



# 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-2019**



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Rasipuram - 637 408, Namakkal Dt, Tamil Nadu.

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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.



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## **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.



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## **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.



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**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	19HSS01	Business English	HS	2	2	0	0	2
2	19HSS03	Psychology and Ethics	HS	2	2	0	0	2
3	19HSS02	English Communicative Skills Laboratory	HS	2	0	0	2	1
4	19HSS04	Technical English For Engineers	HS	2	2	0	0	2
5	19HSS05	Communicative English for Engineers	HS	2	2	0	0	2
6	19HSS06	Basics of Japanese Language	HS	2	2	0	0	2
7	19HSS07	Basics of French Language	HS	2	2	0	0	2
8	19HSS08	Professional Ethics and Human Values	HS	3	3	0	0	3

## Basic Science Courses [BS]

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1	19BSS01	Engineering Physics	BS	3	3	0	0	3
2	19BSS02	Physics and Chemistry Laboratory	BS	2	0	0	2	1
3	19BSS03	Bio and Nanomaterials Sciences	BS	3	3	0	0	3
4	19BSS04	Material Sciences	BS	3	3	0	0	3
5	19BSS05	Physics for Mechanical Engineers	BS	3	3	0	0	3
6	19BSS11	Engineering Chemistry	BS	3	3	0	0	3
7	19BSS12	Environmental Science and Engineering	BS	3	3	0	0	3
8	19BSS13	Organic Chemistry	BS	3	3	0	0	3
9	19BSS14	Physical Chemistry	BS	3	3	0	0	3
10	19BSS15	Applied Chemistry	BS	3	3	0	0	3
11	19BSS16	Organic Chemistry Laboratory	BS	2	0	0	2	1
12	19BSS17	Physical Chemistry Laboratory	BS	2	0	0	2	1
13	19BSS21	Algebra and Calculus	BS	4	3	2	0	4

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**Board of Studies**

**Department of Chemical Engineering**  
**Muthayammal Engineering College (Autonomous)**  
**Rasipuram, Namakkal Dist 637 408**

Programme Code & Name: CH & B.Tech-Chemical Engineering

14	19BSS22	Differential Equations and Vector Analysis	BS	4	3	2	0	4
15	19BSS23	Transform and Partial Differential Equations	BS	4	3	2	0	4
16	19BSS24	Discrete Mathematics	BS	4	3	2	0	4
17	19BSS25	Statistical and Queuing Model	BS	4	3	2	0	4
18	19BSS26	Numerical Methods	BS	4	3	2	0	4
19	19BSS27	Probability and Random Processes	BS	4	3	2	0	4
20	19BSS28	Statistic and Numerical Methods	BS	4	3	2	0	4

**General Engineering Science Courses [GES]**

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1	19GES01	Programming for Problem Solving Using C	GES	3	3	0	0	3
2	19GES02	Programming for Problem Solving Technique	GES	3	3	0	0	3
3	19GES03	Programming in C Laboratory	GES	2	0	0	2	1
4	19GES04	Programming in C and Python Laboratory	GES	2	0	0	2	1
5	19GES05	Electrical and Electronic Sciences	GES	3	3	0	0	3
6	19GES06	Mechanical and Building Sciences	GES	3	3	0	0	3
7	19GES07	Computer Aided Drafting Laboratory	GES	2	0	0	2	1
8	19GES08	Python Programming	GES	3	3	0	0	3
9	19GES09	Programming in Python Laboratory	GES	2	0	0	2	1
10	19GES10	Soft Skills Laboratory	GES	2	0	0	2	1
11	19GES11	Electronic Devices	GES	3	3	0	0	3
12	19GES12	Electronic Simulation Laboratory	GES	2	0	0	2	1
13	19GES13	Electric Circuits	GES	4	2	2	0	3
14	19GES14	Electric Circuits Laboratory	GES	2	0	0	2	1
15	19GES15	Manufacturing Process	GES	3	3	0	0	3
16	19GES16	Manufacturing Process Laboratory	GES	2	0	0	2	1
17	19GES17	Mechanical and Building Sciences Laboratory	GES	2	0	0	2	1
18	19GES18	Construction Materials	GES	3	3	0	0	3
19	19GES19	Concepts in Product Design	GES	3	3	0	0	3
20	19GES20	Renewable Energy Sources	GES	3	3	0	0	3
21	19GES21	Electrical Drives and Control	GES	3	3	0	0	3
22	19GES22	Electrical Drives and Control Laboratory	GES	2	0	0	2	1
23	19GES23	Analog and digital communication	GES	3	3	0	0	3
24	19GES24	Digital Principles and System Design	GES	3	3	0	0	3

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Programme Code & Name: CH & B.Tech-Chemical Engineering

25	19GES25	Digital Principles and System Design Laboratory	GES	2	0	0	2	1
26	19GES26	Engineering Drawing	GES	5	1	0	4	3
27	19GES27	Engineering Geology	GES	3	3	0	0	3
28	19GES28	Engineering Mechanics	GES	4	3	2	0	4
29	19GES29	Wireless Communication	GES	4	3	2	0	4
30	19GES30	Electronics and Microprocessor	GES	3	3	0	0	3
31	19GES31	Electronics and Microprocessor Laboratory	GES	2	0	0	2	1
32	19GES32	Data Structures using Python	GES	3	3	0	0	3

**Professional Core Courses [PCC]**

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/ Week			C
					L	T	P	
1	19CHD01	Chemical Process Calculations	PCC	4	2	2	0	3
2	19CHD02	Fluid Mechanics	PCC	3	3	0	0	3
3	19CHD03	Chemical Process Industries	PCC	2	2	0	0	2
4	19CHD04	Instrumental Methods of Analysis	PCC	3	3	0	0	3
5	19CHD05	Mechanics of solids	PCC	2	2	0	0	2
6	19CHD06	Chemical Engineering Thermodynamics I	PCC	3	3	0	0	3
7	19CHD07	Heat transfer	PCC	4	2	2	0	3
8	19CHD08	Mass Transfer – I	PCC	3	3	0	0	3
9	19CHD09	Mechanical Operations	PCC	2	2	0	0	2
10	19CHD10	Chemical Engineering Thermodynamics II	PCC	3	3	0	0	3
11	19CHD11	Mass Transfer – II	PCC	4	2	2	0	3
12	19CHD12	Chemical Reaction Engineering I	PCC	4	2	2	0	3
13	19CHD13	Transport Phenomena	PCC	3	3	0	0	3
14	19CHD14	Process Modeling and Simulation	PCC	3	3	0	0	3
15	19CHD15	Process Dynamics and Control	PCC	3	3	0	0	3
16	19CHD16	Chemical Reaction Engineering II	PCC	4	2	2	0	3
17	19CHD17	Fluid Mechanics Laboratory	PCC	3	0	0	3	1
18	19CHD18	Instrumental Methods of Analysis Laboratory	PCC	3	0	0	3	1
19	19CHD19	Heat Transfer Laboratory	PCC	3	0	0	3	1
20	19CHD20	Mechanical Operations Laboratory	PCC	3	0	0	3	1
21	19CHD21	Mass Transfer Laboratory	PCC	3	0	0	3	1
22	19CHD22	Process Equipment Design Laboratory	PCC	3	0	0	3	1
23	19CHD23	Process control Laboratory	PCC	3	0	0	3	1

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**Professional Elective Courses [PEC]**

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/ Week			C
					L	T	P	
1	19CHE01	Enzyme Engineering	PEC	3	3	0	0	3
2	19CHE02	Petroleum Refining and Petrochemicals	PEC	3	3	0	0	3
3	19CHE03	Food Technology	PEC	3	3	0	0	3
4	19CHE04	Polymer Technology	PEC	3	3	0	0	3
5	19CHE05	Disaster Management	PEC	3	3	0	0	3
6	19CHE06	Air Pollution and Control	PEC	3	3	0	0	3
7	19CHE07	Waste Water Treatment	PEC	3	3	0	0	3
8	19CHE08	Electrochemical Engineering	PEC	3	3	0	0	3
9	19CHE09	Modern Separation Techniques	PEC	3	3	0	0	3
10	19CHE10	Optimization of Chemical Processes	PEC	3	3	0	0	3
11	19CHE11	Environmental Engineering	PEC	3	3	0	0	3
12	19CHE12	Process Plant Utilities	PEC	3	3	0	0	3
13	19CHE13	Fermentation Engineering	PEC	3	3	0	0	3
14	19CHE14	Pulp and Paper Technology	PEC	3	3	0	0	3
15	19CHE15	Energy Technology	PEC	3	3	0	0	3
16	19CHE16	Drugs and Pharmaceutical Technology	PEC	3	3	0	0	3
17	19CHE17	Chemical Process Plant Safety	PEC	3	3	0	0	3

**EMPLOYABILITY ENHANCEMENT COURSES [EEC]**

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/ Week			C
					L	T	P	
1	19CHF01	Project work – Phase-I	EEC	3	0	0	10	5
2	19CHF02	Project work – Phase-II	EEC	20	0	0	18	9

**OPEN ELECTIVE COURSES [OEC]**

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1		Industrial Robotics	OEC	3	3	0	0	3
2		Industrial Waste Management	OEC	3	3	0	0	3
3		Biomedical Engineering	OEC	3	3	0	0	3
4		Electronics and Microprocessor	OEC	3	3	0	0	3
5		Programming in Python	OEC	3	3	0	0	3
6		Database Management Systems	OEC	3	3	0	0	3
7		Internet of Things	OEC	3	3	0	0	3

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8		Soft Computing Techniques	OEC	3	3	0	0	3
9		M-Commerce	OEC	3	3	0	0	3
10		Programming in Java	OEC	3	3	0	0	3


**MANDATORY COURSES [MC]**


S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1	19CHM01	Organizational Behaviour	MC	3	3	0	0	0
2	19CHM02	India Constitution	MC	3	3	0	0	0
3	19CHM03	Essence of Indian Traditional Knowledge	MC	3	3	0	0	0


  
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 <b>MUTHAYAMMAL ENGINEERING COLLEGE (Autonomous)</b> (Approved by AICTE & Affiliated to Anna University), RASIPURAM – 637 408		CURRICULUM UG R - 2019						
Department		Chemical Engineering						
Programme		B.Tech. – Chemical Engineering						
SEMESTER – I								
Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit C	Contact Hrs
				L	T	P		
<b>Theory</b>								
1.	19HSS01	Business English	HS	2	0	0	2	2
2.	19BSS21	Algebra and Calculus	BS	3	2	0	4	5
3.	19BSS01	Engineering Physics	BS	3	0	0	3	3
4.	19BSS11	Engineering Chemistry	BS	3	0	0	3	3
5.	19GES02	Programming for Problem Solving Technique	GES	3	0	0	3	3
6.	19GES05	Electrical and Electronic Sciences	GES	3	0	0	3	3
<b>Practical</b>								
7.	19GES07	CAD Lab	GES	0	0	3	1	3
8.	19GES04	Programming in C and Python Laboratory	GES	0	0	3	1	3
9.	19HSS02	English Communicative skills Laboratory	HS	0	0	2	1	2
<b>Total Credits</b>							<b>21</b>	


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Department		Chemical Engineering						
Programme		B.Tech. – Chemical Engineering						
SEMESTER – II								
Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit C	Contact Hrs
				L	T	P		
<b>Theory</b>								
1.	19HSS03	Life Skills and workplace Psychology	HS	2	0	0	2	2
2.	19BSS22	Differential Equations and Vector Analysis	BS	3	2	0	4	5
3.	19BSS03	Bio and Nanomaterials Sciences	BS	3	0	0	3	3
4.	19BSS12	Environmental Science and Engineering	BSS	3	0	0	3	3
5.	19GES19	Concepts in Product Design	GES	3	0	0	3	3
6.	19GES06	Mechanical and Building Sciences	GES	3	0	0	3	3
<b>Practical</b>								
7.	19BSS02	Physics and Chemistry Laboratory	BS	0	0	2	1	2
8.	19GES17	Mechanical and Building Sciences Laboratory	GES	0	0	3	1	3
<b>Total Credits</b>							<b>20</b>	


  
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Department		Chemical Engineering							
Programme		B.Tech. - Chemical Engineering							
SEMESTER – III									
Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit C	Contact Hrs	
				L	T	P			
<b>Theory</b>									
1.	19BSS23	Transform and Partial Differential Equations	BS	3	2	0	4	5	
2.	19BSS13	Organic Chemistry	BS	3	0	0	3	3	
3.	19GES21	Electrical Drives and Controls	GES	3	0	0	3	3	
4.	19CHD01	Chemical Process Calculations	PCC	2	2	0	3	4	
5.	19CHD02	Fluid Mechanics	PCC	3	0	0	3	3	
6.	19CHD03	Chemical Process Industries	PCC	2	0	0	2	4	
<b>Practical</b>									
7	19BSS16	Organic Chemistry Laboratory	BS	0	0	3	1	3	
8	19GES22	Electrical Drives and Controls Laboratory	GES	0	0	3	1	3	
9	19CHD17	Fluid Mechanics Laboratory	PCC	0	0	3	1	3	
<b>Total Credits</b>							<b>21</b>		

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Department		Chemical Engineering							
Programme		B.Tech. - Chemical Engineering							
SEMESTER – IV									
Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit C	Contact Hrs	
				L	T	P			
<b>Theory</b>									
1.	19BSS26	Numerical Methods	BS	3	2	0	4	5	
2.	19BSS14	Physical Chemistry	BS	3	0	0	3	3	
3.	19CHD04	Instrumental Methods of Analysis	PCC	3	0	0	3	3	
4.	19CHD05	Mechanics of solids	PCC	2	0	0	2	2	
5.	19CHD06	Chemical Engineering Thermodynamics - I	PCC	3	0	0	3	3	
6.	19GES20	Renewable Energy Sources	GES	3	0	0	3	3	
<b>Practical</b>									
7	19BSS17	Physical Chemistry Laboratory	BS	0	0	3	1	3	
8	19CHD18	Instrumental Methods of Analysis Laboratory	PCC	0	0	3	1	3	
<b>Mandatory course</b>									
9	19CHM01	Organizational Behavior	MC	3	0	0	0	3	
<b>Total Credits</b>							<b>20</b>		


  
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Department		Chemical Engineering						
Programme		B.Tech. - Chemical Engineering						
<b>SEMESTER – V</b>								
Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit C	Contact Hrs
				L	T	P		
<b>Theory</b>								
1.	19CHD07	Heat Transfer	PCC	2	2	0	3	4
2.	19CHD08	Mass Transfer - I	PCC	3	0	0	3	3
3.	19CHD09	Mechanical Operations	PCC	2	0	0	2	2
4.	19CHD10	Chemical Engineering Thermodynamics - II	PCC	3	0	0	3	3
5.		Professional Elective - I	PEC	3	0	0	3	3
6.		Professional Elective – II	PEC	3	0	0	3	3
7.		Open Elective - I	OEC	3	0	0	3	3
<b>Practical</b>								
8.	19CHD19	Heat Transfer Laboratory	PCC	0	0	3	1	3
9.	19CHD20	Mechanical Operations Laboratory	PCC	0	0	3	1	3
<b>Mandatory course</b>								
10.	19CHM02	India Constitution	MC	3	0	0	0	3
<b>Total Credits</b>							<b>22</b>	

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Department		Chemical Engineering						
Programme		B.Tech. - Chemical Engineering						
<b>SEMESTER – VI</b>								
Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit C	Contact Hrs
				L	T	P		
<b>Theory</b>								
1.	19CHD11	Mass Transfer - II	PCC	2	2	0	3	4
2.	19CHD12	Chemical Reaction Engineering - I	PCC	2	2	0	3	4
3.	19CHD13	Transport Phenomena	PCC	3	0	0	3	3
4.		Professional Elective – III	PEC	3	0	0	3	3
5.		Professional Elective - IV	PEC	3	0	0	3	3
6.		Open Elective - II	OEC	3	0	0	3	3
<b>Practical</b>								
7.	19CHD21	Mass Transfer Laboratory	PCC	0	0	3	1	3
8.	19CHD22	Process Equipment Design Laboratory	PCC	0	0	3	1	3
<b>Mandatory course</b>								
9.	19CHM03	Essence of Indian Traditional Knowledge	MC	3	0	0	0	3
<b>Total Credits</b>							<b>20</b>	

  
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Department		Chemical Engineering						
Programme		B.Tech. - Chemical Engineering						
SEMESTER – VII								
Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit C	Contact Hrs
				L	T	P		
<b>Theory</b>								
1	19CHD14	Process Modeling and Simulation	PCC	3	0	0	3	3
2	19CHD15	Process Dynamics and Control	PCC	3	0	0	3	3
3	19CHD16	Chemical reaction Engineering - II	PCC	2	2	0	3	4
4		Professional Elective – V	PEC	3	0	0	3	3
5		Professional Elective - VI	PEC	3	0	0	3	3
6		Open Elective - III	OEC	3	0	0	3	3
<b>Practical</b>								
7	19CHD23	Process Control Laboratory	PCC	0	0	3	1	3
8	19CHF01	Project Phase I	EEC	0	0	10	7	6
<b>Total Credits</b>							<b>26</b>	

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Department		Chemical Engineering						
Programme		B.Tech. - Chemical Engineering						
SEMESTER – VIII								
Sl. No.	Course Code	Course Name	Category	Hours/ Week			Credit C	Contact Hrs
				L	T	P		
1.	19CHF02	Project Phase II	EEC	0	0	20	10	20
<b>Total Credits</b>							<b>10</b>	

Total Credits: 160

Semester	I	II	III	IV	V	VI	VII	VIII	Total	Percentage
HS	3	2							5	3
BS	10	11	8	8					37	23
ES	8	7	4	3					22	14
PC			9	9	13	11	10		52	33
PE					6	6	6		18	11
EEC							7	10	17	10
OE					3	3	3		9	6
<b>Total</b>	<b>21</b>	<b>20</b>	<b>21</b>	<b>20</b>	<b>22</b>	<b>20</b>	<b>26</b>	<b>9</b>	<b>160</b>	

  
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19CHC01

CHEMICAL PROCESS CALCULATIONS

L T P C  
2 2 0 3

**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:**

- 19CHC01.C01 : 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.
- 19CHC01.C02 : 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.
- 19CHC01.C03 : Ability to compute the concentration, degree of saturation and dew point of vapour -gas mixture at the given temperature and pressure using humidity chart.
- 19CHC01.C04 : 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.
- 19CHC01.C05 : 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
19CHC01.C01	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-
19CHC01.C02	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-
19CHC01.C03	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-
19CHC01.C04	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-
19CHC01.C05	x	x	x	x	-	x	-	-	-	x	-	x	-	x	-

**UNIT I**

12

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**

12

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**

12

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

**UNIT IV**

12

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**

12

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: 60 Periods**

  
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**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](https://www.youtube.com/watch?v=_ww0-IDidXM&list=PLwdnzlV3ogoXpDif2e93GJKoojj0SgvV0)
5. [https://www.youtube.com/watch?v=0k3SE16\\_bnU&list=PLyqSpQzTE6M-QFqMp7\\_FJ\\_NuGCXDuHqvf](https://www.youtube.com/watch?v=0k3SE16_bnU&list=PLyqSpQzTE6M-QFqMp7_FJ_NuGCXDuHqvf)



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19CHC02

FLUID MECHANICS

L T P C  
3 0 0 3

**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:**

- 19CHC02.CO1 : Determine the various fluid properties.  
 19CHC02.CO2 : Impart knowledge on fluid in statics and dynamics.  
 19CHC02.CO3 : Determine the various losses in pipes and compute the energy and momentum thickness.  
 19CHC02.CO4 : Explain the processes involved in the flow measurement and pumps.  
 19CHC02.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
19CHC02.CO1	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
19CHC02.CO2	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
19CHC02.CO3	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
19CHC02.CO4	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
19CHC02.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

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



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19CHC03

CHEMICAL PROCESS INDUSTRIES

L T P C  
2 0 0 2

**COURSE OBJECTIVES:**

- To acquire knowledge on chemical industries
- To develop skills in oil and allied industries
- To understand the concepts in fermentation industries.
- To provide knowledge on pulp and leather industries.
- To provide knowledge on cement industries.

**COURSE OUTCOMES:**

- 19CHC03.CO1 : Ability to identifies the contemporary technologies in water treatment and label the process economics in sulphur based industries.
- 19CHC03.CO2 : Ability to design the production methodology of oil industries and analyse the efficiency of the products.
- 19CHC03.CO3 : Ability to analyze and formulate the chemical processes and economics involved in the carbohydrate industries.
- 19CHC03.CO4 : Ability to describe the flow sheets of manufacture process of pulp based, leather industries and engineering problems faced in the industries.
- 19CHC03.CO5 : Ability to evaluate the surface coating and cement industry processes to justify their appropriate production techniques and their handling processes.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19CHC03.CO1	x	x	-	-	x	-	-	-	-	x	-	x	x	-	x
19CHC03.CO2	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
19CHC03.CO3	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
19CHC03.CO4	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
19CHC03.CO5	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x

**UNIT I NITROGEN, PHOSPHOROUS AND SULPHUR BASED INDUSTRIES**

11

Nitrogen, Ammonium nitrate, Ammonium sulphate and Urea. Phosphorus, Phosphoric acid, Ammonium phosphates, Sodium phosphates, Nitrophosphate & Phosphate esters. Mixed fertilizers (NPK Mixtures). Manufacture of Sulphur and Sulphuric acid. Materials for handling, storage and transportation.

**UNIT II OIL AND ALLIED INDUSTRIES**

7

Vegetable oil extraction methods. Refining of vegetable oils. Hydrogenation of Oils. Soaps and Candle. Detergents and Glycerine. Materials for handling, storage and transportation.

**UNIT III CARBOHYDRATES AND FERMENTATION INDUSTRIES**

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 PULP AND LEATHER INDUSTRIES**

9

Production of Pulp. Conversion to paper. Production of Viscose, Acetate and Cuprammoniumrayons and Cellulose acetate. Production of Dimethyl sulphite and Dimethyl sulphoxide from wood liquor. Manufacture of leather from hides and skins. Manufacture of Glue and Gelatin. Materials for handling, storage and transportation.

**UNIT V SURFACE COATING AND CEMENT INDUSTRIES**

9

Constituents of paints & varnishes and their functions. Paint mixing process. Manufacture of pigments such as White lead, Zinc oxide and Titanium dioxide. Cements: Introduction, types of cements, properties and applications. Manufacture of Portland cement.

**TOTAL: 45 Periods**

  
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**TEXT BOOKS:**

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Gopala Rao, M. & Marshall Sittig	Dryden's Outlines of Chemical Technology	Affiliated East-West Press, New Delhi	2004
2	Austin, G.T	Shreve's Chemical Process Industries	McGraw Hill	1984

**REFERENCE BOOKS:**

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Shukla, S.D. Pandey, G.N	A Text Book of Chemical Technology, Vol. I	Vikas, New Delhi	1994
2	Venkateswaralu, D., Upadrashta, K.R. & Chandrasekaran, K.D.	Chemtech - I	Chand & Co., New Delhi	1975
3	Kent, A.J. Van Nostrand	Riegel's Handbook of Industrial Chemistry	Reinhold, New York	1974
4	Stephenson, R.M	Introduction to Chemical Process Industries	Van Nostrand, New Jersey	1966
5	Lowenheim, F.A. & Moran, M.K. : Faith	Keyes and Clark's Industrial Chemicals	John Wiley, New York	1975

**WEB URLS:**

1. <https://www.chemicalprocessing.com/>
2. <https://chemical-materials.elsevier.com/chemical-manufacturing-excellence/chemical-processing-industries-in-spotlight/>
3. <https://www.accessengineeringlibrary.com/content/book/9780071410373/chapter/chapter1>
4. <https://www.youtube.com/watch?v=HdknvtO2x3s>
5. <https://www.youtube.com/watch?v=az8n64NweAE>

  
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19CHC04

INSTRUMENTAL METHODS OF ANALYSIS

L T P C  
3 0 0 3

**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:**

- 19CHC04.CO1 : Ability to analyze the function of electrical and optical component in analytical instruments and their calibration
- 19CHC04.CO2 : Ability to apply the spectroscopic techniques to identify, estimate and characterize analytes
- 19CHC04.CO3 : Ability to analyze the thermal behavior of materials using thermal analysis
- 19CHC04.CO4 : Ability to apply chromatographic and electrophoretic techniques to separate, purify and quantify molecules
- 19CHC04.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
19CHC04.CO1	x	x	-	-	x	-	-	-	-	x	-	x	x	-	x
19CHC04.CO2	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
19CHC04.CO3	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
19CHC04.CO4	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
19CHC04.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

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**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=dAMOCVa8IkQ>
5. <https://www.youtube.com/watch?v=vrlR4oBslV8>

  
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19CHC05

MECHANICS OF SOLIDS

L T P C  
2 0 0 2

**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:**

- 19CHC05.CO1 : Ability to realize the state of stresses and strains in structural components under tension, compression and shear.
- 19CHC05.CO2 : Ability to plot the shear force and bending moment diagrams for all the statically determinate beams.
- 19CHC05.CO3 : Ability to analyze the deflection of determinate beam by different methods.
- 19CHC05.CO4 : Ability to determine principle stress, strain and analysis of plane truss.
- 19CHC05.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
19CHC05.CO1	x	-	x	-	-	-	-	-	-	x	-	x	-	-	-
19CHC05.CO2	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
19CHC05.CO3	x	-	x	-	-	-	-	-	-	x	-	x	-	-	-
19CHC05.CO4	x	-	x	-	-	x	x	-	-	x	-	x	x	-	-
19CHC05.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 deviator 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

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**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:**

6. <https://nptel.ac.in/courses/105/104/105104160/>
7. <https://www.iitk.ac.in/me/research/specialization-areas/solid-mechanics-and-design/mechanics-of-solids>
8. [https://www.youtube.com/watch?v=B9lyGZzb\\_6M](https://www.youtube.com/watch?v=B9lyGZzb_6M)
9. <https://www.youtube.com/watch?v=D6DTb4tXfOQ>
10. <https://www.youtube.com/watch?v=K9nl606I0W0>

  
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19CHC06

CHEMICAL ENGINEERING THERMODYNAMICS I

L T P C  
3 0 0 3

**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:**

- 19CHC06.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.
- 19CHC06.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.
- 19CHC06.CO3 : Ability to predict the changes in the properties of real fluids undergoing changes in process plant equipments.
- 19CHC06.CO4 : Ability to use empirical correlations and experimental data to evaluate thermodynamic quantities that relate to the vapour - liquid or liquid-liquid equilibrium of ideal and non-ideal chemical mixtures.
- 19CHC06.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
19CHC06.CO1	x	-	x	-	-	-	-	-	-	x	-	x	-	-	-
19CHC06.CO2	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
19CHC06.CO3	x	-	x	-	-	-	-	-	-	x	-	x	-	-	-
19CHC06.CO4	x	-	x	-	-	x	x	-	-	x	-	x	x	-	-
19CHC06.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**

12

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**

12

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**

8

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

**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=PLwdnzlV3ogoVnCnlfjDHng\\_8biZSUEYtK](https://www.youtube.com/watch?v=aDXBo0FtALA&list=PLwdnzlV3ogoVnCnlfjDHng_8biZSUEYtK)
5. [https://www.youtube.com/watch?v=yVOzgBfsQI0&list=PLFW6lRTa1g80QsuYcFQZWrsn\\_PB987gn5](https://www.youtube.com/watch?v=yVOzgBfsQI0&list=PLFW6lRTa1g80QsuYcFQZWrsn_PB987gn5)

  
Chairman

Board of Studies

19CHC07

HEAT TRANSFER

L T P C  
2 2 0 3

**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:**

- 19CHC07.CO1 : Ability to solve one-dimensional steady state heat conduction problems for the rectangular, cylindrical and spherical composite walls.
- 19CHC07.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.
- 19CHC07.CO3 : Ability to estimate the heat transfer co-efficient for film wise and drop wise condensation, boiling heat transfer using empirical correlations.
- 19CHC07.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.
- 19CHC07.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
19CHC07.CO1	-	x	-	-	-	-	x	-	-	-	-	x	-	-	-
19CHC07.CO2	x	x	x	x	-	-	x	-	-	-	-	x	x	x	-
19CHC07.CO3	x	x	x	x	-	-	x	-	-	-	-	x	x	x	-
19CHC07.CO4	-	x	x	x	-	-	x	-	-	-	-	x	-	x	-
19CHC07.CO5	x	x	x	x	-	-	x	-	-	-	-	x	x	x	-

**UNIT I**

12

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**

12

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**

12

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**

12

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**

12

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: 60 Periods

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**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=PL1gyM10tgL1hK9666oGndGIWDQdpQzkY9](https://www.youtube.com/watch?v=rxTK_SvSmvs&list=PL1gyM10tgL1hK9666oGndGIWDQdpQzkY9)
4. <https://www.youtube.com/watch?v=kNZi12OV9Xc>
5. <https://www.youtube.com/watch?v=U72ueGTF7n8>

*N. Anny*  
**Chairman**

19CHC08

MASS TRANSFER I

L T P C  
3 0 0 3

**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:**

- 19CHC08.CO1 : Ability to estimate the mass transfer flux for molecular diffusion in fluids and measurement of diffusivity by pseudo diffusion model.
- 19CHC08.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.
- 19CHC08.CO3 : Ability to comprehend the humidification concepts
- 19CHC08.CO4 : Ability to analyze the batch and continues dryers.
- 19CHC08.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
19CHC08.CO1	-	X	X	X	-	X	-	-	-	X	-	X	-	X	-
19CHC08.CO2	X	X	X	X	-	X	-	-	-	X	-	X	X	X	-
19CHC08.CO3	-	X	X	X	-	X	-	-	-	X	-	X	-	X	-
19CHC08.CO4	X	X	X	X	-	X	-	-	-	X	-	X	X	X	-
19CHC08.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

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**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\\_](https://www.youtube.com/watch?v=Yc2eSffzhBI&list=PLwdnzlV3ogoVX_S_8DyKa7RudEazDL0o_)
4. [https://www.youtube.com/watch?v=EyREi7l5020&list=PLbMVogVj5nJSOgW8GYe\\_nJ3MYfnCQ3XXM](https://www.youtube.com/watch?v=EyREi7l5020&list=PLbMVogVj5nJSOgW8GYe_nJ3MYfnCQ3XXM)
5. <https://www.youtube.com/watch?v=Yc2eSffzhBI&t=98s>



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19CHC09

MECHANICAL OPERATIONS

L T P C  
2 0 0 2

**COURSE OBJECTIVES:**

- To impart 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:**

- 19CHC09.CO1 : Ability to calculate the Particle size, shape and surface area by both differential, cumulative analysis
- 19CHC09.CO2 : Ability to compute the power requirement for particle size reduction screen effectiveness by sieve analysis.
- 19CHC09.CO3 : Ability to determine the gravity settling velocity, settling time and calculate the thickener area
- 19CHC09.CO4 : Ability to calculate the pressure drop in filters, filter medium resistance and cake resistance
- 19CHC09.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
19CHC09.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
19CHC09.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC09.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC09.CO4	-	x	x	x	-	-	-	-	-	x	-	x	-	x	-
19CHC09.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, jiggling

**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.

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**Chairman**

**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.inspireignite.com/vtu/mechanical-operations-syllabus-vtu-beb-tech/>
3. <https://www.youtube.com/watch?v=SdP3BbCt4Ak&list=PLwdnzIV3ogoX9tKDKHm6KD1zNnwR0PZOS>
4. <https://www.youtube.com/watch?v=K5vblhUyqXU&list=PLvOh309NvHIGxEMIZ0kYdVXw8V3uMc5Uh>
5. [https://www.youtube.com/watch?v=ziz0UXcOBXI&list=PLvOh309NvHIG0EIcqA\\_F1ShakeyH49Pcx](https://www.youtube.com/watch?v=ziz0UXcOBXI&list=PLvOh309NvHIG0EIcqA_F1ShakeyH49Pcx)

  
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19CHC10

CHEMICAL ENGINEERING THERMODYNAMICS - II

L T P C  
3 0 0 3

**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:**

- 19CHC10.CO1 : Ability to analyze the properties of fluids  
 19CHC10.CO2 : Ability to understand the equilibrium of liquids  
 19CHC10.CO3 : Ability to determine the phase equilibria  
 19CHC10.CO4 : Ability to understand the chemical equilibrium concepts  
 19CHC10.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
19CHC10.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
19CHC10.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC10.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC10.CO4	-	x	x	x	-	-	-	-	-	x	-	x	-	x	-
19CHC10.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

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<b>REFERENCE BOOKS:</b>				
<b>Sl.No</b>	<b>Author(s)</b>	<b>Title of the Book</b>	<b>Publisher</b>	<b>Year of Publication</b>
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:**

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2. [https://catalog.k-state.edu/preview\\_course\\_nopop.php?catoid=24&coid=124602](https://catalog.k-state.edu/preview_course_nopop.php?catoid=24&coid=124602)
3. <https://www.youtube.com/watch?v=UFxLIEEmB58&list=PLvSNXOe4nVGq-DIIyuMHrrueMWw7tCJD8&index=2&t=0s>
4. <https://www.youtube.com/watch?v=lltERuQOW1o&list=PLvSNXOe4nVGq-DIIyuMHrrueMWw7tCJD8&index=4&t=0s>
5. <https://www.youtube.com/watch?v=pF7-Juf0Vcl&list=PLvSNXOe4nVGq-DIIyuMHrrueMWw7tCJD8&index=6&t=0s>

*N. Jeyaraj*  
**Chairman**

19CHC11

MASS TRANSFER II

L T P C  
2 2 0 3

**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:**

- 19CHC11.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.
- 19CHC11.CO2 : Ability to determine the number of plates using Ponchon-savarit and McCabe-thiele method and categorize azeotropic and extractive distillation.
- 19CHC11.CO3 : Ability to determine the number of stages and recovery efficiency for solid-liquid and liquid-liquid separation processes.
- 19CHC11.CO4 : Ability to analyse the applications of leaching
- 19CHC11.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
19CHC11.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
19CHC11.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC11.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC11.CO4	-	x	x	x	-	-	-	-	-	x	-	x	-	x	-
19CHC11.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

**UNIT I ABSORPTION**

12

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**

12

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**

12

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**

12

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**

12

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 adsorbents, break through curves. Principle of Ion exchange, techniques and applications. Membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

TOTAL: 60 Periods

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**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, Curlis W. 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](https://www.youtube.com/watch?v=BBRUvxKuq-I&list=PLwdnzlV3ogoVdYpQY0hlcWgv_75DgUz0m)
4. [https://www.youtube.com/watch?v=HlHyEcP\\_7SU&list=PL38769A2045D58D20](https://www.youtube.com/watch?v=HlHyEcP_7SU&list=PL38769A2045D58D20)
5. [https://www.youtube.com/watch?v=HlHyEcP\\_7SU&list=PLvOh309NvHlGxciL6PIN0gM6-CY1--NdW](https://www.youtube.com/watch?v=HlHyEcP_7SU&list=PLvOh309NvHlGxciL6PIN0gM6-CY1--NdW)

  
Chairman

19CHC12

CHEMICAL REACTION ENGINEERING I

L T P C  
2 2 0 3

**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:**

- 19CHC12.CO1 : Ability to formulate the rate equation from the stoichiometry and reaction mechanism for elementary and non-elementary reactions
- 19CHC12.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
- 19CHC12.CO3 : Ability to analyze kinetic data and determine the components of the rate equation multiple reactions
- 19CHC12.CO4 : Ability to comprehend the behavior of Non-isothermal homogeneous reactor systems.
- 19CHC12.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
19CHC12.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
19CHC12.CO2	x	x	x	x	-	-	-	-	-	x	x	x	x	x	-
19CHC12.CO3	x	x	x	x	-	-	-	-	-	x	x	x	x	x	-
19CHC12.CO4	-	x	x	x	-	-	-	-	-	x	x	x	-	x	-
19CHC12.CO5	x	x	x	x	-	-	-	-	-	x	x	x	x	x	-

**UNIT I**

12

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**

12

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**

12

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

**UNIT IV**

12

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**

12

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: 60 Periods

  
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**TEXT BOOKS:**

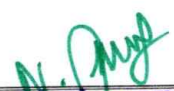
Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Levenspiel O	Chemical Reaction Engineering	Wiley Eastern Ltd	2000
2	Smith, J.M	Chemical Engineering Kinetics	McGraw Hill	1981

**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=ANjzIz\\_Zsak&list=PLbMVogV;5nJRrrhcrAIIjs1W0qgH5axqO](https://www.youtube.com/watch?v=ANjzIz_Zsak&list=PLbMVogV;5nJRrrhcrAIIjs1W0qgH5axqO)
4. <https://www.youtube.com/watch?v=DpLAsVcofao&list=PLwdnzIv3ogoUC9IWWOPTGqV5eEVNRAfGa>
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**

19CHC13

TRANSPORT PHENOMENA

L T P C  
3 0 0 3

**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:**

- 19CHC13.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
- 19CHC13.CO2 : Ability to apply shell balance technique to formulate the differential equation of change for steady and unsteady-state flows
- 19CHC13.CO3 : Ability to analyze the problems involving steady state and unsteady state heat conduction in simple geometries and obtain numerical solutions for the problems.
- 19CHC13.CO4 : Ability to develop microscopic and macroscopic energy balances for steady and unsteady transfer processes
- 19CHC13.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
19CHC13.CO1	-	X	-	-	-	-	X	-	-	-	-	X	-	-	-
19CHC13.CO2	X	X	X	-	-	-	X	-	X	-	-	X	X	X	-
19CHC13.CO3	X	X	X	-	-	-	X	-	-	-	-	X	X	X	X
19CHC13.CO4	-	X	X	-	-	-	X	-	X	-	X	X	-	X	-
19CHC13.CO5	X	X	X	-	-	-	X	-	-	-	-	X	X	X	X

**UNIT I BASIC CONCEPT AND CONSERVATION THEOREM IN MOMENTUM TRANSPORT 9**

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 9**

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 9**

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 9**

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 9**

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: 45 Periods

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**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](http://faculty.washington.edu/finlayso/che499/Group_C/tp.htm)
2. [https://link.springer.com/chapter/10.1007/978-1-4020-8327-3\\_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=JA10h1xtQtk&list=PLvSNXOe4nVGr\\_c42xHNztIukf1i5QK91o](https://www.youtube.com/watch?v=JA10h1xtQtk&list=PLvSNXOe4nVGr_c42xHNztIukf1i5QK91o)

  
Chairman



19CHC14

PROCESS MODELLING AND SIMULATION

L T P C  
3 0 0 3

**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:**

- 19CHC14.CO1 : Ability to know modeling and simulation.  
 19CHC14.CO2 : Ability to determine the steady state lumped systems.  
 19CHC14.CO3 : Ability to establish the unsteady state lumped systems.  
 19CHC14.CO4 : Ability to determine steady state distributed systems.  
 19CHC14.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
19CHC14.CO1	-	x	-	-	-	-	x	-	-	-	-	x	-	-	-
19CHC14.CO2	x	x	x	-	-	-	x	-	x	-	-	x	x	x	-
19CHC14.CO3	x	x	x	-	-	-	x	-	-	-	-	x	x	x	x
19CHC14.CO4	-	x	x	-	-	-	x	-	x	-	x	x	-	x	-
19CHC14.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**

**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

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**Central Engineering College (Autonomous)**  
**Madhavapuram, Namakkal Dist 637 408**



19CHC15

PROCESS DYNAMICS AND CONTROL

L T P C  
3 0 0 3

**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:**

- 19CHC15.CO1 : Ability to devise control strategies for the control of mass and heat transfer equipment using advanced controllers.
- 19CHC15.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.
- 19CHC15.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.
- 19CHC15.CO4 : Ability to draw the bode diagram for the stability of process for the frequency response processes.
- 19CHC15.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
19CHC15.CO1	-	X	-	-	-	-	X	-	-	-	-	X	-	-	-
19CHC15.CO2	X	X	X	-	-	-	X	-	X	-	-	X	X	X	-
19CHC15.CO3	X	X	X	-	-	-	X	-	-	-	-	X	X	X	X
19CHC15.CO4	-	X	X	-	-	-	X	-	X	-	X	X	-	X	-
19CHC15.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**

*N. Anny*  
**Chairman**

**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=45bX07nYW14&list=PLozRYVm0a65dFThqueBdglUuFxpWSWDiF>

  
Chairman

19CHC16

CHEMICAL REACTION ENGINEERING -II

L T P C

2 2 0 3

**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:**

- 19CHC16.CO1 : Ability to realize the nature of catalyst  
 19CHC16.CO2 : Ability to comprehend the heterogeneous catalyst.  
 19CHC16.CO3 : Ability to analyze the gas solid catalytic reactors.  
 19CHC16.CO4 : Ability to determine gas solid non catalytic reactors.  
 19CHC16.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
19CHC16.CO1	-	x	-	-	-	-	x	-	-	-	-	x	-	-	-
19CHC16.CO2	x	x	-	-	-	-	x	-	x	-	-	x	x	x	-
19CHC16.CO3	x	x	-	-	-	-	x	-	-	-	-	x	x	x	x
19CHC16.CO4	-	x	-	-	-	-	x	-	x	-	x	x	-	x	-
19CHC16.CO5	x	x	-	-	-	-	x	-	-	-	-	x	x	x	x

**UNIT I CATALYSTS** 12  
 Nature of catalysts, surface area and pore-volume distribution, catalyst preparation.

**UNIT II HETEROGENEOUS REACTORS** 12  
 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** 12  
 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** 12  
 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** 12  
 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: 60 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

  
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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=PLv0h309NvHIFFFq-VM5u3ecYq21kJt2hP>
4. <https://www.youtube.com/watch?v=lkqoqF-keiE&list=PLOzRYVm0a65cyrKMms9dQtcMnMK-rQ6DX>
5. [https://www.youtube.com/watch?v=1x\\_V-wS-bfs](https://www.youtube.com/watch?v=1x_V-wS-bfs)

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19CHC17

FLUID MECHANICS LABORATORY

L T P C  
0 0 3 1

**COURSE OBJECTIVES:**

- To develop understanding of the non Newtonian fluids.
- To provide knowledge on weir and notches.
- To provide knowledge on flow through pipes.
- To have knowledge on pumps
- To understand the effect of pressure drop.

**COURSE OUTCOMES:**

- 19CHC17.CO1 : Ability to realize the nature of non Newtonian fluids  
 19CHC17.CO2 : Ability to comprehend the weir and notches.  
 19CHC17.CO3 : Ability to analyze the flow through pipes.  
 19CHC17.CO4 : Ability to determine various pumps.  
 19CHC17.CO5 : Ability to analyze the pressure drop.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19CHC17.CO1	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC17.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC17.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC17.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC17.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

**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**

19CHC18 INSTRUMENTAL METHODS OF ANALYSIS LABORATORY

L T P C  
0 0 3 1

**COURSE OBJECTIVES:**

- To provide students an exposure to spectroscopic methods.
- To have a practical hands on experience on Absorption Spectroscopic methods
- To acquire experience in the purification by performing thin layer chromatography
- To validate and analysis using spectrometric and microscopic techniques
- To enhance the knowledge on column chromatography

**COURSE OUTCOMES:**

- 19CHC18.C01 : Ability to differentiate the spectroscopic methods.  
 19CHC18.C02 : Ability to assess absorption spectroscopic methods.  
 19CHC18.C03 : Ability to analyze the thin layer chromatography.  
 19CHC18.C04 : Ability to emphasize the spectrometric and microscopic techniques.  
 19CHC18.C05 : Ability to analyze the column chromatography.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19CHC18.C01	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC18.C02	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC18.C03	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC18.C04	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHC18.C05	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

**LIST OF EXPERIMENTS**

1. Precision and validity in an experiment using absorption spectroscopy.
2. Validating Lambert-Beer's law using KMnO<sub>4</sub>
3. Finding the molar absorptivity and stoichiometry of the Fe (1,10 phenanthroline) using absorption spectrometry.
4. Finding the pK<sub>a</sub> of 4-nitrophenol using absorption spectroscopy.
5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxalate.
7. Estimation of SO<sub>4</sub><sup>2-</sup> by nephelometry.
8. Estimation of Al<sup>3+</sup> by Fluorimetry.
9. Limits of detection using aluminium alizarin complex.
10. Chromatography analysis using TLC.
11. Chromatography analysis using column chromatography.

TOTAL: 30 Periods

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19CHC19

HEAT TRANSFER LABORATORY

L T P C  
0 0 3 1

**COURSE OBJECTIVES:**

- To provide students an exposure to heat exchangers.
- To provide knowledge on forced/natural convection.
- To provide knowledge on radiation.
- To have knowledge on evaporators
- To understand the effect of heat transfer in packed bed.

**COURSE OUTCOMES:**

- 19CHC19.CO1 : Ability to differentiate the heat exchangers.  
 19CHC19.CO2 : Ability to assess forced/natural convection.  
 19CHC19.CO3 : Ability to analyze the types of radiation.  
 19CHC19.CO4 : Ability to emphasize the evaporators.  
 19CHC19.CO5 : Ability to analyze the heat transfer in packed bed.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19CHC19.CO1	x	x	-	-	x	-	-	-	x	-	-	x	x	x	-
19CHC19.CO2	x	x	-	-	x	-	-	-	x	-	-	x	x	x	-
19CHC19.CO3	x	x	-	-	x	-	-	-	x	-	-	x	x	x	-
19CHC19.CO4	x	x	-	-	x	-	-	-	x	-	-	x	x	x	-
19CHC19.CO5	x	x	-	-	x	-	-	-	x	-	-	x	x	x	-

**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

*N. Jay*

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**Board of Studies**

19CHC20

MECHANICAL OPERATIOIS LABORATORY

L T P C  
0 0 3 1

**COURSE OBJECTIVES:**

- To provide students an exposure to size reduction.
- To provide knowledge on filtration.
- To provide knowledge on sedimentation.
- To have knowledge on separators
- To understand the effect of size reduction.

**COURSE OUTCOMES:**

- 19CHC20.CO1 : Ability to understand the size reduction equipments.  
 19CHC20.CO2 : Ability to assess filtration equipments.  
 19CHC20.CO3 : Ability to analyze the sedimentation.  
 19CHC20.CO4 : Ability to emphasize the separators.  
 19CHC20.CO5 : Ability to analyze the size reduction.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19CHC20.CO1	x	x	x	x	-	-	-	-	x	x		x	x	x	-
19CHC20.CO2	x	x	x	x	x	-	-	-	x	x		x	x	x	x
19CHC20.CO3	x	x	x	x	x	-	-	-	x	x		x	x	x	x
19CHC20.CO4	x	x	x	x	x	-	-	-	x	x		x	x	x	x
19CHC20.CO5	x	x	x	x	x	-	-	-	x	x		x	x	x	x

**LIST OF EXPERIMENTS**

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Ball mill
6. Separation characteristics of Cyclone separator
7. Reduction ratio of Roll Crusher
8. Separation characteristics of Elutriator
9. Reduction ratio of Drop weight crusher
10. Size separation using Sub-Sieving

TOTAL: 30 Periods

*N. Jay*  
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19CHC21

MASS TRANSFER LABORATORY

L T P C  
0 0 3 1

**COURSE OBJECTIVES:**

- To provide students an exposure to distillation.
- To provide knowledge on extraction.
- To provide knowledge on dryer.
- To have knowledge on cooling tower
- To understand the effect of leaching.

**COURSE OUTCOMES:**

- 19CHC21.CO1 : Ability to understand the distillation and its types.  
 19CHC21.CO2 : Ability to assess liquid-liquid extraction.  
 19CHC21.CO3 : Ability to analyze the dryer.  
 19CHC21.CO4 : Ability to emphasize the cooling tower.  
 19CHC21.CO5 : Ability to analyze the leaching.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19CHC21.CO1	x	-	x	-	-	-	-	-	-	x	-	x	-	-	x
19CHC21.CO2	x	x	x	-	x	x	x	-	x	x	x	x	x	-	x
19CHC21.CO3	x	x	x	-	x	x	x	-	x	x	x	x	x	-	x
19CHC21.CO4	x	x	x	-	x	x	x	-	x	x	x	x	x	-	x
19CHC21.CO5	x	x	x	-	x	x	x	-	x	x	x	x	-	-	x

**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 Tray dryer
7. Water purification using ion exchange columns
8. Estimation of mass/heat transfer coefficient for cooling tower
9. Surface evaporation
10. Adsorption studies
11. Leaching studies
12. Demonstration of Gas - Liquid absorption

TOTAL: 30 Periods

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19CHC22

PROCESS EQUIPMENT DESIGN LABORATORY

L T P C  
0 0 3 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
- Translate mechanical design specifications in to fabrication drawings for plant erection.
- Draw detailed dimensional drawings shall 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**

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

9

**UNIT II**

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

9

**UNIT III**

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

9

**UNIT IV TRANSFORMERS**

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

9

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

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

9

**TOTAL: 45 Periods**

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19CHC23

PROCESS CONTROL LABORATORY

L T P C  
0 0 3 1

**COURSE OBJECTIVES:**

- To control temperature, pressure, flow, level using PC with the help of different control modes.
- To verify the operation of control valves.
- To verify the operation of I/P & P/I converters.
- To control the speed of DC motor.
- To obtain the time domain specification for a second order system using PID controller.

**COURSE OUTCOMES:**


- 19CHC23.C01 : Demonstrate knowledge and understanding of chemical process systems.  
 19CHC23.C02 : To apply and determine time constants for various first order systems.  
 19CHC23.C03 : Apply acquired engineering knowledge to analyze, assess and solve common process control and instrumentation problems  
 19CHC23.C04 : Use technical literature and other information sources to treat with industrial control and instrumentation engineering problems  
 19CHC23.C05 : Utilize appropriate control engineering and instrumentation documentation and standards

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19CHC23.C01	X	X	X	X	X	-	-	-	X	X	-	X	X	X	X
19CHC23.C02	X	X	X	X	X	-	-	-	X	X	-	X	X	X	X
19CHC23.C03	X	X	X	X	X	-	-	-	X	X	-	X	X	X	X
19CHC23.C04	X	X	X	X	X	-	-	-	X	X	-	X	X	X	X
19CHC23.C05	X	X	X	X	X	-	-	-	X	X	-	X	X	X	X

**LIST OF EXPERIMENTS**

1. Determination of transfer function of DC servomotor
2. Determination of transfer function of AC servomotor
3. DC motor position control systems
4. AC motor position control systems
5. Open loop and closed loop response of first order type-0 and type-1 system
6. Stepper motor position control systems
7. Digital simulation determination of step response and impulse response for first order & second order system with unity feedback using MATLAB
8. (i) Digital simulation of stability analysis using Root locus techniques  
 (ii) Digital simulation of stability analysis using bode plot  
 (iii) Digital simulation of stability analysis using Nyquist plot
9. Digital design lag, lead and lag-lead compensations
10. Digital design of P,PI and PID controllers
11. Syncro transmitter and receiver characteristics

**TOTAL: 30 Periods**

  
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19CHE01

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:**

- 19CHE01.CO1 : Ability to acquire knowledge on microbes.  
 19CHE01.CO2 : Ability to identify the fermentation process  
 19CHE01.CO3 : Ability to analyze the bioreactor design  
 19CHE01.CO4 : Ability to comprehend the function and applications of enzymes  
 19CHE01.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
19CHE01.CO1	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
19CHE01.CO2	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
19CHE01.CO3	x	x	x	-	x	-	-	-	x	x	x	x	-	-	x
19CHE01.CO4	x	x	x	-	x	-	-	-	x	x	x	x	-	-	x
19CHE01.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

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](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](https://www.youtube.com/watch?v=ruifWn_7hVk)
5. <https://www.youtube.com/watch?v=rckx6a1KwJk>

  
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19CHE02

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:**

- 19CHE02.CO1 : Ability to emphasize the petroleum products.  
 19CHE02.CO2 : Ability to determine the various refining techniques.  
 19CHE02.CO3 : Ability to analyze treatment methods.  
 19CHE02.CO4 : Ability to determine extraction process.  
 19CHE02.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
19CHE02.CO1	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE02.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE02.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE02.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE02.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 Vacuum 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 Terephthalate (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


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<b>REFERENCE BOOKS:</b>				
<b>Sl.No</b>	<b>Author(s)</b>	<b>Title of the Book</b>	<b>Publisher</b>	<b>Year of Publication</b>
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 Jersey	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](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>

  
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19CHE03

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:**

- 19CHE03.CO1 : Ability to differentiate the constituents present in food  
 19CHE03.CO2 : Ability to understand the processing methods  
 19CHE03.CO3 : Ability to distinguish the production and utilization of food.  
 19CHE03.CO4 : Ability to know the preservation methods  
 19CHE03.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
19CHE03.CO1	x	-	-	-	-	-	-	-	x	x	-	x	x	-	-
19CHE03.CO2	x	x	x	x	-	-	-	-	x	x	-	x	x	x	-
19CHE03.CO3	x	-	-	-	-	-	-	-	x	x	-	x	x	-	-
19CHE03.CO4	x	x	x	x	-	-	-	-	x	x	-	x	x	x	-
19CHE03.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

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<b>REFERENCE BOOKS:</b>				
<b>Sl.No</b>	<b>Author(s)</b>	<b>Title of the Book</b>	<b>Publisher</b>	<b>Year of Publication</b>
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](http://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>

  
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19CHE04

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:**

- 19CHE04.CO1 : Ability to emphasize about polymers.  
 19CHE04.CO2 : Ability to analyze the free radicals.  
 19CHE04.CO3 : Ability to differentiate the polycondensation.  
 19CHE04.CO4 : Ability to determine molecular weights of polymers.  
 19CHE04.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
19CHE04.CO1	x	x	x	x	x	x	-	-	x	x	-	x	x	x	-
19CHE04.CO2	x	x	x	x	x	x	-	-	x	x	-	-	x	x	-
19CHE04.CO3	x	x	x	x	x	x	-	-	x	x	-	-	x	x	-
19CHE04.CO4	x	x	x	x	x	x	-	-	x	x	-	-	x	x	-
19CHE04.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**

  
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**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, LA	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=p6QPFKwylU>
3. <https://www.youtube.com/watch?v=4IKVZpJl0Oo>
4. [https://www.youtube.com/watch?v=icj\\_5yF-GV8](https://www.youtube.com/watch?v=icj_5yF-GV8)
5. [https://www.youtube.com/watch?v=b\\_XZKangA8Y](https://www.youtube.com/watch?v=b_XZKangA8Y)



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19CHE05

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:**

- 19CHE05.CO1 : Ability to aware of disasters and types.  
 19CHE05.CO2 : Ability to determine the DDR approaches.  
 19CHE05.CO3 : Ability to analyze the disaster and developments.  
 19CHE05.CO4 : Ability to determine disaster risk management in India.  
 19CHE05.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
19CHE05.CO1	x	x	-	-	x	-	-	-	-	-	-	-	x	x	-
19CHE05.CO2	x	x	-	-	-	-	-	-	-	-	x	-	-	-	-
19CHE05.CO3	x	x	-	-	x	-	-	-	x	-	-	-	-	-	-
19CHE05.CO4	x	x	-	-	-	-	-	-	-	-	x	-	-	-	-
19CHE05.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 management.

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**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](https://www.physio-pedia.com/Disaster_Management)
3. [https://www.youtube.com/watch?v=9Wlwljva\\_s](https://www.youtube.com/watch?v=9Wlwljva_s)
4. <https://www.youtube.com/watch?v=DExlZTfKZAM>
5. <https://www.youtube.com/watch?v=HMPBF5rkcb0>

  
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19CHE06

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:**

- 19CHE06.CO1 : Ability to explain about the air pollution.  
 19CHE06.CO2 : Ability to compare the various air polluting gases  
 19CHE06.CO3 : Ability to analyze the particulate air pollution.  
 19CHE06.CO4 : Ability to discuss the hybrid systems.  
 19CHE06.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
19CHE06.CO1	x	x	-	-	-	-	-	-	-	x	-	x	x	-	-
19CHE06.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE06.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE06.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE06.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 Equilibrium laws – Incinerators – Design and Performance – Operation and Maintenance - Absorbers – Design operation and improving performances Absorbers.

**UNIT III PARTICULATE AIR POLLUTION**

9

Particle Collection mechanisms- Fluid particle Dynamics – Particle size Distribution – Efficiency – Gravity Settling chambers Cyclones- Electrostatic precipitators Bannouses

**UNIT IV HYBRID SYSTEM**

9

Heat electrostatic precipitation – Genizing Heat Scrubbers – Dry Scrubbers –Electrostatically Augmented Fabric Filtration

**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



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<b>REFERENCE BOOKS:</b>				
<b>Sl.No</b>	<b>Author(s)</b>	<b>Title of the Book</b>	<b>Publisher</b>	<b>Year of Publication</b>
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](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>



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19CHE07

**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:**

- 19CHE07.CO1 : Ability to realize health and environmental aspects of waste water treatment.  
 19CHE07.CO2 : Ability to determine the selection process.  
 19CHE07.CO3 : Ability to analyze the unit operations involved in the treatment.  
 19CHE07.CO4 : Ability to compare the various biological treatment methods.  
 19CHE07.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
19CHE07.CO1	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE07.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE07.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE07.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE07.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-

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

Terminology – Regulations – 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**

*N. Jeyaraj*

**Chairman**

**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

**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>



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19CHE08

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:**

- 19CHE08.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.
- 19CHE08.CO2 : Ability to discuss the reaction mechanisms and kinetics and obtain electrode over potentials and mass- transfer phenomena, including the estimation of limiting currents.
- 19CHE08.CO3 : Ability to devise the methodology for the development of corrosion control techniques for the industrial boiler water corrosion.
- 19CHE08.CO4 : Ability to explain the principles and working conditions of the different types of primary and secondary batteries.
- 19CHE08.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
19CHE08.CO1	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE08.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE08.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE08.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE08.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 - Helmholtz 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

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**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 Steveng, 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>

*N. Ojha*  
Chairman

19CHE09

BIOCHEMICAL ENGINEERING

L T P C  
3 0 0 3

**COURSE OBJECTIVES:**

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

**COURSE OUTCOMES:**

- 19CHE09.CO1 : Ability to distinguish the chemical and biochemical process and explain the basic terminologies of biochemical engineering.
- 19CHE09.CO2 : Ability to demonstrate the basic concept of enzyme engineering and develop kinetic equation for enzyme catalyzed reactions.
- 19CHE09.CO3 : Ability to analyze the factors affecting the cell growth and develop models for cell growth.
- 19CHE09.CO4 : Ability to apply concepts of mechanical operations, mass transfer and heat transfer in biochemical processes and microbiological systems.
- 19CHE09.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
19CHE09.CO1	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-
19CHE09.CO2	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-
19CHE09.CO3	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-
19CHE09.CO4	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-
19CHE09.CO5	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

Downstream 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

  
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**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](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>

  
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19CHE10

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:**

- 19CHE10.CO1 : Ability to realize the basic applications in optimization.  
 19CHE10.CO2 : Ability to emphasize the single variable optimization.  
 19CHE10.CO3 : Ability to analyze the multi variable optimization.  
 19CHE10.CO4 : Ability to determine different optimization methods.  
 19CHE10.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
19CHE10.CO1	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
19CHE10.CO2	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
19CHE10.CO3	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
19CHE10.CO4	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
19CHE10.CO5	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-

**UNIT I INTRODUCTION**

5

Introduction to optimization; applications of optimization in chemical engineering; classification of optimization 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

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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:**

1. <https://www.youtube.com/watch?v=i5d4Dd0D7qw&list=PLbRMhDVUMngct1skDAxoR2xhblqOnAt0H>
2. <https://www.youtube.com/watch?v=i5d4Dd0D7qw>
3. <https://www.youtube.com/watch?v=DgslWoiIO-Q&list=PLcWr8B2ORieOtP4pJH2ZoZECvNaPmjbxt>
4. <https://gymkhana.iitb.ac.in/~scp/scp/ocw/chemical/cl%20603%20optimization/Optimization%20of%20Chemical%20Processes%20%20Edgar%20Himmelblau%20and%20Lasdon%202nd%20ed.pdf>
5. [https://link.springer.com/chapter/10.1007/978-3-319-14812-0\\_7](https://link.springer.com/chapter/10.1007/978-3-319-14812-0_7)

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19CHE11

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:**

- 19CHE11.CO1 : Ability to determine the hazards and risk analysis.  
 19CHE11.CO2 : Ability to analyze the current strategies on pollution.  
 19CHE11.CO3 : Ability to evaluate the recycling methods.  
 19CHE11.CO4 : Ability to determine the clean technology.  
 19CHE11.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
19CHE11.CO1	x	x	x	x	x	-	-	-	x	x	x	x	x	x	-
19CHE11.CO2	x	x	x	x	x	-	-	-	x	x	x	x	x	x	-
19CHE11.CO3	x	x	x	x	x	-	-	-	x	x	x	x	x	x	-
19CHE11.CO4	x	x	x	x	x	-	-	-	x	x	x	x	x	x	-
19CHE11.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 Technological	Environmental Engineering	Mc Graw Hill Book Company	1985

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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](https://www.youtube.com/watch?v=ocYb7jpVE5k&list=PLNyPK_sfNdSTNj5nKp7mKoyAMPLfpORih)
4. [https://www.youtube.com/watch?v=kXCFFupDK0g&list=PLgzsL8klq6DIOpwb57vb\\_ha\\_IUyNKRUyS](https://www.youtube.com/watch?v=kXCFFupDK0g&list=PLgzsL8klq6DIOpwb57vb_ha_IUyNKRUyS)
5. [https://www.youtube.com/watch?v=1iMpqdMHY-U&list=PLk7ptZcl9vmhN5ck8sQXWgSh\\_3RHYQjr3](https://www.youtube.com/watch?v=1iMpqdMHY-U&list=PLk7ptZcl9vmhN5ck8sQXWgSh_3RHYQjr3)

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19CHE12

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:**

- 19CHE12.CO1 : Ability to discuss about the role of water as process utility and recognize importance of treatment and conservation of water.
- 19CHE12.CO2 : Ability to outline the basic properties of steam along with their generation and utilization of steam in process plants.
- 19CHE12.CO3 : Ability to identify the role of refrigerant for different refrigeration systems and their importations, ventilation systems.
- 19CHE12.CO4 : Ability to explain the various types of compressors and vacuum pumps, piping systems used in industries.
- 19CHE12.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
19CHE12.CO1	x	-	x	-	-	-	-	-	-	x	-	x	-	-	x
19CHE12.CO2	x	x	x	-	x	x	x	-	x	x	x	x	x	-	x
19CHE12.CO3	x	x	x	-	x	x	x	-	x	x	x	x	x	-	x
19CHE12.CO4	x	x	x	-	x	x	x	-	x	x	x	x	x	-	x
19CHE12.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 Monochlorodifluoro Methane, Chlorofluoro 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**



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**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](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=PLYRV6b6qmUFGXZGdBbfb1ChpFKHaQi03X>

  
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19CHE13

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:**

- 19CHE13.CO1 : Ability to outline about fermentation process.  
 19CHE13.CO2 : Ability to examine about instrumentation and control.  
 19CHE13.CO3 : Ability to analyze the purification process.  
 19CHE13.CO4 : Ability to determine effluent treatment process.  
 19CHE13.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
19CHE13.CO1	x	x	x	x	-	-	-	-	-	x	-	x	-	-	x
19CHE13.CO2	x	x	x	x	-	-	-	-	-	x	-	x	-	-	x
19CHE13.CO3	x	x	x	x	-	-	-	-	-	x	-	x	-	-	x
19CHE13.CO4	x	x	x	x	-	-	-	-	-	x	-	x	-	-	x
19CHE13.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 – Online analysis – Control System – Combination of Control Systems – Computer application in fermentation technology.

**UNIT III RECOVERY AND PURIFICATION OF FERMENTATION PRODUCTS** 9

Removal of Microbial cells – Foam Separation – Precipitation Filtration – Different Filtration process – Centrifugation – 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 – Anaerobic 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 Buttsworth Hanman	Principles of fermentation Technology	McGraw Hill	1999
2	C.C Haber. William Andrew	Fermentation and Biochemical Engineering Handbook	McGraw Hill	2007

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<b>REFERENCE BOOKS:</b>				
<b>Sl.No</b>	<b>Author(s)</b>	<b>Title of the Book</b>	<b>Publisher</b>	<b>Year of Publication</b>
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](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](https://www.youtube.com/watch?v=hav_yLrgFqs)

  
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19CHE14

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:**

- 19CHE14.CO1 : Ability to outline about pulp and paper technology.  
 19CHE14.CO2 : Ability to examine about wood yard operation  
 19CHE14.CO3 : Ability to analyze the concept of wood machine operation.  
 19CHE14.CO4 : Ability to determine paper and paperboard.  
 19CHE14.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
19CHE14.CO1	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
19CHE14.CO2	x	x	x	-	x	-	-	-	x	x	x	x	-	-	x
19CHE14.CO3	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
19CHE14.CO4	x	-	x	-	x	-	-	-	x	x	x	x	-	-	x
19CHE14.CO5	x	x	x	-	x	-	-	-	x	x	x	x	-	-	x

**UNIT I INTRODUCTION**

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

9

**UNIT II WOODYARD OPERATION**

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

9

**UNIT III PAPER MACHINE**

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

9

**UNIT IV PAPER AND PAPERBOARD**

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

9

**UNIT V PROPERTIES AND TESTING OF PULP AND PAPER**

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

9

**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

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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>



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19CHE15

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:**

- 19CHE15.CO1 : Ability to outline the basic concept of energy.  
 19CHE15.CO2 : Ability to examine about the conventional energy  
 19CHE15.CO3 : Ability to analyze about non conventional energy.  
 19CHE15.CO4 : Ability to determine biomass energy.  
 19CHE15.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
19CHE15.CO1	x	x	x	x	-	x	-	-	-	x	-	x	x	x	-
19CHE15.CO2	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
19CHE15.CO3	x	x	x	x	x	-	-	-	-	x	-	x	x	x	x
19CHE15.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE15.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. Benchmarking and energy performance, material and energy balance, thermal energy management.

TOTAL: 45 Periods

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**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/](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>



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19CHE16

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:**

- 19CHE16.C01 : Ability to outline the drugs and pharmaceutical industry.  
 19CHE16.C02 : Ability to examine the drug metabolism  
 19CHE16.C03 : Ability to analyze the unit process and their applications.  
 19CHE16.C04 : Ability to determine principles of drug manufacturing.  
 19CHE16.C05 : 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
19CHE16.C01	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE16.C02	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE16.C03	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE16.C04	x	x	x	x	-	-	-	-	-	x	-	x	x	x	-
19CHE16.C05	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; complex chemical 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; parenteral 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

*N.M.*  
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<b>REFERENCE BOOKS:</b>				
<b>Sl.No</b>	<b>Author(s)</b>	<b>Title of the Book</b>	<b>Publisher</b>	<b>Year of Publication</b>
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:**

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19CHE17

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:**

- 19CHE17.CO1 : Ability to acquire the basic knowledge of safety issues in boiler houses, storage vessel for hazardous chemicals.
- 19CHE17.CO2 : Ability to identify the hazardous element due to fire, radiation, electrical and atmospheric contaminants.
- 19CHE17.CO3 : Ability to apply the knowledge on handling and storage of chemical hazards
- 19CHE17.CO4 : Ability to analyze qualitative risk assessment using HAZOP, FMEA and fault tree analysis.
- 19CHE17.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
19CHE17.CO1	-	X	X	-	-	-	-	-	-	X	-	X	-	-	-
19CHE17.CO2	X	X	X	X	-	-	-	-	-	X	-	X	X	X	-
19CHE17.CO3	X	X	X	X	-	-	-	-	-	X	-	X	X	X	-
19CHE17.CO4	X	X	X	X	-	-	-	-	-	X	-	X	X	X	-
19CHE17.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, reconnaissance, 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

  
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**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\\_2:UCG87D-DD3bgR-MT-k5MsYfkeTR](https://www.youtube.com/watch?v=Bq4hVTJpvKk&list=PLLy_2:UCG87D-DD3bgR-MT-k5MsYfkeTR)
4. [https://www.youtube.com/watch?v=QiLbGbk8Qk&list=PLCpX400HWzAVt8ttnlE70kZZQUBzk\\_twb](https://www.youtube.com/watch?v=QiLbGbk8Qk&list=PLCpX400HWzAVt8ttnlE70kZZQUBzk_twb)
5. [https://www.youtube.com/watch?v=bbdhS-aKLHA&list=PLFSDfus95bwldx052OuxcES0GcT\\_rQpsf](https://www.youtube.com/watch?v=bbdhS-aKLHA&list=PLFSDfus95bwldx052OuxcES0GcT_rQpsf)

  
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19CHF01

PROJECT PHASE I

L T P C  
0 0 10 5

**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:**

- 19CHF01.CO1 : Prepare a literature survey in a specific domain as a team / individual to motivate lifelong learning.
- 19CHF01.CO2 : Identify the problem which needs to be provided a sustainable solution using modern tools
- 19CHF01.CO3 : Analyze the problem definition and design its impact on the society and environment.
- 19CHF01.CO4 : Document the literature and bindings.
- 19CHF01.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
19CHF01.CO1	-	X	X	-	-	-	-	-	-	X	-	X	-	-	-
19CHF01.CO2	X	X	X	X	-	-	-	-	-	X	-	X	X	X	-
19CHF01.CO3	X	X	X	X	-	-	-	-	-	X	-	X	X	X	-
19CHF01.CO4	X	X	X	X	-	-	-	-	-	X	-	X	X	X	-
19CHF01.CO5	X	X	X	X	-	-	-	-	-	X	-	X	X	X	-

TOTAL: 45 Periods

  
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19CHF02

PROJECT PHASE II

L T P C  
0 0 18 9

**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 the experimental results
- To develop a dissertation report

**COURSE OUTCOMES:**

- 19CHF02.CO1 : Plan an experimental design to solve engineering / societal problems using modern tools
- 19CHF02.CO2 : Develop lifelong learning to keep abreast of latest technologies.
- 19CHF02.CO3 : Analyze and implement the design to provide sustainable solutions.
- 19CHF02.CO4 : Evaluate and interpret the experimental results and analyze the impact on society and environment.
- 19CHF02.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
19CHF02.CO1	X	X	-	X	-	X	-	X	X	-	X	X	X	X	-
19CHF02.CO2	X	X	X	X	-	-	-	-	X	-	X	X	X	X	-
19CHF02.CO3	X	X	X	X	X	X	-	-	X	-	X	X	X	X	X
19CHF02.CO4	X	X	X	X	X	X	-	-	X	-	X	X	X	X	X
19CHF02.CO5	-	-	-	-	-	-	-	-	X	X	X	X	-	-	-

TOTAL: 45 Periods

  
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