NANDHA ENGINEERING COLLEGE

(Autonomous)

*Affiliated to Anna University, Chennai * Approved by AICTE * Accredited by NAAC (A+ Grade)*

Pitchandampalayam (P.O), Vaikkalmedu, Erode - Perundurai Main Road, Erode - 638 052

Phone: 04294 - 225585, 223711, 223722, 226393 Mobile: 73737 23722 Fax: 04294 – 224787

Website: ww.nandhaengg.org E-mail: info@ nandhaengg.org

1.1.2 - Details of syllabus revision carried out during the year 2023-2024

B.Tech - Chemical Engineering

S.No	Course Code	Course Name	% of Change
1.	22CHC12	Mass Transfer II	30%
2.	22CHC13	Process Engineering Economics	60%
3.	22CHC14	Process Dynamics and Control	40%
4.	22CHP05	Chemical Reaction Engineering Laboratory	10%
5.	22CHP06	Mass Transfer Laboratory	100%
6.	22CHC15	Transport Phenomena	20%
7.	22CHC16	Process Modeling and Simulation	60%
8.	22CHP07	Process Control Laboratory	100%
9.	22CHP08	Process Modeling and Simulation Laboratory	100%
10.	22CHP09	Process Computation Laboratory	40%
11.	22CHP10	Chemical Equipment Design Laboratory	100%
12.	22GED02	Industrial Training / Internships	60%
13.	22CHD01	Project Work	20%
14.	22CHX01	Introduction to Computational Fluid Dynamics	100%
15.	22CHX02	Modern Separation Techniques	100%
16.	22CHX03	Chemical Process Utilities	100%
17.	22CHX04	Corrosion Technology	100%
18.	22CHX05	Materials of Construction for Process Industries	100%
19.	22CHX06	Process Instrumentation	100%
20.	22CHX07	Pharmaceutical Technology	100%
21.	22CHX11	Petroleum Chemistry and Refining Fundamentals	100%
22.	22CHX12	Primary Refining Technology	100%
23.	22CHX13	Petroleum Refining Primary Processing Technology	100%
24.	22CHX14	Secondary Refining Technology	100%
25.	22CHX15	Petrochemical Unit Processes	100%
26.	22CHX16	Petrochemical Derivatives	100%
27.	22CHX17	Petrochemical Technology	100%
28.	22CHX18	Polymer Technology	60%
29.	22CHX09	Fertilizer Technology	100%
30.	22CHX21	Food Chemistry	100%
31.	22CHX22	Food Materials Science	100%
32.	22CHX23	Processing of Dairy Products	100%

H.O.D. Chemical Engineering
Nandha Engineering College,
(Autonomous)
Erode-638 052

NANDHA ENGINEERING COLLEGE

(Autonomous)

*Affiliated to Anna University, Chennai * Approved by AICTE * Accredited by NAAC (A+ Grade)*

Pitchandampalayam (P.O), Vaikkalmedu, Erode - Perundurai Main Road, Erode - 638 052

Phone: 04294 - 225585, 223711, 223722, 226393 Mobile: 73737 23722 Fax: 04294 – 224787

Website: ww.nandhaengg.org E-mail: info@ nandhaengg.org

33.	22CHX24	Fruit and Vegetable Processing and Preservation	100%
34.	22CHX25	Baking and Confectionery Technology	100%
35.	22CHX26	Technology of Fruit and Vegetable Processing	100%
36.	22CHX27	Food Structuring Techniques	100%
37.	22CHX28	Food Quality and Safety	100%
38.	22CHX31	Air Pollution Engineering	100%
39.	22CHX32	Waste Water Treatment	100%
40.	22CHX33	Solid Waste Management	100%
41.	22CHX34	Environmental Impact Assessment	100%
42.	22CHX35	Process Safety Management	100%
43.	22CHX36	Risk Assessment and HAZOP Analysis	100%
44.	22CHX37	Industrial Pollution Control and Management	100%
45.	22CHX38	Environmental Biotechnology	100%
		Average	**86.67%**

H.O.D. Chemical Engineering
Nandha Engineering College,
(Autonomous)
Erode - 638 052.

NANDHA ENGINEERING COLLEGE (AUTONOMOUS), ERODE - 638 052

REGULATIONS - 2022(R22) **CHOICE BASED CREDIT SYSTEM (CBCS)**

B.TECH - CHEMICAL ENGINEERING

CURRICULAM: I to VIII SEMESTER **SYLLABUS: I to IV SEMESTER**

SEMESTER: I									
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
I	22MAN01	Induction Programme							
THEORY									
2	22EYA01	Professional Communication - I	HSMC	-	4	2	0	2	3
3	22MYB01	*Calculus and Linear Algebra	BSC	-	4	3	I	0	4
4	22CYB03	Chemistry	BSC	-	3	3	0	0	3
5	22EEC01	Basic Electrical and Electronics Engineering	ESC	-	3	3	0	0	3
6	22MEC01	Engineering Graphics	ESC	-	4	2	0	2	3
7	22GYA01	தமிழர் மரபு / Heritage of Tamils	HSMC	-	I	I	0	0	I
PRACTICALS									
8	22CYP01	*Chemistry Laboratory	BSC	-	2	0	0	2	I
9	22GEP01	Engineering Practices Laboratory	ESC	-	4	0	0	4	2
MANDATORY NON-CREDIT COURSES									
10	22MAN03	*Yoga - I	MC	-	I	0	0	I	0
				TOTAL	**26**	**14**	**I**	**11**	**20**

*Ratified by Eleventh Academic Council

SEMESTER: II									
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22EYA02	Professional Communication-II	HSMC	-	4	2	0	2	3
2	22MYB02	*Partial Differential Equations And Transforms Techniques	BSC	-	4	3	1	0	4
3	22PYB02	Advanced Material and Nano Technology	BSC	-	3	3	0	0	3
4	22CYB06	*Environmental Science & Sustainability	BSC	-	3	3	0	0	3
5	22CSC01	*Problem Solving and C Programming	ESC	-	3	3	0	0	3
6	22CHC01	*Fundamentals of Chemical Engineering	PCC	-	3	3	0	0	3
7	22GYA02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	-	1	1	0	0	1
PRACTICALS									
8	22PYP01	*Physics laboratory	BSC	-	2	0	0	2	1
9	22CSP01	*Problem Solving and C Programming Laboratory	ESC	-	4	0	0	4	2
MANDATORY NON-CREDIT COURSES									
10	22MAN02R	SOFT/ANALYTICAL SKILLS – I	MC	-	3	1	0	2	0
11	22MAN05	*Yoga - II	MC	-	1	0	0	1	0
				TOTAL	**31**	**19**	**1**	**11**	**23**

*Ratified by Eleventh Academic Council

SEMESTER: III									
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22MYB03	Statistics and Numerical Methods	BSC	-	4	3	1	0	4
2	22MEC08	Basics of Mechanical Engineering	ESC	-	3	3	0	0	3
3	22CHC02	Chemical Engineering Fluid mechanics	PCC	22CHC01	3	3	0	0	3
4	22CHC03	Chemical Process Calculation	PCC	22CHC01	3	3	0	0	3
5	22CHC04	Unit Processes for Chemical Engineers	PCC	-	3	3	0	0	3
6	22CHC05	Mechanical Operations	PCC	22CHC01	3	3	0	0	3
PRACTICALS									
7	22CHP01	Fluid Mechanics Laboratory	PCC	22CHC02	4	0	0	4	2
8	22CHP02	Chemical Analysis Laboratory	PCC	-	4	0	0	4	2
MANDATORY NON-CREDIT COURSES									
9	22MAN04R	SOFT/ANALYTICAL SKILLS – II	MC	-	3	1	0	2	0
10	22MAN09	Indian Constitution	MC	-	1	1	0	0	0
				TOTAL	**31**	**20**	**1**	**10**	**23**

SEMESTER: IV									
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22CHC06	Chemical Reaction Engineering	PCC	-	3	2	1	0	3
2	22CHC07	Process Heat Transfer	PCC	22CHC01	3	2	1	0	3
3	22CHC08	Chemical Engineering Thermodynamics	PCC	-	3	3	0	0	3
4	22CHC09	Mass Transfer I	PCC	22CHC01	3	2	1	0	3
5	22CHC10	Instrumental Methods of Analysis	PCC	-	3	3	0	0	3
6	22CHC11	Chemical Process Industries	PCC	22CHC01	3	3	0	0	3
PRACTICALS									
7	22CHP03	Heat Transfer laboratory	PCC	22CHC07	4	0	0	4	2
8	22CHP04	Mechanical Operation Laboratory	PCC	22CHC05	4	0	0	4	2
MANDATORY NON-CREDIT COURSES									
9	22MAN07R	SOFT/ANALYTICAL SKILLS – III	MC	-	3	1	0	2	0
10	22GED01	Personality and Character Development	EEC	-	1	0	0	1	0
				TOTAL	**30**	**16**	**3**	**11**	**22**

SEMESTER: V									
SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1	22CHC12	Mass Transfer II	PCC	22CHC01	3	2	1	0	3
2	22CHC13	Process Engineering Economics	PCC	-	3	3	0	0	3
3	22CHC14	Process Dynamics and Control	PCC	-	3	2	1	0	3
4	E1	Elective	PEC	-	3	3	0	0	3
5	E2	Elective	PEC	-	3	3	0	0	3
6	E3	Elective	PEC/OEC	-	3	3	0	0	3
PRACTICALS									
7	22CHP05	Chemical Reaction Engineering Laboratory	PCC	22CHC06	4	0	0	4	2
8	22CHP06	Mass Transfer Laboratory	PCC	22CHC12	4	0	0	4	2
MANDATORY NON-CREDIT COURSES									
9	22MAN08R	SOFT/ANALYTICAL SKILLS – IV	MC	-	3	1	0	2	0
				TOTAL	**29**	**17**	**2**	**10**	**22**

*Ratified in twelfth academic council

SEMESTER: VI									
SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1	22CHC15	Transport Phenomena	PCC	22CHC02 22CHC07 22CHC09	3	2	1	0	3
2	22CHC16	Process Modeling and Simulation	PCC	-	3	2	1	0	3
3	E4	Elective	PEC	-	3	3	0	0	3
4	E5	Elective	PEC	-	3	3	0	0	3
5	E6	Elective	OEC	-	3	3	0	0	3
6	E7	Elective	PEC/OEC	-	3	3	0	0	3
PRACTICALS									
7	22CHP07	Process Control Laboratory	PCC	22CHC14	4	0	0	4	2
8	22CHP08	Process Modeling and Simulation Laboratory	PCC	22CHC16	4	0	0	4	2
				TOTAL	**26**	**16**	**2**	**8**	**22**

SEMESTER: VII									
SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1	22GEA01	Universal Human Values	HSMC	-	2	2	0	0	2
2	EM1	Elective (Management)	HSMC	-	3	3	0	0	3
3	E8	Elective	PEC	-	3	3	0	0	3
4	E9	Elective	PEC	-	3	3	0	0	3
5	E10	Elective	OEC	-	3	3	0	0	3
PRACTICALS									
6	22CHP09	Process Computation laboratory	PCC	-	4	0	0	4	2
7	22CHP10	Chemical Equipment Design laboratory	PCC	-	4	0	0	4	2
8	22GED02	Industrial Training / Internships*	EEC	-	-	0	0	0	1
				TOTAL	**24**	**14**	**0**	**8**	**19**

*Two weeks industrial training/internship carries one credit. Industrial training/internship during VI Semester Summer Vacation/ before VII semester will be evaluated in VII semester

SEMESTER: VIII									
SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
PRACTICALS									
1	22CHD01	Project Work	EEC	-	20	0	0	20	10
				TOTAL	20	0	0	20	10

(A) HSMC, MC, BSC, ESC and PCC Courses										
Humanities, Social Science and Management Courses (HSMC)				**AICTE Credit Distribution Norm :12**						
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1	22EYA01	Professional Communication – I	HSMC	-	4	2	0	2	3	1
2	22GYA01	Heritage Of Tamils (தமிழர் மரபு)	HSMC	-	1	1	0	0	1	1
3	22EYA02	Professional Communication-II	HSMC	-	4	2	0	2	3	2
4	22GYA02	Tamils and Technology	HSMC	-	1	1	0	0	1	2
5	22GEA01	Universal Human Values	HSMC		2	2	0	0	2	7
6	E M1	Elective (Management)	HSMC		3	3	0	0	3	7

Mandatory Courses (MC)										
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1	22MAN01	Induction Programme	MC	-	0	0	0	0	0	1
2	22MAN02R	Soft/Analytical Skills – I	MC	-	3	1	0	2	0	1
3	22MAN03	Yoga – I	MC	-	1	0	0	1	0	1
4	22MAN04R	Soft / Analytical Skills - II	MC	-	3	1	0	2	0	2
5	22MAN05	Yoga - II	MC	-	1	0	0	1	0	2
6	22MAN07R	Soft / Analytical Skills - III	MC	-	1	1	0	0	0	3
7	22MAN09	Indian Constitution	MC	-	5	3	0	2	0	3
8	22MAN08R	Soft/Analytical Skills - IV	MC	-	0	0	0	1	0	4
9	22GED01	Personality and Character Development	MC	-	1	0	0	1	0	4

Basic Science Courses (BSC)				AICTE Credit Distribution Norm :25						
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1	22MYB01	Calculus and Linear Algebra	BSC	-	3	3	1	0	4	1
2	22CYB03	Chemistry	BSC	-	3	3	0	0	3	1
3	22CYP01	Chemistry Laboratory	BSC	-	2	0	0	2	1	1
4	22MYB02	Partial Differential Equations And Transforms Techniques	BSC	-	4	3	1	0	4	2
5	22PYB02	Advanced Material and Nano Technology	BSC	-	3	3	0	0	3	2
6	22CYB07	Environmental Science & Sustainability	BSC	-	3	3	0	0	3	2
7	22PYP01	Physics laboratory	BSC	-	2	0	0	2	1	2
8	22MYB03	Statistics and Numerical Methods	BSC	-	4	3	1	0	4	3

Engineering Science Courses (ESC)				AICTE Credit Distribution Norm:24						
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1	22EEC01	Basic Electrical and Electronics Engineering	ESC	-	3	3	0	0	3	1
2	22MEC01	Engineering Graphics	ESC	-	3	2	0	2	3	1
3	22GEP01	Engineering Practices Laboratory	ESC	-	4	0	0	4	2	1
4	22CSC01	Problem Solving and C Programming	ESC	-	3	3	0	0	3	2
5	22CSP01	Problem Solving and C Programming Laboratory	ESC	-	4	0	0	4	2	2
6	22MEC08	Basics of Mechanical Engineering	ESC	-	3	3	0	0	3	2

Programme Core Courses (PCC)				AICTE Credit Distribution Norm :48						
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1	22CHC01	Fundamentals of Chemical Engineering	PCC	-	3	3	0	0	3	1
2	22CHC02	Chemical Engineering Fluid mechanics	PCC	22CHC01	3	3	0	0	3	3
3	22CHC03	Chemical Process Calculation	PCC	22CHC01	3	3	0	0	3	3
4	22CHC04	Unit Processes for Chemical Engineers	PCC	-	3	3	0	0	3	3
5	22CHC05	Mechanical Operations	PCC	22CHC01	3	3	0	0	3	3
6	22CHP01	Fluid Mechanics Laboratory	PCC	22CHC02	4	0	0	4	2	3
7	22CHP02	Chemical Analysis Laboratory	PCC	-	4	0	0	4	2	3
8	22CHC06	Chemical Reaction Engineering	PCC	-	3	2	1	0	3	4
9	22CHC07	Process Heat Transfer	PCC	22CHC01	3	2	1	0	3	4
10	22CHC08	Chemical Engineering Thermodynamics	PCC	-	3	3	0	0	3	4
11	22CHC09	Mass Transfer I	PCC	22CHC01	3	2	1	0	3	4
12	22CHC10	Instrumental Methods of Analysis	PCC	-	3	3	0	0	3	4
13	22CHC11	Chemical Process Industries	PCC	22CHC01	3	3	0	0	3	4
14	22CHP03	Heat Transfer laboratory	PCC	22CHC07	4	0	0	4	2	4
15	22CHP04	Mechanical Operation Laboratory	PCC	22CHC05	4	0	0	4	2	4
16	22CHC12	Mass Transfer II	PCC		3	2	1	0	3	5
17	22CHC13	Process Engineering Economics	PCC		3	2	1	0	3	5
18	22CHC14	Process Dynamics and Control	PCC		3	2	1	0	3	5
19	22CHP05	Chemical Reaction Engineering Laboratory	PCC	22CHC06	4	0	0	4	2	5
20	22CHP06	Mass Transfer Laboratory	PCC	22CHC12	4	0	0	4	2	5

21	22CHC15	Transport Phenomena	PCC		3	2	1	0	3	6
22	22CHC16	Process Modeling and Simulation	PCC		3	3	0	0	3	6
23	22CHP07	Process Control Laboratory	PCC	22CHC14	4	0	0	4	2	6
24	22CHP08	Process Modeling and Simulation Laboratory	PCC	22CHC16	4	0	0	4	2	6
25	22CHP09	Process Computation laboratory	PCC		4	0	0	4	2	7
26	22CHP10	Chemical Equipment Design laboratory	PCC		4	0	0	4	2	7

(C) Programme Elective Courses (PEC)									
Vertical 1: Chemical Industry 4.0									
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
1.	22CHX01	Introduction to Computational Fluid Dynamics	-	-	3	3	0	0	3
2.	22CHX02	Modern Separation Techniques	-	-	3	3	0	0	3
3.	22CHX03	Chemical Process Utilities	-	-	3	3	0	0	3
4.	22CHX04	Corrosion Technology	-	-	3	3	0	0	3
5.	22CHX05	Materials of Construction for Process Industries	-	-	3	3	0	0	3
6.	22CHX06	Process Instrumentation	-	-	3	3	0	0	3
7.	22CHX07	Pharmaceutical Technology	-	-	3	3	0	0	3
8.	22CHX08	Separation and Purification Processes	-	-	3	3	0	0	3
Vertical II: Petroleum Technology									
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
1	22CHX11	Petroleum Chemistry and Refining Fundamentals	-	-	3	3	0	0	3
2	22CHX12	Primary Refining Technology	-	-	3	3	0	0	3
3	22CHX13	Petroleum Refining Primary Processing Technology	-	-	3	3	0	0	3
4	22CHX14	Secondary Refining Technology	-	-	3	3	0	0	3
5	22CHX15	Petrochemical Unit Processes	-	-	3	3	0	0	3
6	22CHX16	Petrochemical Derivatives	-	-	3	3	0	0	3
7	22CHX17	Petrochemical Technology	-	-	3	3	0	0	3
8	22CHX18	Polymer Technology	-	-	3	3	0	0	3

9	22CHX09	Fertilizer Technology	-	-	3	3	0	0	3
Vertical III : Food Technology									
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
1	22CHX21	Food Chemistry	-	-	3	3	0	0	3
2	22CHX22	Food Materials Science	-	-	3	3	0	0	3
3	22CHX23	Processing of Dairy Products	-	-	3	3	0	0	3
4	22CHX24	Fruit and Vegetable Processing and Preservation	-	-	3	3	0	0	3
5	22CHX25	Baking and Confectionery Technology	-	-	3	3	0	0	3
6	22CHX26	Technology of Fruit and Vegetable Processing	-	-	3	3	0	0	3
7	22CHX27	Food Structuring Techniques	-	-	3	3	0	0	3
8	22CHX28	Food Quality and Safety	-	-	3	3	0	0	3
Vertical IV : Environmental and Safety Engineering									
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
1	22CHX31	Air Pollution Engineering	-	-	3	3	0	0	3
2	22CHX32	Waste Water Treatment	-	-	3	3	0	0	3
3	22CHX33	Solid waste Management	-	-	3	3	0	0	3
4	22CHX34	Environmental Impact Assessment	-	-	3	3	0	0	3
5	22CHX35	Process Safety Management	-	-	3	3	0	0	3
6	22CHX36	Risk Assessment and HAZOP Analysis	-	-	3	3	0	0	3
7	22CHX37	Industrial Pollution Control and Management	-	-	3	3	0	0	3
8	22CHX38	Environmental Biotechnology	-	-	3	3	0	0	3

(C) MANAGEMENT ELECTIVES									
1.	22GEA02	Principles of Management	MEC	-	3	3	0	0	3
2.	22GEA03	Total Quality Management	MEC	-	3	3	0	0	3
3.	22GEA04	Professional Ethics and Human Values	MEC	-	3	3	0	0	3

(D) Employability Enhancement Courses (EEC)				AICTE Credit Distribution Norm :15						
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE REQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1	22GED01	Personality and Character Development	EEC	-	5	3	0	2	0	4
2	22GED02	Industrial training/ Internships II**	EEC	-	2	0	0	2	1	7
3	22CHD01	Project Work	EEC		20	0	0	20	10	8

Minor Degree Courses									
Chemical Engineering									
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE REQUISITE	CONTACT PERIODS	L	T	P	C
1	22CHM01	Fundamentals of Chemical Engineering	-	-	3	3	0	0	3
2	22CHM02	Fluid Mechanics	-	-	3	3	0	0	3
3	22CHM03	Basic Process Calculations	-	-	3	3	0	0	3
4	22CHM04	Heat Transfer Operations	-	-	3	3	0	0	3
5	22CHM05	Mass Transfer Operations	-	-	3	3	0	0	3
6	22CHM06	Chemical Reaction Engineering	-	-	3	3	0	0	3
7	22CHM07	Process Plant Utilities	-	-	3	3	0	0	3
8	22CHM08	Process Plant Safety	-	-	3	3	0	0	3

SUMMARY

B.TECH. CHEMICAL ENGINEERING											
S. No	SUBJECT AREA	CREDITS AS PER SEMESTER								TOTAL CREDITS	Percentage (%)
		I	II	III	IV	V	VI	VII	VIII		
1	HSMC	4	4					5		13	8.1
2	BSC	8	11	4						23	14.3
3	ESC	8	5	3						16	10
4	PCC		3	16	22	13	10	4		68	42.2
5	PEC					6	6	6		18	11.2
6	OEC					3	6	3		12	7.4
7	EEC							1	10	11	6.8
	TOTAL	20	23	23	22	22	22	19	10	161	100
	Non Credit/ Mandatory	3	2	2	2	1					

22CHC12 - MASS TRANSFER II				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : 22CHC09

Course Objective:	• To understand the basic principles of mass transfer operations. • To perform design calculations for equilibrium staged separation operations • To gain knowledge on equipments used in absorption, distillation, extraction and leaching

Course Outcomes The Student will be able to		Cognitive Level	Weight age of Cos in End Semester Examination
CO1	Apply important chemical concepts in mass transfer operations.	Ap	20%
CO2	Determine the number of stages required for mass transfer operations	An	20%
CO3	Calculate the number of transfer units and height required for column operations	Ap	40%
CO4	Familiarize the different equipments used in absorption, distillation, extraction and leaching.	An	20%
CO5	Present the types and up-scaling of sustaining separation technologies in process industries.	U	Internal Assessment

UNIT I : ABSORPTION	(9)
Introduction, Choice of solvent, Concepts of Co-current and counter-current operations, choice of solvents, Tray tower absorber– Calculation of number of theoretical and actual number of trays. Packed tower absorber – Tower packing and characteristics, Calculation of NTU, HTU and height.	
UNIT II : DISTILLATION	(9)
Introduction, Vapor-liquid equilibria, Raoult's law and deviations from ideality. Principles of distillation: Simple distillation- calculations using Rayleigh equation, Flash vaporization, Continuous fractionation- Fenske equation; Number of ideal stages by McCabe - Thiele method for binary system.. Principles of extractive and azeotropic distillation.	
UNIT III : INTRODUCTION TO MULTICOMPONENT DISTILLATION	(9)
Introduction, phase equilibria – K-Values and relative volatility- ideal and non-ideal systems-effect of temperature, pressure and composition on K-values and volatility-Phase diagrams-Calculations of bubble points and dew points- flash distillation for multicomponent mixtures - Key fractionation concepts – Approximate material balance.	

UNIT IV : EXTRACTION AND LEACHING	(9)
Introduction. Equilibrium in ternary systems; Solvent selection criteria; Single stage operation, Multistage operation for partially miscible and immiscible systems. Extraction equipment - Spray, packed and Mechanically agitated contactors. Pulsed extractors, Centrifugal extractors. Solid-liquid equilibria; calculations in single stage, multi stage cross current and counter current leaching. Industrial Leaching equipment- Bollman Extractor, Rotocel Extractor, Dorr Agitator and Thickener	
UNIT V : ADSORPTION AND MEMBRANE SEPARATION TECHNIQUES	(9)
Characteristics and choice of adsorbents, industrial applications. Adsorption isotherms & breakthrough curve. Single and multiple cross current and counter current operation. Membranes separation processes - Principle and concept of osmosis; reverse osmosis, electro dialysis and ultrafiltration.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS

1. Transport Processes and Separation Process Principles –Geankopolis C.J., 5th Edition, 2018.
2. Mass Transfer Operations - Robert E.Treybal., 3rd Edition, McGraw-Hill Book Company Ltd., 2017.
3. Mass Transfer: Theory and Practice - Anantharaman N. and Meera Sheriffa Begum K.M., Prentice Hall of India, New Delhi, 2011.
4. Fundamentals of Multicomponent Distillation - Charles D. Holland, McGraw-Hill Book Company Ltd, 1981.

REFERENCE

1. Unit Operation of Chemical Engineering - Warren McCabe, Julian Smith, Peter Harriott, 7th Edition 2017.

Mapping of Course Outcomes (COs)with Programme Outcomes (POs)/
Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3	3											3	
3		3	3										3	
4		3											3	
5									3					
CO	3	3	3						3				3	

22CHC13 PROCESS ENGINEERING ECONOMICS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : 22CHC09				
Course Objective:	• To understanding the concept of Process Economics • To understand the various methods of selecting project profitability and investment alternatives. • To explain concepts of the essential of economics balance and economic balance approach.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge of process economics in chemical industries	Ap	20%
CO2	Prepare the basic cost analysis to take economically sound decisions.	Ap	20%
CO3	Evaluate and select the alternatives in project implementation.	An	40%
CO4	Obtain the economic operating condition of the processes	An	20%
CO5	Make an oral presentation by individual/team on assigned topics related to the course	U	Internal Assessment

UNIT I : INTERESTAND COST ESTIMATION	(9)
Time value of money, Depreciation, capital cost and its estimation, Capital requirement for complete plant, capital recovery, cost indices, demand & supply analysis, break even analysis.	
UNIT II : INVESTMENT ALTERNATIVES AND TAXES	(9)
Economics of selecting alternatives- Four methods of economics of alternative selection- Annual equivalent method, Present worth method and Future worth method, Types of Taxes, Equivalence after Taxes, Cost comparison after taxes .	
UNIT III : PROJECT PROFITABILTY	(9)
Estimation project profitability, project feasibility, replacement policy, forecasting sales, inflation and its impact.	
UNIT IV : ECONOMIC BALANCE INEQUIPMENTS	(9)
Essentials of economic balance, Economic decisions in Chemical Plant–Economics of pipe size— economic balance approach for insulation, batch operation, cyclic operations, evaporation, heat transfer equipment.	
UNIT V : FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT)	(9)
Principles of accounting, Balance sheet, income statement, Financial Ratio - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill, 5th Edition, 2017.
2. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2nd edition, 2013.
3. Dr.S.N.Maheswari and Dr.S.K.Maheshwari: Financial Accounting, Vikas, 2009
4. Schweyer.H.E, "Process Engineering Economics", McGraw Hill,1969.

REFERENCES:

1. Mahajani,V.V., Mokashi S. M., Chemical Project Economics, Macmillan Indian Ltd., New Delhi, India (2005).
2. F.C.Jelenand J.H.Black, "Cost and Optimization Engineering", McGraw Hill, 3rd Edn., 1992.

Mapping of Course Outcomes (COs)with Programme Outcomes (POs)/
Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3											3	
3			3										3	
4		3												
5										3				
CO	3	3	3							3			3	

22CHC14 PROCESS DYNAMICS AND CONTROL				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : 22CHC09				
Course Objective:	• To get knowledge about the principles of controllers and control elements for different applications • To learn the transient response, offset and their stability of open and closed loop system			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge of Laplace transform for time domain equations	Ap	10%
CO2	Develop the transfer function of control systems	Ap	20%
CO3	Analyze the response of control systems	An	30%
CO4	Analyze the stability of control systems and comment the configuration of control loop	An	40%
CO5	Assess the technical and technological advancement in control systems	U	Internal Assessment

UNIT I - TRANSIENT RESPONSE OF SYSTEM	(9)
Introduction to process control - Review of Laplace transforms principles - Transfer function for chemical system- Standard input functions - Transient response and characteristic of first and second order systems - Linearization of nonlinear systems	
UNIT II - DEVELOPMENT OF CLOSED LOOP CONTROL SYSTEM	(9)
Controllers: Types and Transfer functions - Principles of pneumatic and electronic controllers; final control elements: function and Transfer functions – control valve characteristics; Feed-back control systems: concept and development of block diagrams - Transportation lag	
UNIT III - TRANSIENT RESPONSE AND STABILITY ANALYSIS	(9)
Servo and regulator mechanism problems - dynamic response of closed loop system - offset calculations; Stability analysis: Routh test and root locus diagrams	
UNIT IV - FREQUENCY RESPONSE ANALYSIS	(9)
Introduction to frequency response - frequency response characteristic - Bode diagrams - Bode stability criterion - Phase and gain margin - Tuning of controller settings - Ziegler-Nichols and Cohen-Coon methods	

UNIT V -ADVANCED CONTROL SYSTEMS	(9)
Control Valve characterization, Advanced control systems : principle and applications of feed forward cascade, split-range, ratio and feed forward - feed backward control – Introduction to Digital control system	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Donald R. Coughanowr, Steven E. LeBlanc "Process Systems Analysis and Control" 3rd Edition Tata McGraw-Hill New Delhi 2013
2. George Stephanopoulos, Chemical Process Control-An Introduction to Theory & Practice, (Indian Edition) Pearson, 2015.

REFERENCES:

1. Seborg D.E, Edgar T.F., Mellichamp D.A and Doyle III F.J., "Process Dynamics and Control", 3rd edition, Prentice Hall of India, 2011
2. Sudheer S. Bhagade and Govind Das Nageshwa "Process Dynamics and Control" Prentice Hall of India New Delhi 2011.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2		3												3
3			3											
4			3											
5	3												3	
CO	3	3	3										3	3

22CHP05 CHEMICAL REACTION ENGINEERING LABORATORY				
	L	T	P	C
	0	0	4	2
PRE-REQUISITE: 22CHC06				
Course Objective:	• To determine the rate constant of batch reactor for reversible and irreversible reactions. • To understand the behavior of PFR and MFR for the saponification reaction • To determine the performance of combined reactors.			

Course Outcomes The Student will be able to		Cognitive Level
CO1	Apply the knowledge to estimate the rate constant and order of the reaction in a reaction.	Ap
CO2	Determine the rate of dissociation of non-catalytic reactor.	Ap
CO3	Estimate the performance of flow reactor using Residence Time Distribution studies.	Ap
CO4	Calculate and verify the average rate constant of the Flow reactors.	An
CO5	Calculate the conversion of given reactants while carried in the combined-flow reactors.	An

LIST OF EXPERIMENTS

1. Irreversible reaction in a Batch Reactor
2. Reversible reaction in a Batch Reactor
3. Performance study on Combined Reactors (PFR Followed by MFR)
4. Performance study on Combined Reactors (MFR Followed by PFR)
5. Performance Study on Semi Batch Reactor
6. Kinetic Studies in a Mixed Flow Reactor
7. Kinetic Studies in a Plug Flow Reactor
8. Determination of Rate of Dissociation using Solid – Liquid Non Catalytic Reactor
9. Study of Adiabatic Reactor.
10. Residence Time Distribution in flow reactors.

TOTAL (P:60) = 60 PERIODS

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) /
Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3													3
3	3													3
4		3	3											
5		3												
CO	3	3	3											3

22CHP06 MASS TRANSFER LABORATORY				
	L	T	P	C
	0	0	4	2

PRE-REQUISITE : 22CHC09, 22CHC12

Course Objective:	• To develop sound practical knowledge on different types of mass transfer equipments • To understand the basic principle of distillation operations • To explore knowledge on extraction/leaching/drying operations

Course Outcomes The Student will be able to		Cognitive Level
CO1	Analyze and interpret data for diffusivity measurement and surface evaporation.	An
CO2	Calculate the design parameters in different distillation operations	Ap
CO3	Analyze the separation efficiency of different solvents on extraction and leaching operations	An
CO4	Analyze the drying performance of material using different drying equipments	An
CO5	Analyze the separation efficiency of different adsorbent	An

LIST OF EXPERIMENTS

1. Determination of the diffusivity of the given liquid to air.
2. Estimation of Mass transfer co-efficient using Wetted wall column.
3. Verifying the Raleigh's equation for the given system using simple distillation setup
4. Determination of vaporization efficiency (Ev) and Thermal efficiency (Et) of the given system using steam distillation apparatus
5. Estimation of Height Equivalent to a Theoretical Plate and find out % recovery of the overhead and bottom products of given system under total reflux conditions
6. Conduction of Simple /Co-current /Counter – current Leaching studies
7. Conduction of liquid-liquid extraction studies and plot binodal curve for the given ternary system/Conduction of Liquid-liquid extraction studies in Rotating Disc Contactor
8. Studying the concept of Surface Evaporation and finding the constants of Himus Equation

9. Verifying adsorption isotherms by Batch Adsorption tests
10. Conduction of drying experiments using Vacuum Dryer

TOTAL(P:60) = 60 Periods

REFERENCES:

1. Laboratory manual:

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3												
2	3													
3		3	3											3
4		3	3											3
5		3												
CO (W.A)	3	3	3											3

22MAN08R - SOFT/ANALYTICAL SKILLS – IV (Common to All Branches)				
	L	**T**	**P**	**C**
	1	**0**	**2**	**0**
PREREQUISITE : Nil				
Course Objective:	• To enhance the ability to communicate coherently and effectively across contexts • To develop quantitative aptitude and analytical reasoning skills			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in Continuous Assessment Test**
CO1	Develop proficiency to communicate accurately, fluently, and appropriately in various academic, professional and social contexts.	U	40%
CO2	Solve quantitative aptitude problems with more confidence.	Ap	30%
CO3	Draw valid conclusions, identify patterns, and solve problems.	An	30%

UNIT I – VERBAL ABILITY	**(15)**
Grammar - Sentence Completion – Sentence Improvement - Error Spotting - **Listening** - TOEFL Listening Practice Tests - **Speaking** – Interview Skills - **Reading** - GRE Reading Passages - **Writing** - Paragraph Writing.	
UNIT II – APTITUDE	**(15)**
Probability - Permutations and Combinations - Data Interpretation on Multiple Charts - Mensuration - Area, Shapes, Perimeter - Races and Games.	
UNIT III - REASONING	**(15)**
Data Sufficiency - Mathematical Operations - Pattern Completion - Cubes - Embedded Images.	
TOTAL(L:45) = 45 PERIODS	

REFERENCES:

1. Rizvi, M.Ashraf. *Effective Technical Communication.* Tata McGraw-Hill Education, 2017.
2. Aggarwal R S. *Quantitative* Aptitude for Competitive Examinations. S.Chand Publishing Company Ltd(s)., 2022.
3. Sharma, Arun. *How to Prepare for Quantitative Aptitude for the CAT*. Tata McGraw – Hill Publishing, 2022.
4. Praveen R V. *Quantitative Aptitude and Reasoning.* PHI Learning Pvt. Ltd., 2016.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) /
Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1									2	3				
2		2		2										
3		2		2										
CO (W.A)		**1**		**1**					**1**	**1**				

22CHC15 TRANSPORT PHENOMENA				
	L	T	P	C
	2	1	0	3
PRE-REQUISITE : 22CHC02, 22CHC07, 22CHC09				
Course Objective:	• To gain knowledge of the physical quantities that governs in momentum transport, heat transport and mass transport with emphasis on the mathematical formulation of the conservation principles. • To gain knowledge about transport process in the concept of dimensional analysis and scale factors for equation of change for different coordinate systems. • To gain knowledge about transport in turbulent and boundary layer flow.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge to solve problems based on shell momentum, energy & mass balances across various boundary conditions.	Ap	20%
CO2	Apply the equation of changes for systems of various geometry	Ap	20%
CO3	Apply the knowledge of reaction in transport processes.	Ap	40%
CO4	Infer and analyze for steady state operation for momentum, heat & mass transfer.	An	20%
CO5	Ability to perform in a team to make an effective oral presentation of the study on the topic related to the course	U	Internal Assessment

UNIT I :MOMENTUM TRANSPORT	9
Tensor/ Vector, Levels of Transport Phenomena, Viscosity, effect of temperature and pressure on viscosity of gases and liquids, Kinetic theory of viscosity, Newton's law of viscosity (NLV), steady state Shell Momentum balances, boundary conditions, momentum flux at the surfaces, velocity profiles, average velocity of Newtonian and non-Newtonian for flow of a falling film, circular tube, slits, an Annulus, Adjacent flow of two Immiscible fluids.	
UNIT II: HEAT TRANSPORT	9
Thermal conductivity, effect of temperature and pressure on thermal conductivity of gases and liquids, Kinetic theory of thermal conductivity, Fourier's law of heat conduction (FLHC), steady state Shell energy balances, boundary conditions, energy fluxes at surfaces, temperature profiles, average temperature for different types of heat sources such as electrical, nuclear, viscous and chemical.	
UNIT III : MASS TRANSPORT	9
Diffusivity, effect of temperature and pressure on diffusivity, Fick's law of diffusion (FLD), Kinetic theory of diffusivity, steady state Shell mass balances, boundary conditions, Molar flux at surfaces, concentration profiles, average concentration for diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion into a falling liquid film, Diffusion and chemical reaction in porous catalyst.	

UNIT IV : EQUATIONS OF CHANGE AND THEIR APPLICATIONS	9
Momentum: Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems. Heat: Equations of change (non-isothermal), equation of motion for forced and free convection, equation of energy (non-isothermal). Mass: Equation of continuity for binary mixtures, equation of change to set up diffusion problems for simultaneous heat and mass transfer.	
UNITV :TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW	9
Turbulence phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface. Introduction to macroscopic balances for isothermal flow systems, non-isothermal systems and multicomponent systems.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. R. B. Bird, W.E. Stewart, E.W. Lightfoot, Transport Phenomena, 2nd Revised Edition, John Wiley, 2007
2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena A Unified Approach", Brodkey Publishing 2003.
3. Bodh Raj, Introduction to Transport Phenomena, PHI Learning Publications, 2015.

REFERENCES:

1. R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition, John Wiley, New York, 2007
2. C. J. Geankoplis, Transport Processes and Separation Process Principles, Prentice- Hall Inc., 4th Edition 2003.
3. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition McGraw Hill, 1983.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3												3	
3	3													
4		3											3	
5									3	3				
Total	3	3							3	3			3	

22CHC16 PROCESS MODELING AND SIMULATION				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To gain knowledge in process simulation • To develop a mathematical modeling equation for various unit operations and process

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply knowledge of the thermodynamic principles required for formulating a mathematical model.	Ap	20
CO2	Apply the fundamental laws to build mathematical models for chemical processes.	Ap	20
CO3	Develop a mathematical modeling for the Unit-process and Unit-operation	Ap	30
CO4	Analyze and develop a suitable approach to build models for complex chemical processes.	An	30
CO5	Demonstrate simulation of chemical processes in Professional Simulation Packages.	R	Internal Assessment

UNIT I: FUNDAMENTALS OF PROCESS MODELING	(9)
Mathematical modeling, use of modeling, fundamental laws used in modeling, Model building, Constitutive equations, initial conditions and boundary conditions, black box modeling, gray box modeling, Applications of modeling in process industries	
UNIT II: MODELS IN FLUID FLOW OPERATIONS	(9)
The process and the model aspects: Mixed vessel - laminar flow in pipe - Gravity flow tank - Cone shaped tank - Mixing tank - Stirred tank heater - Two stirred tank heaters - Interacting stirred tank heaters - Interacting and Non-interacting tanks - Agitated tank for solid dissolution.	
UNIT III: MODELING OF REACTORS	(9)
The Process and the model aspects: Batch reactor - Tubular reactor - Jacketed tubular reactor - isothermal and non-isothermal CSTR - CSTR with cooling jacket - CSTRs in series - constant and variable holdup - Continuous stirred tank bioreactor.	
UNIT IV: MODELING OF SEPERATION PROCESS	(9)
Mathematical model aspects: Multi component flash drum - Compartmental distillation model - Ideal binary distillation column - Binary continuous distillation column - Absorption column - steady state single stage and two stage solvent extraction – Forward and backward feed triple effect evaporator –Double pipe heat exchanger	

UNIT V: PROCESS SIMULATION	(9)
Process Simulation: Introduction - Scope of process simulation - Formulation of problem - Steps in steady state simulation - Simulation approach for steady state process. Process Simulator: Introduction - Structure of Process Simulator - Professional Simulation Packages (ASPEN and HYSYS) -Selection of Proper Equation of State/Fluid packages -Available Unit Operation Models – HTRI Exchanger Suite modules. Introduction to unsteady state processes.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Babu B.V, "Process Plant Simulation", 1st Edition, Oxford University Press, New Delhi, 2004.
2. Amiya K. Jana, "Chemical Process Modeling and Computer Simulation", 3rd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2017 for units I, II, III and IV.

REFERENCES:

1. Luyben W.L, "Process Modeling, Simulation and Control for Chemical Engineers", 2nd Edition, Tata McGraw Hill Publishing Company Ltd, New York, 1990.
2. Amiya K. Jana, "Chemical Process Modeling and Computer Simulation", 2nd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2014.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) /

Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3											
3			3										3	
4				3									3	
5					3								3	
CO	3		3	3	3								3	

22CHP07 PROCESS CONTROL LABORATORY				
	L	T	P	C
	0	0	4	2

PRE-REQUISITE : 22CHC14

Course Objective:	• To get knowledge about the principles of controllers • To learn the transient response of chemical system and controller

Course Outcomes The Student will be able to		Cognitive Level
CO1	Determine the time constant for first order and second order system	An
CO2	Analysis the performance behavior of P, PI, PD, PID & ON-OFF controller	An
CO3	Examine the performance characteristics of various control valves and optimization of Controller parameter	An
CO4	Analyze the response of higher order system using software	An
CO5	Engage in individual/peer learning and communicate effectively.	C

LIST OF EXPERIMENTS (Any Ten)

1. Wheatstone and Kelvin's bridge for measurement of resistance
2. Study the characteristics of LVDT/ Hall effect/ Photoelectric transducer
3. Estimate the time constant of First order system
4. Determine the time constant and study the response of evaluation of interacting/ non-interacting level systems
5. Study the response of ON-OFF control on thermal and level process
6. Examine the effect of gain of controller in flow process
7. Analysis the effect of derivative time of the controller in level process
8. Investigate the effect of integral time of the controller in thermal process
9. Verification of the flow coefficient and performance characteristics of various control valve
10. Estimation of optimum controller settings in thermal process
11. Study the characteristic behavior of servo mechanism problem for higher order systems using MATLAB (Simulink)Study the characteristic behavior of regulator mechanism problem for higher order systems using MATLAB (Simulink)

TOTAL=60 PERIODS
REFERENCES/MANUALS/SOFTWARE:
1. Laboratory Manual

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) /

Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2		3											3	
3			3											3
4					3									3
5									1	1				
CO	3	3	3		3				1	1			3	3

22CHP08 PROCESS MODELING AND SIMULATION LABORATORY				
	L	T	P	C
	0	0	4	2
PRE-REQUISITE: 22CHC16				
Course Objective:	• To explore a knowledge in simulating equipments used in process industries.			

Course Outcomes The Student will be able to		Cognitive Level
CO1	Apply the knowledge to construct T-x-y / P-x-y diagrams and estimate the physical properties of chemical components.	Ap
CO2	Compute the simulation of heat transfer equipment using simulation software	Ap
CO3	Demonstrate sensitivity analysis and optimization of parameters using simulation software.	An
CO4	Perform simulation of reactor and mass transfer equipment using simulation software	Ap
CO5	Simulate a process flow diagram using simulation software	Ap

LIST OF EXPERIMENTS (Any Ten)

1. Analysis of physical properties and thermodynamic equilibrium diagram construction
2. Estimation of physical property for a non- data bank component
3. Simulation of mixer
4. Simulation of flash separator
5. Simulation of heat exchanger by shortcut method
6. Calculation of Bubble Point and Dew Point Temperature/Pressure
7. Simulation of distillation column
8. Simulation of heat exchanger by detailed method
9. Simulation of CSTR/Plug flow reactor
10. Simulation and analysis of absorption column
11. Simulation and analysis of extraction column
12. Sensitivity analysis and optimization of parameters
13. Generate a simple process flow diagram and perform simulation study

TOTAL (P:60) : 60 PERIODS

REFERENCES/MANUAL/SOFTWARE:
1. JumaHayday, "Chemical Process Design and Simulation – Aspen Plus and Aspen Hysys Applications", AICHE – Wiley, USA, 2019. 2. Laboratory Manual

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) /

Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3												
2					3									3
3		3		3	3		3							
4					3									3
5					3									3
CO	3	3		3	3		3							3

22CHP09 PROCESS COMPUTATION LABORATORY				
	L	T	P	C
	0	0	4	2

PRE-REQUISITE: NIL

Course Objective:	• To learn the basic chemical calculations using spreadsheet • To develop a Process Flow and Process Instrumentation Diagrams using software • To perform the mathematical calculations using software

Course Outcomes The Student will be able to		Cognitive Level
CO1	Apply knowledge to perform fundamental chemical calculations using spreadsheet.	Ap
CO2	Sketch the Process Flow (PFD) and Process & Instrumentation Diagram (P&ID).	Ap
CO3	Compute 3D diagram of various Unit-Operations.	Ap
CO4	Perform mathematical algebraic calculations and computations of Unit-Operations.	Ap
CO5	Design of process equipment using suitable software.	Ap

LIST OF EXPERIMENTS (Any Ten)

1. Performing basic chemical calculations using spreadsheet
2. Linearization & Error Analysis of graphical data using spreadsheet
3. Performing Mass & Energy Balance using spreadsheet
4. Development of a Process Flow Diagram using AutoCAD
5. Development of Piping and Instrumentation Diagram using AutoCAD and MS Visio
6. 3D drawing of a pressure vessel/ heat exchanger/ flash column/ distillation column using AutoCAD and MS Visio
7. Basic Commands and Operations in MATLAB:
   a) Matrix computations
   b) Solving algebraic/ ODE/ PDE problems
8. Design of Shell and Tube / Double pipe heat exchanger using software.
9. Design of Condenser using software.
10. Estimation of Humidity using software.

11. Design of Single effect evaporator using software. 12. Design of Plug flow / Mixed Flow Reactor for a given reaction using software.
TOTAL (P:60) : 60 PERIODS

REFERENCES/MANUAL/SOFTWARE:
1. Laboratory Manual

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) /

Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3				3									3
2					3									3
3					3									3
4			3		3									3
5			3		3							3		3
CO	3		3		3							3		3

22CHP10 PROCESS EQUIPMENT DESIGN LABORATORY				
	L	T	P	C
	0	0	4	2

PRE-REQUISITE: Nil

Course Objective:	• Understand processes and equipments used in chemical industries • Understand the internals of process equipments. • Develop design solutions using design principles.

Course Outcomes The Student will be able to		Cognitive Level
CO1	Apply knowledge to identify processes and equipment to formulate the process flow diagram.	Ap
CO2	Apply knowledge for design consideration and assumption requirements for process implementation.	Ap
CO3	Analyze and relate the accessories for chemical equipments.	An
CO4	Calculate design parameters for process equipments used in process industries	An
CO5	Conceptualize and develop design solutions to create visual communications that meet the needs of the project.	U

LIST OF EXPERIMENTS

1. Design and drawing considerations of Heat exchangers
2. Design and drawing considerations of condensers.
3. Design and drawing considerations of evaporators.
4. Design and drawing considerations of cooling towers
5. Design and drawing considerations of driers.
6. Design and drawing considerations of Distillation column
7. Design and drawing considerations of Packed column,
8. Design and drawing considerations of Reactors
9. Design and drawing considerations of Storage vessel and Pressure vessel.
10. Design of Plant Layout, Pipe lines and Pipe Layouts.

TOTAL(P:60) = 60 Periods

TEXT BOOKS:

1. M.V. Joshi and V.V. Mahajan, "Process Equipment Design", MacMillan India Ltd.
2. S. D. Dawande, "Process Design of Equipment's", Central Techno Publications, Nagpur, 2000.
3. R.S. Khurmi, "Textbook of Machine design". S. Chand & Company, XXV Edition, 2005.
4. M.V. Joshi and V.V. Mahajan, "Design of Process Equipment Design", McMillan India III Edition 1994.

REFERENCES:

1. S.D. Dawande, "Process Design of Equipment's", Central Techno Publications, Nagpur, 2000.
2. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
3. R.H. Perry, "Chemical Engineers' Handbook", McGraw-Hill.
4. Suresh C. Maidargi, Chemical Process Equipment Design & Drawing, Vol 1,PHI Learning Ltd (2012).

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3													
3		3											3	
4			3										3	
5			3											3
CO	3	3	3										3	3

22GED02 – INTERNSHIP / INDUSTRIAL TRAINING				
	L	T	P	C
	0	0	0	1

PREREQUISITE : NIL

Course Objective:	• To obtain a broad understanding of the emerging technologies in Industry • To gain knowledge about I/O models.

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Engage in Industrial activity which is a community service.	U
CO2	Prepare the project report, three minute video and the poster of the work.	Ap
CO3	Identify and specify an engineering product that can make their life comfortable.	An
CO4	Prepare a business plan for a commercial venture of the proposed product, together with complying to relevant norms.	Ap
CO5	Identify the community that shall benefit from the product.	E

During semester breaks, students are encouraged to engage in industrial training or undergo internship in an industry related to the field of study. The duration of the activity shall be of 4 to 6 weeks. The work carried out in the semester break is assessed through an oral seminar accompanied by a written report. It is expected that this association will motivate the student to develop simple Electronic (or other) products to make their life comfortable and convert new ideas into projects.

Every student is required to complete 12 to 16 weeks of internship (with about 40 hours per week), during the Summer/Winter semester breaks. The Internships are evaluated through Internship Reports and Seminars during the VI and VIII semesters. The internships can be taken up in an industry, a government organization, a research organization or an academic institution, either in the country or outside the country, that include activities like:

- Successful completion of Internships/ Value Added Programs/Training
- Programs/ workshops organized by academic Institutions and Industries
- Soft skill training by the Placement Cell of the college
- Active association with incubation/ innovation /entrepreneurship cell of the
- institute;
- Participation in Inter-Institute innovation related competitions like Hackathons

- Working for consultancy/ research project within the institutes
- Participation in activities of Institute's Innovation Council, IPR cell, Leadership
- Talks, Idea/ Design/ Innovation contests
- Internship with industry/ NGO's/ Government organizations/ Micro/ Small/
- Medium enterprises
- Development of a new product/ business plan/ registration of a start-up

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1						2								
2										3				
3		1												
4							2	3			2			
5						2								
CO (W.A)		**1**				**2**	**2**	**3**		**3**	**2**			

22CHD01 PROJECT WORK				
	L	T	P	C
	0	0	20	10

PRE-REQUISITE: -

Course Objective:	• Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution. • Conducting experiments, analyse and discuss the test results, and make conclusions.

Course Outcomes The Student will be able to		Cognitive Level
CO1	Study problems in the field of chemical Engineering through literature survey and its reviews also to identify the future work.	Ap
CO2	Carry out the experiments/design/theoretical design/ simulations work in team in the predetermined methodology.	An
CO3	Understand the essence and need of professional ethics during project documentation.	U

DESCRIPTION

Project work may be allotted to a single student or to a group of students not exceeding 4 per group. The students in a group will be assigned an experimental, design, a case study or an analytical problem or an Industrial Project to be carried out under guidance of a faculty member. The project has to be assigned at the beginning of the eighth semester. The project group should complete the preliminary literature survey & plan of project and submit the report at the end of semester; This is evaluated by a committee constituted by the HoD for assessment. There shall be three reviews during the semester by the committee to review the progress. Students are encouraged to present the one technical paper in any national or international conference at the end of the semester.

TOTAL(P:240)=240 PERIODS

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3										3	3	
2				3						3				3
3								3					1	
CO		3		3				3		3		3	2	3

22CHX01 INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To learn the governing equations for fluid flow and heat transfer. • To acquire knowledge in the different types of models for turbulence. • To attain knowledge infinite volume method for developing solution of steady state diffusion and convection diffusion problems. • To conquer knowledge in the solution algorithms for pressure–velocity coupling in steady flows.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Explain governing equations for fluid flow, heat transfer and demonstrate the different types of models for turbulence	Ap	20%
CO2	Apply finite volume method for developing solution of steady state diffusion and convection diffusion problems.	An	20%
CO3	Apply the knowledge of algorithms in solving unsteady flow heat conduction and convection diffusion processes	Ap	40%
CO4	Identity the algorithms for pressure–velocity coupling in steady flows.	An	20%
CO5	Develop the mathematical modeling using Chemical software's	Ap	Internal Assessment

UNIT – I CONSERVATION LAWS OF FLUID MOTION AND BOUNDARY CONDITIONS	9
Governing equations of fluid flow and heat transfer: Equations of state -Navier-Stokes equations for Newtonian fluid - conservative form of governing equations of flow - differential and integral forms of general transport equations - classification of physical behavior.	
UNIT – II TURBULENCE AND ITS MODELING	9
Transition from laminar to turbulent flow - effect of turbulence on properties of the mean flow - Reynolds-averaged Navier-Stokes equations and classical turbulence models - mixing length model – k-ϵ model; Turbulent models - Reynolds Stress model and large eddy simulation.	
UNIT – III FINITE VOLUME METHOD FOR DIFFUSION AND CONVECTIVE-DIFFUSION PROBLEMS	9
Finite volume method for one-dimensional, two-dimensional and three-dimensional steady state diffusion - steady one-dimensional convection and diffusion- Discretization schemes: the central differencing scheme - Properties of discretization schemes - Assessment of the central differencing scheme for convection-diffusion problems - upwind differencing scheme - Hybrid differencing scheme - power-law scheme.	

UNIT – IV SOLUTION ALGORITHMS FOR PRESSURE-VELOCITY COUPLING IN STEADY FLOWS	9
Staggered grid - momentum equations - SIMPLE algorithm - Assembly of a complete method - SIMPLER, SIMPLEC, and PISO algorithms. Solution of discretized equations: Tri-diagonal matrix algorithm - application of TDMA to two-dimensional and three-dimensional problems.	
UNIT – V FINITE VOLUME METHOD FOR UNSTEADY FLOWS	9
One-dimensional unsteady state heat conduction - implicit method for two-and three-dimensional problems - discretization of transient convection- diffusion equation - solution procedures for unsteady flow calculations - steady state calculations using pseudo-transient approach.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOK:

1. Versteeg H.K. and Malalasekara W, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd edition, Pearson Education, India, 2007.

REFERENCE:

1. Anderson John D., "Computational Fluid Dynamics-The Basics with Applications", 1st edition, Tata McGraw Hill Publishing Company Ltd, United State of America, 2012.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3												3	
3	3												3	
4		3											3	
5					3									3
CO	3	3			3								3	3

22CHX02 MODERN SEPERATION TECHNIQUES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To learn the separation processes for selecting optimal process for new and innovative applications and the novel techniques of filtration • To acquire the knowledge in types of membranes and membrane materials and exhibit the understanding of various membrane separation processes

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply and demonstrate the separation process in process industries	Ap	20%
CO2	Apply the knowledge of engineering fundamentals to utilize separation operations in chemical industries.	Ap	20%
CO3	Identify membrane processes in terms of materials, modules, mechanisms of transport and industrial applications.	An	40%
CO4	Demonstrate the pursuance of sustainable development through Electro dialysis, Electrophoresis and Ion exchange chromatography techniques	An	20%
CO5	Differentiate the separation techniques in terms of their relative advantages, disadvantages and applicability in the context of technological changes.	U	Internal Assessment

UNIT – I FUNDAMENTALS AND FILTRATION	9
Basic Concepts – Characteristics and Mechanism of Separation, Feasibility of Separation Processes. Theory and Selection of Equipment for Filtration Process	
UNIT – II MEMBRANE PROCESS	9
Theory of Membranes Process, Types and Choice of Membranes, Types and Relative Merits of Membrane Modules	
UNIT – III APPLICATIONS OF MEMBRANE PROCESS	9
Principle and Applications of Dialysis and Electro Dialysis; Nano Filtration and Reverse Osmosis, Pervaporation, Ultra filtration, Micro filtration.	
UNIT – IV OTHER SEPARATION PROCESS I	9
Principle and Applications of Ion Exchange, Electrophoresis, Dielectrophoresis, Lyophilisation, Chromatography-Gas Chromatography, Column, Paper, HPLC.	
UNIT – V OTHER SEPARATION PROCESS II	9
Principles and Applications of Supercritical Fluid Extraction, Zone melting, Adductive crystallization, Reversible Chemical Complexation, Foam Separation, Thermal Diffusion, Cryoseparations	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOK:

1. Seader, J.D., Ernest J., Henley, Keith Roper D., "Separation Process Principles", 3rd Edition, John Wiley & Sons, USA, 2010.
2. Separation Processes, C. J. King, Second Edition, McGraw Hill Chemical Engineering Series

REFERENCES:

1. Scott K., Hughes R, "Industrial Membrane Separation Technology", 1st Edition, Blackie Academic and Professional Publications, United State of America, 1996.
2. Ronald W Rousseau, " Hand book of Separation Process Technology", 1st Edition, Wiley India Pvt Ltd, 2008.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3													
3		3											3	
4		3					3						3	
5												3		
CO	3	3					3					3	3	

22CHX03 CHEMICAL PROCESS UTILITIES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : -				
Course Objective:	• To learn the fundamentals and applications of utilities in process industries			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply knowledge on the utilities used to support the manufacturing process	Ap	20
CO2	Apply the knowledge on application of utilities in process industries	Ap	30
CO3	Analyze and identify the suitable utilities needed for process industries	An	30
CO4	Develop solution to improve effective utilization steam, water and air in process industries	Ap	20
CO5	As an individual/team, Describe the essential utilities needed for chemical process flow diagram.	U	Internal Assessment

UNIT I – STEAM AND WATER	(9)
Steam: Properties of steam, Mollier chart, determination of dryness fraction of steam- Different types of calorimeter; Efficient use of steam in process plants, Insulation of Steam Mains. Water: Source and characteristics of water- soft and Demineralised water - Treatment of water for boiler and cooling towers.	
UNIT II – COMPRESSED AIR AND INERT GAS	(9)
Compressed Air – Introduction, Plant Air Systems, Instrument Air Systems, Operation and Maintenance. Inert Gases – Properties, Uses of inert gases, Sources and Methods of Generation	
UNIT III - BOILERS	(9)
Types and classification of boilers: water tube, fire tube, coal, oil and gas fired boilers; Stoker fired, pulverized and fluidized bed boilers. Mountings and accessories. Performance and efficiency calculation of boilers	
UNIT IV - REFRIGERATION	(9)
Principles - compression and absorption refrigeration systems, calculation of efficiency and capacity of refrigeration - Types and properties of refrigerants - eco- friendly refrigerants.	
UNIT V - VACUUM SYSTEM	(9)
Introduction, Classification of Vacuum, Vacuum Generation equipment – Liquid Ring Vacuum Pump, Steam Jet Ejector, Mechanical Vacuum Pump, Vacuum Measurement using McLeod Gauge, Vacuum Conveying of powders, Vacuum Filtration and Drying	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Jack Broughton, "Process Utility System - Introduction to Design Operation and Maintenance", 1st Edition, Institution of Chemical Engineers, United Kingdom, 1994
2. Wolfgang Jorisch, "Vacuum Technology in the Chemical Industry", 1st Edition, Wiley VCH, 2014.

REFERENCES

1. Lyle O, "Efficient use of Steam", 1st Edition, H M S O Publishers, United Kingdom, 2000.
2. Eskel Nordell, "Water treatment for industrial and other uses", 1st Edition, Reinhold Publishing Corporation, New York, 1961.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3													3
3		3											3	
4				3										
5									2					
CO	3	3		3					2				3	3

22CHX04 CORROSION TECHNOLOGY				
	L	T	P	C
	3	0	0	3

PRE REQUISITE : -

Course Objective:	• To acquire knowledge in the corrosion protection methods for applications in chemical process industries • To obtain knowledge in the corrosion in specific environments and its control

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge about the different types of corrosion and their testing methods	Ap	20%
CO2	Apply the knowledge on corrosion inspection and management system for given condition	Ap	30%
CO3	Identify the suitable corrosion prevention technique for given condition	An	30%
CO4	Identify the corrosion involved in specific environment	An	20%
CO5	Comprehend of making effective oral presentation	U	Internal Assessment

UNIT – I CORROSION TYPES AND TESTING	9
Basic principles of corrosion and its control: Forms of corrosion, Uniform, Galvanic, Crevice, Pitting, Inter-granular, Selective leaching, Erosion, Stress corrosion. Hydrogen Blistering and Embrittlement, Cracking, Cavitation and their Fracture Mechanics. Corrosion testing: Classification, Purpose, Material and Specimen, Surface preparation, Measuring and Weighing. Exposure techniques: Duration – Planned interval test; NACE test methods, Slow-Strain-Rate test, Linear Polarization, AC Impedance method.	
UNIT – II PREVENTION METHODS	9
Corrosion inhibitors, Electroplated coatings, Conversion coatings, Anodizing, Hot dipping, Spray metal coatings, Zinc coating by alloying, Electrophoteric coatings and electro painting, Powder coating. Corrosion minimization by material selection. Cathodic and Anodic protections	
UNIT – III INSPECTION AND MANAGEMENT	9
Corrosion inspection methods: visual, liquid penetration, magnetic particle, radiographic, eddy current, ultrasonic, thermography testing. Corrosion management systems. Process maintenance procedures.	
UNIT – IV CORROSION IN SPECIFIC ENVIRONMENTS	9
Corrosion by organic acids and alkalies. Sea water and Fresh water corrosion on concrete structures, Corrosion in automobiles, Biological corrosion, Halogen corrosion of metals, Corrosion in Petroleum industry, Corrosion in aerospace.	

UNIT – V CORROSION IN SPECIFIC CASES AND CONTROL	9
Corrosion and selection of materials of pulp and paper plants. Corrosion of wet scrubbers in pollution control. Nuclear waste isolation and corrosion by liquid metal and fused salts. Corrosion of surgical implants and prosthetic devices. Corrosion in electronic equipment.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Fontana M.G., "Corrosion Engineering", 1st edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2005
2. Pierre R. Roberge, "Corrosion Inspection and Monitoring", 1st edition, John Wiley and Sons Inc, Canada, 2008

REFERENCES:

1. Jones D.A, "Principle and Protection of Corrosion", 1st Edition, Prentice Hall of India Pvt. Ltd, India, 1996.
2. Sastri V.S., Ghali E., Elboujdaini M., "Corrosion Prevention and Protection: Practical Solutions", 1st Edition, John Wiley & Sons Inc, United State of America, 2007.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3												3	
3		3											3	
4		3												
5									3					
CO	3	3							3				3	

22CHX05 MATERIALS OF CONSTRUCTION FOR PROCESS INDUSTRIES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To learn the properties of the material, deformation of material under load • To empower the knowledge in selecting the material for sustainability

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge and comment the properties for the material	Ap	20%
CO2	Implement the knowledge on classifying the material	Ap	30%
CO3	Examine the properties and selecting the suitable material for specific application	An	30%
CO4	Comprehend the materials to demonstrate the knowledge of sustainable development.	Ap	20%
CO5	Custom the composite materials to use in different engineering disciplines	U	Internal Assessment

UNIT I – FERROUS METAL	(9)
Materials- types and properties; Iron carbide phase diagram. Pig, cast and wrought iron - properties and application in chemical industries; deformation of metal; recovery and recrystallization.	
UNIT II –STAINLESS STEEL	(9)
Special steels – grade, composition, special properties and applications; general criterion and factor affecting the selection of material in process industries	
UNIT III -NON FERROUS METAL	(9)
Nickel, Aluminium, Copper, Chromium, Lead, Titanium, Zinc and magnesium - alloys, properties and applications in process industries.	
UNIT IV – OTHER MATERIAL	(9)
Polymers, Ceramic, Glass, Wood and Rubber – Types, Properties, fabrication techniques, stress analysis and application in chemical process industries.	
UNIT V – ADVANCE MATERIAL	(9)
Mechanism of reinforcement, master bath & compounding equipment used for reinforcement -metallic reinforced matrix, ceramic reinforced matrix, polymer reinforced matrix; Metallic glasses and oxides for high temperature applications; materials for biomedical, cryogenics and sour service	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. James A. Lee, — Materials of Construction for Chemical Process Industries, McGraw Hill, 1950.
2. Frank Rumford, —Chemical Engineering Materials‖ , Nabu Press, 2013

REFERENCES:

1. Agrawal B.K., —Introduction to Engineering Materials‖ , Tata McGraw Hill, 1988
2. Krishan K. Chawla, "Composite Materials Science and Engineering", 2nd edition, Springer New York Heidelberg Dordrecht London.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3												3	
3		3											3	
4							3							
5												3		
CO	3	3					3					3	3	

22CHX06 PROCESS INSTRUMENTATION				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To learn the types, performance characteristics and error generation of measurement • To get knowledge in measuring device applied in chemical industries

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge and Explain the components for the measuring device	Ap	20%
CO2	Apply the knowledge for measuring process parameter using instrument	Ap	30%
CO3	Identify the suitable instrument for measuring process parameter at a given condition	An	30%
CO4	Apply norms for selecting the instrument used	Ap	20%
CO5	Comprehend of making effective oral presentation	U	Internal Assessment

UNIT – I PRINCIPLES OF MEASUREMENT	9
Measuring Instrument: Introduction and its types- Elements and its function. Transducer: Importance and its classification - Measuring errors: Sources - reduction - quantification of systematic and Random errors. Performance characteristics: Static and Dynamic characteristics	
UNIT – II TEMPERATURE MEASUREMENT	9
Principles of temperature measurement: Thermoelectric effect sensors - Varying resistance devices - Radiation thermometers - Thermography - Thermal expansion methods - Fibre-optic temperature sensors - Selection of temperature transducers.	
UNIT – III PRESSURE MEASUREMENT	9
Principles of Pressure Measurement: Manometers - Bourdon tube - Bellows - Diaphragms - Capacitive pressure sensor - Fibre-optic pressure sensors - Resonant-wire devices - Dead-weight gauge - Special measurement devices for low pressures measurement -Selection of pressure sensors.	
UNIT – IV FLOW AND VISCOSITY MEASUREMENT	9
Principles of Flow Measurement: Mass flow rate measurement and Volume flow rate measurement - Choice between flow meters for particular applications. Viscosity measurement: Capillary and tube viscometers - Falling body viscometer - Rotational viscometers.	

UNIT – V LEVEL MEASUREMENT	9
Principles of Level Measurement: Float systems - Pressure measuring devices - Capacitive devices - Ultrasonic level gauge - Radar (microwave) methods - Radiation methods - Vibrating level sensor and Laser methods - Choice between different level sensors.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Alan S Morris, Reza Langari, "Measurement and Instrumentation: Theory and Application", 3rd Edition, Academic Press, USA, 2001.
2. Singh S.K, "Industrial Instrumentation and Control", 2nd Edition, McGraw Hill International Edition, New Delhi, 2006.

REFERENCE:

1. William C Dunn , "Fundamentals of Industrial Instrumentation and Process Control", 1st Edition, McGraw Hill International Edition, New Delhi, 2005.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3												3	
3		3											3	
4	3													
5								3	3					
CO	3	3						3	3				3	

22CHX07 PHARMACEUTICAL TECHNOLOGY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To get the knowledge in the formulation and manufacturing of drug delivery systems • To get knowledge in societal, health, safety and legal aspects in pharmaceutical industries. • To learn the norms in pharmaceutical industries

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge in the drug metabolism system	Ap	20%
CO2	Apply the knowledge in drug synthesis and delivery system	Ap	30%
CO3	Identify the suitable drug delivery system for given circumstance	An	30%
CO4	Contextual knowledge to assess societal, health, safety and legal aspects in pharmaceutical industries.	Ap	20%
CO5	Committed to follow the ethics in pharmaceutical industries	U	Internal Assessment

UNIT– I PRINCIPLES AND KINETICS:	9
Introduction to drugs and pharmaceutical, application of organic therapeutic agents, pharmaco kinetics-Absorption, Distribution, metabolism and Excretion- mechanism and physicochemical principles.	
UNIT– II PROCESS SYNTHESIS:	9
Chemical Conversion process-alkylation, arboxylation, condensation and cyclisation, dehydration, esterification, halogenation, oxidation and sulfonation reactions.	
UNIT– III DRUG DELIVERY SYSTEMS:	9
Tablets and capsules-Types of Tablets and capsules-Formulation and Manufacturing; parential solutions, oral liquids, injections and ointments-methods of preparation.	
UNIT– IV PHARMACEUTICAL PRODUCTS:	9
Vitamins-Functions, laxatives-classification and uses, analgesics -Types and Mechanisms, antacids and antiseptics-classification, mechanism and applications.	
UNIT–V QUALITY CONTROL:	9
Concept of quality control –IPQC tests for tablets, Quality analysis–raw materials, process and finished products. Good Manufacturing Practices- cGMP, FDA regulations.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Brahmankar D.M. and Sunil B. Jaiswal, "Bio pharmaceutics and Pharmacokinetics: A Treatise", 1st Edition, Vallabah Prakashan India, 2017
2. Arthur Owen Bentley,"TextbookofPharmaceutics",8th Edition,All India Traveller Book Seller, India, 2002

REFERENCE:

1. BankerG.S. andRhodes C.T.,"Modern Pharmaceutics", 4thEdition, Marcel Dekker Inc, United Stateof America, 2002.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3													
3		3											3	
4						3							3	
5								3						
CO	3	3				3		3					3	

22CHX08 SEPARATION AND PURIFICATION PROCESSES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• Students will gain a basic knowledge about recent separation methods. • To gain a knowledge about various membrane separation techniques • To gain a knowledge about adsorption and chromatography separation technique.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the latest concepts like super critical fluid extraction, pervaporation, lyophilisation etc., in Chemical industries.	Ap	20%
CO2	Apply the knowledge to improve the performance of separation methods	Ap	30%
CO3	Identify the suitable separation methods for given circumstance	An	30%
CO4	Contextual knowledge to assess societal, health, safety and legal aspects in process industries.	Ap	20%
CO5	Committed to **follow the** ethics in in disposal of wastes	U	Internal Assessment

UNIT I BASICS OF SEPARATION PROCESS	(9)
Review of Conventional Processes, Modern Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.	
UNIT II MEMBRANE SEPARATIONS	(9)
Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fibre, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nano-filtration, Ultra filtration diafiltration and Micro filtration, Ceramic- Bio Membranes.	
UNIT III SEPARATION BY ADSORPTION	(9)
Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.	
UNIT V INORGANIC SEPARATIONS	(9)
Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Di-electrophoresis, Electro-dialysis, EDR, Bipolar Membranes.	

UNIT V APPLICATION OF MODERN SEPARATION TECHNIQUES	(9)
Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. J D Seader and Ernest J Henley, Separation Process Principles, Wiley; 1 edition (January 23, 1998)
2. Judson king Separation processes, McGraw-Hill College; Subsequent edition (January 1, 1980

REFERENCES:

1. Nakagawal, O. V., "Membrane Science and Technology'" Marcel Dekkar, 1992
2. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3													
3		3											3	
4	3												3	
5								3						
CO	3	3						3					3	

22CHX11 PETROLEUM CHEMISTRY AND REFINING FUNDAMENTALS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE :

Course Objective:	• To learn the fundamentals and methodologies in the petroleum refining processes. • To enable students to express the objectives of petroleum refining and classify the processes used in petroleum refining

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the classification, composition and testing methods of petroleum refinery process and its products. Learn the mechanism of the refining process.	Ap	20%
CO2	Analyze the insights of primary refining processes to produce the precursors.	An	20%
CO3	Apply the secondary treatment processes to produce more petroleum products.	Ap	40%
CO4	Apply the treatment techniques for the removal of impurities from petroleum products.	An	20%
CO5	Understand the societal impact of petrochemicals learn their manufacturing processes.	U	Internal Assessment

UNIT I CRUDE CHEMISTRY AND PRODUCTS	(9)
Origin, Formation, and Evaluation of Crude Oil -Indian petroleum industries- types of Hydrocarbons - composition of crude oil (PONA, S, N2,etc) -Thermo-physical and physical properties of crude oil petroleum standards- chemical analysis data- Testing methods of petroleum products quality of products- Types of crude-Crude assay- selection of crude based on product yield.	
UNIT II - BASICS FOR REFINING	(9)
Properties of gas-Ideal gas laws-partial pressure-specific gravity-density-Properties of liquid- viscosity and index-boiling point-pressure of fluid at rest-flow resistance-static/induced pressure specific/latent heat/condensation-modes of heat transfer-diffusion mass transfer-properties of solid.	
UNIT III - PETROLEUM THERMODYNAMICS AND CALCULATION	(9)
First/second law-behavior of gas and liquid – PVT relationship- equation of state-VLE- equilibrium constant-Multi component liquid vapor composition calculation-specific gravity calculation-TBP distillation-ASTM-conversion to pseudo-components-Molecular weight calculation-pseudo-critical properties-calculation of enthalpy of petroleum fractions-Generalized equation for thermo physical properties of petroleum.	
UNIT IV - REFINERY UNIT OPERATIONS AND CALCULATION	(9)
Distillation-types-column internals-multi component distillation-relative volatility- 9 azeotropic mixture-absorption- desorption- adsorption- refrigeration - extraction- drying curve-humfidication principle-crystallization-stripping operation-.boiling curve- application of all operation in refinery and its basic design calculations.	

UNIT V - REFINERY PROCESSES AND CATALYST FUNDAMENTAL	(9)
Treating processes of petroleum products- Thermal/catalytic/hydro cracking-reforming/ isomerization /alkylation -principles and reactions- Catalyst phenomenon and theory- surface area/void volume/porosity- catalyst classification and preparation/selectivity/yield/reactivity- heterogeneous reactions- catalytic reactor types (packed bed/moving bed/fluidized bed)- residence time-space velocity- Catalyst loading techniques.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKs:

1. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology
3. Modern Petroleum Refining Processes, BK Bhaskara Rao, Oxford & IBH Publishinng Co. Pvt. Ltd.

REFERENCES:

1. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969
2. J. H. Gary, H. Hanwerk and M. J. Kaiser,,, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007
3. Wayne C. Edmister, "Applied Hydrocarbon Thermodynamics", Gulf Publishing Co., 2nd edition, 1988

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2	2												2	
3					2								2	
4	2			2										2
5			2										2	
CO	2		2	2	2								2	2

22CHX12 PRIMARY REFINING TECHNOLOGY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE :

Course Objective:	• To enable the students to learn the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the methodologies in the primary petroleum refining processes like crude preparation.	Ap	20%
CO2	Analyze how each refinery process works.	An	20%
CO3	Analyze to learn the operating variables which are applied to achieve the objectives of each refinery process	Ap	40%
CO4	Analyze the feed stocks.	An	20%
CO5	Apply the concepts in asphalt processing and wax treatment technology	U	Internal Assessment

UNIT I - FEED PREPARATION	(9)
Pipelines from port to tank farm -safety and regulations -storage techniques in crude oil-impurities removal-measuring by dipping -spiking techniques -types of salts in crude - desalting process – electric desalter-preheating train and design- furnace and its operation.	
UNIT II - ATMOSPHERIC DISTILLATION	(9)
Operation and process description of ADU-design characteristics of ADU tower-cutpoints-degree of fractionation-over flash-column pressure and overhead temperature- Preflash system- overhead system-side streams-intermediate pump around and reflux systems- Refinery off gas- LPG treatment-Naphtha stabilizer and splitter-side stripping sections-operating variables	
UNIT III - VACUUM DISTILLATION	(9)
Operation of VDU- Need of vacuum- ejectors and its types/principle- Overhead ejector system - flash zone-draw off temperature- internal flow in VDU- light/middle/heavy cuts- routing to secondary units- lube based treatments-packing section tower loading of VDU.	
UNIT IV - LUBE OIL BASE STOCKS	(9)
Viscosity index calculation and pour point - LOBS processing by solvent treatment and hydro treatment-solvent selection-solvent extraction by NMP, furfural, MEK solvent dewaxing/- refrigerating and filtration - hydro finishing- types of LOBS based on VI- types or groups of lube processing-spindle/LN/IN/HN/BN processing and blending.	

UNIT V - ASPHALT AND WAX TECHNOLOGY	(9)
Vacuum residue properties- propane deasphalting-asphalt processing and types-chemical structure-air blowing of bitumen- slack wax processing- wax and types/properties- wax deoiling- unit operations in wax plants- refrigerating and filtration/ hydro treating of wax- molding and storage	
TOTAL (L:45): 45 PERIODS	

TEXT BOOKS:

1. Modern Petroleum Refining Processes, BK Bhaskara Rao, Oxford & IBH Publishinng Co. Pvt. Ltd.
2. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000

REFERENCES:

1. J.G. Speight and B. Ozum, "Petroleum Refining Processes", Marcel Dekker Inc, New York, 2002
2. G.D. Hobson, "Modern Petroleum Technology", Vol I & II, John Wiley & Sons, New York, 5th edition, 1984
3. 3) David.S.J."STAN"Jones and Peter R.Pujado "Handbook of Petroleum Processing,Springer,2006.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2		3		2										2
3		3		2										2
4				2									2	
5								3					2	
CO	3	3		2				3					2	2

22CHX13 PETROLEUM REFINING PRIMARY PROCESSING TECHNOLOGY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE :

Course Objective:	• To gain the knowledge on Origin and Occurrence of petroleum with various theories • To gain the knowledge on universal standard Testing methods for Petroleum and its products. • To gain the knowledge about pre Treatment, separation of crude and its products.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply knowledge on crude composition, types and their characteristics in primary refining operations.	Ap	20%
CO2	Analyze the suitability of various testing methods to check the quality of crude oil and its products.	An	20%
CO3	Analyze the concept of pre - treatment techniques and separating of crude oil and its products by using fractionating column.	Ap	40%
CO4	Identify the production techniques available for the components like lube oil , wax and bitumen.	An	20%
CO5	Analyze the role of various chemical additives added in the commercial products of petroleum for environment sustainability	U	Internal Assessment

UNIT I CRUDE OIL COMPOSITION AND CLASSIFICATION	(9)
Theories behind the Origin of petroleum – Exploration and production of petroleum – Basics of hydrocarbon chemistry - Composition of crude oil – Impurities present in crude oil - Crude oil classification and its characteristics – Crude oil properties, Crude oil assay – Indigenous and imported crudes – Crude availability Vs demands – Refining capacity of India.	
UNIT II TESTING OF PETROLEUM PRODUCTS	(9)
IS 1448: Standard – Important commercial petroleum products: LPG, Gasoline, Kerosene, ATF, Diesel, and Lube oil - Specifications, Important testing methods and their Significance.	
UNIT III CRUDE PROCESSING	(9)
Pretreatment of crude oil – Dehydration and desalting – Types of fractionating column - Types of trays - Flow pattern in the trays – Products separation using Atmospheric distillation - Vacuum distillation of residue products – Reflux types and its significance.	
UNIT IV LUBE DISTILLATE TREATMENT TECHNIQUES	(9)
Lubricating oil classification and its uses - Production of lubricating oils from vacuum distillates with different treatment techniques: Solvent extraction, Deasphalting, Dewaxing, Catalytic dewaxing and Hydrofining process – Industrial Grease - Manufacture of Calcium Grease.	

UNIT V WAX AND BITUMEN PROCESSING TECHNIQUES	(9)
Paraffinic wax: Classification and its uses, Petroleum jelly manufacture - Bitumen: Types and their properties – Bitumen Testing: Ductility, Penetration Index and Softening point - Asphalt manufacture: Air blowing technology.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKs:

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers. 2008
2. Bhaskara Rao, B.K., "Modern Petroleum Refining Processes", 6th edition, Oxford and IBH Publishing Company Pvt. Ltd. 2018.

REFERENCES:

1. James H. Gary and Glenn E. Handwerk., "Petroleum Refining Technology and Economics", 4th Edition, Marcel Dekker Inc., 2001.
2. Nelson, W.L., "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited, 1985.
3. Hobson, G.D., "Modern Petroleum Refining Technology ", 5th Edition, John Wiley Publishers, 1984

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3											2	
2		3	3										2	3
3			3	3									2	
4	3			3										3
5							3		2					
CO	3	3		3			3		2				2	3

22CHX14 SECONDARY REFINING TECHNOLOGY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE :

Course Objective:	• To enable the students to learn the methodologies in the secondary petroleum refining or upgrading processes. • To enable students to learn refinery operation, mechanism and importance of catalytic cracking. • To enable students learn each operating variables like steam, cooling water, instrument air, H2, N2.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge on different methodologies in the secondary petroleum refining processes.	Ap	20%
CO2	Analyze the operation of Catalytic cracking on the food stock.	An	20%
CO3	Apply the process of hydro conversion for the industrial purpose2.	Ap	40%
CO4	Apply the basic knowledge on advanced thermodynamic and chemical operation.	An	20%
CO5	Gather some knowledge in the finishing processes and utilities of refining industries.	U	Internal Assessment

UNIT I - THERMAL CRACKING AND COKING	(9)
Residue upgradation technologies- cracking-thermal cracking-mechanism/principle/reactions process variables-Visbreaking- soaker process- coil visbreaker - Disadvantages-Coking- thermodynamics and mechanism of coking-delayed coking-operation-fluid coking- flexicoking - types of coke and properties- yield pattern of cracking and coking	
UNIT II - CATALYTIC CRACKING	(9)
Principles of catalytic cracking-mechanisms- FCC- main reaction of FCC- role of FCC in refinery- Fluidization-feedstocks/products/yield pattern- Kinetics and thermodynamics of FCC reactions- FCC catalyst and licensor technologies- reaction/regeneration/fractionation sections-slide valves and its importance- riser/cyclone separator/reactor internals-RFCC/MSCC/Petro FCC	
UNIT III - HYDROGEN AND HYDROCONVERSION	(9)
H2 requirements-steam reforming and shift conversion-operation and thermodynamics of reformer and NI catalyst-Hydro treatment processes- catalyst and reaction chemistry Naphtha/Diesel/lube/wax/gasoline hydro treatment-Hydrocracking process- Typical hydrocracker in refinery- catalyst/severity/conversion/Temperature profile for yield pattern-reaction kinetics of hydrocracker- Operation and variables	

UNIT IV – REFORMING / ISOMERISATION / ALKYLATION	(9)
Reforming feed index-RON-various reforming technologies-platforming reactions-kinetics and thermodynamics of Pt catalyst reactions-Operation in Straight Run and Continuous Run mode yield calculation- Isomerization techniques- reactions and kinetics- various technologies in isomer importance of catalyst-hexane production-Alkylation process-reactions – various alkylation processes- process variables in reforming/isomer/alky	
UNIT V - FINISHING PROCESSES AND UTILITIES	(9)
Sources of sulfur in refinery-types of sulfur compounds in crude-sweetening processes- various sulfur treatment process in products-H2S properties and removal by physical and chemical process- Amine selection –amine absorption and regeneration-sour water stripping- Merox process- Sulfur recovery from H2S by Claus /super Claus/ modified Claus technology/SCOT Process/CS2 process; Electricity and steam generation by Gas turbine/boiler-Cooling tower operation-Fuel oil-Cryogenic distillation of air to N2 and O2 production-Instrument air operation	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOK:

1. Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000 .
3. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969

REFERENCES:

1. J.G. Speight and B. Ozum, "Petroleum Refining Processes", Marcel Dekker Inc, New York, 2002
2. G.D. Hobson, "Modern Petroleum Technology", Vol I & II, John Wiley & Sons, New York, 5th edition, 1984
3. David.S.J."STAN"Jones and Peter R.Pujado "Handbook of Petroleum Processing, Springer,2006.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2												3
2				2									2	
3				3										2
4				3									2	
5							3		2				2	
CO	3	2		3			3		2				2	3

22CHX15 PETROCHEMICAL UNIT PROCESSES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To learn feed stock and source of petrochemicals, synthesis gas production. • To understand the principles involved in Sulphonation, Sulfation and Isomerization. • To understand Skills on Fundamental and Technological principles involved tertiary unit processes

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the principles of various feed stock and sources in the petrochemical industry.	Ap	20%
CO2	Apply the synthesis of gas production.	An	20%
CO3	Analyze the Fundamental and principle involved in petrochemical primary unit processes.	Ap	40%
CO4	Analyze the Fundamental and principle involved in petrochemical secondary unit processes.	An	20%
CO5	Understand Skills on Fundamental and Technological principles involved tertiary unit processes	U	Internal Assessment

UNIT I - FEED STOCK AND SOURCE OF PETROCHEMICALS	(9)
Overview of Petrochemical Industry – The key growth area of India, Economics – Feed stock selections for Petrochemicals – Steam cracking of Gas and Naphtha to produce Olefins, Diolefins and Production of Acetylene.	
UNIT II - SYNTHESIS GAS PRODUCTION	(9)
Steam reforming of Natural gas – Naphtha and Heavy distillate to produce Hydrogen and Synthesis gas – Production of Methanol – Oxo process.	
UNIT III - PRIMARY UNIT PROCESSES	(9)
Fundamental and Technological principled involved in Alkylation – Oxidation – Nitration and Hydrolysis.	
UNIT IV - SECONDARY UNIT PROCESSES	(9)
Fundamental and Technological principled involved in Sulphonation, Sulfation and Isomerisation.	

UNIT V - TERTIARY UNIT PROCESSES	(9)
Fundamental and Technological principles involved in Halogenation and Esterification	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. BhaskaraRao, B.K., "A Text on Petrochemicals", Khanna Publishers, 2000.
2. SukumarMaiti, "Introduction to Petrochemicals", 2nd Edition, Oxford and IBH Publishers, 2002.

REFERENCES:

1. Margaret Wells, "Handbook of Petrochemicals and Processes", 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., "Chemistry of Petrochemical Processes", 2nd Edition, Gulf Publishing Company, 2000.
3. Dryden, C.E., "Outlines of Chemical Technology", 2nd Edition, Affiliated East-West Press, 1993.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											3	
2		3		3									2	
3		3											3	
4		3											3	
5						2								2
CO	3	3		3		2							3	2

22CHX16 PETROCHEMICAL DERIVATIVES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To classify the petrochemicals and to know the alternate routes of producing petrochemicals. • To identify the alternate route to first, second and third generation petrochemicals

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Design the techniques and their alternate production of precursors of petrochemicals.	Ap	20%
CO2	Analyze the various chemicals from first generation petrochemicals production.	An	20%
CO3	Analyze the manufacturing process of second generation of petrochemicals.	Ap	40%
CO4	Analyze the production third generation petrochemicals.	An	20%
CO5	Learn the properties and characteristics of third generation petrochemical.	U	Internal Assessment

UNIT I - PRECURSORS	(9)
Indian Petrochemical Industry - Sources of Petrochemicals - Classification of Petrochemicals - Classification of Hydrocarbons - Alternate routes with flow diagram for production of methane, ethylene, propylene, acetylene. Chemicals from methane, ethylene, propylene, acetylene.	
UNIT II - FIRST GENERATION PETROCHEMICALS	(9)
Alternate routes with flow diagram for production of butadiene, related dienes, aromatics – Benzene, toluene, xylene – Chemicals from butadiene, related dienes, aromatics – Benzene, toluene, xylene.	
UNIT III - SECOND GENERATION PETROCHEMICALS	(9)
Alternate routes with flow diagram for production of ethylene glycol, ethylene oxide, Ethyl benzene, VCM, acrylonitrile, phenol, adipic acid, hexmethylenediamine, DMT, TPA, maleic anhydride, styrene.	
UNIT IV - THIRD GENERATION PETROCHEMICALS	(9)
Polymerization – Modes and techniques – Production of polyethylene – LDPE, HDPE, polypropylene, SBR, SAN, ABS, PU.	
UNIT V - THIRD GENERATION PETROCHEMICALS	(9)
Polyacrylonitrile, polyvinyl chloride, polycarbonates, nylon 6, nylon 66, polyesters, resins, explosives, organic dyes.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. BhaskaraRao, B.K., "A Text on Petrochemicals", Khanna Publishers, 2000.
2. SukumarMaiti, "Introduction to Petrochemicals", 2nd Edition, Oxford and IBH Publishers, 2002.

REFERENCES:

1. Margaret Wells, "Handbook of Petrochemicals and Processes", 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., "Chemistry of Petrochemical Processes", 2nd Edition, Gulf Publishing company, 2000.
3. Dryden, C.E., "Outlines of Chemical Technology", 2nd Edition, Affiliated East-West Press, 1993

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1			3										2	
2	2	3											2	
3	2	3											2	
4	2	3											2	
5							3					2		2
CO	2	3	3				3					2	2	2

22CHX17 PETROCHEMICAL TECHNOLOGY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To learn the operation and methodologies in petrochemical industries • To learn the application of petrochemicals in all process fields • To learn each products of petrochemical industries and its application with production techniques in detail.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the basic knowledge on petrochemical industry and their growth, history.	Ap	20%
CO2	Apply the different methods of production in petrochemical products and their derivatives.	An	20%
CO3	Apply knowledge on the production of petrochemical products.	Ap	40%
CO4	Analyze the petrochemical industries and its application with production techniques in polymers.	An	20%
CO5	Understand the application of petrochemicals in all process fields	U	Internal Assessment

UNIT I - PETROCHEMICALS EVOLUTION	(9)
Petrochemical Industries and their feedstock selection .History, Economics, Growth of petrochemical industry.-structure of Petrochemical complexes- Classification of petrochemicals- Basic building processes- Integration with refinery-flow scheme	
UNIT II - INTERMEDIATES FOR PETROCHEMICALS INDUSTRIES	(9)
Production Methods - Reforming and cracking of feed stocks; Sources: Chemicals from synthesis gas, olefins and aromatics-Ethylene, Propylene, C4hydrocarbons, higher olefins, Benzene, Toluene, Xylene and their derivatives	
UNIT III - COMPLEX PETROCHEMICAL PRODUCTS	(9)
Acrylonitrile, Acrylic acid, dimethyl terephthalate, ethanol, ethylene glycol, linear alkyl benzene, methyl tertiary butyl ether, vinyl acetate, vinyl chloride, Maleic and phthalic anhydride, ethyl benzene, Phenol, Cumene, Styrene, Bisphenol, Aniline – Process flow scheme- various technology- advantages-yield pattern-process variables	
UNIT IV – POLYMERS	(9)
Polymers production: Fibers, Rubbers and Plastics. Acrylonitrile butadiene styrene (ABS), polyethylene-LDPE, HDPE, Polypropylene, PVC, PS, SAN, SBR, PAN, Nylon and Polycarbonates.	

UNIT V - GLOBAL CHEMICALS	(9)
Petrochemicals-Lubricants, additives, adhesives, agrochemicals, cosmetics raw materials, electronic chemicals, detergents, paint, healthcare and pharmaceuticals, Fertilizers - Ammonia, Urea, NPK etc.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Bhaskara Rao, B.K. "A Text on Petrochemicals", 2nd Edition, Khanna Publishers, NewDelhi,1998
2. H. Steiner, "Introduction to petrochemicals", Pergamon Press, NewYork, 1961.
3. Wiseman.P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley &Sons,1986.
4. IDMall, 'Petrochemical process Technology', Macmillan India Limited,2007.
5. A. Chawvel and G. Lefebvre, "Petrochemical Process", Vol. I & II, Gulf Publishing Co., Houston, London

REFERENCES:

1. Brown stein A.M. 'Trends in Petrochemical Technology', Petroleum Publishing Company, 1976.
2. G.MargaretWells,'HandbookofPetrochemicalsandProcesses'2nd Revised Edition, Gower Publishing Company.
3. Groogins, "Unit Process in Organic Synthesis", McGraw Hill Book Company, New York
4. Robert A. Meyers, "Handbook of Petrochemicals Production Processes", McGraw-Hill Education: New York, 2 nd edition, 2019 (ISBN: 9781259643132).
5. L.F. Hatc and MatarSarri, "From Hydrocarbons to Petrochemicals", Gulf Publishing Co., Houston, London.
6. 6. A.L. Waddams, "Chemicals from Petroleum", Gulf Publishing Company, London, 4th edition, 1980

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2												2	
2		2												3
3	2													2
4		3											2	
5							3						2	
CO	2	3					3						2	2

22CHX18 FERTILIZER TECHNOLOGY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : -				

Course Objective:	• To know the production of fertilizers and its characteristics. • To know the applications of NPK fertilizers. • To express the role of nutrients in mixed fertilizers.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the various manufacturing process involved in production of fertilizers.	Ap	20%
CO2	Analyze the concepts of phosphatic fertilizers types and their manufacturing methods.	An	20%
CO3	Analyze the role of potassium fertilizer production.	Ap	40%
CO4	Analyze the production of complex and NPK fertilizers.	An	20%
CO5	Understand the knowledge of bio fertilizers, fluid fertilizers and slow release fertilizers and their applications	U	Internal Assessment

UNIT I - NITROGENOUS FERTILISERS	(9)
Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.	
UNIT II - PHOSPHATIC FERTILISERS	(9)
Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.	
UNIT III - POTASSIC FERTILISERS	(9)
Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.	
UNIT IV - COMPLEX AND NPK FERTILISERS	(9)
Methods of production of ammonium phosphate, sulphatediammonium phosphate, nitrophosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.	
UNIT V - MISCELLANEOUS FERTILISERS	(9)
Mixed fertilizers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers, controlled release fertilizers.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

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

REFERENCES:

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

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3											3	
2	2													2
3	2													2
4	2													2
5							2						3	
CO	2	3					2						3	2

22CHX19 POLYMER TECHNOLOGY

	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To know the industrial polymerizations concepts. • To know the significance of glass transition temperature and properties of polymers. • To know the principles of plastics molding

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the concept and classification of polymers and polymerization methods.	Ap	20%
CO2	Apply the types of polymerization mechanism.	An	20%
CO3	Apply the knowledge on molecular weight and its significance through industry.	Ap	40%
CO4	Design the process on glass transition temperature and melting point.	An	20%
CO5	Explain the concept of different molding techniques for different applications.	U	Internal Assessment

UNIT I – INTRODUCTION	(9)
Basic concepts of macromolecules – Monomers – Polymers – Natural and Synthetic polymers - structure of natural products like cellulose, rubber and proteins - Chemistry of Olefins and Dienes – double bonds - Functionality - degree of polymerization-Classification and nomenclature of polymers – Thermoplastic and thermosetting polymerization.	
UNIT II - ADDITION AND CONDENSATION POLYMERIZATION	(9)
Addition Polymerization: free radical polymerization – cationic polymerization – anionic polymerization – coordination polymerization – industrial polymerization – bulk, emulsion, suspension and solution polymerization techniques – Copolymerization concepts – Condensation polymerization	
UNIT III - MOLECULAR WEIGHTS OF POLYMERS	(9)
Acrylonitrile, Acrylic acid, dimethyl terephthalate, ethanol, ethylene glycol, linear alkyl benzene, methyl tertiary butyl ether, vinyl acetate, vinyl chloride, Maleic and phthalic anhydride, ethyl benzene, Phenol, Cumene, Styrene, Bisphenol, Aniline – Process flow scheme- various technology- advantages-yield pattern-process variables	
UNIT IV - GLASS TRANSITIONS TEMPARATURE	(9)
Glass transition Temperature: significance and experimental study – Melting Point of polymer - significance and experimental study – Relationship between Tg and Tm – Crystallinity in polymers – effect of crystallization– factors affecting crystallization - Polymer Density / Apparent Density, Viscosity measurements.	
UNIT V -PLASTICS PROCESS – MOULDING TECHNIQUES	(9)
Injection molding: Principle, Types and advantages - Blow molding: Principle, Types and advantages - Thermoforming: Principle, Types and advantages - Compression molding: Principle, Types and advantages - Extrusion : Principle, Types and advantages – Calendaring : Principle, Types and advantages	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

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

REFERENCES:

1. Joel,R.F; Polymer Science and Technology, Eastern Economy Edition, 1999.
2. Rodriguez, F., Cohen.C.,Oberic.K and Arches, L.A., Principles of Polymer Systems, 6th edition, CRC Press, 2014.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											2	2
2		3											2	
3			2										2	
4				2	3								2	
5							2					2		2
CO	3	3	2	2	3		2					2	2	2

22CHX21 FOOD CHEMISTRY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: -

Course Objective:	• To explore a knowledge in food composition, Processing and nutrients • To gain knowledge in food coloring, Pigments, aroma and phytochemicals

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the principle and properties of carbohydrates in industrial processing.	Ap	20%
CO2	Apply the knowledge, operation and process in food technology.	Ap	30%
CO3	Analyze the properties and types of fat and oils.	Ap	20%
CO4	Apply the principle of food processing in Chemical process industries.	Ap	30%
CO5	To learn knowledge the aroma and phytochemicals in food.	U	Internal Assessment

UNIT I: CARBOHYDRATES	(9)
The principal carbohydrates in the human diet.Chemical properties of carbohydrates -dehydration, caramelization, Maillard reaction. Types Simple Sugars mono and disaccharides, solubility; Artificial sweeteners; Glucose syrup, fructose syrup, Sugar alcohols; Oligosaccharides structure, nomenclature, occurrence, uses in foods. Polysaccharides Starch- amylose and amylopectin- properties, thickening & gelatinization, modified starches, resistant starch, Dextrins and dextrans, Starch hydrolysates – Maltodextrins and dextrins; Structure of glycogen. Fiber-Cellulose & hemicellulose Pectins Gums & seaweeds- gel formation & viscos	
UNIT II: PROTEINS	(9)
The principal proteins in the human diet. Review of protein structure & conformation; Optical activity, solubility, hydration, swelling, foam formation & stabilization, gel formation, emulsifying effect, thickening & binding, amino acids in Maillard reaction, denaturation; Properties & reactions of proteins in food systems and Food enzymes and its role in food spoilage, application of food enzymes; Texturized proteins; Functional role and uses in foods.	
UNIT III:LIPIDS	(9)
Review of structure, composition and nomenclature of fats. Properties of fats & oils Edible oil refining processes, winterization, melting points, plasticity, isomerisation, hydrolysis of triglycerides, Saponification number, iodine value, Reichert-Meissl number. Types of fatty acids; Modification of fats hydrogenation- cis and trans isomers, inter-esterification, acetylation, Hydrolytic rancidity & oxidative rancidity; Shortening power of fats, tenderization, frying - smoke point, auto oxidation, polymerization, lipids having emulsifying properties, its application in food industry and detergents; Shortening power of fats, chemistry of steroids, types of fat substitute.	

UNIT IV: FOOD COMPOSITION, WATER, MINERALS AND VITAMINS	(9)
Proximate composition of food, water activity in food, moisture content of food, water quality for food processing. Mineral & vitamin content of foods- stability & degradation during food processing.	
UNIT V: AROMA & IMPORTANT PHYTOCHEMICALS IN FOOD	(9)
Naturally occurring colours/pigments in food and impact on antioxidant level, Synthetic food grade Colours, enzymatic browning of food, flavour& aroma components present in herbs, spices, coffee, tea, cocoa, fruits, vegetables & fermented products; and Naturally similar /artificial flavours, Threshold values, off flavours& food taints. Naturally occurring toxic substances, protease inhibitors, bioactive components phytates, polyphenols, saponins, phytoestrogens etc	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Belitz H.-D, Grosch W and Schieberle P. Food Chemistry, 4th Edition, Springer-Verlag, 2009.
2. Meyer, Lillian Hoagland "Food Chemistry". CBS Publishers, 1987.

REFERENCES:

1. Vaclavik, V. A. and Christian E. W. "Essentials of Food Science". 4th Edition, Kluwer - Academic, Springer, 2014.
2. Richard Owusu-Apenten "Introduction to Food Chemistry" CRC Press, 2005.
3. SrinivasanDamodaran, Kirk L. Parkin, "Fennema's Food Chemistry"5th Edition, CRCPress, 2008.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2													3	
3	3												3	
4	3													
5						3							3	
CO	3					3							3	

22CHX22 FOOD MATERIALS SCIENCE				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: -

Course Objective:	• Impart an understanding on the micro structural and molecular basis of food materials.. • To gain have a basic idea on characterization of food materials.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply fundamental concept in chemical food processing industry.	Ap	20%
CO2	Design the given data and find the formation and structure of food biopolymers.	An	20%
CO3	Analyze of the food gels and food structure and food processing.	An	40%
CO4	Apply Interpret the technologies for characterization of engineered/structured food materials.	Ap	20%
CO5	Apply the knowledge of engineering food materials.	Ap	Internal Assessment

UNIT I: INTRODUCTION	(9)
Fundamentals of food materials, Molecular basis of food materials, Observation of materials at various size ranges and size-property relationship, The Composite Structure of Biological Tissue, Amorphous and crystalline structures of materials.	
UNIT II: MICROTOMACROLEVELSTRUCTURESOFFOODMATERIALS	(9)
Microstructure definitions, Measurement of microstructures/nanostructures, The relationship between structure and quality, Microstructure and emulsions, Fibrous Composites, Visualisation of surface structures, Interfacial assembly of food materials.	
UNIT III: FOOD GELS	(9)
Introduction tofood biopolymers, Rheology of food gels: yielding and gelling soft matter, Formation andstructure of biopolymer network gels, Formation micro- andnano-gelparticles, Structure–rheology relationships of food gels and food gel structures.	
UNIT IV: FOODMATERIALCHARACTERIZATION	(9)
Introduction, Material Characterization Techniques; Nuclear Magnetic Resonance (NMR), Fourier Transform Infra-Red (FT-IR), X-ray powder diffraction, Small angle neutron & X-ray scattering (SANSandSAXS),Confocalmicroscopy,Scanningelectronmicroscopy,AtomicForceMicroscopy (AFM).	
UNIT V: FOODMATERIALENGINEERING	(9)
Food structure and bio-accessibility of nutrients, Effects of Processing Technologies on Food Material, Properties, Technologies for protection and delivery of nutrients, Design of foods and encapsulation systems, Food Nanoparticles: Formation, Properties and Applications.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Bhesh Bhandari & YrjöH. Roos. "Food Materials Science and Engineering" Wiley - Blackwell Publishing, 2012.
2. José Miguel Aguilera & Peter J. Lillford, "Food Materials Science - Principles and Practice", Springer New York, 2008.

REFERENCES:

1. Alexandru Mihai Grumezescu & Alina Maria Holban, "Handbook of food bioengineering" Elsevier Science, 2018.
2. Charis Michel Galanakis, "Food Structure and Functionality" Elsevier Science, 2020.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2		3												
3		3												
4													3	
5	3					3								
CO	3	3				3							3	

22CHX23 PROCESSING OF DAIRY PRODUCTS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: -				
Course Objective:	• To gain a knowledge about the composition of milk and physical and chemical properties of milk. • To Understand the process flow for the preparation of different dairy products..			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the basic concept of various process operation in dairy processing.	Ap	20%
CO2	Apply the principles of different thermal processing.	Ap	30%
CO3	Apply the principles and process of Homogenization and cream separation in dairy processing.	Ap	30%
CO4	Analyze the process flow for the preparation of different dairy products.	An	20%
CO5	Understand the process and equipments used for the manufacturing of dairy production.	U	Internal Assessment

UNIT I: EVAPORATION & MIXING	(9)
Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers. Mixing andagitation:Theoryandpurposeof mixing. Equipmentsusedformixing solids, liquidsand gases. Different types of stirrers, paddles and agitators.	
UNIT II: DRYING	(9)
Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rateofdrying-constantandfallingrate,EffectofShrinkage,Classificationofdryers-sprayand drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers.	
UNIT III: PROCESSING EQUIPMENTS	(9)
Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheesemaking equipments. Packaging equipments: Packagingmachinesfor milk &milk products. Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction.	
UNIT IV: MECHANICAL SEPARATION	(9)
Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, ratesof filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges.	

UNIT V: THERMAL PROCESSING	(9)
Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers. Sterilization: Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Blow molding machines.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. De Sukumar Outlines of Dairy Technology, Oxford University press, New Delhi, 2002.
2. R.K.Robinson, Modern dairy technology Vol. I Advances in Milk processing. Elsevier Applied Science Publishes, London, 1986.
3. Gerrit Smit, Dairy processing Improving quality, Published by Wood head Publishing Limited, CCR PRESS, 2000.

REFERENCES:

1. H.G.Kessler,Food engineering and dairy technology, Verlag A.Kessler, Freising, (F.R.Germany.) 1981.
2. A.W.Farrall, Engineering for dairy and food products, John Wiley and Sons, NewYork, 1963.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3												3	
3	2												2	
4		2											3	
5							3						2	
CO	3	2					3						3	

22CHX24 FRUIT AND VEGETABLE PROCESSING AND PRESERVATION				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To understand the concept of physiological and post harvest changes in fruits and vegetables • To learn the pre processing for fruits and vegetables and preservation techniques.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply research to suitable preservation techniques employed for fruits and vegetables.	Ap	20%
CO2	Apply the techniques to process different fruit beverages	Ap	30%
CO3	Analyze the physiological and post harvest changes in fruits and vegetables.	An	30%
CO4	Analyze to Select suitable storage and pre processing for fruits and vegetables.	An	20%
CO5	Develop processing techniques for various fruits and vegetable products	U	Internal Assessment

UNIT I: PHYSIOLOGY AND POST HARVEST CHANGES OF FRUITS AND VEGETABLES	(9)
Scope of Fruits and Vegetables Processing Industry in India and World-present status. Classification of Fruits and Vegetables, Physiological Development, Harvesting methods, Postharvest changes of fruits and vegetables, Methods of reducing post-harvest changes.	
UNIT II: PREPROCESSING OPERATIONS AND STORAGE METHODS	(9)
Precooling, Evaporative Cooling, Washing, Peeling, Grading, Blanching. Storage methods: Storage of fruit and vegetables - under ambient conditions, low temperature storage.	
UNIT III:PRESERVATION OF FRUITS AND VEGETABLES PRODUCT	(9)
Chilling, Freezing, Pasteurization, Sterilization, Irradiation, Waxing, Edible coating, Controlled Atmospheric Storage (CAS), Modified Atmospheric Storage (MAS).	
UNIT IV: FRUIT AND BEVERAGES	(9)
Classification of fruit beverages, Juice, Squash, cordial, Juice concentrate, nectar, Ready to Serve (RTS). Fermented fruit beverages – Wine, vinegar production. Juice making equipment.	
UNIT V:PROCESSING OF FRUITS AND VEGETABLES PRODUCTS	(9)
Production of Intermediate Moisture Foods (IMF) - jam, jellies and marmalades, Defects in Jam and Jelly. Candied preserve, fruit bar, tutti fruity, fruit powder, Fermented vegetables products – Pickle, sauerkraut.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Srivastava R.P &Sanjeev Kumar, "Fruit and Vegetable Preservation: Principles and Practices", 3rd Edition, CBS Publishers & Distributors, New Delhi, 2014.
2. Fellows, P J. "Food Processing Technology Principles and Practice". 3rd Edition, Woodhead, 2009.

REFERENCES:

1. Rajarathnam S &Ramteke R.S, "Advances in Preservation and Processing Technologies of Fruits and Vegetables", 1st Edition, New India Publishing Agency, New Delhi, 2011.
2. Salunke,D . K and S. S Kadam "Hand Book of Fruit Science and Technology Production, Composition, Storage and Processing". Marcel Dekker, 2005.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3												3	
3		3											3	
4		3												
5						3			3				3	
CO	3	3				3			3				3	

22CHX25 BAKING AND CONFECTIONERY TECHNOLOGY				
	L	T	P	C
	3	0	0	3

PRE -REQUISITE : -

Course Objective:	• To explore a knowledge in bakery products • To gain knowledge in confectionery products

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the function and process of baking and confectionery technology.	Ap	30%
CO2	Design the appropriate equipment for baking process and relate the rheological properties of dough.	Ap	20%
CO3	Design and apply processing techniques for manufacturing process.	Ap	30%
CO4	Illustrate the processing techniques for preparation of miscellaneous bakery products	Ap	20%
CO5	Apply the processing techniques to formulate different confectionery products	Ap	Internal Assessment

UNIT I: INTRODUCTION TO BAKING	(9)
Classification of bakery products. Bakery ingredients and their functions-Essential ingredients Flour, yeast and sour dough, water, salt- Other ingredients Sugar, color, flavor, fat, milk, milk powder and bread improvers. Leaveners and yeast foods. Shortenings, emulsifiers and antioxidants	
UNIT II: EQUIPMENTS IN BAKERY INDUSTRY	(9)
Handling of ingredients- dough mixers, dividers, rounder, sheeter, laminating equipments, fermentation enclosures and brew equipment, ovens and slicers. Farinograph, Amylograph, Alveograph, Extensograph. And Mixograph.	
UNIT III:BREAD MAKING PROCESS	(9)
Chemistry of Dough Development. Bread making methods- Straight dough/bulk fermentation, Sponge and dough, Activated dough development, Chorleywood bread process, No time process. Characteristics of good bread- Internal and external characters. Bread defects/faults and remedies. Spoilage of bread.	
UNIT IV: BAKERY PRODUCTS	(9)
Production of cakes and cookies/ biscuits. Types of biscuit dough's –Developed dough, short dough's, semi-sweet, enzyme modified dough's and batters. Cake making Ingredients and their function Structure builders. Tenderizers, moisteners and flavor enhancers. Production process for Wafers- type of flour, raising agents and maturing. Other miscellaneous products puff pastry, chemically leavened. Problems of baking.	
UNIT V:CONFECTIONERY PRODUCTS	(9)
Composition and manufacturing process- Sugar boiled products-Candy, Toffees, fudge, caramel, aerated confectionery. Bubble gums and chewing gums. Chocolate Processing –chocolate shells, candy bars. Fruit confections. Confectionery product quality parameters, faults and corrective measures. Spoilage of confectionery products.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:
1. Matz, Samuel A., —Bakery Technology and Engineering, 1992, 3rd Edition, Chapman & Hall, London. 2. Cauvain, Stanley P, and Young, Linda S., —Technology of Bread Making, 2007, springer
REFERENCES:
1. Edwards W.P. — Science of bakery products, RSC, UK, 2007. 2. Samuel A. Matz., —Equipment for Bakers, Pan Tech International Publication. 1988. 3. Sugar Confectionery manufacture-(Ed) E.B.Jackson, 2nd Edition, Blackie Academic and professional, Glasgow,1995

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2	3		3											3
3			3											3
4			3											3
5							3							2
CO	3		3				3						2	3

22CHX26 TECHNOLOGY OF FRUIT AND VEGETABLE PROCESSING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: -

Course Objective:	• Enable students to appreciate the application of scientific principles in the processing of fruits and vegetables. • To gain a knowledge about thermal processing methods in fruit and vegetable technology.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the basic process agricultural aspects of fruits and vegetables.	Ap	20%
CO2	Apply the techniques and processing of fruits and vegetables by through industrial processed product.	Ap	20%
CO3	Analyze the preservation and apply the process to preserve the processed product.	An	40%
CO4	Apply thermal processing methods in fruit and vegetable technology.	Ap	20%
CO5	Identify the suitable processing techniques of fruit and vegetable products.	Ap	Internal Assessment

UNIT I: BASIC AGRICULTURAL ASPECTS OF VEGETABLES AND FRUITS	(9)
Ability to identify all commercially important fruits and vegetables with their names in important Indian languages, important regions, season, Production and processing scenario of fruits and vegetable India and World. Scope of Fruit and Vegetable Preservation Industry in India. Present status, constraints and prospectus.	
UNIT II: FRESH FRUITS AND VEGETABLES	(9)
Physical,Texturalcharacteristics,structureandcomposition.Maturitystandards;Importance, methods of Maturity determinations maturity indices for selected fruits and vegetables. Harvesting of important fruits and vegetables. Fruit ripening- chemical changes, regulations, methods. Calculation of respiration rates, Spoilage of fruits, vegetable and their processed products.	
UNIT III: PRESERVATION OF FRUITS AND VEGETABLES	(9)
Preservation by fermentation- Definition, Advantages, disadvantages, Types of fermentation, equipments; Fruit wine. Irradiation applications for fruits and Vegetable. Minimally processed fruits and vegetables, solving problems with respect to natural resistance of fruit, General preprocessing, drying and freezing of fruits and vegetables.	
UNIT IV: CANNING,PUREES AND JUICES	(9)
Canning- General pre-processing, specific or salient points in fruits and vegetables like – Blanching, exhausting, processing conditions; Indian Food Regulation and Quality assurance Fruit Juice / pulp/ Nectar/Drinks, concentrates - General and specific processing, different packing including aseptic.	

UNIT V:FRUIT AND VEGETABLE PRODUCTS	(9)
Ready to eat fruit and vegetable products, Jams/Marmalades, Squashes/cordials, Ketchup/sauces, Chutneys, Fruit Bar, Soup powders, Candied Fruits, Natural colors, Fruit and Vegetable Fibres- General and specific processing, different packing including aseptic, Dried Onion, Powder. Garlic Dried Garlic, Powder, Oil. Potato Wafer; starch, Papad, Carrot Preserve, candy, Pickle, Jam. Cauliflower and cabbage Dried cauliflower and cabbage, Sauerkraut, Pickle Leafy vegetables; Dried Leafy Vegetables.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOK:

1. Fellows, PJ. "Food Processing Technology Principles and Practice". 3rd Edition, Wood head, 2009.

REFERENCES:

1. Salunke, D. K and S. S Kadam "Hand Book of Fruit Science and Technology Production, Composition, Storage and Processing". Marcel Dekker, 2005.
2. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2	3												2	
3		2											3	
4	3												2	
5							3						2	
CO	3	2					3						2	

22CHX27 FOOD STRUCTURING TECHNIQUES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: -				
Course Objective:	• To learn the technical and functional performance of structured food materials • To Understand the Performance of food structured.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the techniques to developing structured food products.	Ap	20%
CO2	Apply the knowledge of the Performance of food structured	Ap	30%
CO3	Apply the modern techniques of food structure development.	Ap	30%
CO4	Design the technical and functional performance of structured food materials.	An	20%
CO5	Understand the concepts and principles of food structuring.	U	Internal Assessment

UNIT I: INTRODUCTION	(9)
Nature of food structure, Food structure development, Role of hydrocolloids and proteins in food structure development, making of structured foods, Destruction, destabilization and deformation of food matrix, Application of materials science in food design.	
UNIT II: TECHNIQUES FOR FIBROUS STRUCTURE FORMATION	(9)
Cultured meat, Myco protein, Wet spinning, Electro spinning, Extrusion, Mixing of proteins and hydrocolloids, Freeze structuring, Shear cell technology. Food Printing: 3D food printing; Approaches, Technologies in food printing, Printability of food components, Factors affecting the printability, 4D Printing; Concept and Functionality, smart food materials, shape memory effect in 4D food printing	
UNIT III:FOOD STRUCTURE DEVELOPMENT IN EMULSION SYSTEMS	(9)
Emulsions: Principles and Preparation, Basic constituents of Food emulsion, Emulsion architecture, Microstructure design and performance. Food Structure Development in Oil and Fat Systems; nano scale crystals and the structures of lipids and fat, fat crystal network.	
UNIT IV: STRUCTURING OF FOOD SYSTEMS	(9)
Structuring Dairy Products by means of Processing and Matrix Design, Processing of Food Powders, Structured Cereal Products, Structured Meat Products, Structured Chocolate Products, Edible Moisture Barriers for Food Product Stabilization.	

UNIT V: PERFORMANCE OF STRUCTURED FOOD	(9)
Food Structure Development for Rheological/ Tribological Performance; structure-property-oral process relationships. Developing Food Structure for Mechanical Performance; structure and bulk behavior of soft solid foods, particulate composites and gels, cellular solid foams, and short fiber- reinforced foods.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Fotis Spyropoulos, Aris Lazidis & Ian Norton, "Handbook of Food Structure Development" Royal Society of Chemistry, 2020.
2. Bhesh Bhandari & YrjöH. Roos. "Food Materials Science and Engineering" Wiley-Blackwell Publishing, 2012.

REFERENCES:

1. Jose Miguel Aguilera & Peter J. Lillford, "Food Materials Science - Principles and Practice", Springer New York, 2008.
2. AlexandruMihaiGrumezescu&AlinaMariaHolban,"Handbookoffoodbioengineering" Elsevier Science, 2018.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2												2	
2		3											2	
3	3												3	
4			3											
5						3							2	
CO	2	3	3			3							2	

22CHX28 FOOD QUALITY AND SAFETY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To familiarize with the different types of plastic packaging, paper and paperboard packaging • To gain knowledge about trends in packaging

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the principle and concepts in food packaging.	Ap	20%
CO2	Apply the paper and paperboards for various food applications.	Ap	20%
CO3	Apply the appropriate metal and glass containers for food packaging	Ap	40%
CO4	Analyze suitable plastic for packaging based on their properties	An	20%
CO5	Learn to Select and adapt recent trends in food packaging	U	Internal Assessment

UNIT I: FOOD QUALITY AND PACKAGING	(9)
Definitions and basic functions of a food package. Food package design and development. Physical and physico-chemical processes affecting product quality, migration from packaging to foods, predicting the shelf life of foods. Package standards and regulation. Labeling, bar coding.	
UNIT II: PAPER AND PAPERBOARD PACKAGING	(9)
Paper and paperboard- manufacture, properties analysis and packaging aspects. Package types – pouches, sacks, cartons, boxes, tubes, tubs, labels, sealing tapes, cap liners and diaphragm.	
UNIT III:PLASTIC PACKAGING	(9)
Types of plastics used in packaging – PE, PP, PET, PVC, EVOH, PVA. Secondary conversion techniques – film, extrusion and thermal lamination. Printing of plastic films and rigid plastic containers. Natural extracts in plastic food packaging. Food contact and barrier properties. Sealability and closure.	
UNIT IV: METAL CANS AND GLASS CONTAINERS	(9)
Raw materials for can making –steel, aluminum. Can making processes – three piece welded cans, DWI, DRD cans – end making processes, coating, film laminates and inks, corrosion and sulphur staining. Flash 18 process, retorting equipment. Definition and composition. Glass container manufacture – melting, forming, surface treatments. Closure selection. Glass bottle design and specification.	
UNIT V:TRENDS IN FOOD PACKAGING	(9)
Active and intelligent packaging, modified atmosphere packaging - vacuum and inert gas packaging, biodegradable and edible packaging, aseptic packaging, self-heating and cooling cans. Recycling of non-biodegradable packaging materials.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Richard Coles and Mark J. Kirwan, "Food and Beverage Packaging Technology", 2nd Edition, Blackwell Publishing Asia Pvt Ltd, CRC press, USA, 2011.
2. Han, Jung H. "Innovations in Food Packaging". Elsevier, 2005.

REFERENCES:

1. Han Jung H, "Innovations in Food Packaging", 2nd Edition, Academic Press, USA, 2014.
2. Ahvenainen, Raija. "Novel Food Packaging Techniques". Wood Head Publishing, 2003.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													3
2	3												2	
3	3												3	
4		3												3
5							3					3	2	
CO	3	3					3					3	2	3

22CHX31 AIR POLLUTION ENGINEERING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To understand the nature and characteristics of air pollutants, • To Identify, formulate and solve air pollution problems using air pollution control devices • Understand the knowledge about particulate air pollutants and control devices

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the nature and characteristics of air pollutants, and basic concepts of air quality management.	An	20%
CO2	Design and formulate solve air pollution problems using air pollution control devices to meet applicable standards.	An	20%
CO3	To analyze the particulate air pollutants and control devices.	An	40%
CO4	Analyze the air quality behavior and its measurement.	An	20%
CO5	Demonstrate the knowledge to control the air pollution in industries using various models.	U	Internal Assessment

UNITI : INTRODUCTION	9
Introduction to Air Quality; An Overview of the Clean Air Act Amendments; Air Pollution Regulatory Framework –Regulatory System –Laws and Regulations– Clean air Act–Provisions for Recent Developments. Ambient Air Quality Standards in India; Properties of Air Pollutants; Sources and effects of air pollution, emission standards, Air Quality Index	
UNITII:GASEOUS POLLUTANTS	9
Absorption- Principles, Description of equipment-Packed and Plate columns -Design and Performance equations; .Adsorption- Principle Adsorbents, Equipment descriptions - PSA - Adsorption cycle - Solvent recovery system-Continuous Rotary bed, Fluidized bed, Design and Performance equations ; Incinerators, Hydrocarbon incineration kinetics- Equipment description- Design and Performance equations.	
UNITIII: PARTICULATE AIR POLLUTION	9
Particle Collection mechanisms – Fluid particle Dynamics – Particle size Distribution – Efficiency–Gravity Settling chambers Cyclones – Electrostatic precipitators and Bagfilters	
UNITIV: AIR POLLUTION CONTROL	9
Principles of Pollution Prevention- Characteristics and control of VOCs and HCs, Characteristic sand control of sulphur oxides and nitrogen oxides, Control of mobile source pollutants - Control of particulate matters– Techniques of air pollution control-equipments	

UNITV: AIR POLLUTION MODELLING	9
Meteorology and winds- Stability of the atmosphere, lapse rates & inversions- Air pollution dispersion models, Gaussian equation and variation, Industrial Air Pollution Sources and Prevention	
TOTAL (L:45) : 45 PERIODS	

TEXTBOOKS:

1. Richardw. Boubeletal., "Fundamentals of Air Pollution", Academic Press, NewYork,1994.
2. Noel DeNevers, "Air Pollution Control Engg.", McGraw Hill, NewYork,1995.
3. M.N.Raoetal., "Air Pollution" Tata McGraw Hill,1989.

REFERENCES

1. David, H.F. ,Liu, Bela G., Liptak Air Pollution, Lweis Publishers, 2000.
2. Stern, A.C., Air Pollution (Vol.I–Vol.VIII), AcademicPress,2006.
3. Davis, W.T., Air Pollution Engineering Manual, John Wiley & Sons, Inc., 2000.
4. Heck, R.M., and Farrauto, R.J., Catalytic Air Pollution Control: Commercial Technology, 2nd Edition John Wiley Sons, 2012
5. Pierce, J.J., Environmental pollution and control, Butterworth-Heinemann, 4thedn, 1997.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											3	
2	3	3												2
3	3												2	
4				3									2	
5											3			2
CO	3	3		3							3		2	2

22CHX32 WASTE WATER TREATMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : -				
Course Objective:	• To understand the Physical and chemical Characteristics of wastewater and their measurement. • To understand the various pollutant treatment techniques. • Understand the concepts using biological treatment methods			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the Physical and chemical Characteristics of wastewater and their measurement.	An	20%
CO2	Apply the various pollutant treatment techniques in waste water treatment process.	Ap	20%
CO3	Analyze the concepts using biological treatment methods.	An	40%
CO4	Design the reactors used for various treatment techniques based on the process.	Ap	20%
CO5	Understand the membrane based advanced waste water treatment process.	U	Internal Assessment

UNIT I: WASTE WATERTREATMENT AN OVERVIEW	9
Terminology – Regulations – Health and Environment Concerns in waste water management –Constituents in waste water; inorganic, Organic and heavy metal constituents.	
UNIT II: CHEMICAL UNIT PROCESSES	9
Role of unit processes in waste water treatment-Principles of Chemical treatment – Coagulation -flocculation–Precipitation–flotation–solidification and stabilization–disinfection	
UNIT III: BIOLOGICAL TREATMENT	9
Objectives of biological treatment– significance–Principles of aerobic and anaerobic treatment-kinetics of biological growth – Factors affecting growth – attached and suspended growth -Determination of Kinetic coefficients for organics removal – Biodegradability assessment –selection of process-reactors-batch-continuous type.	
UNIT IV: AEROBIC AND ANAEROBIC TREATMENT METHODS	9
Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters- RBC-Moving Bed Reactors- fluidized bed reactors, aerated lagoons, waste stabilization ponds- Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal	

UNIT V: ADVANCED WASTEWATER TREATMENT	9
Technologies used in advanced treatment – Classification of technologies- Removal of Colloids and suspended particles– Membrane Filtration – Ion Exchange – Advanced oxidation process –Zero liquid Discharge.-Software Applications	
TOTAL (L:45) : 45 PERIODS	

TEXTBOOKS:

1. Wastewater Engineering Treatment and Reuse: McGraw Hill, G.Tchobanoglous, FIBiston, 2002.
2. S.P.Mahajan, Pollution control in process industries, 27th Ed.Tata McGraw Hill Publishing Company Ltd., 2012.
3. C.S.Rao, Environmental Pollution Control Engineering, New Age International, 2007

REFERENCES

1. Casey,T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, 2006.
2. Metcalf & Eddy, Inc. Wastewater Engineering - Treatment, Disposal, and Reuse, Fourth Edition, Tata McGraw - Hill,1995.14
3. Cheremisinoff, P.N., Handbook of water and wastewater technologies, BH Publications, 2002.
4. Sincero,P.A., and Sincero ,A.G., Physical Chemical treatment of water and wastewater, IWA Publications, 2002.
5. Spellman, R.F., Handbook of water and wastewater treatment plant operations, CRCPress /Taylor&FrancisPublications,2009.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2	3	2												3
3	3												2	
4		3												3
5							2				3			3
CO	3	3					2				3		2	3

22CHX33 SOLID WASTE MANAGEMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : -				

Course Objective:	• To know about the solid waste characteristics and its sources. • To identify and analyze different methods of treatment of solid waste • To understand Industrial practices in solid waste management

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the solid waste characteristics and its sources.	Ap	20%
CO2	Analyze different methods of treatment of solid waste.	An	20%
CO3	Analyze the Industrial practices in solid waste management.	Ap	40%
CO4	Apply and Discuss the process and significance of processing of solid wastes.	An	20%
CO5	Understand the waste and management of the waste disposal.	U	Internal Assessment

UNIT I : SOURCES AND CHARACTERISTICS	9
Sources and types of municipal solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics - Elements of integrated solid waste management – Requirements and salient features of Solid waste management rules (2016) –- Role of public and NGO" s- Public Private participation – Elements of Municipal Solid Waste Management Plan	
UNIT II: SOURCE REDUCTION, WASTE STORAGE AND RECYCLING	9
Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste – On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – case studies under Indian conditions – Recycling of Plastics and Construction/Demolition wastes.	
UNIT III: COLLECTION AND TRANSFER OF WASTES	9
Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations –location, operation and maintenance; options under Indian conditions – Field problems- solving.	
UNIT IV: PROCESSING OF WASTES	9
Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio meth nation; Thermal processing options – case studies under Indian conditions.	
UNIT V: WASTE DISPOSAL	9
Land disposal of solid waste- Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill – Dumpsite Rehabilitation	
TOTAL (L:45) : 45 PERIODS	

TEXTBOOKS:

1. William A. Worrell, P. AarneVesilind (2012) Solid Waste Engineering, Cengage Learning, 2012.
2. John Pitchel (2014), Waste Management Practices-Municipal, Hazardous and industrial – CRC Press, Taylor and Francis, New York.
3. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". McGraw Hill, New York, 1993.
4. Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", Prentice Hall, Inc., 1981

REFERENCES:

1. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of UrbanDevelopment, New Delhi, 2000.
2. Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		2		3										3
3		3												3
4			3		2									2
5							3						2	
CO	3	3	3	3	2		3						2	3

22CHX34 ENVIRONMENTAL IMPACT ASSESSMENT				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To understand the concept of environmental Impact assessment • To know various components and assessment techniques of EIA • To gain knowledge about EIA monitoring studies through various industrial exposure

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the concept of environmental Impact assessment.	Ap	20%
CO2	The Students will be able to know various components and assessment techniques of EIA	An	20%
CO3	The Students will be able to understand Environmental management plan	Ap	40%
CO4	The Students will be able to understand socio economic assessment plans	An	20%
CO5	The Students will be able to gain knowledge about EIA monitoring studies through various industrial exposure	U	Internal Assessment

UNIT I: INTRODUCTION	9
Impacts of Development on Environment – Rio Principles of Sustainable Development- Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework.	
UNIT II: ENVIRONMENTAL ASSESSMENT	9
Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction	
UNIT III: ENVIRONMENTAL MANAGEMENT PLAN	9
Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Public Hearing-Environmental Clearance.	
UNIT IV: SOCIO ECONOMIC ASSESSMENT	9
Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis	

UNIT V: MONITORING STUDIES AND APPLICATIONS	9
Environmental monitoring - guidelines - policies - planning of monitoring programmes; Environmental Management Plan- Post project audit ; Case studies of EIA of developmental projects in Food, Fertilizer and Petrochemical industry	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Canter, L. W., Environmental Impact Assessment, McGraw Hill, New York, 1996.
2. Petts, J., Handbook of Environmental Impact Assessment Vol. I and II, Blackwell Science, London, 2009.
3. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003.
4. Anjaneyulu, Y., and Manickam, V., Environmental Impact Assessment, Methodologies, 2nd Edition, BS Publications, 2007

REFERENCES:

1. Becker H. A., Frank Vanclay, "The International handbook of social impact assessment" conceptual and methodological advances, Edward Elgar Publishing,2003.
2. Barry Sadler and Mary McCabe, "Environmental Impact Assessment Training Resource Manual", United Nations Environment Programme,2002.
3. Judith Petts, "Handbook of Environmental Impact Assessment Vol. I and II", Blackwell Science New York, 1998.
4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
	POs												PSOs	
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1					2									
2							3	2					3	
3							3						3	
4						2	3						3	
5									3					
CO					2	2	3	2	3				3	

22CHX35 PROCESS SAFETY MANAGEMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : -				
Course Objective:	• To understand the chemical process safety, safety codes, safe handling of chemicals and plant inspection • To learn the different analysis to overcome the accidents in process industry • To understand the hazard analysis and safety management in process industry			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the basic, importance of chemical process safety, safety codes.	Ap	20%
CO2	Apply the procedure of safety of safe handling of chemicals and plant inspection	An	20%
CO3	Analyze the different analysis to overcome the accidents in process industry	Ap	40%
CO4	Analyze the way of hazard analysis in process industry	An	20%
CO5	Understand the safety management in different process industry	U	Internal Assessment

UNIT I: PROCESS SAFETY INFORMATION	9
Safety vs Process Safety, Importance of Process Safety, Elements of Process safety - Overview ; Process Safety Information (PSI) – Importance of Process Safety Information , Types of PSI, Collection of PSI, familiarization of formats for capturing PSI, Challenges	
UNIT II: SAFETY PROGRAMMES AND PROCEDURES	9
Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling-Implementation of safety procedures – periodic inspection and replacement; Standard Operating Procedure – Overview and its importance, how to write effective operating procedure, Types of Procedures, Standard operating conditions and consequence of deviation; Emergency planning	
UNIT III: ACCIDENT ANALYSIS	9
Accidents – identification and prevention, promotion of industrial safety. Process Safety Incident reporting and Investigation – Element overview, reporting and its importance; Process safety incident classification, Root cause analysis, making recommendations ; Past accident analysis- Fixborough-Mexico- Chernobyl nuclear disaster-Bhopal gas analysis- process safety indicators	
UNIT IV: PROCESS HAZARD ANALYSIS	9
Hazard identification- safety audits, checklist, what if analysis, vulnerability models- event tree analysis- fault tree analysis. Asset Integrity Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)	

UNIT V: SAFETY MANAGEMENT	9
Employee Participation – Overview, Benefits of Employee participation, Various modes of engaging workforce in PSM, Challenges; Management of Change – Types of Changes, Managing Changes in PSM Perspective, Framework, evaluating changes-Institutionalizing and integrating safety into the PSM fabric, 5 tier approach, selection, training, Performance monitoring; Case studies – Process safety management in industry – present and futuristic approach	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
2. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.
3. Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.
4. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004

REFERENCES:

1. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw Hill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2												2	
2			3										2	
3				3									3	
4		2		2									2	
5											3			
CO		2	3	3		3		3			3		2	

22CHX36 RISK ASSESMENT AND HAZOP ANALYSIS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To Understand the knowledge of types of risks arising in working environment • To Perform Risk Assurance and Assessment • To HAZOP and its consequences and to create hazard free working premises

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze the types of risk arising in working environment.	Ap	20%
CO2	Apply the techniques to know the Risk Assurance and Assessment.	An	20%
CO3	Design Risk management systems and planning to development of risk management.	Ap	40%
CO4	Analyze to identified the hazard and to select the techniques.	An	20%
CO5	Demonstrate the knowledge of HAZOP and its consequences and to create hazard free working premises.	U	Internal Assessment

UNIT I: RISK ANALYSIS	9
Risk analysis introduction, quantitative risk assessment, rapid risk analysis –comprehensive risk analysis – identification, evaluation and control of risk	
UNIT II: RISK ASSESSMENT	9
Risk assessment – introduction and available methodologies, Risk assessment steps- Quantitative risk analysis-event tree, fault tree, consequence analysis and layer of protection analysis- Bow tie analysis	
UNIT III: EMERGENCY PLANNING	9
Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies- marketing terminal, gas processing complex ; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball	
UNIT IV: HAZARD	9
Hazard - Hazard identification – methods: Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)	

UNIT V: HAZOP	9
Introduction to HAZOP-Significance of HAZOP -HAZOP procedure –HAZOP Analysis -Computer usage in HAZOP- softwares employed - Limitations of HAZOP – case studies.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
2. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.
3. Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.
4. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004

REFERENCES:

1. Handley, W., "Industrial Safety Hand Book ", 2nd Edition. McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3											2	
2		2												2
3			2											2
4		3												2
5						3			2				2	
CO		3	2			3			2				2	2

22CHX37 INDUSTRIAL POLLUTION CONTROL AND MANAGEMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : -				
Course Objective:	• To learn about industrial wastes and its sources • To learn about control and removal of specific industrial pollutants. • To learn about audit methods and pollution control regulations			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Analyze about industrial wastes and its sources	Ap	20%
CO2	Apply the concept removal of specific industrial pollutants.	An	20%
CO3	Analyze and management the various industrial pollutants.	Ap	40%
CO4	Apply the recent trends to manage the industrial waste management	An	20%
CO5	The Students will be able to learn about audit methods and pollution control regulations	U	Internal Assessment

UNIT I	9
Industrial wastes and their sources: Various industrial processes, Sources and types of solid, liquid, gaseous wastes, Noise & radiation emissions. Sources of industrial water usages and various industrial processes requiring water use and required water quality.	
UNIT II	9
Processes responsible for deterioration in water quality, Various waste water streams, Control and removal of specific pollutants in industrial wastewaters, e.g., oil and grease, bio-degradable organics, chemicals such as cyanide, fluoride, toxic organics, heavy metals, radioactivity etc. Wastewater reuse & recycling, Concept of zero discharge effluent.	
UNIT III	9
Control of gaseous emissions: Hood and ducts, Tall stacks, Particulate and gaseous pollutant control, Solid waste generation and disposal management. Hazardous wastes: Definitions, concepts and management aspects. Noise& radiation: Generation, control and management	
UNIT IV	9
Recent trends in industrial waste management, Cradle to grave concept, Life cycle analysis, Clean technologies; Case studies of various industries, e.g., dairy, fertilizer, distillery, sugar, pulp and paper, iron and steel, metal plating, thermal power plants, etc.	
UNIT V	9
Environmental audit: Definition and concepts, Environmental audit versus accounts audit, Compliance audit, Relevant methodologies, Various pollution regulations, Introduction to ISO and ISO 14000.	
TOTAL (L:45) : 45 PERIODS	

TEXTBOOKS

1. Metcalf & Eddy "Wastewater Engineering: Treatment & Reuse", Tata McGraw Hill.
2. Azad, H.S. "Industrial Wastewater Management Handbook", McGraw Hill.
3. Arceivala, S.J. & Asolekar, S.R. "Wastewater Treatment for Pollution Control and Reuse", McGraw Hill.
4. Culp, G., George, W., Williams, R. and Mark, Hughes, V.Jr. "Wastewater Reuse and Recycling Technology-Pollution Technology" Review-72, Noyes Data Corporation, New Jersey.

REFERENCES

1. Pandey, G.N. and Corney, G.C. "Environmental Engineering", Tata McGraw Hill.
2. Edmund, B. Besselieve P.E. "The Treatment of Industrial Wastes", McGraw Hill.
3. Nancy, J.S. "Industrial Pollution Control: Issues and Techniques", Van Nostrand Reinhold.
4. Shen, T.T. "Industrial Pollution Prevention Handbook", Springer-Verlag.
5. Environment (protection) Act - 1986, Ministry of Environment and Forest, Government of India.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2												2	
2	2												2	
3			2											2
4					2									2
5								2			2		2	
CO	2		2		2			2			2		2	2

22CHX38 ENVIRONMENTAL BIOTECHNOLOGY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : -				

Course Objective:	• To critically analyze relevant journal articles and investigate industrial applications of the concepts of biotechnology for effluent treatment. • To learn as to how they can manipulate, enhance or retard biological processes

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge of existing and emerging technologies that are important in the area of environment biotechnology.	Ap	20%
CO2	Apply the knowledge of importance of microbial diversity and technologies for environmental sustainability and processes.	Ap	20%
CO3	Apply the knowledge of waste water technologies and analyze case studies of the area to conceptualize a research program with an aim to solve the existing global environmental problems.	AP/An	40%
CO4	Analyze relevant journal articles and investigate industrial applications of the concepts of biotechnology for effluent treatment.	An	20%
CO5	Present the biological processes for bioremediation of natural sources and xenobiotic degradation.	U	Internal Assessment

UNIT I: ENVIRONMENTAL SYSTEMS AND POLLUTANTS	9
Physical and chemical aspects of natural environmental processes, Metals and nonmetals, carcinogens, radioactive materials, and pathogens/pathogenic sample. Industrial, Municipal and agricultural waste, Handling, processing, and disposal of various hazardous and toxic materials, diversity and role of microorganisms in diverse and complex environments, Use and management of microbes for the benefit of ecosystems and society	
UNIT II: AIR POLLUTION	9
Dynamic nature of air quality, Ambient and industrial conditions, Principals and practices of air quality management, Air Quality Management, Air treatment technologies, Contaminant movement in air matrices, and data analysis	
UNIT III: WATER AND WASTE WATER TREATMENT	9
Water resources, drinking water standards, water quality characteristics, water pollutants, Sampling and laboratory instrument procedures, An overview of the geology, properties, flow, and pollution of ground water systems, sewage and potable water treatment plants, Unit operations, physical, chemical and biological used in waste water treatment, Design of an Effluent treatment plant, Reactors for waste water treatment	

UNIT IV: SOIL POLLUTION AND SOLID WASTE MANAGEMENT	9
Generation, processing, and disposal of municipal, industrial, and agricultural waste materials, technical concepts of solid waste management, Design and operation of landfills, waste-to-energy systems, composting facilities, recycling facilities, and other emerging waste management technologies.	
UNIT V: POLLUTION PREVENTION	9
Principles of pollution prevention and environmentally conscious products, processes and manufacturing systems, Post-use product disposal, life cycle analysis, Pollution prevention economics, Overview of major environmental laws such as the Clean Air and Clean Water Acts, Regulatory issues	
TOTAL (L:45) : 45 PERIODS	

TEXTBOOKS

1. Young MM, Comprehensive Biotechnology; Pergamon Press.
2. De AK, Environmental Chemistry; Wiley Eastern Ltd.

REFERENCES

1. Allsopp D, Seal KJ, Introduction to Biodeterioration; ELBS/Edward Arnold.
2. Metcalf, Eddy, Tchobanoglous G,Waste Water Engineering - Treatment, Disposal and Reuse; Tata McGraw Hill

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3												3	
3		3											3	
4		3												
5									3	3				
CO	3	3							3	3			3