v=EyREi7l5020&list=PLbMVogVj5nJSOgW8GYe_nJ3MYfnCQ3XXM
5. https://www.youtube.com/watch?v=Yc2eSffzhBI&t=98s

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD11 **MATERIAL TECHNOLOGY FOR PROCESS INDUSTRIES** **L T P C**
3 2 0 4

COURSE OBJECTIVES:

- To introduce the elementary concepts about properties, process and application of metals and alloys used in Chemical process industries.
- To provide knowledge on ferrous materials
- To provide knowledge on polymeric materials
- To design materials for prevention and control of corrosion
- To have knowledge on types of materials and their selection

COURSE OUTCOMES:

16CHD11.CO1 : Ability to understand the nature of materials
16CHD11.CO2 : Ability to analyze the properties of ferrous materials
16CHD11.CO3 : Ability to determine the polymerization materials
16CHD11.CO4 : Ability to understand the manufacturing process of materials
16CHD11.CO5 : Ability to comprehend the materials selection

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD11.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
16CHD11.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD11.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD11.CO4	-	x	x	x	-	-	-	-	-	x	-	x	-	x	-
16CHD11.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I **9**

Nature of Materials and Processing of Metals and Alloys: Micro and macro structures, properties and definitions: mechanical, thermal, chemical, electrical and magnetic properties. Casting- hot and cold rolling-extrusion - forging- deep drawing- plastic deformation of metal, single crystal and poly crystalline metals.

UNIT II **9**

Ferrous Metals: Pure iron, cast iron, mild steel, special steels and alloys, high temperature steels, iron carbide phase diagram, heat treatment of plain carbon steels-Manufacture, properties and application in chemical industries.

UNIT III **9**

Polymeric Materials: Polymerization reactions-Industrial polymerization methods-Crystallinity and stero-isomerism in thermoplastics – thermosetting elastomers- creep and fracture of polymeric materials. Composite and Ceramic Materials: Fiber-reinforced plastic composite materials.

UNIT IV **9**

Manufacturing methods - asphalt and asphalt mixtures- wood-sandwich structures. Ceramic crystal and silicate structures, Properties-glasses, porcelain, enamels and their application to chemical process industries. Corrosion and Protective Coatings, types of corrosion. Anti-corrosion methods. Organic paints and coatings.

UNIT V **9**

Material Selection: General criteria for selection of materials of construction for process industries. Stainless steel, Alloys of Nickel, Copper, Chromium, Tin, Zinc, Magnesium, Aluminium, Lead and their application to different chemical process equipment and industries.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Khanna O. P	A text book of Material Science and Metallurgy	Rai Publications	1998
2	Hajra Choudhury, S K and Hajra Choudhury, A K	Materials Science and Processes	Media Promotors & Publishers	1995

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Carl. A and Keyser.C.E	Material Science in Engineering	McGraw-Hill	1968
2	Clauster Henry R	Industrial and Engineering Materials	McGraw-Hill	1975
3	R. Balasubramaniam	Callisters Materials Science and Engineering	Wiley	2013
4	W F Smith, J Hashemi, R Prakash	Materials Science and Engineering	McGraw Hill	2008
5	L H Van Vlack	Elements of Materials Science and Engineering	Pearson India	2008

WEB URLs:

1. https://www.nap.edu/catalog/10037/materials-technologies-for-the-process-industries-of-the-future-management
2. https://food-beverage.pall.jp/content/dam/pall/food-beverage/literature-library/non-gated/IMAPT06.pdf
3. https://www.youtube.com/watch?v=8ETBAdEQr7M
4. https://www.youtube.com/watch?v=eYJN-z97Hq4
5. https://www.youtube.com/watch?v=RjZJjneJ5fk

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD12 **PROCESS DYNAMICS AND CONTROL** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To develop understanding of instrumentation of control.
- To provide knowledge on open loop control.
- To provide knowledge on closed loop control.
- To have knowledge on frequency response
- To understand the effect of advanced control schemes.

COURSE OUTCOMES:

16CHD12.CO1 : Ability to devise control strategies for the control of mass and heat transfer equipment using advanced controllers.

16CHD12.CO2 : Ability to apply conservation principles in order to model the dynamics of simple process systems to develop first, second and multi capacity transfer functions.

16CHD12.CO3 : Ability to analyze closed loop stability systems by applying transient responses and also to test the stability of the control system by Root Locus methods.

16CHD12.CO4 : Ability to draw the bode diagram for the stability of process for the frequency response processes.

16CHD12.CO5 : Ability to discuss P, PI, PD, PID controller actions and its transfer functions. practice block diagram development for closed loop systems by applying transient responses to find the process error.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD12.CO1	-	x	-	-	-	-	x	-	-	-	-	x	-	-	-
16CHD12.CO2	x	x	x	-	-	-	x	-	x	-	-	x	x	x	-
16CHD12.CO3	x	x	x	-	-	-	x	-	-	-	-	x	x	x	x
16CHD12.CO4	-	x	x	-	-	-	x	-	x	-	x	x	-	x	-
16CHD12.CO5	x	x	x	-	-	-	x	-	-	-	-	x	x	x	x

UNIT I INSTRUMENTATION **9**

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS **9**

Laplace transformation and its application in process control. 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; transportation lag.

UNIT III CLOSED LOOP SYSTEMS **9**

Loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE **9**

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules.

UNIT V ADVANCED CONTROL SCHEMES **9**

Feedback control of systems with dead time and inverse response. Control systems with multiple loops. Advanced Control Schemes a) Feed forward b) ratio control. control of distillation towers and heat exchangers.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

LIST OF EXPERIMENTS

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level system
4. Response of Interacting level system
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a level system
10. Tuning of a pressure system
11. Tuning of a thermal system
12. Flow co-efficient of control valves
13. Characteristics of different types of control valves
14. Closed loop study on a pressure system
15. Tuning of pressure system
16. Closed loop response of cascade control system
17. Optimum Controller Tuning using Ziegler Nichols method

*Minimum 10 experiments shall be offered.

TOTAL: 30 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Coughnowr, D	Process Systems Analysis and Control	McGraw Hill	2008
2	Stephanopoulos, G	Chemical Process Control	Prentice Hall of India	2003

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp	Process dynamics and control I	John Wiley & Sons	1997
2	Marlin, T. E	Process Control	McGraw Hill	2000
3	Smith, C. A. and Corripio, A. B	Principles and Practice of Automatic Process Control	John Wiley	1997
4	Jason L. Speyer, Walter H. Chung	Stochastic Processes, Estimation, and Control	PHI Ltd	2013
5	Harriot P	Process Control	Tata McGraw Hill	1997

WEB URLs:

1. http://www.users.abo.fi/khaggblo/PDC/PDC%20intro%20-%20longer.pdf
2. https://ocw.mit.edu/courses/chemical-engineering/10-450-process-dynamics-operations-and-control-spring-2006/
3. https://www.youtube.com/watch?v=txQ0u4VZbaA&list=PLDrFpUa730qkMa8GcUdSWhJu3ljYME4ri
4. https://www.youtube.com/watch?v=hvrab4o7Yi0&list=PLNpBqxJULiWRust51RVZ1dQWI2sd-pdgT
5. https://www.youtube.com/watch?v=45bX07nYWl4&list=PLOzRYVm0a65dFThqueBdgIUuFxpWSWDiF

Chairman
Board of Studies
Department of Chemical Engineering
...amal Engineering College (A...nomous)
Kasipuram, Namakkal Dist ...

16CHD13 **MASS TRANSFER II** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To understand the general concepts of absorption.
- To provide knowledge on principles and types of distillation.
- To provide knowledge on liquid extraction.
- To have knowledge on leaching
- To understand the effect of adsorption process.

COURSE OUTCOMES:

16CHD13.CO1 : Ability to compute the number of plates required for a given separation by graphical and analytical method and choose the packing material for gas-liquid operations.
16CHD13.CO2 : Ability to determine the number of plates using Ponchon-savarit and Mccabe-thiele method and categorize azeotropic and extractive distillation.
16CHD13.CO3 : Ability to determine the number of stages and recovery efficiency for solid-liquid and liquid-liquid separation processes.
16CHD13.CO4 : Ability to analyse the applications of leaching
16CHD13.CO5 : Ability to calculate the quantity of adsorbent required for stage-wise operations and illustrates the types of adsorption, adsorption isotherms and ion-exchange process.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD13.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
16CHD13.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD13.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD13.CO4	-	x	x	x	-	-	-	-	-	x	-	x	-	x	-
16CHD13.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I ABSORPTION 9

Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations.

UNIT II DISTILLATION 9

Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio.

UNIT III LIQUID-LIQUID EXTRACTION 9

Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction

UNIT IV LEACHING 9

Solid-liquid equilibria- leaching equipment for batch and continuous operations- calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

UNIT V ADSORPTION AND ION EXCHANGE & MEMBRANE SEPARATION PROCESS 9

Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

LIST OF EXPERIMENTS

1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of Vacuum Dryer
7. Drying characteristics of Tray dryer
8. Drying characteristics of Rotary dryer
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Surface evaporation
13. Adsorption studies
14. Leaching studies
15. Demonstration of Gas – Liquid absorption

*Minimum 10 experiments shall be offered.

TOTAL: 30 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Wankat, P	Equilibrium Stage Separations	Prentice Hall	1993
2	Treybal, R.E	Mass Transfer Operations	McGraw-Hill	1981

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Geankoplis, C.J	Transport Processes and Unit Operations	Prentice Hall Inc	2003
2	Seader, J.D. and E.J. Henley	Separation Process Principles	John Wiley	2006
3	McCabe, W.L, Smith, J.C, and Harriot, P.	Unit Operations in Chemical Engineering	McGraw-Hill	2005
4	King, C. J	Separation Processes	McGraw-Hill	1980
5	Alan S. Foust, Leonard A Wenzel, CurlisW.Clump, Louis Maus, L.Bryce Andersen	Principles of Unit operation	John Wiley and Sons	2008

WEB URLs:

1. https://nptel.ac.in/courses/103/104/103104046/
2. http://www.digimat.in/nptel/courses/video/103104046/L35.html
3. https://www.youtube.com/watch?v=BBRUvxKuq-I&list=PLwdnzlV3ogoVdYpQY0hlcWgv_75DgUz0m
4. https://www.youtube.com/watch?v=HlHyEcP_7SU&list=PL38769A2045D58D20
5. https://www.youtube.com/watch?v=HlHyEcP_7SU&list=PLvOh309NvHlGxciL6PlN0gM6-CY1--NdW

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD14 **CHEMICAL REACTION ENGINEERING –II**

L	T	P	C
3	2	0	4

COURSE OBJECTIVES:

- To develop understanding of the state of catalysts.
- To provide knowledge on heterogeneous catalyst.
- To provide knowledge on gas solid catalytic reactors.
- To have knowledge on gas solid non catalytic reactors
- To understand the effect of gas liquid reactors.

COURSE OUTCOMES:

16CHD14.CO1 : Ability to realize the nature of catalyst
16CHD14.CO2 : Ability to comprehend the heterogeneous catalyst.
16CHD14.CO3 : Ability to analyze the gas solid catalytic reactors.
16CHD14.CO4 : Ability to determine gas solid non catalytic reactors.
16CHD14.CO5 : Ability to develop gas liquid reactors.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD14.CO1	-	x	-	-	-	-	x	-	-	-	-	x	-	-	-
16CHD14.CO2	x	x	-	-	-	-	x	-	x	-	-	x	x	x	-
16CHD14.CO3	x	x	-	-	-	-	x	-	-	-	-	x	x	x	x
16CHD14.CO4	-	x	-	-	-	-	x	-	x	-	x	x	-	x	-
16CHD14.CO5	x	x	-	-	-	-	x	-	-	-	-	x	x	x	x

UNIT I CATALYSTS **15**

Nature of catalysts, surface area and pore-volume distribution, catalyst preparation.

UNIT II HETEROGENEOUS REACTORS **15**

Rate equations for heterogeneous reactions, adsorption isotherms, rates of adsorption and desorption, surface reaction analysis of rate equation and rate controlling steps,

UNIT III GAS-SOLID CATALYTIC REACTORS **15**

Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets, effectiveness factor, Thiele Modulus, fixed bed reactors.

UNIT IV GAS-SOLID NON-CATALYTIC REACTORS **15**

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

UNIT V GAS-LIQUID REACTORS **15**

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: 75 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Smith, J. M	Chemical Engineering Kinetics	McGraw-Hill	1981
2	Levenspiel. O	Chemical Reaction Engineering	John Wiley & Sons	1972

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Fogler, H S	Elements of Chemical Reaction Engineering	Prentice Hall of India	2008
2	Froment G.F & K.B. Bischoff	Chemical Reaction Analysis and Design	John Wiley and Sons	1979
3	E. Bruce Nauman	Chemical Reactor design, Optimization and Scaleup	McGraw Hill Inc	2002
4	Peter Harriot	Chemical Reactor Design	Marcel and Dekker Inc	2003
5	Hugo A. Jakobsen	Chemical Reactor Modeling: Multiphase Reactive Flows	Springer-Verlag	2008

WEB URLs:

1. https://www.classcentral.com/course/swayam-chemical-reaction-engineering-ii-12900
2. https://nptel.ac.in/courses/103/106/103106117/
3. https://www.youtube.com/watch?v=jeUW6h2oVEY&list=PLvOh309NvHlFFFq-VM5u3ecYq21kJt2hP
4. https://www.youtube.com/watch?v=IkqoqF-keiE&list=PLOzRYVm0a65cyrKMms9dQtcMnMK-rQ6DX
5. https://www.youtube.com/watch?v=1x_V-wS-bfs

Chairman
Board of Studies
Department of Chemical Engineering
Mu... ...mmal Engineering College (Autonomous)
... ...m, Namakkal Dist 637 408

16CHD15 **PROCESS MODELLING AND SIMULATION** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To provide a basic knowledge on modeling and simulation.
- To gain awareness on steady state lumped systems.
- To provide knowledge on unsteady state lumped systems.
- To have knowledge on steady state distributed system
- To understand the unsteady state distributed system.

COURSE OUTCOMES:

16CHD15.CO1 : Ability to know modeling and simulation.
16CHD15.CO2 : Ability to determine the steady state lumped systems.
16CHD15.CO3 : Ability to establish the unsteady state lumped systems.
16CHD15.CO4 : Ability to determine steady state distributed systems.
16CHD15.CO5 : Ability to comprehend unsteady state distributed systems and other modeling systems.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD15.CO1	-	x	-	-	-	-	x	-	-	-	-	x	-	-	-
16CHD15.CO2	x	x	x	-	-	-	x	-	x	-	-	x	x	x	-
16CHD15.CO3	x	x	x	-	-	-	x	-	-	-	-	x	x	x	x
16CHD15.CO4	-	x	x	-	-	-	x	-	x	-	x	x	-	x	-
16CHD15.CO5	x	x	x	-	-	-	x	-	-	-	-	x	x	x	x

UNIT I INTRODUCTION **7**

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS **9**

Degree of freedom analysis, single and network of process units, systems yielding linear and nonlinear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS **9**

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM **7**

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES **13**

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations. Empirical modeling, parameter estimation, population balance and stochastic modeling.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

LIST OF EXPERIMENTS

1. Analysis of physical properties and generation of T-x-y and P-x-y diagram for different systems
2. Estimation of physical property for a non data bank component
3. Calculation of bubble point and dew point temperature/pressure
4. Simulation of mixer and flash separator
5. Simulation of heat exchanger
6. Simulation of distillation column
7. Simulation of batch and flow reactors
8. Simulation and analysis of absorption/extraction column
9. Sensitivity analysis and optimization of parameters
10. Simulation and analysis of simple flow sheets problems
11. Design of shell and tube heat exchanger
12. Design of plate and frame exchanger
13. Design of air cooler
14. Simulation of drying of solids

* Any 10 of the above experiments shall be offered

TOTAL: 30 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Babu B.V	Process Plant Simulation	Oxford University Press, New Delhi	2004
2	Luyben W.L	Process Modelling, Simulation and Control for Chemical Engineers	McGraw Hill Book Co., New York	1990

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Gaikwad R.W and Dhirendra	Process Modeling and Simulation	Denett & Co., Nagpur	2006
2	Amiya K. Jana	Chemical Process Modelling and Computer Simulation	Prentice Hall of India	2004
3	Franks, R.G.E	Modeling and Simulation in Chemical Engineering	Wiley-Interscience, New York	1972
4	Himmelblau, D.M. and Bischoff, K.B	Process Analysis and Simulation	Wiley	1968
5	Ramirez,W.F	Computational methods for Process Simulation	Butterworths, NewYork	1998

WEB URLs:

1. https://www.youtube.com/watch?v=6sGMzv6MOTQ&list=PLJ3IRwxyit3ewQBYKFBTNYUJyjsgUlr8T
2. https://www.youtube.com/watch?v=2RCcX8Qt6hw
3. https://www.youtube.com/watch?v=zmbS_TmNDP4&list=PLSGws_74K01-4rcWuB5BEATHSsOrBd1ye
4. https://www.wiley.com/en-us/Process+Modeling+and+Simulation+for+Chemical+Engineers%3A+Theory+and+Practice-p-9781118914687
5. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118914670

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD16 **TOTAL QUALITY MANAGEMENT** **L T P C**
4 0 0 3

COURSE OBJECTIVES:

a. To facilitate the understanding of Quality Management needs.
b. To provide knowledge on TQM principles.
c. To provide knowledge on FEMA techniques.
d. To have knowledge on QFD
e. To understand the different management systems.

COURSE OUTCOMES:

16CHD16.CO1 : Ability to Describe the basic concepts of Total Quality Management.
16CHD16.CO2 : Ability to Identify the Principles of Total Quality Management.
16CHD16.CO3 : Ability to Apply and acquire knowledge of quality tools.
16CHD16.CO4 : Ability to Formulate the Quality Management System for use in an industry.
16CHD16.CO5 : Ability to Justify and Gain confidence in implementing Total Quality Management in an industry.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD16.CO1	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16CHD16.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16CHD16.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16CHD16.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16CHD16.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I INTRODUCTION **9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II TQM PRINCIPLES **9**

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I **9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II **9**

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY MANAGEMENT SYSTEM **9**

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation— Documentation—Internal Audits—Registration--ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001— Benefits of EMS.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Dale H.Besterfiled, Carol B.Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe	Total Quality Management	Pearson Education Asia	2013
2	James R. Evans and William M. Lindsay	The Management and Control of Quality	Cengage Learning	2012

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Janakiraman. B and Gopal .R.K	Total Quality Management - Text and Cases	Prentice Hall (India) Pvt. Ltd.,	2006
2	Suganthi.L and Anand Samuel	Total Quality Management	Prentice Hall (India) Pvt. Ltd	2006
3	Kumar S	Total Quality Management	Laxmi Publications (P) Ltd., Delhi	2007
4	Naagarazan R.S and Arivalagar A.A	Total Quality Management	New Age International (P) Ltd., New Delhi	2005
5	Subburaj Ramasamy	Total Quality Management	Tata McGraw Hill publishing Company Ltd, New Delhi	2006

WEB URLs:

1. https://asq.org/quality-resources/total-quality-management
2. https://managementhelp.org/quality/total-quality-management.htm
3. https://www.youtube.com/watch?v=YKwcxjUnots
4. https://www.youtube.com/watch?v=8qaYone7J_A
5. https://www.youtube.com/watch?v=5pMWmU_8lfI&list=PLPjSqITyvDeUUUwunyiwq41yJZofQEzMI

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD17 **TRANSPORT PHENOMENA** **L T P C**
3 2 0 4

COURSE OBJECTIVES:

- To understand the transport phenomena by molecular motion.
- To provide knowledge on one dimensional transport in laminar flows.
- To provide knowledge on equation of change and applications.
- To have knowledge on turbulent flow
- To understand the analogies between transport process.

COURSE OUTCOMES:

16CHD17.CO1 : Ability to determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate Continuity, Navier-Stokes and Euler equations

16CHD17.CO2 : Ability to apply shell balance technique to formulate the differential equation of change for steady and unsteady-state flows

16CHD17.CO3 : Ability to analyze the problems involving steady state and unsteady state heat conduction in simple geometries and obtain numerical solutions for the problems.

16CHD17.CO4 : Ability to develop microscopic and macroscopic energy balances for steady and unsteady transfer processes

16CHD17.CO5 : Ability to apply the individual and overall mass transfer coefficient in multi-phase systems for design applications

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD17.CO1	-	x	-	-	-	-	x	-	-	-	-	x	-	-	-
16CHD17.CO2	x	x	x	-	-	-	x	-	x	-	-	x	x	x	-
16CHD17.CO3	x	x	x	-	-	-	x	-	-	-	-	x	x	x	x
16CHD17.CO4	-	x	x	-	-	-	x	-	x	-	x	x	-	x	-
16CHD17.CO5	x	x	x	-	-	-	x	-	-	-	-	x	x	x	x

UNIT I BASIC CONCEPT AND CONSERVATION THEOREM IN MOMENTUM TRANSPORT **12**

Derivation of the basic momentum transport equation - derivation using elementary volume concept and conservation theorems. Equation of continuity and motion - Navier-Stokes and Euler equations of motion in rectangular, cylindrical and spherical coordinate systems. Dimensional analysis of equations of change. Analysis of momentum transport using shell balance technique and basic transport equations - types of boundary conditions.

UNIT II APPLICATIONS OF EQUATIONS OF CHANGE IN MOMENTUM TRANSPORT **12**

Flow of fluids in thin films, parallel plates, circular tubes and annulus, adjacent flow of two immiscible fluids, Couetteflow, rotating surface flow and radial flow. Flow near a wall suddenly set in motion.

UNIT III BASIC CONCEPTS AND CONSERVATION THEOREMS IN ENERGY TRANSPORT **12**

Basic energy transport equations - derivations using elementary volume concept and conservation theorems in different coordinate systems. Dimensional analysis of equations of change. Analysis of energy transport using shell balance technique and basic transport equations - types of boundary conditions.

UNIT IV APPLICATIONS OF EQUATIONS OF CHANGE IN ENERGY TRANSPORT **12**

Conduction with energy sources in fixed bed catalytic reactors and in cooling fins. Forced convection in circular tubes – Natural convection from a heated plate. Unsteady state conduction of finite slab.

UNIT V MASS TRANSPORT **12**

Continuity equation for a binary mixture and its derivation. Dimensional analysis of equations of change. Analysis of mass transport using shell balance technique and types of boundary conditions. Steady and unsteady state one dimensional diffusion, diffusion in porous catalyst with and without chemical reaction and diffusion in falling liquid film.

TOTAL: 60 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	R.B. Bird, W.E. Stewart and E.W. Lightfoot	Transport Phenomena	John Wiley	2006
2	Robert, S Brodkey, Harry C. Hershey	Transport Phenomena A Unified Approach	Brodkey Publishing	2003

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	L.S.Sissom, and D.R.Pitts	Elements of Transport Phenomena	McGrawHill, New York	1972
2	R.W.Fahien	Elementary Transport Phenomena	McGraw-Hill, New York	1983
3	J.R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W	Fundamentals of Momentum Heat and Mass Transfer	John Wiley, New York	2007
4	Carroll O.Bennet, John Earle Meyers	Momentum, Heat and Mass Transfer	Tata-McGraw Hill, New Delhi	1983
5	Christie J. Geankoplis	Transport Processes and Separation Process principles	Prentice Hall	2003

WEB URLs:

1. http://faculty.washington.edu/finlayso/che499/Group_C/tp.htm
2. https://link.springer.com/chapter/10.1007/978-1-4020-8327-3_2
3. https://www.youtube.com/watch?v=KBa240ehOus&list=PLxjkv5sTI9AB8ttNgBUVbqHJpqZzdScBB
4. https://www.youtube.com/watch?v=Iz8Xc-ICxgo&list=PLSDDrfoKhTPXSLuc-Y5TorUhN07YXzHeq
5. https://www.youtube.com/watch?v=JAl0h1xtQtk&list=PLvSNXOe4nVGr_c42xHNztIukf1i5QK91o

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 40

16CHD18 **CHEMICAL PROCESS PLANT SAFETY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the industrial plant safety.
- To provide knowledge types of hazards.
- To provide knowledge on handling and storage.
- To have knowledge on risk analysis
- To understand the protection systems.

COURSE OUTCOMES:

16CHD18.CO1 : Ability to acquire the basic knowledge of safety issues in boiler houses, storage vessel for hazardous chemicals.
16CHD18.CO2 : Ability to identify the hazardous element due to fire, radiation, electrical and atmospheric contaminants.
16CHD18.CO3 : Ability to apply the knowledge on handling and storage of chemical hazards
16CHD18.CO4 : Ability to analyze qualitative risk assessment using HAZOP, FMEA and fault tree analysis.
16CHD18.CO5 : Ability to apply the safety principles to identify the fire hazards and its safety protecting system in practices.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHD18.CO1	-	x	x	-	-	-	-	-	-	x	-	x	-	-	-
16CHD18.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD18.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD18.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHD18.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I DEVELOPMENT OF INDUSTRIAL PLANT SAFETY **9**

Introduction to safety: Concept and importance of industrial safety. Safety in the site selection and lay out. Location and design parameters for chimney, flares rupture discs, location of boiler houses, storage of hazardous chemicals etc. Safety in operations and processes, work permit system, confined space safety practices.

UNIT II INDUSTRIAL SAFETY **9**

Chemical hazards classification, hazards due to fire, explosion, toxic chemicals and radiation. Reduction of process hazards by plant condition monitoring. Electrical exposures, guarding live electrical elements. Electrical wiring switches and fuses. Grounding and ground fault interrupter. Classification of atmospheric contaminants.

UNIT III HANDLING AND STORAGE **9**

TLV - classification and significance. Contamination reduction (or) removal methods. handling and storage of hazardous chemicals. Pressurized lines and containers (LPG, Compressed air, gases or fluids). extreme temperatures - hot and cold, reaction safety. Run away reactions.

UNIT IV RISK ANALYSIS **9**

Risk assessment, qualitative, reconnoitres, rapid and comprehensive risk assessment techniques: checklists, indices, HAZOP, maximum credible accident analysis, fault tree analysis, past accident analysis, FMEA (failure mode and effect analysis), quantitative risk assessment, domino effect and its assessment.

UNIT V PROTECTION SYSTEMS **9**

Emergency preparedness: Fire and explosion. Fire hazards. Fire pyramid. Types of fires. Types of fire extinguishers and its handling. Types of built in extinguishing system. Fire fighting techniques, Emergency procedures and types of alarm systems

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Ras[illegible], Namakkal Dist 637 408

TEXT BOOKS:				
Sl.No	**Author(s)**	**Title of the Book**	**Publisher**	**Year of Publication**
1	Tweeddale, Mark	Managing risk and reliability of process plants	Gulf Professional Publishing	2003
2	Kletz, Trevor	Still going wrong, Case histories of process plant disasters and how they could have been avoided	Gulf Professional Publishing	2003

REFERENCE BOOKS:				
Sl.No	**Author(s)**	**Title of the Book**	**Publisher**	**Year of Publication**
1	Crowl, Daniel A. and Louvar, Joseph F	Chemical process safety, Fundamentals with applications	Prentice Hall	2002
2	William Handley	Industrial Safety Hand Book	McGraw-Hill Book Company	2001
3	Fawatt, H.H. and Wood, W.S	Safety and Accident Prevention in Chemical Operation,	Interscience	1963
4	Heinrich, H.W. Dan Peterson, P.E. and Nester Rood	Industrial Accident Prevention	McGraw-Hill Book	1980
5	Ridley	Safety at Work	Butterworth Heinman	2007

WEB URLs:

1. https://www.osha.gov/archive/Publications/osha3091.html
2. https://www.cheric.org/files/education/cyberlecture/e201102/e201102-101.pdf
3. https://www.youtube.com/watch?v=Bq4hVTJpvKk&list=PLLy_2iUCG87D-DD3bgR-MT-k5MsYfkeTR
4. https://www.youtube.com/watch?v=QilLbGbk8Qk&list=PLCpX4O0HWzAVt8ttnlE70kZZQUBzk_twb
5. https://www.youtube.com/watch?v=bbdhS-aKLHA&list=PLFSDfus95bwldx052OuxcES0GcT_rQpsf

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHD19 **PROCESS EQUIPMENT DESIGN LABORATORY** **L T P C**
0 0 2 1

COURSE OBJECTIVES:

- Familiarize standard symbols of process flow diagrams.
- Learn basic symbols used instrumentation diagrams
- Impart the knowledge mechanical aspects of pressure vessel design
- Translatemechanical design specifications in to fabrication drawings for plant erection.
- Draw detailed dimensional drawingsshall include sectional front view, Full Top/side view depending on equipment.

COURSE OUTCOMES:

19CHC22.CO1 : Identify equipment and process involved in process flow diagrams
19CHC22.CO2 : Demonstrate process from process flow diagrams.
19CHC22.CO3 : Explain the different control strategies employed in the process from the instrumentation diagrams
19CHC22.CO4 : State the IS Codes used in the mechanical design.
19CHC22.CO5 : Design and draw fabrication diagrams by scaling.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19CHC22.CO1	x	x	x	x	x	-	-	-	x	x	-	x	x	x	x
19CHC22.CO2	x	x	x	x	x	-	-	-	x	x	-	x	x	x	x
19CHC22.CO3	x	x	x	x	x	-	-	-	x	x	-	x	x	x	x
19CHC22.CO4	x	x	x	x	x	-	-	-	x	x	-	x	x	x	x
19CHC22.CO5	x	x	x	x	x	-	-	-	x	x	-	x	x	x	x

UNIT I **9**

Design and drawing considerations of bolt, nut and screws, welded and riveted joints, flanged joints, nozzles and reinforcements. Pipe fittings.

UNIT II **9**

Design and drawing considerations of vessel supports such as bracket, saddle, skirt, etc. Storage Tanks for solids, liquids and gases.

UNIT III **9**

General design and drawing consideration of vessels subjected to internal pressure, and external pressure. High pressure vessels.

UNIT IV TRANSFORMERS **9**

Fundamental principles, equations, general design and drawing considerations of cyclone separators centrifuges, thickeners and filtration equipments.

UNIT V TESTING OF DC MACHINES AND TRANSFORMERS **9**

General design and drawing considerations of crystallizers, agitated vessel, jacketed and coil heated vessels.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram-Namakkal Dist 637 408

16CHE01 **ENZYME ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of microorganisms and enzymes.
- To provide knowledge on fermentation.
- To provide knowledge on bioreactor design.
- To have knowledge on biochemical aspects of enzyme
- To understand the working of bioreactors.

COURSE OUTCOMES:

16CHE01.CO1 : Ability to acquire knowledge on microbes.
16CHE01.CO2 : Ability to identify the fermentation process
16CHE01.CO3 : Ability to analyze the bioreactor design
16CHE01.CO4 : Ability to comprehend the function and applications of enzymes
16CHE01.CO5 : Ability to explore the industrial applications of enzymes

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE01.CO1	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
16CHE01.CO2	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
16CHE01.CO3	x	x	x	-	x	-	-	-	x	x	x	x	-	-	x
16CHE01.CO4	x	x	x	-	x	-	-	-	x	x	x	x	-	-	x
16CHE01.CO5	x	x	x	-	x	-	-	-	x	x	x	x	-	-	x

UNIT I **9**

Types of Microorganism: Structure and function of microbial cells. Fundamentals of microbial growth, batch and continuous culture. Isolation and purification of enzymes from cells. Cell and Enzyme Immobilization.

UNIT II **9**

Fermentation – Types of mechanisms, Continuous fermentation – aeration and agitation, kinetics of fermentation – Processes

UNIT III **9**

Introduction of Bioreactor design: Continuously stirred aerated tank bioreactors. Mixing power correlation. Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power.

UNIT IV **9**

Introduction to Biochemistry, Function and applications. Nature and function of enzyme. Coenzyme / Cofactor. Classification of enzymes. Assay methods and units. Examples of applications of enzymes in industry, analytical technique medicine and Pharmaceuticals.

UNIT V **9**

Industrial Bioreactors Utilizing Isolated enzymes and biosensors development and applications. Designs of reactor, Batch and continue type; analysis for immobilized enzyme reactors. Sterile and non sterile operations; reactors in series with and without recycle.

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Wiseman. A and Blakeborough N and Dunnill P	Enzymic and nonenzymic catalysis	Ellis and Harwood, U.K	1981
2	Cornish. A -Bowden	Analysis of Enzyme Kinetic Data	Oxford University Press	1996

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Wiseman A	Topics in enzyme and fermentation Bio-technology	Ellis and Harwood, U.K	1990
2	Shuler M.L., Kargi F	Bioprocess Engineering Basic Concepts	Prentice Hall of India	2002
3	Bailey J.E., Ollis D.F	Biochemical Engineering Fundamentals	McGraw-Hill, International Edition	2010
4	Lee J.M	Biochemical Engineering	Prentice Hall	1992
5	Blanch H.W., Clark D.S	Biochemical Engineering	Marcel Dekker	1997

WEB URLs:

1. https://www.cell.com/trends/biotechnology/fulltext/0167-7799(83)90057-4
2. https://onlinelibrary.wiley.com/doi/abs/10.1002/bit.27329
3. https://eng.au.dk/en/research/biological-and-chemical-engineering/industrial-biotechnology/enzyme-engineering/
4. https://www.youtube.com/watch?v=ruifWn_7hVk
5. https://www.youtube.com/watch?v=rckx6a1KwJk

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHE02 **PETROLEUM REFINING AND PETROCHEMICALS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of crude oil .
- To provide knowledge on refining techniques.
- To provide knowledge on treatment techniques.
- To have knowledge on petroleum products
- To understand the petrochemicals production.

COURSE OUTCOMES:

16CHE02.CO1 : Ability to emphasize the petroleum products.
16CHE02.CO2 : Ability to determine the various refining techniques.
16CHE02.CO3 : Ability to analyze treatment methods.
16CHE02.CO4 : Ability to determine extraction process.
16CHE02.CO5 : Ability to Apply the knowledge of treatment processes to develop the manufacture of petroleum products.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE02.CO1	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE02.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE02.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE02.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE02.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I **9**

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum – Atmospheric and Vaccum Distillation.

UNIT II **9**

Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen.

UNIT III **9**

Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance, Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining.

UNIT IV **9**

Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, Catalytic Reforming of Petroleum Feed Stocks and Extraction of Aromatics.

UNIT V **9**

Production of Petrochemicals like Dimethyl Terephathalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and Production of Carbon Black.

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Nelson, W. L	Petroleum Refinery Engineering	McGraw Hill, New York	1985
2	Bhaskara Rao, B. K	Modern Petroleum Refining Processes	Oxford and IBH Publishing Company	1990

Chairman
Board of Studies
Department of Chemical Engineering
...mal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Bhaskara Rao, B. K	A Text on Petrochemicals	Khanna Publishers	1987
2	Wiseman. P	Petrochemicals	UMIST Series in Science and Technology	2001
3	H. Steiner	Introduction to petrochemicals Industry	Pergamon	1961
4	Chauvel A., Lefebvre G	Petrochemical Processes	McGraw Hill, New York	1989
5	Onohue D., Lang K	A First Course in Petroleum Technology	Prentice Hall, New Jersy	1989

WEB URLs:

1. https://www.total.com/energy-expertise/transformation-development/refining-petrochemical
2. https://www.fkit.unizg.hr/_download/repository/PRPP_2013_Crude_oil_composition.pdf
3. https://www.youtube.com/watch?v=yvqSR3KeDt4
4. https://www.youtube.com/watch?v=xhT8w54E8OA
5. https://www.youtube.com/watch?v=In3Slgka8gc

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonom
Rasipuram, Namakkal Dist 637 40

16CHE03 **FOOD TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To acquire knowledge about food and energy
- To know about the general aspects in food.
- To gain knowledge about the production of food products
- To know the fundamentals of preservation methods.
- To know different packing materials for the preservation of foods.

COURSE OUTCOMES:

16CHE03.CO1 : Ability to differentiate the constituents present in food
16CHE03.CO2 : Ability to understand the processing methods
16CHE03.CO3 : Ability to distinguish the production and utilization of food.
16CHE03.CO4 : Ability to know the preservation methods
16CHE03.CO5 : Ability to understand the concept of food packing materials.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE03.CO1	x	-	-	-	-	-	-	-	x	x	-	x	x	-	-
16CHE03.CO2	x	x	x	x	-	-	-	-	x	x	-	x	x	x	-
16CHE03.CO3	x	-	-	-	-	-	-	-	x	x	-	x	x	-	-
16CHE03.CO4	x	x	x	x	-	-	-	-	x	x	-	x	x	x	-
16CHE03.CO5	x	x	x	x	-	-	-	-	x	x	-	x	x	x	-

UNIT I FOOD CONSTITUENTS AND DERIVATIVE FACTORS **9**

Constituents of food – carbohydrates, lipids, proteins, vitamins and minerals, food additives; deteriorative factors and their control.

UNIT II GENERAL ENGINEERING ASPECTS AND PROCESSING METHODS **9**

Preliminary processing methods; conversion and preservation operations

UNIT III PRODUCTION AND UTILISATION OF FOOD PRODUCTS **9**

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

UNIT IV PRESERVATION METHODS **9**

Preservation by heat and cold; Dehydration; Frying; Drying; Irradiation; Microwave heating sterilization and pasteurization; fermentation and pickling

UNIT V FOOD PACKAGING **9**

Basic packaging materials, types of packaging materials used for different kinds of foods, HACCP Introduction and Principles, Introduction to Food Labeling.

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	B. Sivasanker	Food Processing & Preservation	Prentice-Hall Of India Pvt. Ltd.	2002
2	Potter N.N.	Food Science	The AVI Publishing Co., Westport	2006

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	W.C. Frazier & D.C. Westhoff	Food Microbiology	Mcgraw-Hill Book Co.,	1988
2	J.M. Jay	Modern Food Microbiology	Cbs Publications	1987
3	Barbosa-Canovas, G. V., & Ibarz, A	Introduction to food process engineering	CRC Press	2014
4	Sahu, J. K	Introduction to advanced food process engineering	CRC Press	2014
5	P. Coultate	Food – The Chemistry Of Its Components	Royal Society, London	1992

WEB URLs:

1. www.fao.org/wairdocs/x5434e/x5434e00.htm
2. https://www.mooclist.com/course/food-security-and-sustainability-crop-production-edx?static=true
3. https://www.mooclist.com/course/nutrition-and-health-part-3-food-safety-edx?static=true
4. https://www.youtube.com/watch?v=1JbnRA-Hpwg
5. https://www.youtube.com/watch?v=fr1nzF9AMXs

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHE04 **POLYMER TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To gain familiarity on polymers.
- To provide knowledge on addition polymerization.
- To provide knowledge on condensation polymerization.
- To have knowledge on molecular weights of polymers
- To understand the transitions in polymers.

COURSE OUTCOMES:

16CHE04.CO1 : Ability to emphasize about polymers.
16CHE04.CO2 : Ability to analyze the free radicals.
16CHE04.CO3 : Ability to differentiate the polycondensation.
16CHE04.CO4 : Ability to determine molecular weights of polymers.
16CHE04.CO5 : Ability to comprehend the crystallization in polymers.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE04.CO1	x	x	x	x	x	x	-	-	x	x	-	x	x	x	-
16CHE04.CO2	x	x	x	x	x	x	-	-	x	x	-	-	x	x	-
16CHE04.CO3	x	x	x	x	x	x	-	-	x	x	-	-	x	x	-
16CHE04.CO4	x	x	x	x	x	x	-	-	x	x	-	-	x	x	-
16CHE04.CO5	x	x	x	x	x	x	-	-	x	x	-	x	x	x	-

UNIT I INTRODUCTION **6**

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 **12**

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 **9**

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 **9**

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 **9**

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: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Billmeyer.F.W.,Jr	Text Book of Polymer Science	Wiley-Interscience	1984
2	Seymour. R.B., and Carraher.C.E., Jr	Polymer Chemistry	Marcel Dekker	1988

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Gowariker.V.T., Viswanathan.N.V., and Sreedar.J	Polymer Science	Wiley Eastern Ltd.,	1988
2	Joel,R.F	Polymer Science and Technology	Eastern Economy Edition	1999
3	Rodriguez, F., Cohen.C., Oberic.K and Arches, L.A	Principles of Polymer Systems	Taylor and Francis	2001
4	Belov P.S	Fundamentals of Petroleum Chemicals Technology	, Mir Publishers, Moscow	1970
5	Wiseman P	Petrochemicals	Ellis Horwood	1986

WEB URLs:

1. https://www.dupont.com/knowledge/polymer-technology.html
2. https://www.youtube.com/watch?v=p6QPFKwylnU
3. https://www.youtube.com/watch?v=4lKVZpJI0Oo
4. https://www.youtube.com/watch?v=icj_5yF-GV8
5. https://www.youtube.com/watch?v=b_XZKangA8Y

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
...puram, Namakkal Dist 637 408

16CHE05 **DISASTER MANAGEMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

COURSE OUTCOMES:

16CHE05.CO1 : Ability to aware of disasters and types.
16CHE05.CO2 : Ability to determine the DDR approaches.
16CHE05.CO3 : Ability to analyze the disaster and developments.
16CHE05.CO4 : Ability to determine disaster risk management in India.
16CHE05.CO5 : Ability to comprehend applications and case studies.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE05.CO1	x	x	-	-	x	-	-	-	-	-	-	-	x	x	-
16CHE05.CO2	x	x	-	-	-	-	-	-	-	-	x	-	-	-	-
16CHE05.CO3	x	x	-	-	x	-	-	-	x	-	-	-	-	-	-
16CHE05.CO4	x	x	-	-	-	-	-	-	-	-	x	-	-	-	-
16CHE05.CO5	x	x	x	-	-	-	-	-	-	-	-	-	x	x	-

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority (SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

management.

TOTAL: 45 Periods

TEXT BOOKS:				
Sl.No	**Author(s)**	**Title of the Book**	**Publisher**	**Year of Publication**
1	Singhal J.P	Disaster Management	Laxmi Publications	2010
2	Tushar Bhattacharya	Disaster Science and Management	McGraw Hill India Education Pvt. Ltd.,	2012

REFERENCE BOOKS:				
Sl.No	**Author(s)**	**Title of the Book**	**Publisher**	**Year of Publication**
1	Gupta Anil K, Sreeja S. Nair	Environmental Knowledge for Disaster Risk Management	NIDM, New Delhi	2011
2	Kapur Anu	Vulnerable India: A Geographical Study of Disasters	Sage Publishers	2010
3	Ramana Murthy	Disaster Management	Dominant, New Delhi	2004
4	Rajdeep Dasgupta	Disaster Management and Rehabilitation	Mittal Publishers, New Delhi	2007
5	Khanna B K	All You Wanted To Know About Disasters	New India Publishing Agency, New Delhi	2005

WEB URLs:

1. https://ndma.gov.in/
2. https://www.physio-pedia.com/Disaster_Management
3. https://www.youtube.com/watch?v=9WIwlljva_s
4. https://www.youtube.com/watch?v=DExlZTfKZAM
5. https://www.youtube.com/watch?v=HMPBf5rkcb0

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
...puram, Namakkal Dist 637 408

16CHE06 **AIR POLLUTION AND CONTROL** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To enable the students to learn about air pollution.
- To provide knowledge on air pollution gases.
- To provide knowledge on particulate air pollution.
- To have knowledge on hybrid systems
- To understand the about the air pollution control equipment.

COURSE OUTCOMES:

16CHE06.CO1 : Ability to explain about the air pollution.
16CHE06.CO2 : Ability to compare the various air polluting gases
16CHE06.CO3 : Ability to analyze the particulate air pollution.
16CHE06.CO4 : Ability to discuss the hybrid systems.
16CHE06.CO5 : Ability to design the air pollution control equipment

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE06.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
16CHE06.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE06.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE06.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE06.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I INTRODUCTION **9**

Air Pollution Regulatory Framework Histroy – Air Pollution Regulatory Framework - Regulatory System – Laws and Regulations – Clean air Act – Provisions for Recent Developments.

UNIT II AIR POLLUTION GASES **9**

Measurement fundamentals – chemicals and physical properties – Phase Equelbonemconsecoation laws – Incinerators – Design and Performance – Operation and Maintainance - Absorbers – Design operation and improving performances Absorbers.

UNIT III PARTICULATE AIR POLLUTION **9**

Particle Collection mechanisms– Fluid particle Dynamics – Particle size Distribution – Efficency – Gravity Setling chambers Cyclones- Electrostatic precepators Bannouses

UNIT IV HYBRID SYSTEM **9**

Heat electrostatic precepitation – Genizing Heat Scrubbers – Dry Scrubbers –Electrostatically Augmented Fabric Fillration

UNIT V AIR POLLUTION CONTROL EQUIPMENT **9**

Introduction – Installation – Cost Model.

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Louis Theodore, Burley.	Air Pollution Control Equipment	Intuscence	2008
2	CD Cooper and FC. Alley	Air Pollution Control	Wairland Press	2002

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Noel de nevey	Air Pollution Control Engg	Mc graw Hill	1999
2	Rao, C.S	Environmental Pollution Control Engineering	Wiley Eastern, New Delhi	1991
3	Pandey, G.N. And Carney, G.C	Environmental Engineering	, Tata McGraw Hill, New Delhi	1998
4	Kapoor B.S	Environmental Engineering	Khanna Publishers, Delhi	1989
5	Sharma, N., Agarwal, A.K., Eastwood, P., Gupta, T., Singh, A.P	Air Pollution and Control	Springer	2014

WEB URLs:

1. https://www.ymparisto.fi/en-US/Climate_and_air/Air_pollution_control
2. https://www.qld.gov.au/environment/pollution/monitoring/air/air-pollution/controlling
3. https://www.youtube.com/watch?v=HHxHQb5zx2I
4. https://www.youtube.com/watch?v=mP-AZjMGuks
5. https://www.youtube.com/watch?v=0d95KzoWDfI

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHE07 **WASTE WATER TREATMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand overview of waste water treatment.
- To provide knowledge on process analysis.
- To provide knowledge on chemical unit operations.
- To have knowledge on biological treatment
- To understand the advanced treatment methods.

COURSE OUTCOMES:

16CHE07.CO1 : Ability to realize health and environmental aspects of waste water treatment.
16CHE07.CO2 : Ability to determine the selection process.
16CHE07.CO3 : Ability to analyze the unit operations involved in the treatment.
16CHE07.CO4 : Ability to compare the various biological treatment methods.
16CHE07.CO5 : Ability to comprehend the advanced treatment methods.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE07.CO1	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE07.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE07.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE07.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE07.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I WASTE WATER TREATMENT AN OVERVIEW **9**

Terminology – Regulatios – Health and Environment Concerns in waste water management – Constituents in waste water inorganic – Organic and metallic constituents.

UNIT II PROCESS ANALYSIS AND SELECTION **9**

Components of waste water flows – Analysis of Data – Reactors used in waste water treatment – Mass Balance Analysis – Modeling of ideal and non ideal flow in Reactors – Process Selection.

UNIT III CHEMICAL UNIT PROCESSES **9**

Role of unit processes in waste water treatment chemical coagulation – Chemical precipitation for improved plant performance chemical oxidation – Neutralization – Chemical Storage.

UNIT IV BIOLOGICAL TREATMENT **9**

Overview of biological Treatment – Microbial metabolism – Bacterial growth and energatus – Aerobic biological oxidation – Anaerobic fermentation and oxidation – Trickling filters – Rotating biological contractors – Combined aerobic processes – Activated sludge film packing.

UNIT V ADVANCED WASTE WATER TREATMENT **9**

Technologies used in advanced treatment – Classification of technologies Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process.

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Metcalf Eddy	Wastewater Engineering - Treatment and Reuse	Tata McGraw Hill, New Delhi	2002
2	Mark J. Hammer	Water and Wastewater Technology	Prentice Hall of India Pvt Limited, New Delhi	2012

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
...ram, Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Nicholas P. Cheremisinoff	Handbook of Water and Wastewater Treatment Technologies	Elsevier	2002
2	James M. Montgomery	Water Treatment Principles and Design	Wiley Interscience publication	1985
3	Austin G.T	Shreve's Chemical Process Industries	McGraw Hill	1998
4	S.C. Rangwala	Water supply and Sanitary Engineering	Charotar Publishing House	2003
5	Pandey G.N	Text Book of Chemical Technology	Vikas Publishing House Pvt. Ltd	1992

WEB URLs:

1. https://www.safewater.org/fact-sheets-1/2017/1/23/wastewater-treatment
2. https://www.usgs.gov/special-topic/water-science-school/science/wastewater-treatment-water-use
3. https://www.youtube.com/watch?v=rKn0NuUpRf0
4. https://www.youtube.com/watch?v=FvPakzqM3h8
5. https://www.youtube.com/watch?v=s8IVjQg7yno

Chairman
Board of Studies
Department of Chemical Engineering
M...mmal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHE08 **ELECTROCHEMICAL ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand basics of electrochemistry.
- To provide knowledge on mass transfer in electrochemical analysis.
- To provide knowledge on corrosion process.
- To have knowledge on electrochemical process
- To understand the basics of electrodes.

COURSE OUTCOMES:

16CHE08.CO1 : Ability to explain balanced electrochemical reactions, analyse the open-circuit potentials of electrochemical cells including liquid-junction potentials and describe the structure of the electric double layer, based partly on surface-tension data.

16CHE08.CO2 : Ability to discuss the reaction mechanisms and kinetics and obtain electrode over potentials and mass- transfer phenomena, including the estimation of limiting currents.

16CHE08.CO3 : Ability to devise the methodology for the development of corrosion control techniques for the industrial boiler water corrosion.

16CHE08.CO4 : Ability to to explain the principles and working conditions of the different types of primary and secondary batteries.

16CHE08.CO5 : Ability to specify the electrodes used in electrochemical industries like metal finishing, electroplating and electro polishing.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE08.CO1	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE08.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE08.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE08.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE08.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I **9**

Review basics of electrochemistry: Faraday's law - Nernst potential –Galvanic cells – Polarography, The electrical double layer: 94It's role in electrochemical processes –Electrocapillary curve – Helmoltz layer – Guoy –Steven's layer – fields at the interface.

UNIT II **9**

Mass transfer in electrochemical systems: diffusion controlled electrochemical reaction – the importance of convention and the concept of limiting current. over potential, primary-secondary current distribution – rotating disc electrode.

UNIT III **10**

Introduction to corrosion, series, corrosion theories derivation of potential-current relations of activities controlled and diffusion controlled corrosion process. Potential-pH diagram, Forms of corrosion- definition, factors and control methods of various forms of corrosion-corrosion control measures- industrial boiler water corrosion control – protective coatings –Vapor phase inhibitors – cathodic protection, sacrificial anodes – Paint removers.

UNIT IV **8**

Electro deposition – electro refining – electroforming – electro polishing – anodizing – Selective solar coatings, Primary and secondary batteries – types of batteries, Fuel cells.

UNIT V **9**

Electrodes used in different electrochemical industries: Metals-Graphite – Lead dioxide – Titanium substrate insoluble electrodes – Iron oxide – semi conducting type etc. Metal finishing-cell design. types of electrochemical reactors, batch cell, fluidized bed electrochemical reactor, filter press cell, Swiss roll cell, plug flow cell, design equation, figures of merits of different type of electrochemical reactors.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
...ammal Engineering College (Autonomous)
...puram, Namakkal Dist 637 408

TEXT BOOKS:				
Sl.No	**Author(s)**	**Title of the Book**	**Publisher**	**Year of Publication**
1	Picket	Electrochemical Engineering	Prentice Hall	1977
2	Newman, J. S	Electrochemical systems	Prentice Hall	1973

REFERENCE BOOKS:				
Sl.No	**Author(s)**	**Title of the Book**	**Publisher**	**Year of Publication**
1	Barak, M. and Stevenge, U. K	Electrochemical Power Sources - Primary and Secondary Batteries	The Institution of Electrical Engineers	1980
2	Mantell, C	Electrochemical Engineering	McGraw Hill	1972
3	Thomas F. Fuller, John N. Harb	A Comprehensive Reference for Electrochemical Engineering Theory and Application	John Wiley & Sons	2016
4	John Newman, Karen E. Thomas-Alyea	Electrochemical Systems	John Wiley & Sons	2012
5	Nestor Perez	Electrochemistry and Corrosion Science	Springer	2014

WEB URLs:

1. https://edu.epfl.ch/coursebook/en/electrochemical-engineering-CHE-407
2. https://www.wiley.com/en-in/Electrochemical+Engineering-p-9781119004257
3. https://www.youtube.com/watch?v=qP3D-Ev6Ukc
4. https://www.youtube.com/watch?v=taqW9FMVNxE
5. https://www.youtube.com/watch?v=8hvnqgN8cYg

Chairman
Board of Studies
Department of Chemical Engineering
Engineering College (Autonomous)
Namakkal Dist 637 408

16CHE09 **BIOCHEMICAL ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

f. To emphasize concepts of biochemical engineering.
g. To provide knowledge on enzymes and their kinetics.
h. To provide knowledge on microbial kinetics.
i. To have knowledge on transport in microbial systems
j. To understand the concept of downstream processing.

COURSE OUTCOMES:

16CHE09.CO1 : Ability to distinguish the chemical and biochemical process and explain the basic terminologies of biochemical engineering.
16CHE09.CO2 : Ability to demonstrate the basic concept of enzyme engineering and develop kinetic equation for enzyme catalyzed reactions.
16CHE09.CO3 : Ability to analyze the factors affecting the cell growth and develop models for cell growth.
16CHE09.CO4 : Ability to apply concepts of mechanical operations, mass transfer and heat transfer in biochemical processes and microbiological systems.
16CHE09.CO5 : Ability to design bioreactors for downstream processes and effluent treatment.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE09.CO1	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16CHE09.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16CHE09.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16CHE09.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16CHE09.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I INTRODUCTION 6

Industrial biochemical processes with typical examples, comparing chemical and biochemical processes, development and scope of biochemical engineering as a discipline. Industrially important microbial strains; their classification; structure; cellular genetics.

UNIT II KINETICS OF ENZYME ACTION 9

Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, modulation and regulation of enzyme activity, types of inhibition. Immobilized enzyme technology: enzyme immobilization, Immobilized enzyme kinetics: effect of external mass transfer resistance.

UNIT III KINETICS OF MICROBIAL GROWTH 9

Kinetics of cellular growth in batch and continuous culture, models for cellular growth unstructured, structured and cybernetic models , medium formulation. Thermal death kinetics of cells and spores, stoichiometry of cell growth and product formation , Design and analysis of biological reactors.

UNIT IV TRANSPORT PHENOMENA 9

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

UNIT V DOWN STREAM PROCESSING 12

Down stream processing: Strategies to recover and purify products; separation of insoluble products, filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra filtration and reverse osmosis),chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification –crystallization and drying.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Mahammal Engineering College (Autonomous)
Pullipuram, Namakkal Dist 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	J.E.Bailey and D.F.Ollis	Biochemical engineering fundamentals	McGraw Hill	1986
2	Michael L. Shuler and Fikret Kargi	Bioprocess Engineering	Pearson education	2002

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	James M.Lee	Biochemical engineering	Prentice-Hall	1992
2	Pauline M. Doran	Bioprocess engineering principles	Academic Press	1995
3	H.W. Blanch and D.S. Clark	Biochemical Engineering	Marcel Dekker	1997
4	Rao D.G	Introduction to Biochemical Engineering	McGraw Hill	2010
5	Shigeo Katoh, Jun-ichi Horiuchi, Fumitake Yoshida	Biochemical Engineering A Textbook for Engineers, Chemists and Biologists	Wiley	2015

WEB URLs:

1. https://ocw.mit.edu/courses/chemical-engineering/10-442-biochemical-engineering-spring-2005/
2. https://www.youtube.com/watch?v=_LnJHU1DKQg
3. https://www.youtube.com/watch?v=lrMTRgrbRaE
4. https://www.youtube.com/watch?v=QJSEzWkxtPE
5. http://beb.iitd.ac.in/research.html

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHE10 **OPTIMIZATION OF CHEMICAL PROCESSES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand basic optimization problems.
- To provide knowledge on single variable optimization.
- To provide knowledge on multi variable optimization.
- To have knowledge on other optimization methods
- To understand the applications of optimization.

COURSE OUTCOMES:

16CHE10.CO1 : Ability to realize the basic applications in optimization.
16CHE10.CO2 : Ability to emphasize the single variable optimization.
16CHE10.CO3 : Ability to analyze the multi variable optimization.
16CHE10.CO4 : Ability to determine different optimization methods.
16CHE10.CO5 : Ability to comprehend the applications of optimization.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE10.CO1	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16CHE10.CO2	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16CHE10.CO3	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16CHE10.CO4	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16CHE10.CO5	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-

UNIT I INTRODUCTION **5**

Introduction to optimization; applications of optimization in chemical engineering; classification ofoptimization problems.

UNIT II SINGLE VARIABLE OPTIMIZATION **9**

Necessary and sufficient conditions for optimum; region elimination methods; interpolation methods;direct root methods.

UNIT III MULTIVARIABLE OPTIMIZATION WITHOUT AND WITH CONSTRAINTS **9**

Necessary and sufficient conditions for optimum; direct search methods; indirect search methods.

UNIT IV OTHER OPTIMIZATION METHODS **9**

Introduction to geometric, dynamic and integer programming and genetic algorithms.

UNIT V APPLICATIONS OF OPTIMIZATION **13**

Formulation of objective functions; fitting models to data; applications in fluid mechanics, heat transfer, mass transfer, reaction engineering, equipment design, resource allocation and inventory control.

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rao, S. S	Engineering Optimization - Theory and Practice	Wiley & Sons	1996
2	Edgar, T.F., Himmelblau, D.M	Optimisation of Chemical Processes	McGraw-Hill Book Co	2003

Chairman
Board of Studies
Department of Chemical Engineering
...al Engineering College (Autonomous)
..., Namakkal Dist. 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Reklaitis, G.V., Ravindran, A., Ragsdell, K.M	Engineering Optimisation	John Wiley, New York	1980
2	Biles W.E., Swain J.J	Optimization and Industrial Experimentation	Inter Science, New York	1980
3	Seinfeld J.H., Lapidus L	Process Modeling, Estimation and Identification	Prentice Hall, Englewood Cliffs, New Jersey	1974
4	Suman Dutta	Optimization in Chemical Engineering	Cambridge University Press	2016
5	Adrian Bonilla-Petriciolet	Multi-Objective Optimization in Chemical Engineering	John Wiley, New York	2013

WEB URLs:

6. https://www.youtube.com/watch?v=i5d4Dd0D7qw&list=PLbRMhDVUMngct1skDAxoR2xhbIqOnAt0H
7. https://www.youtube.com/watch?v=i5d4Dd0D7qw
8. https://www.youtube.com/watch?v=DgslWoiiO-Q&list=PLcWr8B2ORieOtP4pJH2ZoZECvNaPmjbxt
9. https://gymkhana.iitb.ac.in/~scp/scp/ocw/chemical/cl%20603%20optimization/Optimization%20of%20Chemical%20Processes%20%20Edgar%20Himmelblau%20and%20Lasdon%202nd%20ed.pdf
10. https://link.springer.com/chapter/10.1007/978-3-319-14812-0_7

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHE11 **ENVIRONMENTAL ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To emphasize the basic awareness on environment.
- To provide knowledge on unit operations related to environmental engineering.
- To provide basics on recycling methodology.
- To have knowledge on clean technology
- To understand the prevention of pollution.

COURSE OUTCOMES:

16CHE11.CO1 : Ability to determine the hazards and risk analysis.
16CHE11.CO2 : Ability to analyze the current strategies on pollution.
16CHE11.CO3 : Ability to evaluate the recycling methods.
16CHE11.CO4 : Ability to determine the clean technology.
16CHE11.CO5 : Ability to comprehend pollution prevention.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE11.CO1	x	x	x	x	x	-	-	-	x	x	x	x	x	x	-
16CHE11.CO2	x	x	x	x	x	-	-	-	x	x	x	x	x	x	-
16CHE11.CO3	x	x	x	x	x	-	-	-	x	x	x	x	x	x	-
16CHE11.CO4	x	x	x	x	x	-	-	-	x	x	x	x	x	x	-
16CHE11.CO5	x	x	x	x	x	-	-	-	x	x	x	x	x	x	-

UNIT I ENVIRONMENT AWARENESS **9**

Environment – friendly chemical Process; Hazard and risk analysis; Environmental Audit.

UNIT II CHEMICAL ENGINEERING PROCESSES **9**

Unit Operations – application of - Abatement of water pollution; Current strategies to control air pollution; Disposal of solid wastes

UNIT III RECYCLING METHODOLOGY **9**

Economic recovery and recycling of waste; Transport fuel- Bio-diesel for a cleaner environment.

UNIT IV CLEAN TECHNOLOGY **9**

Towards Eco- friendly products of chemical industry; Pesticides –Their transfer and Transformation in the environment, Biological and electrochemical technology for effluent treatments

UNIT V POLLUTION PREVENTION **9**

Mass exchange network synthesis for pollution control and minimization Implications of environmental constraints for process design, policies for regulation of environmental impacts, Concept of common effluent treatment; Environmental legislations, Role of Government and Industries

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rao, C.S	Environmental Pollution control Engineering	Wiley- Eastern Ltd	1991
2	Peavy H.S. Rowe D.R., and George Technologious	Environmental Engineering	Mc Graw Hill Book Company	1985

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram. Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rao M.N and H.V.N. Rao	Air pollution	Tata McGraw Hill Publishing Co. ltd.	1989
2	Theodore L and Buomlore A.J	Air pollution control equipments	Prentice Hall Inc	1982
3	Wahi S.K., Agnihotri A.K and Sharmma J.S	Environmental Management in Petroleum Industry	Wiley Eastern Ltd	1996
4	Smith, R	Chemical Process Design	McGraw Hill	1995
5	Paul L Bishop	Pollution Prevention Fundamentals and Practice	Mc Graw Hill	2000

WEB URLs:

1. https://www.mcgill.ca/civil/undergrad/areas/environmental
2. https://www.environmentalscience.org/environmental-engineering
3. https://www.youtube.com/watch?v=ocYb7jpVE5k&list=PLNyPK_sfNdSTNj5nKp7mKoyAMPLfpORih
4. https://www.youtube.com/watch?v=kXCFFupDK0g&list=PLgzsL8klq6DIOpwb57vb_ha_IUyNKRUyS
5. https://www.youtube.com/watch?v=1iMpqdMHY-U&list=PLk7ptZcI9vmhN5ck8sQXWgSh_3RHYQjr3

Chairman
Board of Studies
Department of Chemical Engineering
[illegible] Engineering College (Autonomous)
[illegible], Namakkal Dist 637 408

16CHE12 **PROCESS PLANT UTILITIES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the importance of utilities.
- To provide knowledge on steam generation.
- To provide knowledge on refrigeration.
- To have knowledge on compressed air
- To understand the fuel and waste disposal.

COURSE OUTCOMES:

16CHE12.CO1 : Ability to discuss about the role of water as process utility and recognize importance of treatment and conservation of water.
16CHE12.CO2 : Ability to outline the basic properties of steam along with their generation and utilization of steam in process plants.
16CHE12.CO3 : Ability to identify the role of refrigerant for different refrigeration systems and their importations, ventilation systems.
16CHE12.CO4 : Ability to explain the various types of compressors and vacuum pumps, piping systems used in industries.
16CHE12.CO5 : Ability to examine the suitable waste disposal methods.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE12.CO1	x	-	x	-	-	-	-	-	-	x	-	x	-	-	x
16CHE12.CO2	x	x	x	-	x	x	x	-	x	x	x	x	x	-	x
16CHE12.CO3	x	x	x	-	x	x	x	-	x	x	x	x	x	-	x
16CHE12.CO4	x	x	x	-	x	x	x	-	x	x	x	x	x	-	x
16CHE12.CO5	x	-	x	-	x	x	x	-	x	x	x	x	-	-	x

UNIT I IMPORTANT OF UTILITIES 9

Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

UNIT II STEAM AND STEAM GENERATION 9

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

UNIT III REFRIGERATION 9

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.

UNIT IV COMPRESSED AIR 9

Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air – Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.

UNIT V FUEL AND WASTE DISPOSAL 9

Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. Internal Combustion Engine, Petrol and Diesel Engine. Waste Disposal.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Eckenfelder, W. W, Jr	Industrial Water Pollution Control	McGraw-Hill: New York	1966
2	P. L. Ballaney	Thermal Engineering	Khanna Publisher New Delhi	1986

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Perry R. H. Green D. W	Perry's chemical Engineer's Handbook	McGraw Hill, New York	2007
2	P. N. Ananthanarayan	Basic Refrigeration & Air conditioning	McGraw Hill, New Delhi	2007
3	W.L McCabe J.C.Smith, and Harriot. P	Unit Operations of Chemical Engineering	McGraw Hill, Publication	2008
4	Ludwig, E.E	Applied Process Design for Chemical and Petrochemical Plants	Gulf Publishing Company, Texas	2011
5	Ashutosh Pande	Plant Utilities	Vipul Prakashan	2002

WEB URLs:

1. http://hsbte.org.in/pdf/Stream_info/CHEMICAL%20ENGINEERING%20(Spl.%20Paint%20Tech)/Detailed%20content%20SEM-6.pdf
2. https://www.amu.ac.in/emp/studym/2269.pdf
3. https://www.youtube.com/watch?v=yJtaHAr1cEY
4. https://www.youtube.com/watch?v=ABCNOfdJwWA
5. https://www.youtube.com/watch?v=fprw1ISUj44&list=PLYRV6b6qmUFGXZGdBbfB1ChpFKHaQiO3X

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHE13 **FERMENTATION ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the role of fermentation microorganisms.
- To provide knowledge on instrumentation and control.
- To emphasize knowledge on recovery and purification process.
- To have knowledge on effluent treatment
- To understand the fermentation economics.

COURSE OUTCOMES:

16CHE13.CO1 : Ability to outline about fermentation process.
16CHE13.CO2 : Ability to examine about instrumentation and control.
16CHE13.CO3 : Ability to analyze the purification process.
16CHE13.CO4 : Ability to determine effluent treatment process.
16CHE13.CO5 : Ability to comprehend the fermentation economics.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE13.CO1	x	x	x	x	-	-	-	-	-	x	-	x	-	-	x
16CHE13.CO2	x	x	x	x	-	-	-	-	-	x	-	x	-	-	x
16CHE13.CO3	x	x	x	x	-	-	-	-	-	x	-	x	-	-	x
16CHE13.CO4	x	x	x	x	-	-	-	-	-	x	-	x	-	-	x
16CHE13.CO5	x	x	x	x	-	-	-	-	-	x	-	x	-	-	x

UNIT I INTRODUCTION TO FERMENTATION PROCESSES **9**

Microbial biomass – Microbial Enzymes – Microbial metabolites – Recombinant products – Transformation Process – Microbial growth Kinetics – Isolation and preservation and improvement of industrially important micro organism.

UNIT II INSTRUMENTATION AND CONTROL **9**

Measurement of process variables – Temperature and its control – Flow measurement and control – Gases and Liquids – Pressure measurement and control – Cenline analysis – Control System – Combination of Control Systems – Computer application in termentation technology.

UNIT III RECOVERY AND PURIFICATION OF FERMENTATIONPRODUCTS **9**

Removal of Microbial cells – Foam Separation – Precipitation Filtration – Different Filtration process – Centifugation – Different centrifuge cell description – Different methods – Solvent recovery – Superfluid extraction – Chromatography – Membrane processes – Drying – Crystallization – Whole growth processing.

UNIT IV EFFLUENT TREATMENT **9**

Strength of fermentation effluent – Treatment and disposal – Treatment Processes – Physical, chemical and biological – Aerobic process – Anareobic treatment.

UNIT V FERMENTATION ECONOMICS **9**

Introduction – Isolation of micro organisms of industrial interest – Strain improvement – Market potential – Plant and equipment – Media – Air sterilization – Heating and cooling – Recovery costs.

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	P.Stanbury Buttuworth Hanman	Principles of fermentation Technology	McGraw Hill	1999
2	C.C Haber. William Andrew	Fermentation and Biochemical Engineering Handbook	McGraw Hill	2007

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
sipuram, Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	James M.Lee	Biochemical engineering	Prentice-Hall	1992
2	Pauline M. Doran	Bioprocess engineering principles	Academic Press	1995
3	H.W. Blanch and D.S. Clark	Biochemical Engineering	Marcel Dekker	1997
4	Rao D.G	Introduction to Biochemical Engineering	McGraw Hill	2010
5	Shigeo Katoh, Jun-ichi Horiuchi, Fumitake Yoshida	Biochemical Engineering A Textbook for Engineers, Chemists and Biologists	Wiley	2015

WEB URLs:

1. https://www.btec.ncsu.edu/industry/short_courses/fermentation.php
2. https://professional.mit.edu/course-catalog/fermentation-technology
3. https://www.youtube.com/watch?v=5eKdZ0dVCCo
4. https://www.youtube.com/watch?v=OZgx10mdOYI
5. https://www.youtube.com/watch?v=hav_yLrgFqs

Chairman
Board of Studies
Department of Chemical Engineering
mal Engineering College (Autonomous)
Namakkal Dist 637 40[illegible]

16CHE14 **PULP AND PAPER TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide basic knowledge on pulp and paper.
- To provide knowledge on wood yard operation.
- To understand the concept of wood machine operation.
- To have knowledge on paper and paperboard
- To understand the properties of pulp and paper.

COURSE OUTCOMES:

16CHE14.CO1 : Ability to outline about pulp and paper technology.
16CHE14.CO2 : Ability to examine about wood yard operation
16CHE14.CO3 : Ability to analyze the concept of wood machine operation.
16CHE14.CO4 : Ability to determine paper and paperboard.
16CHE14.CO5 : Ability to comprehend the properties of pulp and paper.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE14.CO1	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
16CHE14.CO2	x	x	x	-	x	-	-	-	x	x	x	x	-	-	x
16CHE14.CO3	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
16CHE14.CO4	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
16CHE14.CO5	x	x	x	-	x	-	-	-	x	x	x	x	-	-	x

UNIT I INTRODUCTION 9

Introduction Basic pulp and paper technology – Wood haves dry – Wood as a raw material.

UNIT II WOODYARD OPERATION 9

Woodyard operation - Mechanical pulping – Chemical pulping – Secondary fibre pulp processing

UNIT III PAPER MACHINE 9

Paper Machine wet and addition paper machine dry and operation – Paper machine - Wet and operation.

UNIT IV PAPER AND PAPERBOARD 9

Paper and paperboard frames and products – Surface treatments – Finishing operation– End uses.

UNIT V PROPERTIES AND TESTING OF PULP AND PAPER 9

Properties and Testing of pulp and paper Process control – Quality assurance – Water and air pollution control.

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	John B. Calkin	Modern Pulp and paper Making	Reinhold Pub.Corp.,	1960
2	Stephenson N	Pulp and Paper manufacture	McGraw Hill, New York	1950

Chairman
Board of Studies
Department of Chemical Engineering
M ...mmal Engineering College (Autonomous)
...ram, Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Halpern M.G	Pulp Mill Processes	Park Ridge, N.J: Noyce Data Corporation	1975
2	Britt.K.W	Handbook of Pulp and Paper Technology	CBS Publishers Delhi	1984
3	Smook, G.A	Handbook for pulp and paper technologist	Angus Wilde Publications	2003
4	Casey J.P	Pulp and Paper: Chemistry and Chemical technology	Wiley Interscience	1983
5	James M. Montgomery	Water Treatment Principles and Design	Wiley Interscience publication, New York	1985

WEB URLs:

1. https://www.pulpandpaper-technology.com/
2. https://core.ac.uk/download/pdf/234685264.pdf
3. https://www.youtube.com/watch?v=YkmPi7T8TXA
4. https://www.youtube.com/watch?v=2Uh3XIadm1A
5. https://www.youtube.com/watch?v=oiVH2MDpbeQ

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHE15 **ENERGY TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand basic concept of energy.
- To provide knowledge on conventional energy.
- To provide knowledge on non conventional energy.
- To have knowledge on biomass energy
- To understand the energy conservation.

COURSE OUTCOMES:

16CHE15.CO1 : Ability to outline the basic concept of energy.
16CHE15.CO2 : Ability to examine about the conventional energy
16CHE15.CO3 : Ability to analyze about non conventional energy.
16CHE15.CO4 : Ability to determine biomass energy.
16CHE15.CO5 : Ability to comprehend the energy conservation.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE15.CO1	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
16CHE15.CO2	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
16CHE15.CO3	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
16CHE15.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE15.CO5	x	x	x	x	-	-	-	-		x	-	x	x	x	-

UNIT I ENERGY **8**

Introduction to energy – Global energy scene – Indian energy scene - Units of energy, conversion factors, general classification of energy, energy crisis, energy alternatives.

UNIT II CONVENTIONAL ENERGY **8**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT III NON-CONVENTIONAL ENERGY **10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion,tidal energy conversion, geothermal energy.

UNIT IV BIOMASS ENERGY **10**

Biomass origin - Resources – Biomass estimation. Thermochemical conversion – Biological conversion, Chemical conversion – Hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification.

UNIT V ENERGY CONSERVATION **9**

Energy conservation - Act; Energy management importance, duties and responsibilities; Energy audit – Types methodology, reports, instruments. Benchmalcing and energy performance, material and energy balance, thermal energy management.

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
Mahendra Engineering College (Autonomous)
Mahendhirapuram, Namakkal Dist 637 408

TEXT BOOKS:				
Sl.No	**Author(s)**	**Title of the Book**	**Publisher**	**Year of Publication**
1	Rao, S. and Parulekar, B.B	Energy Technology	Khanna Publishers	2005
2	Rai, G.D	Non-conventional Energy Sources	Khanna Publishers	1984

REFERENCE BOOKS:				
Sl.No	**Author(s)**	**Title of the Book**	**Publisher**	**Year of Publication**
1	Nagpal, G.R	Power Plant Engineering	Khanna Publishers	2008
2	Paul W.O'Callaghan	Energy Management	McGraw – Hill	1993
3	Nejat Vezirog	Alternate Energy Sources	McGraw Hill	1998
4	El. Wakil	Power Plant Technology	Tata McGraw Hill	2002
5	Sukhatme. S.P	Solar Enery - Thermal Collection and Storage	Tata McGraw hill	1981

WEB URLs:

1. https://www.wiley-vch.de/de/shop/journals/397-energy-technology-2198-de
2. https://www.sciencedaily.com/news/matter_energy/energy_technology/
3. https://www.youtube.com/watch?v=1VdlMCzEdl8
4. https://www.youtube.com/watch?v=EoTVtB-cSps
5. https://www.youtube.com/watch?v=noT8mVbMjaw

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

16CHE16 **DRUGS AND PHARMACEUTICAL TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the basis of drugs.
- To provide knowledge on drug metabolism.
- To provide knowledge on unit process and applications.
- To have knowledge on drug manufacturing principles
- To understand the pharmaceutical products.

COURSE OUTCOMES:

16CHE16.CO1 : Ability to outline the drugs and pharmaceutical industry.
16CHE16.CO2 : Ability to examine the drug metabolism
16CHE16.CO3 : Ability to analyze the unit process and their applications.
16CHE16.CO4 : Ability to determine principles of drug manufacturing.
16CHE16.CO5 : Ability to comprehend the analysis of pharmaceutical products.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHE16.CO1	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE16.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE16.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE16.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHE16.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

UNIT I INTRODUCTION **9**

Development of drugs and pharmaceutical industry; organic therapeutic agents uses and economics

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

Drug metabolism; physico chemical principles; pharma kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones

UNIT III IMPORTANT UNIT PROCESSES AND THEIR APPLICATION **9**

Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complexchemical conversions fermentation.

UNIT IV MANUFACTURING PRINCIPLES & PACKING AND QUALITY CONTROL **9**

Compressed tablets; wet granulation; dry granulation or slugging; advancement in 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 & PHARMACEUTICAL ANALYSIS **9**

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

TOTAL: 45 Periods

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rawlines, E.A	Bentleys Text book of Pharmaceutics	Bailliere Tindall, London	1977
2	Yalkonsky, S.H.; Swarbick. J	Drug and Pharamaceutical Sciences	Marcel Dekkar Inc., New York	1975

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Felton, Linda A	Remington's Pharmaceutical Sciences	Mack Publishing Co	1975
2	Brahmankar D.M. and Jaiswal S.B	Biopharmaceutics and Pharmacokinetics	Vallabh Prakashan, New Delhi	2015
3	Lachman L. Lieberman H.A. and Kanig J.L	The Theory and Practice of Industrial Pharmacy	Varghese Publishing House, Mumbai	2013
4	uergen Siepmann, Ronald A. Siegel, Michael J. Rathbone	Fundamentals and Applications of Controlled Release Drug Delivery	Springer	2011
5	Tyagi O.D., Yadav M. A	Text Book of Synthetic Drugs	Anmol Publications	2011

WEB URLs:

1. https://www.pharmaceutical-technology.com/
2. https://www.longdom.org/scholarly/pharmaceutical-technology-journals-articles-ppts-list-1956.html
3. https://www.youtube.com/watch?v=LvPvpztxTCg
4. https://www.youtube.com/watch?v=BnIno3mzvls
5. https://www.youtube.com/watch?v=-xFwOCq3ewI

Chairman
Board of Studies
Department of Chemical Engineering
Muthayammal Engineering College (Autonomous)
...namakkal Dist. 637 408

16CHF01 **PROJECT PHASE I** **L T P C**
0 0 6 3

COURSE OBJECTIVES:

- To practical implementation of theoretical knowledge gained during the study from First year to Third year
- To implement their ideas/real time industrial problem/ current application of their engineering branch which they have studied in curriculum
- To build confidence in the student what he has learnt theoretically.
- To identify the appropriate problem solving methodology
- To Analyze and process the experimental information

COURSE OUTCOMES:

16CHF01.CO1 : Prepare a literature survey in a specific domain as a team / individual to motivate lifelong learning.
16CHF01.CO2 : Identify the problem which needs to be provided a sustainable solution using modern tools
16CHF01.CO3 : Analyze the problem definition and design its impact on the society and environment.
16CHF01.CO4 : Document the literature and bindings.
16CHF01.CO5 : Chose the domain of biotechnology and apply to variety of real time problem scenarios.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHF01.CO1	-	x	x	-	-	-	-	-	-	x	-	x	-	-	-
16CHF01.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHF01.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHF01.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
16CHF01.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineering
[illegible] Engineering College (Autonomous)
Ku[illegible]uram, Namakkal Dist 637 408

16CHF02 **PROJECT PHASE II** **L T P C**
0 0 30 15

COURSE OBJECTIVES:

- To Plan an experimental design to solve Engineering problems
- To develop an attitude of team work and independent working on real time problems
- To Analyze and process the experimental information
- To evaluate, interpret and justify he experimental results
- To develop a dissertation report

COURSE OUTCOMES:

16CHF02.CO1 : Plan an experimental design to solve engineering / societal problems using modern tools
16CHF02.CO2 : Develop lifelong learning to keep abreast of latest technologies.
16CHF02.CO3 : Analyze and implement the design to provide sustainable solutions.
16CHF02.CO4 : Evaluate and interpret the experimental results and analyze the impact on society and environment.
16CHF02.CO5 : Implement and test the application for the real time problems.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16CHF02.CO1	x	x	-	x	-	x	-	x	x	-	x	x	x	x	-
16CHF02.CO2	x	x	x	x	-	-	-	-	x	-	x	x	x	x	-
16CHF02.CO3	x	x	x	x	x	x	-	-	x	-	x	x	x	x	x
16CHF02.CO4	x	x	x	x	x	x	-	-	x	-	x	x	x	x	x
16CHF02.CO5	-	-	-	-	-	-	-	-	x	x	x	x	-	-	-

TOTAL: 45 Periods

Chairman
Board of Studies
Department of Chemical Engineerin
Muthayammal Engineering College (Autonome
Rasipuram, Namakkal Dist 637 40