NANDHA ENGINEERING COLLEGE

(An Autonomous Institution affiliated to Anna University Chennai and approved by AICTE, New Delhi)
Erode-638 052, Tamilnadu, India, Phone: 04294 – 225585

Curriculum and Syllabi

for

B.Tech., Chemical Engineering [R22]

[CHOICE BASED CREDIT SYSTEM]

[This Curriculum and Syllabi are applicable to Students admitted of (2022-2026) and (2023-2027) Batches only]

JULY 2024

INSTITUTE VISION AND MISSION	
VISION	• To be an Institute of excellence providing quality Engineering, Technology and Management education to meet the ever changing needs of the society.
MISSION	• To provide quality education to produce ethical and competent professionals with social Responsibility • To excel in the thrust areas of Engineering, Technology and Entrepreneurship by solving real- world problems. • To create a learner centric environment and improve continually to meet the changing global needs.

B.TECH. - CHEMICAL ENGINEERING	
VISION	• To produce globally competent engineers in chemical engineering and allied disciplines to meet the growing needs of the society.
MISSION	• To develop skilled and employable graduates to meet the challenges in emerging fields of Engineering and Technology. • To prepare the students for prosperous career in Engineering and Entrepreneurship by inculcating the leadership qualities with professional and ethical responsibilities for the benefit of the society • To provide learner centric environment by imparting quality education to cater the needs of the society
PROGRAMME EDUCATIONAL OBJECTIVES (PEO)	The graduates of Chemical Engineering will be **PEO1: Core Competency:** A successful professional with core competency and inter-disciplinary skills to satisfy the Industrial needs. **PEO2: Research, Innovation and Entrepreneurship:** Capable of identifying technological requirements for the society and providing innovative ideas for real time problems. **PEO3: Ethics, Human values and Life-long learning:** Able to demonstrate ethical practices and managerial skills through continuous learning.
PROGRAMME SPECIFIC OUTCOMES (PSO)	The students of Chemical Engineering will be able to **PSO 1:** Identify, formulate and analyze the problems of chemical engineering systems and product development. **PSO 2:** Implement appropriate engineering tools for modeling, simulation, analysis and optimization of chemical processes.

PROGRAM OUTCOMES:

At the end of this programme the students will be able to

a-i	GRADUATE ATTRIBUTES	PO No.	PROGRAMME OUTCOMES
a	Engineering Knowledge	PO1	Apply fundamental concept gained from mathematics, science & chemical engineering courses.
b	Problem Analysis	PO2	Design and conduct experiments, as well as to analyze and interpret data.
c	Design and Development of Solutions	PO3	Design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, safety, manufacturability and sustainability.
d	Investigation of Complex Problems	PO4	Apply research methods like design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e	Modern Tool Usage	PO5	Apply modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
f	The Engineer and Society	PO6	Infer societal, health, safety, legal & cultural issues and consequent responsibilities relevant to the professional engineering practice.
g	Environment and Sustainability	PO7	Understand the impact of engineering solutions in societal and environmental contexts, and demonstrate the need for sustainable development.
h	Ethics	PO8	Apply ethical principles and commit to professional ethics and responsibilities of the engineering practice.
i	Individual and Team Work.	PO9	Function effectively as an individual / team in diverse and multi-disciplinary environments.
j	Communication	PO10	Communicate effectively through reports, presentations and discussions within both the engineering domain and the community at large.
k	Project Management and Finance	PO11	Demonstrate knowledge and understanding of engineering, management, principles, finance and apply these to manage projects in multidisciplinary environments.
l	Lifelong Learning	PO12	Acknowledge the need for learning and engage in life-long learning in the broadest context of technological change.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the Programme Educational Objectives and the Outcomes is given in the following table

Program Educational Objectives (PEOs)	Programme Outcomes (POs)											
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	1	2	3	3	2	2	1	1	2	1
2	3	3	3	3	2	3	3	2	2	2	2	1
3	3	1	2	1	1	2	3	3	2	1	1	3

MAPPING OF PROGRAM SPECIFIC OUTCOMES WITH PROGRAMME OUTCOMES

A broad relation between the Program Specific Objectives and the outcomes is given in the following table

Program Specific Outcomes (PSOs)	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	2	2	1	2	3	2	3	-	-	-
2	3	2	1	2	3	2	2	2	2	-	1	1

Contribution 1: Reasonable 2: Significant 3: Strong

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**
1	22MAN01	Induction Programme	MC	-	-	-	-	-	-
THEORY									
2	22EYA01	Professional Communication - I	HSMC	-	4	2	0	2	3
3	22MYB01	*Calculus and Linear Algebra	BSC	-	4	3	1	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	-	1	1	0	0	1
PRACTICALS									
8	22CYP01	*Chemistry Laboratory	BSC	-	2	0	0	2	1
9	22GEP01	Engineering Practices Laboratory	ESC	-	4	0	0	4	2
MANDATORY NON-CREDIT COURSES									
10	22MAN02	Soft/Analytical Skills - I	MC	-	3	1	0	2	0
11	22MAN03	*Yoga - I	MC	-	1	0	0	1	0
				TOTAL	**29**	**15**	**1**	**13**	**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	22MAN04	Soft / Analytical Skills - II	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	22MAN07#/ 22MAN07R##	Soft / Analytical Skills - III	MC	-	3	1	0	2	0
10	22MAN09	Indian Constitution	MC	-	1	1	0	0	0
				TOTAL	**31**	**20**	**1**	**10**	**23**

 # - Applicable for 2022-2026 batch students
- Applicable for 2023-2027 batch students

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	22MAN08#/ 22MAN08R##	Soft/Analytical Skills - IV	MC	-	3	1	0	2	0
10	22GED01	Personality and Character Development	EEC	-	1	0	0	1	0
				TOTAL	**30**	**16**	**3**	**11**	**22**

 # - Applicable for 2022-2026 batch students
- Applicable for 2023-2027 batch students

SEMESTER: V									
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22CHC12	Mass Transfer I I	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	22MAN10R	Communication and Quantitative Reasoning*	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	22MAN02	Soft/Analytical Skills – I	MC	-	3	1	0	2	0	1
3	22MAN03	Yoga – I	MC	-	1	0	0	1	0	1
4	22MAN04	Soft / Analytical Skills - II	MC	-	3	1	0	2	0	2
5	22MAN05	Yoga - II	MC	-	1	0	0	1	0	2
6	22MAN07/ 22MAN07R	Soft / Analytical Skills - III	MC	-	1	1	0	0	0	3
7	22MAN09	Constitutions of India	MC	-	5	3	0	2	0	3
8	22MAN08/ 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
10	22MAN10R	Communication and Quantitative Reasoning	MC	-	3	1	0	2	0	5

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					

22MAN01 INDUCTION PROGRAMME
(For Common To All Branches)

	L	T	P	C
	-	-	-	-

PRE-REQUISITE : NIL

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. "

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

REFERENCES:

1.Guide to Induction program from AICTE

22EYA01 - PROFESSIONAL COMMUNICATION I (Common to All Branches)					
		L	T	P	C
		2	0	2	3
PRE-REQUISITE : NIL					
Course Objective:	• To build essential English skills to address the challenges of communication • To enhance communication employing LSRW skills				
Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination		
CO1	Communicate effectively in various work environments.	R	20%		
CO2	Involve in diverse discourse forms utilizing LSRW Skills.	U	20%		
CO3	Participate actively in communication activities that enhance the creative skill.	U	20%		
CO4	Associate with the target audience and contexts using varied types of communication.	Ap	20%		
CO5	Convey the ideas distinctly both in verbal and non-verbal communication in work culture.	U	20%		

UNIT I –INTRODUCTORY SKILLS	(6+6)
Grammar – Parts of Speech – Verb (Auxiliaries – Primary & Modal, Main Verb) -Listening – Listening to Short Conversations or Monologues - Listening to Experiences – Listening to Descriptions- Speaking Introducing Oneself – Exchanging Personal information - Talking about food and culture - Reading– Reading for Interrogation – Reading Newspaper, Advertisements and Interpreting - Writing – Seeking Permission for Industrial Visit & In-plant Training	
UNIT II – LANGUAGE ACUMEN	(6+6)
Grammar – Word Formation – Tenses (Present Tense) – Synonyms & Antonyms - Listening – Listening to Announcements – Listening to Interviews - Listening and Note-taking - Speaking – Talking about Holidays & Vacations – Narrating Unforgettable Anecdotes - Reading – Skimming – Scanning (Short Texts and Longer Passages) – Critical Reading - Writing – Instruction – Process Description	
UNIT III – COMMUNICATION ROOTERS	(6+6)
Grammar– Cause and Effect – Tenses (Past Tense) – Discourse Markers - Listening – Listening to Telephonic Conversations – Listening to Podcasts - Speaking – Talking about neoteric Technologies – Eliciting information to fill a form - Reading –Book Reading(Motivational) - Practicing Speed Reading (reading newspaper reports & biographies) - Writing – Checklist – Circular, Agenda & Minutes of the Meeting	

UNIT IV - DISCOURSE FORTE	(6+6)
Grammar – Tenses (Future Tense) –Yes/No & WH type questions – Negatives - Listening – Listening to TED/ Ink talks -Speaking – Participating in Short Conversations - Reading – Reading Comprehension (Multiple Choice / Short / Open Ended Questions) - Writing - E-Mail Writing	
UNIT V - LINGUISTIC COMPETENCIES	(6+6)
Grammar – Articles – Homophones & Homonyms – Single line Definition – Phrasal Verb - Listening – Intensive listening to fill in the gapped text - Speaking –Expressing opinions through Situations & Role play - Reading – Cloze Texts - Writing – Paragraph Writing	
LIST OF SKILLS ASSESSED IN THE LABORATORY 1. Grammar 2. Listening Skills 3. Speaking Skills 4. Reading Skills 5. Writing Skills	
TOTAL (L:30 , P:30) = 60 PERIODS	

TEXT BOOK:

1. Shoba K N., Deepa Mary Francis. English for Engineers and Technologists. Volume 1, 3rd Edition, Orient Black Swan Pvt. Ltd, Telangana, 2022.

REFERENCES:

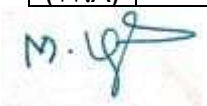
1. Koneru, Aruna . English Language Skills. Tata McGraw Hill Education (India) Private Limited, Chennai, 2006.
2. Hewings, M. Advanced English Grammar. Cambridge University Press, Chennai, 2000.
3. Jack C Richards, Jonathan Hull and Susan Proctor. Interchange. Cambridge University Press New Delhi, 2015 (Reprint 2021).

WEB REFERENCE:

1. https://youtu.be/f0uqUzEf3A8?si=vyzu5KGIfbu35_IQ

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	3				
3									2	3				
4									2	3				
5									2	3				
CO (W.A)									2	3				



22MYB01-CALCULUS AND LINEAR ALGEBRA (Common to All Branches)				
	L	T	P	C
	3	1	0	4

PRE-REQUISITE : NIL

Course Objective:	• To understand the mathematical concepts of matrices and analytical geometry in real time problems. • To formulate differential and integral equations to model physical, biological, and engineering systems

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the concepts of matrix theory for find solutions to complex problems efficiently.	Ap	20%
CO2	Analyze the geometric configurations and relationships by using Analytical geometry.	An	20%
CO3	Interpret the partial derivatives which involve heat conduction problems modeled by the heat equation.	Ap	20%
CO4	Apply the differential and integral techniques to solve the differential equations and multiple integrals in heat conduction, fluid mechanics and potential theory.	Ap	40%
CO5	Demonstrate the importance of matrix theory, analytical geometry and integral methods using programming tools.	Ap	Internal Assessment

UNIT I–MATRICES	(9+3)
Characteristic Equation-Eigen values and Eigen vectors of a matrix- Cayley Hamilton Theorem(excluding proof)and its applications-Quadratic Form-Reduction of a Quadratic form to canonical form by orthogonal transformation.	
UNIT II–ANALYTICAL GEOMETRY OF THREE DIMENSIONS	(9+3)
Equation of plane–Angle between two planes–Equation of straight lines-Coplanar lines–Equation of sphere –Orthogonal spheres.	
UNIT III-GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS	(9+3)
Curvature–Curvature in Cartesian co-ordinates-Centre and Radius of curvature-Circle of curvature-Evolutes and Involutes.	
UNIT IV-FUNCTIONS OF SEVERAL VARIABLES	(9+3)
Partial derivatives-Euler's theorem on homogeneous function-Jacobian-Maxima and Minima of functions of Two variables-Constrained Maxima and Minima by Lagrange's multiplier method.	
UNIT V-MULTIPLE INTEGRALS	(9+3)
Double integration in Cartesian Co-ordinates-Change of order of integration-Area as double integral-Triple Integration in Cartesian Co-ordinates-Volume as triple integrals.	
TOTAL(L:45+T:15) :60 PERIODS	

LIST OF PROGRAMS USING MATLAB (Assignment/Online Test):

1. Introduction to MATLAB
2. Matrix operations–Addition, Multiplication, Transpose and Inverse
3. Characteristic equation of a Matrix
4. Eigen values and Eigen vectors of Higher order Matrices.
5. Curve Tracing
6. Determining Maxima and Minima of a function of one variable.
7. Determining Maxima and Minima of a function of two variables.
8. Evaluating double integrals
9. Evaluating triple integrals
10. Finding area between two curves.

TEXT BOOKS:

1. Grewal, B.S., "Higher Engineering Mathematics", Khanna publications,42nd Edition, 2012.
2. Erwin Kreyszig, "Advanced Engineering mathematics",JohnWiley&sons,9th Edition, 2013.
3. Veerarajan,T., "Engineering Mathematics of semesterI&II",TataMcGrawHill,3rd Edition, 2016.

REFERENCES:

1. Bali,N.P., Manish Goyal, "A Textbook of Engineering Mathematics-Sem-II", Laxmi Publications, 6th Edition,2014.
2. Kandasamy,P., Thilagavathy,K., Gunavathy,K., "Engineering Mathematics for first year", Scand & Co Ltd,9th Revised Edition, 2013.
3. GlynJames, "Advanced Engineering Mathematics", Wiley India, 7th Edition, 2007.

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												
4	3													
5	3				2				3			2		
CO (W.A)	3	2			2				3			2		

*Ratified in Eleventh Academic Council

22CYB03 CHEMISTRY (For CHEMICAL Branch Only)					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : NIL					
Course Objective:	• To make the students conversant with water treatment, boiler feed water techniques, nature of bonding, engineering materials and corrosive nature of metals. • To impart knowledge on the basic principles and preparatory methods of Nanomaterials.				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Identify the types of hardness in water and its removal by various water treatment techniques.	Ap	20%
CO2	Categorize the properties of lubricants and refractories for various applications.	Ap	20%
CO3	Explore the type of corrosion and its control measures.	An	20%
CO4	Predict the nature, oxidation and reduction potential of an electrode.	An	20%
CO5	Illustrate the principles, theory of analytical techniques and investigate the nanomaterials.	Ap	20%

UNIT I – WATER TECHNOLOGY	(9)
Hardness – types – estimation by EDTA method. Water quality parameter – BOD and COD. Domestic water treatment – disinfection methods (chlorination, ozonation and UV treatment) – Boiler troubles (scale, sludge, priming, foaming and caustic embrittlement) – Internal conditioning (carbonate, phosphate and calgon) – External conditioning – demineralization process – desalination – reverse osmosis method.	
UNIT II – CHEMICAL BONDING AND ENGINEERING MATERIALS	(9)
Chemical bond – Types of bonds - Covalent bond – Hydrogen fluoride, Methane (overview only) - Ionic bond – Sodium Chloride, Magnesium Oxide (overview only) - Coordinate bond – Hydrogen Peroxide, Ozone (overview only) - Hydrogen Bond – Types of hydrogen bond (overview only). Engineering Materials : Synthesis of Abrasives – Properties of Refractories – Properties of Lubricants	
UNIT III – SCIENCE OF CORROSION	(9)
Corrosion – types - chemical corrosion - pilling bedworth rule - electrochemical corrosion – mechanism - galvanic corrosion - differential aeration corrosion - factors influencing corrosion - corrosion control - sacrificial anode and impressed cathodic current methods - corrosion inhibitors.	

UNIT IV – ELECTROCHEMISTRY AND FUEL CELLS	(9)
Electrode potential - Nernst equation - derivation and problems - reference electrodes - standard hydrogen electrode -calomel electrode - potentiometric titrations (redox) - conductometric titrations (acid-base).- Fuel cell – hydrogen and oxygen fuel cell – microbial fuel cell – polymer electrolyte membrane fuel cell.	
UNIT V –ANALYTICAL TECHNIQUES AND NANOCHEMISTRY	(9)
Colorimetry – principle - estimation of iron by colorimetry – UV- Visible spectroscopy – principle – instrumentation (Block diagram only) - IR spectroscopy - principle –instrumentation (Block diagram only) - Atomic absorption spectroscopy – principle – estimation of nickel by atomic absorption spectroscopy - Nanomaterials – synthesis (laser ablation, and chemical vapour deposition method) - applications of nanomaterials.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Dr.Ravikrishnan, A," Engineering Chemistry I & Engineering Chemistry II , Sri Krishna Hitech Publishing chem.. Co. Pvt Ltd., 13th ed., Chennai , 2020.
2. S.S. Dara," A Text book of Engineering Chemistry", S.Chand&Co.Ltd. New Delhi, 2019.

REFERENCES:

1. P.C.Jain and Monica Jain, "Engineering Chemistry", Vol I &II, DhanpatRai Pub, Co,New Delhi 15th ed.,2018.
2. B.Sivasankar, "Engineering Chemistry" , Tata McGraw- Hill Pub.Co.Ltd.,New Delhi,2018

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														
4			2				2							
5		2				2						2		
CO (W.A)	3	2	2			2	2		2			2		

22EEC01 - BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (Common to CHEMICAL and CIVIL Branches)					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : NIL					
Course Objective:	• To impart knowledge on the concepts of electrical circuit laws, measuring instruments, AC and DC machines. • To Gain information on the basic principles of semiconductor devices with applications and digital systems.				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply principles of semiconductor physics to predict the behavior of electrical circuits, diodes, bipolar junction transistors (BJTs) in different circuit configurations and basics of digital systems using logic gates.	Ap	25%
CO2	Illustrate the operation and types of electrical circuits and machines including measuring instruments.	Ap	25%
CO3	Analyze the Characteristics for various diodes, AC machines and DC machines.	An	25%
CO4	Design digital circuits that meet specified needs with appropriate consideration and develop a simple electronic circuit using diodes and transistors	Ap	25%
CO5	Achieve as an independent learner in a team to build an authentic application of electrical and electronics engineering and make an effective oral presentation.	C	Internal Assessment (Seminar)

UNIT I - ELECTRICAL CIRCUITS AND MEASURMENTS	(9)
Introduction to DC circuits - Ohm's Law - Kirchhoff's Laws - Resistive circuits - Resistors in Series and parallel - Introduction to AC circuits - Power and Power factor - Classification of measuring instruments - Dynamometer type wattmeter - Induction type energy meter	
UNIT II - DC MACHINES	(9)
DC Generator: Construction, Types, Principle of operation, EMF equation, Characteristics. DC Motor: Principle of operation, Types, Torque equation, Characteristics and Applications.	
UNIT III - AC MACHINES	(9)
Single phase induction motor: Construction, Types, working principle - Three phase induction motor: Construction, Types, Torque - Slip Characteristics - Synchronous motor: Construction, working principle.	

UNIT IV - SEMICONDUCTOR DEVICES AND ITS APPLICATIONS	(9)
Introduction - Characteristics of PN junction diode and Zener diode - Half wave rectifier - Bipolar junction transistor: CB, CE, CC configurations and characteristics.	
UNIT V - DIGITAL SYSTEMS	(9)
Number System - Binary, Decimal, Octal, Hexadecimal - Binary arithmetic - Boolean Algebra - Logic Gates - Applications: Half Adder.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, "Basic Electrical Engineering", McGraw Hill Education (India) Private Limited, 4th Edition, Third Reprint, 2019.
2. R Muthusubramaian, S.Salivahanan and K.A.Muraleedharan, "Basic Electrical, Electronics and Computer Engineering", 2nd Edition, Tata McGraw Hill publishers, New Delhi, 2012

REFERENCES:

1. Jr.,William H. Hayt,Kemmerly, Jack E.Phillips, Jamie D.Durbin, Steven M. "Engineering Circuits Analysis," 9th Edition, Tata McGraw Hill publishers, New Delhi, 2020
2. S.K.Bhattacharya, "Basic Electrical and Electronics Engineering", 2nd Edition, Pearson India, New Delhi, 2017.

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											2	
4	3												2	
5									3	3	3	3		
CO (W.A)	3	3							3	3	3	3	2	

22MEC01 - ENGINEERING GRAPHICS (Common to AGRI, CIVIL, CHEMICAL and EEE Branches)					
		L	T	P	C
		2	0	2	3
PRE-REQUISITE : Nil					
Course Objective:	• To Construct various plane curves • To Construct the concept of projection of points, lines and plane • To Develop the projection of solids • To Solve problems in sectioning of solids and developing the surfaces • To Apply the concepts of orthographic and isometric				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge of engineering drawing standards to drawn 2D Engineering drawings.	Ap	40%
CO2	Apply the knowledge of engineering drawing standards to solve the given 2D problem using first angle of projection.	Ap	20%
CO3	Apply the knowledge of engineering drawing standards solve the 3D problem using first angle of projection	Ap	20%
CO4	Analyze the given problem to create 3D drawing	An	20%
CO5	Engage independent study as a member of team and make effective oral presentation on engineering graphics	U	Internal Assessment

CONCEPTS AND CONVENTIONS (Not for Examination)	
Importance of graphics in engineering applications - use of drafting instruments - BIS conventions and specifications - size, layout and folding of drawing sheets - lettering and dimensioning - scales.	
UNIT I - PLANE CURVES	(6+6)
Basic geometrical constructions, curves used in engineering practices - conics - construction of ellipse, parabola and hyperbola by eccentricity method - construction of cycloid - construction of involutes of square and circle - drawing of tangents and normal to the above curves - theory of projection - principle of multi-view orthographic projection - profile plane and side views - multiple views - representation of three dimensional objects - layout of views.	
UNIT II - PROJECTION OF POINTS, LINES AND PLANES	(6+6)
Principal planes - first angle projection - projection of points - projection of straight lines (only first angle projections) inclined to both the principal planes - determination of true lengths and true inclinations by rotating line method - projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.	
UNIT III - PROJECTION OF SOLIDS	(6+6)
Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to anyone of the principal plane and parallel to another by rotating object method.	

UNIT IV - SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES	(6+6)
Sectioning of solids (prism, cube, pyramid, cylinder and cone) in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other - obtaining true shape of section - development of lateral surfaces of simple and sectioned solids - prisms, pyramids cylinder and cone.	
UNIT V - ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS	(6+6)
Principles of isometric projection - isometric scale - isometric projections of lines, plane figures, simple solids and truncated solids - prisms, pyramids, cylinders, cones – free hand sketching of orthographic views from isometric views of objects.	
TOTAL (L:30+P:30) : 60 PERIODS	

TEXT BOOKS:

1. K.Venugopal and V.Prabhu Raja, "Engineering Graphics", New Age International (P) Limited, 2022.
2. N.S Parthasarathy and Vela Murali, "Engineering Drawing", Oxford University Press, 2015.

REFERENCES:

1. N.D.Bhatt and V.M.Panchal, "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2014.
2. K.R.Gopalakrishna, "Computer Aided Engineering Drawing" (Vol I and II combined) Subhas Stores, Bangalore, 2017.
3. K. V.Natarajan, "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
4. Luzzader, Warren.J, and Duff, John M, "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production", Eastern Economy Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2005.
5. M.B.Shah and B.C.Rana, "Engineering Drawing", Pearson, 2nd Edition, 2009.

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								1	3	
2	3			3								1	3	
3	3			3								1	3	
4	3			3								1	3	
5	3			3					2			1	3	
CO (W.A)	3			3					2			1	3	

22CYP01 CHEMISTRY LABORATORY (Common to AGRI, BME, CHEM, CIVIL, ECE, EEE and MECH Branches)					
		L	T	P	C
		0	0	2	1
PRE-REQUISITE : NIL					
Course Objective:	• To determine the copper in brass in the given solution and explain the origin of hardness, alkalinity, chloride and dissolved oxygen in water. • To perform a potentiometric, conductometric titration and pH of an acidic solution of known Normality.				

Course Outcomes The Student will be able to		Cognitive Level
CO1	Predict the various water quality parameters by volumetric analysis.	An
CO2	Evaluate the amount of copper in the given solution by titration method.	E
CO3	Analyze the conductance and emf of the different solutions.	An
CO4	Analyze and gain experimental skill about potential of hydrogen ion.	An
CO5	Examine the pH of various acidic, basic and neutral solutions.	An

LIST OF EXPERIMENTS :

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of alkalinity in water sample.
3. Determination of chloride content of water sample by Argentometric method.
4. Determination of DO content of water sample by Winkler's method.
5. Estimation of copper in brass by EDTA.
6. Conductometric titration of strong acid vs strong base.
7. Estimation of iron content of the given solution using potentiometer.
8. Determination of strength of given hydrochloric acid using pH meter.

Total (30 P) = 30 periods

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							
4					3									
5							2							
CO (W.A)					3		2							

*Ratified in Eleventh Academic Council

22GEP01 - ENGINEERING PRACTICES LABORATORY (Common to AGRI, BME, CHEM, CIVIL, ECE, EEE and MECH Branches)				
	L	T	P	C
	0	0	4	2
PRE-REQUISITE : NIL				
Course Objective:	• To provide hands on training on various basic engineering practices in civil engineering • To provide hands on training on welding in mechanical engineering • To provide hands on training on various basic engineering practices in mechanical engineering • To understand the basic working principle of electric components • To understand the basic working principle of electronic components			

Course Outcomes The Student will be able to		Cognitive Level
CO1	Design new layouts of civil work for residential and industrial buildings.	Ap
CO2	Apply the concepts of welding in repairing works and making various components	Ap
CO3	Design new components using machining processes in real life and industries	Ap
CO4	Apply the skills of basic electrical engineering for wiring in different areas and Measure various electrical quantities	Ap
CO5	Apply electronic principles to measure various parameters of a signal.	Ap

GROUP-A (MECHANICAL AND CIVIL ENGINEERING)	
I - CIVIL ENGINEERING PRACTICE	(15)
Buildings: a. Study of plumbing and carpentry components of residential and industrial buildings, Safety aspects	
Plumbing: a. Study of tools and operations b. Hands-on-exercise: External thread cutting and joining of pipes	
Carpentry: a. Study of tools and operations b. Hands-on-exercise: "L" joint and "T" joint	
II - MECHANICAL ENGINEERING PRACTICE	(15)
Welding: a. Study of arc welding, gas welding tools and equipments b. Arc welding- Butt joints, Lap joints and Tee joints c. Practicing gas welding	

Basic Machining: a. Study of lathe and drilling machine b. Facing and turning c. Drilling and Tapping	
Sheet Metal Work: a. Study of tools and operations b. Rectangular tray c. Cone	
GROUP - B (ELECTRICAL AND ELECTRONICS)	
I - ELECTRICAL ENGINEERING PRACTICE	(15)
a. Residential house wiring using Switches ,fuse, indicator, lamp b. Fluorescent lamp wiring c. Stair Case Wiring d. Measurement of electrical quantities – Voltage, current ,power in R Circuit e. Study of Electrical apparatus-Iron box & water heater f. Study of Electrical Measuring instruments- Megger	
II - ELECTRONICS ENGINEERING PRACTICE	(15)
a. Study of Electronic components and various use of multi meter. b. Measurement of AC signal parameter (peak-peak, RMS period, frequency) using CRO. c. Study of logic gates AND, OR, XOR and NOT. d. Study of Clock Signal. e. Soldering practice -Components Devices and Circuits - Using general purpose PCB. f. Study of Half Wave Rectifier (HWR) and Full Wave Rectifier (FWR). g. Study of Telephone, FM Radio and Cell Phone.	
TOTAL (P: 60) = 60 PERIODS	

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	3													
2		3												
3			2											
4	3												1	
5	3												1	
CO (W.A)	3	3	2										1	

22MAN02 - SOFT/ANALYTICAL SKILLS – I (Common to All Branches)				
L	T	P	C	
1	0	2	0	

PRE-REQUISITE : NIL

Course Objective:	• To understand the basic concepts of grammar and apply them in a structured Manner • To solve mathematical problems and thereby reducing the time taken for performing job functions

Course Outcomes The Student will be able to		Cognitive Level	Weightage of Continuous Assessment Test
CO1	Recognize and apply fundamental grammatical rules in both written and spoken contexts.	U	40%
CO2	Solve real-time problems for performing job functions easily.	Ap	30%
CO3	Enhance their aptitude round clearing ability in interview process.	An	30%

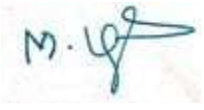
UNIT I – VERBAL ABILITY	(5+10)
Tenses - One Word Substitution- Articles - Preposition - Conjunction	
UNIT II – BASIC APTITUDE	(5+10)
Percentage - Ratio and Proportion - Blood Relations - Analogy	
UNIT III – LOGICAL REASONING	(5+10)
Probability - Profit and Loss - Syllogism - Statement Assumptions.	
TOTAL (L:45) = 45 PERIODS	

REFERENCES:

1. Murphy, Raymond. English Grammar in Use. Fourth Edition, Cambridge University, 2012.
2. Dr. R.S. Aggarwal. A Modern Approach to Verbal & Non-Verbal Reasoning. S Chand and Company Limited, New Delhi, 2014.
3. Aggarwal, Ashish. Quick Arithmetic. S Chand and Company Limited, 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									2	3				
2		2		2										
3		2		2										
CO (W.A)		2		2					2	3				



22MAN03 YOGA – I (For Common To All Branches)				
	L	T	P	C
	0	0	I	0
PRE-REQUISITE : NIL				

Course Objective:	• To make students in understanding the importance of yoga in shaping mental and physical wellness. • To provide awareness about the significance of leading a peaceful life by following yoga exercises and principles. • To develop mental wellbeing through meditation and breathing exercises. • To strengthen the body through physical exercises. • To inculcate the knowledge about different types of Asanas and their benefits

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Understand the importance of yoga for physical and mental goodness.	U	Internal Assessment
CO2	Perform the yoga exercises for hand, leg, eye and sun salutation etc.	Ap	
CO3	Learn and practice meditation techniques for keeping good mental health	Ap	
CO4	Develop their body by performing yoga exercises.	Ap	
CO5	Demonstrate different types of yoga Asanas for improving their personal fitness.	Ap	

UNIT I – INTRODUCTION TO YOGA	(3)
Meaning and Importance of Yoga - Elements of Yoga - Introduction - Asanas, Pranayama, Meditation and Yogic Kriyas - Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana and Shashankasana) - Relaxation Techniques for improving concentration - Yog-nidra.	
UNIT II - YOGA AND LIFE STYLE	(3)
Asanas as Preventive measures – Hypertension:Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana – Obesity: Procedure, Beneits and contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana – Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana - Diabetes: Procedure, Benefits and contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana – Asthema: Procedure, Benfits and contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.	
UNIT III – MIND EXERCISES	(3)
Naadi sudhi – Thanduvada sudhi – Breathing meditation – Silent meditation – Relax meditation.	

UNIT IV – PHYSICAL EXERCISES (PART– I)	(3)
Hand Exercises – Leg Exercises – Eye Exercises – Sun Salutation.	
UNIT V – ASANAS (PART-I)	(3)
Asanas –Tadasana – Yegapadhasana – Chakrasana – Udkaddasana – Thirikosana – Thandasana – Paschimottanasana.	
TOTAL (P:15) : 15 PERIODS	

TEXT BOOKS/REFERENCES:
1. Light On Yoga by B.K.S. Iyengar.

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	2			3		
3								3	2			3		
4								3	2			3		
5								3	2			3		
CO (W.A)								3	2			3		

*Ratified in Eleventh Academic Council

22EYA02- PROFESSIONAL COMMUNICATION- II (Common to All Branches)					
		L	T	P	C
		2	0	2	3
PRE-REQUISITE : 22EYA01					
Course Objective:	• To enhance the students with necessary English language skills • To enable students to communicate effectively in an academic setting				
Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination		
CO1	Frame sentences both in written and spoken forms with accuracy and fluency.	R	20%		
CO2	Use linguistic structures to read and understand well-structured texts encountered in academic or social contexts.	U	20%		
CO3	Gain essential competency to express one's thoughts orally and in writing in a meaningful way.	U	20%		
CO4	Attain and enhance competence in the four modes of literacy: Listening, Speaking, Reading and Writing.	Ap	20%		
CO5	Perform various tasks, such as role plays, debates, group discussions apart from the use of correct spelling and punctuation.	U	20%		

UNIT I - LANGUAGE RUDIMENTS	(6+6)
Grammar – Active and Passive Voice – Impersonal Passive Voice – Numerical Expressions - Listening – Listening for Specific Information and Match / Choose / Fill in the texts - Speaking – Describing a Person - Making Plans -Reading – Intensive Reading -Writing – Job Application with Resume	
UNIT II - RHETORIC ENHANCERS	(6+6)
Grammar – Reported Speech – Infinitive and Gerund - Listening – Listening to Iconic Speeches and making notes - Listening news / documentaries - Speaking –Talking over Phone – Narrating Incidents - Reading – Extensive Reading (Motivational Books) - Writing – Recommendation	
UNIT III - TECHNICAL CORRESPONDENCE	(6+6)
Grammar – If Conditionals – Blended Words - Listening – Listening to business conversation on audio and video of Short Films, News, Biographies - Speaking – Synchronous communication and Asynchronous communication - Opportunities and threats in using digital platform- Reading - Finding key information in a given text - Writing –Netiquettes- Inviting Dignitaries - Accepting & Declining Invitation	
UNIT IV - CORPORATE COMMUNICATION	(6+6)
Grammar – Concord – Compound Words - Listening – Listening to Roles and Responsibilities in Corporate - Listening to technical videos - Speaking – Introduction to Technical Presentation - Story Telling - Reading – Reading and Understanding Technical Articles - Writing – Report Writing (Accident, Survey and feasibility)	

UNIT V - LANGUAGE BOOSTERS	(6+6)
Grammar - Idiomatic Expressions – Relative Clauses – Confusable words - Listening – Listening to different kinds of Interviews - Listening to Group Discussion - Speaking – Group Discussion - Reading – Reading and Interpreting Visual Materials - Writing – Analytical Paragraph Writing	
LIST OF SKILLS ASSESSED IN THE LABORATORY 1. Grammar 2. Listening Skills 3. Speaking Skills 4. Reading Skills 5. Writing Skills	
TOTAL (L:30 , P:30) = 60 PERIODS	

TEXT BOOK:

1. Sudharshana, N.P and Saveetha.C. English for Technical Communication. Cambridge University Press, New Delhi, 2016 (Reprint 2017).

REFERENCES:

1. Rizvi, M Ashraf. Effective Technical Communication. Second Edition, McGraw Hill Education India Pv Ltd, 2017.
2. Rodney Huddleston, Geoffrey K. Pullum and Brett Reynolds. A Student's Introduction to English Grammar. Second Edition, Cambridge University Press, New Delhi, 2022.

WEB REFERENCE:

1. http://youtu.be/URtdGiutVew

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	3				
3									2	3				
4									2	3				
5									2	3				
CO (W.A)									2	3				

22MYB02 – PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES (Common to AGRI,CIVIL,CHEMICAL, MECH Branches)				
	L	T	P	C
	3	1	0	4
PRE-REQUISITE : NIL				
Course Objective:	• To make the conversant with concepts of Laplace transforms, Fourier series, Fourier Transforms to represent periodical physical problems in engineering analysis. • To provide adequate knowledge in partial differential equation and to analyze the boundary value problems.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the various techniques of Fourier series to obtain solution for different functions.	Ap	20%
CO2	Interpret the methods of partial differential equations in fluid mechanics and water resource management.	Ap	20%
CO3	Solve the initial and boundary value problems by using Fourier series.	Ap	20%
CO4	Analyze the concepts of Transform Techniques to solve the problems in stability analysis, Structural Analysis, control system design and analysis.	An	40%
CO5	Demonstrate the importance of Transform Techniques and partial differential equations in engineering using modern tools.	Ap	Internal Assessment

UNIT I – FOURIER SERIES	(9+3)
Dirichlet's condition – Fourier series: Half range sine series – Half range cosine series – Parseval's identity for half range series – Root mean square value of a function – Harmonic analysis.	
UNIT II –PARTIAL DIFFERENTIAL EQUATIONS	(9+3)
Formulation of partial differential equations by eliminating arbitrary constants and functions – Solution of standard types first order partial differential equations of the type f(p,q)=0,Clairaut's form – Lagrange's linear equations –Linear partial differential equation of second and higher order with constant coefficient of homogeneous types.	
UNIT III –APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	(9+3)
Classification of second order quasi linear partial differential equations – Solution of one dimensional wave equation (Zero and non-zero velocity) – One dimensional heat equation (Temperature reduced to zero and non zero boundary conditions) – Steady state solution of two dimensional heat equation(Finite and infinite plate).	

UNIT IV –-FOURIER TRANSFORM	(9+3)
Fourier integral theorem(Statement only) – Fourier transform pair - Sine and Cosine transforms – Properties -Transforms of simple functions – Convolution theorem – Parseval's identity(Excluding proof).	
UNIT V –LAPLACE TRANSFORM	(9+3)
Condition for existence - Transforms of Elementary functions –Basic Properties- First & Second Shifting Theorems(Statement only) - Initial and Final value Theorems. Inverse Laplace transforms -Convolution theorem (Excluding proof)- Solution of linear second order ordinary differential equations with constant coefficients using Laplace transform.	
TOTAL (L:45+T:15) : 60 PERIODS	

TEXT BOOKS:

1. Veerarajan.T, "Engineering Mathematics (for semester III), 3rd ed., Tata McGraw Hill, New Delhi.
2. Kandasamy.P, Thilagavathy.K, and Gunavathy.K., "Engineering Mathematics; Volume III", S.Chand&Coltd., 2008.
1. GrewalB.S,"Higher Engineering Mathematics", 42nd ed., Khanna publishers, New Delhi, 2012.

REFERENCES:

1. Goyal Manish and Bali.N.P,"A Text book of Engineering mathematics", 6th ed.,Laxmi Publication (P) Ltd,New Delhi, 2012.
2. Kreyszig, Erwin,"Advanced Engineering Mathematics", 9th ed., Wiley Publications, New Delhi, 2006.

Singaravelu.A,"Transforms and Partial Differential Equations", Reprint Edition 2013, Meenakshi Publications, Tamilnadu.

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	3													
4	3													
5	3				2				3			3		
CO (W.A)	3	2			2				3			3		

*Ratified in Eleventh Academic Council

22PYB02 - ADVANCED MATERIALS AND NANO TECHNOLOGY (Common to CIVIL, CHEM & AGRI)				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: Nil

Course Objective:	• To gain adequate information about the properties of matter and nanomaterial's. • To expose the concepts of Photonics, fiber optics and Advanced new engineering materials.

Course Outcomes The student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Correlate the stress and strain ratio to apply the elasticity for spring materials.	An	20%
CO2	Discriminate the thermal conductivity of the medium to employing in instrument applications.	An	20%
CO3	Articulate the role of nanotechnology in environmental sustainability for the field of agriculture.	Ap	20%
CO4	Operate the optical fibers in sensor devices.	Ap	20%
CO5	Appraise the classification of composites in the applications of aerospace components, automotive parts, and sports equipment.	Ev	20%

UNIT I -PROPERTIES OF MATTER	(9)
Elasticity – Hooke's law Stress-strain diagram and its uses – factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple – torsion pendulum: theory and experiment - bending of beams – bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment – I-shaped girders - stress due to bending in beams.	
UNIT II -THERMAL PHYSICS	(9)
Mode of heat transfer-thermal conductivity-Newton 's law of cooling –thermal conduction through compound media (bodies in series and parallel) – Thermal conductivity of a good conductor – Forbe's method - Thermal conductivity of bad conductor – Lee's disc – Hazards– Cyclone and flood hazards – Fire hazards and fire protection, fire – proofing of materials, fire safety regulations and firefighting equipment. Prevention and safety measures.	
UNIT III -SYNTHESIS AND PROPERTIES OF NANOSTRUCTURES	(9)
Introduction to Nanoscience – Types of nanostructure and properties of Nanomaterials – Synthesis and preparation of Nanomaterials – Nanosensors – Biosensors – Nanoscience and Environment.	
UNIT IV -PHOTONICS AND FIBER OPTICS	(9)
Photonics: Population of energy levels – Einstein's A and B coefficients derivation – Resonant cavity – Types of lasers – solid state laser (Neodymium) – gas laser (CO_2) Applications of lasers in science – Engineering – Medicine.	

Fibre optics: Principle, numerical aperture and acceptance angle - Types of optical fibres (Material, refractive index and mode) -Losses in optical fibre - Fibre optic communication Fibre optic sensors (pressure and displacement).	
UNIT V -ADVANCED NEW ENGINEERING MATERIALS	(9)
Ceramics - Types and applications - Composites: classification, role of matrix and reinforcement, processing of fiber reinforced plastics - Metallic glasses: types, glass forming ability of alloys, melt spinning process, applications - Shape memory alloys: phases, shape memory effect, pseudoelastic effect, NiTi alloy and application - Bio material - applications.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Dattu prasad, Ramanlal Joshi, "Engineering Physics" Tata McGraw hill education, 2019.
2. V.Rajendran, — Engineering Physics, Tata McGraw-Hill. New Delhi.2017.
3. Marikani, "Materials Science", PHI Learning Private Limited, Eastern Economy Edition, 2018.

REFERENCES:

1. Subrahmanyam N, Brijlal, "A Text Book of Optics" S.Chand & Co. Ltd, New Delhi, 2017.
2. Kongbam chandramanisingh, "Basic Physics", PHI, 2018.
3. M.N.Avathanalu, P.G.Kshirsagar "A text book of engineering physics" S.Chand & company Ltd, 2017.

WEB LINKS:

1. https://bayanbox.ir/view/7764531208313247331/Kleppner-D.-Kolenkow-R.J.-Introduction-to-Mechanics-2014.pdf.
2. https://physicaeducator.files.wordpress.com/2017/11/electricity_and_magnetism-by-purcell-3ed-ed.pdf.
3. https://rajeshvcet.home.blog/regulation-2021/ph3151-engineering-physics-study-materials/
4. https://zenodo.org/record/243407#.ZEgPZXZBzIU
5. https://farside.ph.utexas.edu/teaching/qmech/qmech.pdf.
6. https://web.pdx.edu/~pmoeck/phy381/workbook%20nanoscience.pdf.

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						2							
4	3		2											
5	3					2	2					2		
CO	3	2	2	0	0	2	2	0	0	0	0	2	0	0

22CYB06 - ENVIRONMENTAL SCIENCE AND SUSTAINABILITY (Common to CHEM-2nd, BME-3rd, ECE-5th AND EEE-4th SEM)				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To impart knowledge on ecosystem, biodiversity, environmental pollution and familiarize about sustainable development, carbon credit and green materials. • To make the students conversant with the global and Indian scenario of renewable resources, causes of their degradation and measures to preserve them.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Illustrate the values and conservation methods of biodiversity.	Ap	20%
CO2	Predict the causes, effects of environmental pollution and contribute the preventive measures to the society.	An	20%
CO3	Analyze the renewable and non-renewable resources and preserve them for future generations.	An	20%
CO4	Examine the different goals of sustainable development and apply them for suitable technological advancement and societal development.	Ap	20%
CO5	Execute the sustainability practices, identify green materials and energy cycles.	E	20%

UNIT I - ENVIRONMENT AND BIODIVERSITY	(9)
Environment - scope and importance - Eco-system- Structure and function of an ecosystem - types of biodiversity- genetic - species and ecosystem diversity– Values of biodiversity - India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity - habitat loss - poaching of wildlife - man-wildlife conflicts – endangered and endemic species of India – Conservation of biodiversity - In-situ and ex-situ.	
UNIT II - ENVIRONMENTAL POLLUTION	(9)
Pollution – Causes - Effects and Preventive measures of Water – Soil - Air - Noise Pollution - Solid waste management - methods of disposal of solid waste – various steps of Hazardous waste management - E-Waste management - Environmental protection – Air acts – water acts.	
UNIT III - RENEWABLE SOURCES OF ENERGY	(9)
Energy management and conservation -New Energy Sources - Different types new energy sources – Hydrogen energy – Geothermal energy - Solar energy – wind energy – biomass energy - Applications of Hydrogen energy - Ocean energy resources -Tidal energy conversion.	

UNIT IV – SUSTAINABILITY AND MANAGEMENT	(9)
Development – Factors affecting development – advantages – disadvantages – GDP - Sustainability- needs – concept - from unsustainability to sustainability - millennium development goal - Sustainable Development goals - Climate change – Concept of carbon credit – carbon footprint - Environmental management.	
UNIT V – SUSTAINABILITY PRACTICES	(9)
Zero waste and R concept - ISO 14000 Series - Environmental Impact Assessment - Sustainable habitat - Green buildings - Green materials- Sustainable energy - Non-conventional Sources - Energy Cycles- carbon cycle and carbon emission - Green Engineering - Sustainable urbanization.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Dr. A.Ravikrishan, Envrionmental Science and Engineering. Sri Krishna Hitech Publishing Co. Pvt.Ltd., Chennai,15thEdition, 2023.
2. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers , 2018.

REFERENCES:

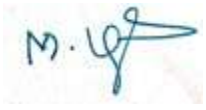
1. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
2. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

WEB LINKS:

1. http://www.jnkvv.org/PDF/080420202015128Amit1.pdf
2. https://www.conserve-energy-future.com/types-of-renewable-sources-of-energy.php
3. https://ugreen.io/sustainability-engineering-addressing-environmental-social-and-economic-issues/

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							
3	2		2					2						
4							3							
5						3						2		
CO (W.A)	2	2	2			3	3	2				2		



*Ratified in Eleventh Academic Council

22CSC01 - PROBLEM SOLVING AND C PROGRAMMING (Common to All Branches)					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : NIL					
Course Objectives:	To equip students with the essential skills and knowledge to solve computational problems using the C programming language.				
Course Outcomes The student will be able to		Cognitive Level	Weightage of COs in End Semester Examination		
CO1	Apply basic syntax and semantics of C language to write clear and structured code.	Ap	20%		
CO2	Make use of both conditional statements and iterative control structures for developing applications.	Ap	20%		
CO3	Apply knowledge of arrays and strings to solve computational problems.	Ap	20%		
CO4	Identify modular solutions that integrate problem-solving techniques to solve complex computational problems.	An	20%		
CO5	Analyze the performance implications using pointers and to manage file operations efficiently.	An	20%		

UNIT I -PROBLEM SOLVING AND C PROGRAMMING BASICS	(9)
General Problem Solving: Algorithms, Flowcharts and Pseudo-codes, implementation of algorithms Basics o C Programming : Introduction to C - Structure of C program - Programming Rules –Compilation – Errors - C Declarations: Tokens - keywords - identifiers - constants - data types - variable declaration and initialization - type conversion - constant and volatile variables - operators and expressions.	
UNIT II - DECISION CONTROL STATEMENTS	(9)
Managing Input and Output operations, Decision Control Statements: Decision control statements, Selection/conditional branching Statements: if, if-else, nested if statements. Basic loop Structures/Iterative statements: while loop, for loop, selecting appropriate loop. Nested loops break and continue statements.	
UNIT III - ARRAYS AND STRINGS	(9)
Introduction to Array - Definition - Array initialization - Characteristics - One Dimensional Array - Array operations -Two dimensional arrays -Strings and String handling functions.	
UNIT IV - FUNCTIONS	(9)
Functions: Basics - definition - Elements of User defined Functions - return statement, Function types, Parameter Passing Techniques, Function returning more values - Passing Array to Functions - Recursion - Storage classes.	

UNIT V - POINTERS AND FILE MANAGEMENT	(9)
Pointer concepts - Pointers & Arrays, Structure concepts - Defining, Declaring, Accessing Member Variables, Structure within Structure - Union - File Management in C- Dynamic Memory Allocation	
TOTAL (L:45) :45 PERIODS	

TEXT BOOKS:

1. Ashok N. Kamthane, "Programming in C", 2nd Edition, Pearson Education, 2013.
2. Sumitabha Das, "Computer Fundamentals and C Programming", 1st Edition, McGraw Hill, 2018.

REFERENCES:

1. R. G. Dromey, "How to Solve it by Computer", Pearson Education India; 1st Edition, ISBN10: 8131705625, ISBN-13: 978-8131705629
2. Maureen Spankle, "Problem Solving and Programming Concepts", Pearson; 9th Edition, India, ISBN-10: 9780132492645, ISBN-13: 978- 0132492645
3. Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2018.
4. Reema Thareja., "Programming in C ", 2nd Edition, Oxford University Press, New Delhi, 2018.
5. Balagurusamy E., "Programming in ANSI C", 7th Edition, Mc Graw Hill Education, 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												3	
2	3												3	
3	3											3	3	
4		3										3	3	
5		3											3	2
CO (W.A)	3	3										3	3	2

*Ratified in Eleventh Academic Council

22CHC01 FUNDAMENTALS OF CHEMICAL ENGINEERING				
L	T	P	C	
3	0	0	3	
PRE-REQUISITE : NIL				
Course Objective:	• To understand the Fundamentals and basic concepts of Chemical Engineering.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the concepts and basics of unit operations and unit processes in design calculations.	Ap	30%
CO2	Apply the knowledge of mass and energy balances in process plant.	Ap	30%
CO3	Apply the principles of chemical Engineering processes and operations to solve problems in process industries.	Ap	20%
CO4	Apply knowledge to relate the chemical processes and operations involved in the process industries.	Ap	20%
CO5	Engage in effective written communication through assignments/poster presentation on the applications of fluid mechanics, mechanical operations, heat and mass transfer and process calculations	U	Internal Assessment

UNIT I: BASICS OF CHEMICAL PROCESS INDUSTRIES	(9)
Unit process and Unit Operations concepts- Outlines of Unit process- Calcination, Carbonylation, Combustion, Hydration, dehydration, Hydrolysis, Nitration, Sulfonation, Polymerization – Addition and Condensation Polymerization.	
UNIT II: FUNDAMENTALS OF FLUID MECHANICS	(9)
Definition of fluids, Types of Fluids -compressible and incompressible fluids, Ideal and Real fluids. Physical properties of fluids-density, specific weight, specific volume, specific gravity, viscosity and vapor pressure. Pressure Measurement – Simple U-tube Manometer. Dimensionless Number–Reynolds number. Osborne Reynolds experiment – Laminar flow and Turbulent flow	
UNIT III: FUNDAMENTALS OF MECHANICAL OPERATIONS	(9)
Size reduction-Crushing and Grinding Equipment's and Uses, Solid - fluid Separations Equipment and Industrial uses, Gas-solid Separations Equipment and Industrial uses. Solid handling - Conveyors types and uses.	
UNIT IV: BASICS OF HEAT AND MASS TRANSFER	(9)
Heat Transfer –Modes of heat transfer-Principles of Conduction, Convection and Radiation. Definition of Boiling and Condensation. –Heat Transfer equipment's - Exchanger, Reboiler and Evaporator. Concept of Mass Transfer Operations - Diffusion, Humidification, Drying, Distillation, Absorption, Extraction, Leaching, Adsorption with examples.	

UNIT V: BASICS OF CHEMICAL PROCESS CALCULATIONS	(9)
Basic concepts: Units and Dimensions, systems of units, conversion and conversion factors of units, Basic chemical principles - Atomic weight , Molecular weight, Basis of calculation, concept of Mole, Mole fraction ,Mole percent, Weight percent, simple problems. Simple material balance calculations on drying, evaporation, distillation, absorption and Extraction	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Dryden's Outlines of Chemical Technology for the 21st Century – Gopal Rao & Sittig 3rd Edition-Affiliated East West Press Pvt.Ltd, New Delhi.
2. Venkataramani V, Anantharaman N. and Meera Sheriffa Begum K.M, Process Calculation ", 2nd edition, Prentice Hall of India , New Delhi ,2011.
3. McCabe, W.L., Smith, J. C. and Harriot, P. "Unit operations in Chemical Engineering", McGraw Hill, 7th Edition, 2001.

REFERENCES:

1. Salil K. Ghosal, Siddhartha Datta "Introduction to Chemical Engineering" Tata McGraw Hill Education.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 6th Edition, Tata McGraw Hill, 1997.
3. Randolph Norris Shreve, George T. Austin, "Shreve'e Chemical Process Industries", 5th edition, McGraw Hill, 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	3												3	
3	3												3	
4	3													
5										3				
CO (W.A)	3									3			3	

22PYP01 - PHYSICS LABORATORY (Common to All Branches)					
		L	T	P	C
		0	0	2	1
PRE-REQUISITE : 22CHC09					
Course Objective:	• To infer the practical knowledge by applying the experimental methods to correlate with the Physics theory. • To introduce different experiments to test basics of physics concepts applied in optics and electronics				
Course Outcomes The Student will be able to		Cognitive Level			
CO1	Examine the effects of material type and loading conditions on the results of the non-uniform bending experiment.	An			
CO2	Utilize principles of light interaction to determine the particle size of materials using laser diffraction techniques.	Ap			
CO3	Evaluate the accuracy of the wavelength of different colors with the accepted values in the literature	Ev			
CO4	Measure the effectiveness of the solar cell based on its V-I characteristics.	Ev			
CO5	Analyze the principles underlying the Air wedge method for the determination of the thickness of a thin wire,	An			

LIST OF EXPERIMENTS:

1. Determination of Young's modulus by non-uniform bending method
2. Determination of (a) wavelength and (b) particle size using Laser.
3. Determination of thermal conductivity of a bad conductor – Lee 's Disc method.
4. Determination of wavelength of mercury spectrum – spectrometer grating
5. Determination of band gap of a semiconductor.
6. Determination of thickness of a thin wire – Air wedge method.
7. Determination of V-I characteristics of solar cell.

TOTAL (P:30) = 30 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	-	-	-	-	-	-	-	-	-	-	-	-
2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
4	3	-	-	-	-	-	-	-	-	-	-	2	-	-
5	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO	3	3	0	0	0	0	0	0	0	0	0	2	0	0

*Ratified in Eleventh Academic Council

22CSP01 - PROBLEM SOLVING AND C PROGRAMMING LABORATORY (Common to All Branches)					
		L	T	P	C
		0	0	4	2
PRE-REQUISITE : NIL					
Course Objective:	To develop programs to solve basic problems by understanding basic concepts in C language				
Course Outcomes The student will be able to		Cognitive Level			
CO1	Formulate the algorithms for simple problems	Ap			
CO2	Apply the concept of pointers of different types	Ap			
CO3	Apply and manipulate data with arrays, strings and structures	Ap			
CO4	Apply the concept of functions and dynamic memory allocation	Ap			
CO5	Analyse and correct logical errors encountered during execution	An			

C-Programming:

1. Draw the flowchart for the following using Raptor tool.
    a) Simple interest calculation
    b) Greatest among three numbers
    c) Find the sum of digits of a number
2. Programs for demonstrating the use of different types of operators like arithmetic, logical, relational and ternary operators (Sequential and Selection structures)
3. Programs for demonstrating repetitive control statements like 'for', 'while' and 'do-while' (Iterative structures)
4. Programs for demonstrating one-dimensional and two-dimensional numeric array
5. Programs to demonstrate modular programming concepts using functions
6. Programs to implement various character and string operations with and without built-in library functions.
7. Programs to demonstrate the use of pointers
8. Programs to illustrate the use of user-defined data types
9. Programs to implement various file management.
10. Program Using Dynamic memory allocation functions

HARDWARE / SOFTWARE REQUIRED FOR A BATCH OF 30 STUDENTS:
Hardware: • LAN System with 33 nodes (OR) Standalone PCs – 33 Nos. • Printers – 3 Nos. Software: • RAPTOR Tool • Compiler – C
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												3	
2	3												2	
3	3												2	
4	3												2	
5		3			2							2	3	
CO (W.A)	3	3			2							2	2.4	

*Ratified in Eleventh Academic Council

22MAN04 - SOFT/ANALYTICAL SKILLS – II (Common to All Branches)				
	L	T	P	C
	1	0	2	0
PRE-REQUISITE : NIL				
Course Objective:	• To acquire satisfactory competency in verbal reasoning. • To develop skill to meet the competitive examinations for better job opportunity.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of Continuous Assessment test
CO1	Enhance vocabulary which in turn will help in developing language competency.	U	40%
CO2	Solve the problems easily by using Short-cut method with time management.	Ap	30%
CO3	Analyze the problems logically and approach the problems in a different manner.	An	30%

UNIT I - VERBAL COMPETENCY	(5+10)
Voice - Modal Verbs - Synonyms & Antonyms - Confusable Words	
UNIT II - NUMERICAL REPRESENTATION	(5+10)
Average - Data Interpretation - Simple Interest and Compound Interest - Venn Diagram.	
UNIT III - RESOLUTION TENDENCY	(5+10)
Time and Work - Pipes and Cistern - Number Series and Odd man Out - Cube Problems	
TOTAL (L:45) = 45 PERIODS	

REFERENCES:

1. Murphy, Raymond. English Grammar in Use. Fourth Edition, Cambridge University, 2012.
2. Dr. R.S. Aggarwal. A Modern Approach to Verbal & Non-Verbal Reasoning. S Chand and Company Limited, New Delhi, 2014.
3. Aggarwal, Ashish. Quick Arithmetic. S Chand and Company Limited, 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									2	3				
2		2		2										
3		2		2										
CO (W.A)		1		1					1	1				

22MAN05 - YOGA – II (For Common To All Branches)				
	L	T	P	C
	0	0	I	0

PRE-REQUISITE : NIL

Course Objective:	• To strengthen the body through physical exercises. • To understand the importance of value system and ethics. • To know the life philosophy of yogis and maharishis. • To understand the nature laws, cause and effect theory. • To inculcate knowledge about different types of Asanas and their benefits.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Perform physical exercises like spine exercises, massage and acupressure.	Ap	Internal Assessment
CO2	Learn the human values, ethics, time management and the importance of introspection.	U	
CO3	Analyze various life philosophies of yogi's and rishi's.	An	
CO4	Understand life lessons and nature laws.	U	
CO5	Demonstrate different types of yoga Asanas and improve their personal fitness.	Ap	

UNIT I – PHYSICAL EXCERCISES (PART-II)	(3)
Breathing Exercises – Kapalapathi – Maharasanam (Spine Exerices) – Massage and Acupressure.	
UNIT II – HUMAN VALUE	(3)
Divine power – Life force (Bio magnetism) – Importance of Introspection – Time management – Punctuality – self-confidence – mind control.	
UNIT III – PHILOSOPHY OF LIFE	(3)
Basic needs for life – Hunger and thirst – climatic/weather changes – Body wastes – pressure of excretory organs – safety measures – protection from natural disaster – protection from enmity – protection from accidents – ethics – morality – duty – charity – Wisdom of perfection stages – faith – understanding – realization.	
UNIT IV – NATURE'S LAW OF CAUSE AND EFFECT	(3)
Food transformation into seven minerals – Natural actions – pattern – precision – regularity – Required skills – planned work – awareness – introspection.	

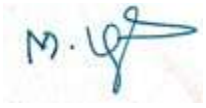
UNIT V – ASANAS (PART-II)	(3)
Ustrasana – Vakrasana –Komugasana – Padmasana – Vajrasana – Sukhasana – Yogamudra – mahamudra.	
TOTAL (P:15) : 15 PERIODS	

TEXT BOOKS/REFERENCES:
1. Light On Yoga by B.K.S. Iyengar.

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	2			3		
3								3	2			3		
4								3	2			3		
5								3	2			3		
CO (W.A)								3	2			3		

*Ratified in Eleventh Academic Council



22GYA01 HERITAGE OF TAMILS *(For Common To All Branches)*				
	L	**T**	**P**	**C**
	I	**0**	**0**	**I**
PRE REQUISITE : NIL				

UNIT I - LANGUAGE AND LITERATURE	**(3)**
Language Families in India - Dravidian Languages – Tamil as aClassical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.	
UNIT II - HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE	**(3)**
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.	
UNIT III - FOLK AND MARTIAL ARTS	**(3)**
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.	
UNIT IV - THINAI CONCEPT OF TAMILS	**(3)**
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.	
UNIT V - CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE	**(3)**
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.	
TOTAL (L:15) : 15 PERIODS	

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் –கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல.சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22GYA01 தமிழர் மரபு (அனைத்து பாடப்பிரிவினருக்கும்)				
	L	T	P	C
	1	0	0	1
முன் தேவை: இல்லை				

அலகு 1 மொழி மற்றும் இலக்கியம்	(3)
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை– சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.	
அலகு 2 மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக்கலை:	**(3)**
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள்– தேர் செய்யும் கலை– சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.	
அலகு 3 நாட்டுப்பறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:	**(3)**
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டாம், தோல்பாவைக்கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.	
அலகு 4 தமிழர்களின் திணைக் கோட்பாடுகள்:	**(3)**
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளின் சோழர்களின் வெற்றி.	
அலகு 5 இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:	**(3)**
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் –இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு, கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ் புத்தக்களின் அச்சு வரலாறு.	
TOTAL (L:15) : 15 PERIODS	

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் –கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல.சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
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10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22GYA02 TAMILS AND TECHNOLOGY *(For Common To All Branches)*				
	L	**T**	**P**	**C**
	I	**0**	**0**	**I**
PRE REQUISITE : NIL				

UNIT I - WEAVING AND CERAMIC TECHNOLOGY	**(3)**
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.	
UNIT II - DESIGN AND CONSTRUCTION TECHNOLOGY	**(3)**
Designing and Structural construction House & Designs n household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.	
UNIT III - MANUFACTURING TECHNOLOGY	**(3)**
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.	
UNIT IV - AGRICULTURE AND IRRIGATION TECHNOLOGY	**(3)**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.	
UNIT V - SCIENTIFIC TAMIL & TAMIL COMPUTING	**(3)**
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.	
TOTAL (L:15) : 15 PERIODS	

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் –கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல.சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22GYA02 தமிழரும் தொழில்நுட்பமும் (அனைத்து பாடப்பிரிவினருக்கும்)				
	L	T	P	C
	I	0	0	I
முன் தேவை: இல்லை				

அலகு 1 நெசவு மற்றும் பானைத் தொழில்நுட்பம்:	(3)
சங்ககாலத்தில் நெசவுத்தொழில் – பானைத் தொழிலநுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.	
அலகு 2 வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:	**(3)**
சங்ககாலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் மற்றும் சங்ககாலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு – சங்ககாலத்தில் கட்டுமான பொருட்களும் நடுக்கல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ–சாரோசெனிக் கட்டிடக் கலை.	
அலகு 3 உற்பத்தி தொழில் நுட்பம்:	**(3)**
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எக்கு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.	
அலகு 4 வேளாண்மை மற்றும் நீர்பாசனத் தொழில் நுட்பம்:	**(3)**
அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.	
அலகு 5 அறிவியல் தமிழ் மற்றும் கணித்தமிழ்:	**(3)**
அறிவியல் தமிழின் வளர்ச்சி – கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின் பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.	
TOTAL (L:15) : 15 PERIODS	

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் –கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல.சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22MYB03 – STATISTICS AND NUMERICAL METHODS (Common to AGRI, AI&DS,CSE,IT,IOT,CS(Cyber security)CIVIL,CHEMICAL,EEE,MECH Branches)				
	L	T	P	C
	3	I	0	4
PRE-REQUISITE : NIL				
Course Objective:	• To understand the concept of testing of hypothesis for small and large samples and design of experiments. • To provide adequate knowledge in numerical techniques to solving ordinary differential equations and numerical integration which plays an important role in engineering and technology disciplines.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Interpret the principles and techniques in experimental design to solve the variance	Ap	20%
CO2	Apply the fundamental numerical techniques used to solve various types of mathematical problems on solution of equations, interpolation and numerical integration.	Ap	40%
CO3	Determine the statistics based on the data and related to the testing of hypothesis.	An	20%
CO4	Solve the real-world problems using numerical methods for IVPs, demonstrating their applicability and limitations.	Ap	20%
CO5	Demonstrate the importance of interpolation and approximation techniques to solve real-world problems in various disciplines of Engineering using modern tools.	Ap	Internal Assessment

UNIT I - TESTING OF HYPOTHESIS	(9+3)
Sampling Distributions-Tests for single mean, difference of means (Large and Small samples) Using z ,t - distribution, F – distribution- Chi-square - Test for independence of attributes and Goodness of fit.	
UNIT II - DESIGN OF EXPERIMENTS	(9+3)
Analysis of variance- Completely randomized design - Randomized block design - Latin square design.	
UNIT III - SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS	(9+3)
Solution of algebraic and transcendental equations - Fixed point iteration method - Newton Raphson method- Solution of linear system of equations Gauss elimination method – Iterative methods of Gauss Jacobi and Gauss Seidel Methods– Eigenvalues of a matrix by Power method .	

UNIT IV - INTERPOLATION AND APPROXIMATION	(9+3)
Lagrange's and Newton's divided difference interpolations - Newton's forward and backward difference interpolation - Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules -Romberg's Methods.	
UNITV - NUMERICAL DIFFERENTIATION AND INTEGRATION	(9+3)
Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge - Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.	
TOTAL (L:45+T:15) : 60 PERIODS	

TEXT BOOKS:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
3. Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.

REFERENCES:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 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													
2	3													
3		2												
4	3													
5	3				2				3			2		
CO (W.A)	3	2			2				3			2		

22MEC08- BASICS OF MECHANICAL ENGINEERING (Chemical Engineering only)				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PREREQUISITE : Nil

Course Objective:	• To acquire knowledge on the effect of pressure and temperature on gases • To introduce the properties of steam and energy conservation opportunities in steam systems • To introduce types of boilers, mounting and accessories • To acquire knowledge of turbines and vacuum systems • To know about basic machine elements parts and its functions

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the effect of pressure and temperature on gases	Ap	30%
CO2	Identify energy conservation opportunities by analyzing the steam distribution and utilization systems.	An	20%
CO3	Analyze the fundamentals of boilers and calculate boiler efficiency using simple calculations.	An	20%
CO4	To comprehend, apply the principles of steam turbines and calculate turbine efficiency.	Ap	30%
CO5	Identify the parts and comprehend the functions of basic machine elements.	U	Internal Assessment

UNIT I - HEATING AND EXPANSION OF GASES	**(9)**
Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.	
UNIT II - PROPERTIES OF STEAM	**(9)**
Properties of steam, Mollier chart, dryness fraction of steam- Different types of calorimeters. Concept of Steam distribution systems. Steam traps- types and their characteristics. Energy conservation opportunities in steam systems.	
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 of boilers.	
UNIT IV - TURBINES AND VACUUM SYSTEMS	**(9)**
Steam turbines- types and working principles: Reaction and impulse turbines; Application of co-generation principles in process industries. Gas turbines- principle and working. Production of Vacuum: Systems and Equipment- Vacuum Pumps, Steam Ejectors; Instrumental methods of Vacuum measurement.	

UNIT V – BASIC MECHINE ELEMENTS	(9)
Gears (Terminology, spur, helical and bevel gear, gear train) Belt drives. Robe drives, Chain drives - types and its applications. Simple problems.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Rajput R.K., "Thermal Engineering", 10th Edition, Laxmi Publications, 2010.
2. Rudramoorthy R., "Thermal Engineering", 4thEdition, Tata McGraw Hill PublishingCompany, New Delhi, 2006.
3. Kumar. T, LeenusJesu Martin and Murali. G., "Basic Mechanical Engineering", Suma Publications, Chennai, 2007.

REFERENCES:

1. Kothandaraman, C.P., Domkundwar and Domkundwar, "Course in Thermodynamics and Heat Engines", 3rdEdition, DhanpatRai& Sons, New Delhi, 2011.
2. Ballaney P.L., "Thermal Engineering", Khanna Publishers, 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												1	1
2		3											1	
3		3												
4	3												1	
5												2	1	
CO (W.A)	3	3										2	1	1

22CHC02 CHEMICAL ENGINEERING FLUID MECHANICS					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : 22CHC01					
Course Objective:	• To use important concepts of continuity equation, Bernoulli's equation and turbulence, and apply the same to problems				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply basic principles of pressure & conservation laws to solve fluid flow problems	Ap	20%
CO2	Develop correlations / solutions for flow processes that meet specific needs	An	20%
CO3	Categorize the equipments used to transport the fluids	Ap	30%
CO4	Estimate energy requirements and losses in transportation and metering of fluids.	An	30%
CO5	Engage in independent study to make oral presentation on topic related to the course	U	Internal Assessment

UNIT I - FLUID STATICS AND DIMENSIONAL ANALYSIS	(9)
Introduction to Fluid statics, properties and Based problems; Hydrostatic equation and its applications; Pressure measurement – Manometers and its types - Decanters; Units and Dimensions; Dimensional analysis – Models and Similitude –Types and principles of Similarity;	
UNIT II - FLOW THROUGH CONDUITS	(9)
Types of flow – Shear stress distribution - Laminar and turbulent flow in pipes; Friction factor - Moody Chart – Losses in piping system; Introduction to Boundary layer; Flow through non-circular conduits; Basic equations - Continuity equation - Bernoulli's equation and its applications;	
UNIT III - FLOW AROUND SOLIDS	(9)
Drag and its types - Drag coefficient; Industrial applications of Packed and fluidized bed - Packing materials; Pressure drop across packed bed - Ergun's equation; Fluidization and its classification - Pressure drop across the fluidized bed – Minimum fluidization velocity- Motion of particles through fluids – Terminal settling velocity;	
UNIT IV - FLOW METERING	(9)
Classification and Selection of flow meters; Principle, working and applications of Venturimeter, Orificemeter, rotameters and pitot tube; Determination of discharge coefficient; Other meters: Anemometer - Mass flow meter - High viscous flow meter; Notches and weirs;	

UNIT V - FLUID MOVING MACHINERY	(9)
Classification and selection of fluid moving machinery; Principle, working and applications of Centrifugal pump and Reciprocating pump - Characteristics curves of centrifugal pump; Elementary principles of gear, air lift, diaphragm and submersible pumps; Types and application of valves and pipe fittings;	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Dr. R.K.Banzal ,"A Textbook of Fluid Mechanics and Hydraulic Machines , 9th edition. 2010.
2. McCabe W.L, Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw Hill International Edition, New York, 2006.
3. Noel De Nevers, "Fluid Mechanics for Chemical Engineers", 3rd Edition, McGraw Hill, New York, 2004.

REFERENCES:

1. Cengel, Yunus and Cimbala John M, "Fluid Mechanics Fundamentals and Applications", 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2006
2. J.M. Coulson and J.F. Richordson, "Chemical Engineering Vol - I & II", 6th Edition Butterworth – New Delhi-2000.

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		
CO (W.A)	3	3										3	3	

22CHC03 - CHEMICAL PROCESS CALCULATIONS					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : 22CHC01					
Course Objective:	• To know basic idea of chemical process calculations. • To gain fundamental knowledge on material balance and energy balance in process industry • To know the methods of identifying composition of liquids and gases.				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply composition of mixtures/solution and determine Pressure, volume and temperature of glass using equation of state	Ap	20%
CO2	Apply the law of conversion of mass and energy for different batch and continues unit operations	Ap	40%
CO3	Apply the law of conversion of mass for unit processes and evaluate yield, conversion, recycle ratio/purge/bypass of chemical reactors	Ap	20%
CO4	Apply knowledge on analysis of gas, liquid and solids	Ap	20%
CO5	Prepare a report as per the norms on analysis of gas, liquid and solids	U	Internal Assessment

UNIT I - BASIC CHEMICAL CALCULATIONS	(9)
Methods of expression; the ideal gas law; calculation of pressure, volume and temperature using ideal and Vander Waals equations. Use of partial pressure and pure component volume in gas mixture calculations; average molecular weight of gas mixture; density of gas mixture;	
UNIT II - MATERIAL BALANCE WITHOUT CHEMICAL REACTION	(9)
Stoichiometric principles, application of material balance to unit operation like Distillation, Evaporation, Crystallization, Drying, Extraction, Mixing/Blending and Absorption. Humidification and dehumidification basic concepts -calculation of absolute molal, relative and percentage humilities; Use of psychometric chart;	
UNIT III - MATERIAL BALANCE WITH CHEMICAL REACTION	(9)
Material balance for the systems involving chemical reaction; limiting and excess reactants- yield and selectivity. Bypass, recycle and purging.	
UNIT IV – ENERGY BALANCE	(9)
Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy. Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction. - Energy balance for systems with and without chemical reaction - Unsteady state energy balances	

UNIT V – COMBUSTION AND FLUE GAS ANALYSIS	(9)
Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from Orsat technique, problems on sulphur and sulphur burning compounds	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Bhatt B.L and Thakore S.B, "Stoichiometry", 5th edition, Tata McGraw Hill publishing company, New Delhi, 2017.
2. Venkataramani V, Anantharaman N. and Meera Sheriffa Begum K.M, "Process Calculation", 2nd edition, Prentice Hall of India , New Delhi ,2011.

REFERENCES:

1. Himmelblau D.M, "Basic Principle and calculation in Chemical Engineering", 8th edition, Prentice Hall of India, New Delhi, 2013.
2. Richard M. Felder Ronald W .Rousseau, "Elementary Principles of Chemical Process", 3rd edition, 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											3	
5		3				3								1
CO (W.A)	3	3				3							3	1

22CHC04 UNIT PROCESSES FOR CHEMICAL ENGINEERS					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : NIL					
Course Objective:	• Learn various reaction mechanisms, preparation of organic compounds and their properties. • Highlights the synthesis of industrially important organic compounds				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the principles of the various unit process in synthesis of organic compounds	Ap	20%
CO2	Analyze of different chemical reaction and reaction conditions	An	20%
CO3	Apply the knowledge of reaction schemes and mechanisms for a reaction used in organic synthesis	Ap	40%
CO4	Apply the knowledge about the synthesis of chemicals in industries	Ap	20%
CO5	Engage in independent study to make oral presentation on assigned topic related to the course	U	Internal Assessment

UNIT I : NITRATION AND AMINATION	(9)
Principle of Nitration, nitrating agents and Nitration esters- Typical industrial equipment and processes- Nitration of Benzene and Propane; Principle of Amination methods – reduction and its methods, Manufacture of Aniline and Nitro-Aniline by different methods.	
UNIT II : HALOGENATION AND SULFONATION PROCESSES	(9)
Halogenation reactions, Chlorination mechanism, Manufacture of Vinyl Chloride and Chloral. Sulfonation and sulfation agents, Industrial process- sulfonation of benzene and production of ethanol; Desulfonation reactions	
UNIT III : AMMONOLYSIS AND OXIDATION	(9)
Principles of Ammonolysis. Aminating agents and amination reactions, Manufacture of Aniline, p-Pheneyldiamine and Methylamines; Principles of Oxidation, Oxidizing agents, Types of Oxidative reaction, Synthesis of Acetic acid, Formaldehyde and Styrene.	
UNIT IV : HYDROGENATION AND HYDROFORMYLATION	(9)
Production and Properties of Hydrogen, Catalytic hydrogenation and Hydrogenolysis - Hydrogenation of Cotton seed oil and Synthesis of Methanol; Methanation and Fisher-Tropsch reactions- Oxo, Synol processes.	

UNIT V : ESTERIFICATION, HYDROLYSIS AND ALKYLATION	(9)
Esterification of organic and inorganic acids, applications in chemical industries- Manufacture of ethyl acetate and vinyl acetate monomer; Hydrolyzing agents, processes and equipment-manufacture of Glycerol, Furfural and Ethanol. Types and Factors affecting alkylation, Industrial alkylation process-Alkyl aryl detergent	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

1. Austin G.T., "Shreve's Chemical Process Industries ",5th edition (Special Reprint edition), McGraw Hill International co., 2005
2. Groggins P.H.,"Unit Processes in Organic Synthesis",5th edition (reprint), McGraw Hill International Co., 2001.

REFERENCES:

1. K.S.Tewari & N.K. Vishnoi, "A Textbook of Organic Chemistry", 4rd Edition, Vikas Publishing House, New Delhi, 2017.
2. Graham Solomons T.W., Craig B.Fryhle and scott A. Snyder, "Organic Chemistry", 11th edition, international student version, John Wiley And sons inc, New York,2013.

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 (W.A)	3	3										3	3	

22CHC05 - MECHANICAL OPERATIONS					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : 22CHC01					
Course Objective:	• Understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications • To impact knowledge in the field of particle size reduction and also construction and working of equipment's used for mechanical operations.				

Course Outcomes The student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply knowledge of particulate properties in handling and storage of the materials.	Ap	20%
CO2	Apply the knowledge of solid-solid and gas-solid separation techniques in process industries.	Ap	30%
CO3	Analyze particle size and shape with deeper understanding on different particle diameters.	An	20%
CO4	Apply various separation and purification techniques and equipments employed in solid particles	Ap	30%
CO5	Ability to make an oral presentation by an individual or as a team member of the application concepts of the course in process industries.	U	Internal Assessment

UNIT I - CHARACTERISTICS AND HANDLING OF PARTICULATE SOLIDS	(9)
Characteristics of particulate solids, techniques for particle size analysis, agglomeration and segregation; different methods for storage and transportation of solids	
UNIT II - SIZE REDUCTION AND SCREENING	(9)
Laws of size reduction; classification, principle and working of size reduction equipments; screening- screen effectiveness- industrial screening equipments	
UNIT III - MECHANICAL SEPARATIONS	(9)
Principles and equipment for gravity settling, sedimentation, thickening, centrifugal separation, froth flotation, magnetic and electrostatic separators, heavy media separations	
UNIT IV - FILTRATION	(9)
Theory of filtration, constant pressure and constant rate filtration; batch and continuous filters; principle and equipment for gravity, pressure and centrifugal filters; selection of filters; vacuum filter and its application.	

UNIT V - MIXING AND AGITATION	(9)
Principles, types and equipment for mixing; Impellers, power requirement for agitation; Mixer for powders and pastes, equipment for blending and kneading	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. McCabe W.L, Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw Hill International Edition, New York, 2006.
2. Coulson J.M. and Richardson J.F., "Chemical Engineering", Volume II, 5th Edition, Elsevier publication, 2006.
3. G.G. Brown "Unit Operations " 1st edition , CBS Publishers, 2005

REFERENCES:

1. Badger Walter L. and Banchero Julius T, "Introduction to Chemical Engineering", Tata McGraw Hill Publishing Company, NewDelhi,21st Reprint, 2008
2. Alans Foust, "Principles of Unit Operations", 2nd Edition, John Wiley & Sons International Edition, 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											3	
4	3												3	
5						3				3		3		
CO (W.A)	3	3				3				3		3	3	

22CHP01 FLUID MECHANICS LABORATORY					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : 22CHC02					
Course Objective:	• To examine the properties of fluids and to conduct experiments involving both incompressible and compressible flow.				
Course Outcomes The Student will be able to		Cognitive Level			
CO1	Apply the basic principle for estimating the coefficient of discharge in various channel	Ap			
CO2	Estimate pressure drop and minimum fluidization velocity through packed bed and fluidized bed	An			
CO3	Conduct experiments and perform characteristic studies of fluid flow equipments	Ap			
CO4	Analysis the fluid flow principle and interpretation of data, and synthesis of the information to provide valid conclusions.	An			
CO5	Conduct fluid flow experiments in team and derive valid conclusions.	U			

LIST OF EXPERIMENTS

1. Determination of coefficient of discharge of venturimeter.
2. Determination of coefficient of discharge of orifice meter.
3. Determination of coefficient of discharge of notch.
4. Determination of friction factor for flow through straight pipe.
5. Determination of friction factor for flow through concentric pipes.
6. Determination of friction factor for flow through Spiral and helical coil.
7. Determination of pressure drop in packed bed.
8. Determination of minimum fluidization velocity flow through fluidized bed.
9. The study of characteristics curves of centrifugal pump.
10. The study of characteristics curves of reciprocating pump.

Total (P:60) = 60 Periods

REFERENCE:
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									3					
CO (W.A)	3	3	3	3					3					3

22CHP02 CHEMICAL ANALYSIS LABORATORY				
	L	T	P	C
	0	0	4	2

PRE-REQUISITE : NIL

Course Objective:	• To gain the knowledge in basic principle involved in analysis and identification of different organic compounds • To provide hands on exposure for analyzing the given fuel oil sample

The Student will be able to	Course Outcomes	Cognitive Level
CO1	Apply knowledge on identification of different organic compounds	Ap
CO2	Apply knowledge on the measure of quality of water	Ap
CO3	Analyze the properties of fuel oil.	An
CO4	Analyze the purity of washing soda	An
CO5	Analyze the purity of glycerol	An

LIST OF EXPERIMENTS (Any Ten)

1. Preparation of meta di nitro benzene from Nitro benzene.
2. Preparation of Benzoic acids from Ethyl benzoate.
3. Preparation of Benzoic acid from Benzaldehyde.
4. Determination of Turbidity and color of waste water by using Nephlometer.
5. Determination of flash point, fire point, cloud and pour point of fuel oil.
6. Determination of aniline point of given fuel oil sample.
7. Determination of saponification value of oil.
8. Determination of purity of washing soda.
9. Identification of carbohydrates and/or acids from unknown organic compounds.
10. Identification of Phenol and/or ester from unknown organic compounds.
11. Identification of amine and/or Urea from unknown organic compounds.
12. Identification of Aldehyde and/or Ketone from unknown organic compounds.
13. Estimation of purity of Glycerol.

Total (P:60) = 60 Periods

REFERENCE:

1. Lab 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	2													3
3		3												3
4		3												
5		3												3
CO (W.A)	3	3												3

22MAN07-SOFT / ANALYTICAL SKILLS – III (Common to All Branches)				
	L	**T**	**P**	**C**
	1	**0**	**2**	**0**

PRE-REQUISITE : NIL

Course Objective:	• Improving overall language proficiency for personal or professional reasons • To develop problem solving skills across all levels

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of Continuous Assessment Test**
CO1	Write grammatically correct and coherent sentences.	U	40%
CO2	Develop problem solving skills across all levels.	Ap	30%
CO3	Solve reasoning problems with ease.	An	30%

UNIT I - VERBAL COMPETENCY	(5+10)
Sentence Selection - Paragraph Formation - Sentence Correction - Spellings	
UNIT II - APTITUDE	(5+10)
Clocks - Calendar- Age Problems - Problem on Trains - Problems on Numbers - Partnerships	
UNIT III - LOGICAL & REASONING	(5+10)
Coding & Decoding - Logical Equivalent - Venn Diagram Problem	
TOTAL (L:45) = 45 PERIODS	

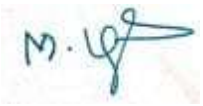
REFERENCES:

1. Murphy, Raymond. *English Grammar in Use*. Fourth Edition, Cambridge University, 2012.
2. Dr. R.S. Aggarwal. *A Modern Approach to Verbal & Non-Verbal Reasoning.* S Chand and Company Limited, New Delhi, 2014.
3. Aggarwal, Ashish. *Quick Arithmetic.* S Chand and Company Limited, 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									2	3				
2		2		2										
3		2		2										
CO (W.A)		**1**		**1**					**1**	**1**				

#Applicable for 2022-2026 batch students



22MAN07R - SOFT/ANALYTICAL SKILLS – III (Common to All Branches)				
	L	**T**	**P**	**C**
	1	**0**	**2**	**0**
PREREQUISITE : Nil				
Course Objective:	• To improve language proficiency for personal or professional reasons • To enhance students' mathematical problem-solving and critical thinking skills			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in Continuous Assessment Test**
CO1	Demonstrate effective communication skills by listening actively, speaking clearly, reading critically, and writing coherently in contexts.	U	40%
CO2	Develop proficiency in applying mathematical concepts of time, speed, distance, and financial calculations involving simple and compound interest.	Ap	30%
CO3	Analyse logical reasoning skills through various forms of statements.	An	30%

UNIT I – VERBAL ABILITY	**(5+10)**
Grammar - Concord - Relative Clause - **Listening** - IELTS Listening (Advanced) and Gap Filling - **Speaking** - Introducing Others - Formal Conversations - **Reading** - Reading Comprehension - **Writing** - Hints Development.	
UNIT II – APTITUDE	**(5+10)**
Simple and Compound Interest - Time, Speed and Distance - Problems on Trains - Boats and Streams - Chain Rule - Time and Work - Pipe and Cisterns.	
UNIT III - REASONING	**(5+10)**
Seating Arrangements - Syllogism - Statement and Conclusion - Statement and Assumption - Statement and Course of Action.	
TOTAL(L:45) = 45 PERIODS	

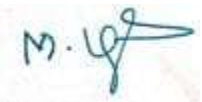
REFERENCES:

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**				

#Ratified by Twelfth Academic Council
 # - Applicable for 2023-2027 batch students



22MAN09 - INDIAN CONSTITUTION (Common to All Branches)				
	L	**T**	**P**	**C**
	I	**0**	**0**	**0**

PREREQUISITE : NIL

Course Objective:	• To educate students to learn about the Constitutional Law of India. • To motivate students to understand the role of Union Government. • To make students to understand about State Government. • To understand about District Administration, Municipal Corporation and Zila Panchayat. • To encourage students to Understand about the election commission.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Gain Knowledge about the Constitutional Law of India.	U	Internal Assessment
CO2	Know the Union Government and role of President and Prime Minister.	R	
CO3	Gain knowledge about State Government and role of Governor, Chief Minister.	U	
CO4	Understand the District Administration, Municipal Corporation and Zila Panchayat.	U	
CO5	Understand the role and function of election commission.	U	

UNIT I - THE CONSTITUTION INTRODUCTION	(3)
The History of the Making of the Indian Constitution - Preamble and the Basic Structure, and its interpretation - Fundamental Rights and Duties and their interpretation - State Policy Principles.	
UNIT II - UNION GOVERNMENT	(3)
Structure of the Indian Union - President - Role and Power - Prime Minister and Council of Ministers - Lok Sabha and Rajya Sabha	
UNIT III - STATE GOVERNMENT	(3)
Governor - Role and Power - Chief Minister and Council of Ministers - State Secretariat	
UNIT IV - LOCAL ADMINISTRATION	(3)
District Administration - Municipal Corporation - Zila Panchayat	
UNIT V - ELECTION COMMISSION	(3)
Role and Functioning - Chief Election Commissioner - State Election Commission	
TOTAL (L:15) : 15 PERIODS	

TEXT BOOKS:

1. Rajeev Bhargava, "Ethics and Politics of the Indian Constitution", Oxford University Press, New Delhi, 2008.
2. B.L. Fadia, "The Constitution of India", Sahitya Bhawan; New edition (2017).
3. DD Basu, "Introduction to the Constitution of India", Lexis Nexis; Twenty-Third 2018 edition.

REFERENCES:

1. Steve Blank and Bob Dorf, "The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company", K & S Ranch ISBN – 978-0984999392
2. Eric Ries, "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" , Penguin UK ISBN - 978-0670921607
3. Adrian J. Slywotzky with Karl Weber, "Demand: Creating What People Love Before They Know They Want It", Headline Book Publishing ISBN - 978-0755388974
4. Clayton M. Christensen, "The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business", Harvard business ISBN: 978-142219602.

REFERENCES: Web link

1. https://www.fundable.com/learn/resources/guides/startup
2. https://corporatefinanceinstitute.com/resources/knowledge/finance/corporate- structure/
3. https://www.finder.com/small-business-finance-tips
4. https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/

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		2		3		
3						3		3		2		3		
4						3		3		2		3		
5						3		3		2		3		
CO (W.A)						**3**		**3**		**2**		**3**		

22CHC06 CHEMICAL REACTION ENGINEERING				
	L	T	P	C
	2	1	0	3

PRE-REQUISITE : NIL

Course Objective:	• To understand the basic concepts of chemical kinetics studies and types of reactions. • To gain knowledge over multiple rectors with series/parallel configurations.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the basic concepts of reaction kinetics in process industries	Ap	20%
CO2	Develop performance equations for different types of reactors using mass balances.	Ap	30%
CO3	Analyze the performance of different types of reactors in serious and parallel	An	30%
CO4	Design reactors for different type of reactions (single and multiple reactions)	An	20%
CO5	Develop skills to choose the right reactor among single, multiple, recycle reactor, through continuous learning.	U	Internal Assessment

UNIT I : FUNDAMENTAL CONCEPTS AND CHEMICAL KINETICS	(9)
Chemical Kinetics, Classification of chemical reactions, Rate, rate equation, rate constant, Order and Molecularity, activation energy, Arrhenius theory, collision theory ,transition state theory, Elementary and non-elementary reactions, half-life period, constant volume reaction- Irreversible uni-molecular type first order reactions. Variable volume Batch reactor. Zero order reaction.	
UNIT II : DESIGN OF SINGLE IDEAL REACTORS	(9)
Chemical reactors: Batch reactors, performance equation. Advantages and disadvantages of Batch reactors, Space time and space velocity. Simple calculations. CSTR, performance equation, Conversion yield, Simple problems.	
UNIT III : DESIGN OF MULTIPLE REACTORS	(9)
Steady state Mixed flow reactors performance equation, Plug flow reactor Design equation, Mixed flow reactors in series and parallel connection, Plug flow reactors in series and parallel connection, reactors of different types in series. Simple problems	
UNIT IV : DESIGN FOR MULTIPLE REACTIONS	(9)
Series reactions, parallel reactions, series-parallel reactions, qualitative discussion about product distribution in mixed flow reactor, quantitative treatment of product distribution in mixed flow reactor, overall fractional yield ,instantaneous fractional yield, selectivity. Simple problems.	
UNIT V :BASIC CONCEPTS OF NON-IDEAL FLOW	(9)
Residence time distribution, RTD Measurement, Characteristics of a tracer, E curve, C curve and F curve, Mean residence time, The RTD in a plug flow reactor, State of aggregation of the flowing stream, Simple problems.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. H.S. Fogler, Elements of Chemical Reaction Engineering, 3rd Ed., Prentice Hall India Pvt. Ltd., New Delhi,2001
2. O. Levenspiel, Chemical Reaction Engineering, 3rd Ed., Wiley Publications, 1999.

REFERENCES:

1. Gilbert F Froment, Kenneth B Bischoff and Juray D Wilde "Chemical Reactor Analysis and Design", Wiley, New York (2010).
2. J.M. Smith, Chemical Engineering Kinetics, 2nd Ed., McGraw-Hill, 1981.
3. P.V. Danckwerts, Gas-liquid reactions, Sharma and Doraiswamy Vols. I & II Froment and Bischoff.

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	
4			3										3	2
5												3		
CO (W.A)	3	3	3										3	

22CHC07 PROCESS HEAT TRANSFER				
	L	T	P	C
	2	1	0	3
PRE-REQUISITE : 22CHC01				
Course Objective:	• To impart the basic laws of various modes of heat transfer and their applications • To make conversant with the heat transfer analysis related to the design of heat exchangers and evaporators.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply important basic concepts and principles to draw conclusions about heat transfer operations.	Ap	20%
CO2	Analyze a design problem associated to conduction, convection and radiation.	An	20%
CO3	Calculate an analyze heat utilization and heat loss in any heat exchangers and evaporators.	An	40%
CO4	Design heat exchangers using LMTD and NTU methods and also evaporators.	Ap	20%
CO5	Prepare a consolidated report on the prescribed standards/ safety norms to run heat transfer equipments	U	Internal Assessment

UNIT I: CONDUCTION	(9)
Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer – Concept of thermal conductivity measurement-effect of temperature on thermal conductivity - Fourier's Law - One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and composite cylinder - critical thickness of insulation; fundamental concepts in extended surfaces heat transfer; Transient heat conduction.	
UNIT II : CONVECTION (without phase change)	(9)
Concepts of heat transfer by convection - Natural and forced convection - Application of dimensional analysis for convection and dimensionless numbers - Relationship between Individual and overall heat transfer coefficients - Equations for natural convection in vertical plates and vertical and horizontal cylinders - Equations for forced convection under laminar and turbulent flow conditions in pipes.	
UNIT III: CONVECTION (with phase change) AND RADIATION	(9)
Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation - Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling - condensers-vertical and horizontal types. Concept and nature of thermal radiations -Concept of Black and grey bodies; Stefan Boltzmann, Kirchhoff,,s, Planck,,s and Wien laws- Radiation shield.	
UNIT IV: HEAT EXCHANGERS	(9)
Heat Exchangers – Classification- Types and practical application (Double Pipe and Shell and Tube heat exchanger) – LMTD - use of correction factor charts - Fouling factors - surface area calculations for double pipe and shell and tube heat exchangers - NTU and efficiency of Heat exchangers.	

UNIT V: EVAPORATORS	(9)
Introduction – Types of Evaporators (Standard vertical tube, long tube, Forced circulation)– Capacity – Steam economy – Boiling point elevation - Material and energy balance of single effect evaporator - surface area calculations for single effect evaporator - Theory of multiple effect evaporators.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. B.K. Dutta, Heat transfer principles and applications, PHI Learning PVT Ltd, 2016
2. Holman, J. P., 'Heat Transfer ', 10th Edn., McGraw Hill,2010.
3. Kern, D.Q., "Process Heat Transfer ", McGraw-Hill, 1999.
4. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn., McGraw-Hill, 2001.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998

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	2		3										3	
5						3								
CO (W.A)	3	3	3			3							3	

22CHC08 - CHEMICAL ENGINEERING THERMODYNAMICS					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : NIL					
Course Objective:	• To Have a basic concepts and laws of thermodynamics • To understand the Phase equilibrium between phase and engineering systems • To develop knowledge on chemical reaction equilibrium for homogenous reactions				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply thermodynamic concepts and the laws of thermodynamics to various systems and processes	Ap	30%
CO2	Apply the knowledge for determining enthalpy change, entropy change and free energy change	Ap	30%
CO3	Apply reaction equilibrium in the systems with two or more coexisting phases	Ap	20%
CO4	Analyze the PVT behavior of ideal and real gases	An	20%
CO5	Make an oral presentation on topics related to the course.	U	Internal Assessment

UNIT I: LAW OF THERMODYNAMICS	(9)
Basic concepts; Terminology of Thermodynamics, Zeroth law; First law; application to non-flow and flow processes; second law –heat engine, Carnot cycle and theorem, Entropy calculation; Third law of thermodynamics.	
UNIT II: PROPERTIES OF REAL GASES AND THRMODYNAMICS FORMULATIONS	(9)
Ideal Gas law -simple problems, PVT behavior of fluids – compressibility factor; two and three parameter theorems of corresponding states. Equation of state – Virial, Vander Waals, Redlich-Kwong and Peng-Robinson equation; Basic energy relations; Maxwell relations and Pnemonic diagram.	
UNIT III: PROPERTIES OF SOLUTIONS	(9)
Partial molar properties Chemical potential, Fugacity, Activity and Activity coefficient; Gibbs-Duhem equation, Applications, Raoult's law and Henry's law; simple problems, enthalpy and Gibbs free energy change in mixing of ideal solution	
UNIT IV -PHASE EQUALIBRIA	(9)
Phase equilibrium and stability criteria for equilibrium between phases in single and multi-component non-reacting system; vapor –liquid equilibrium of binary solution (ideal and non ideal); Azeotropes; P-x-y and T-x-y diagrams.	

UNIT V - CHEMICAL EQUILIBRIA	(9)
Criteria of equilibrium; standard free energy change and reaction equilibrium constant Kp and Kc; effect of temperature and pressure on reaction equilibrium constant Relationship between Kp and Kc. Simple problems.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Narayanan K.V., "A Text book of Chemical Engineering Thermodynamics", 2nd edition, Prentice Hall India Pvt. ltd., New Delhi, 2013
2. Smith J.M., Van Ness H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics", 7th edition, McGraw Hill, 2009.

REFERENCES:

1. Rao Y.V.C., "Chemical Engineering Thermodynamics", Universities press (India) Ltd., Hyderabad (A.P), India, 2004.
2. Kyle B.G., "Chemical and Process Thermodynamics",3rd Edition, Prentice Hall India Pvt. ltd., New Delhi, 1999

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				
CO (W.A)	3	3								3			3	

22CHC09 - MASS TRANSFER I					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : 22CHC01					
Course Objective:	• To understand the basic principles and theories of mass transfer operations. • To perform basic design calculations for humidification operations. • To explain various types of equipment's widely used in drying humidification and crystallization.				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply important chemical concepts and principles to draw conclusions about mass transfer operations.	Ap	20%
CO2	Apply knowledge on obtaining the relationship between different mass transfer coefficients.	Ap	20%
CO3	Design of column/equipments by calculating number of transfer units and height required for humidification operations.	Ap	40%
CO4	Demonstrate knowledge about the significance of different mass transfer equipment used in drying humidification and crystallization.	An	20%
CO5	Engage in self-study to make oral presentation on assigned topics related to course	U	Internal Assessment

UNIT I : DIFFUSION	(9)
Introduction to mass transfer operations - Molecular and eddy diffusion in gases and liquids – Steady state molecular diffusion in fluids at rest and in laminar flow - Binary diffusivity measurement and prediction - Multi component diffusion and diffusion in solids.	
UNIT II : INTERPHASE MASS TRANSFER	(9)
Concept of mass transfer co-efficient, Theories of mass transfer - film, penetration and surface renewal theories; momentum, heat and mass transfer analogies. Inter phase mass transfer – relationship between individual and overall mass transfer coefficient – Equipment for gas-liquid operations – Sparged and agitated vessels, Sieve and tray tower, Venturi scrubber and packed tower.	
UNIT III : HUMIDIFICATION	(9)
Humidification –Terminology and definitions - Equilibrium, humidity chart, adiabatic saturation and wet bulb temperatures; Cooling tower construction and its operation, calculations - Adiabatic humidification and dehumidification operations.	
UNIT IV : DRYING	(9)
Drying Terms and definitions – Equilibria, the drying rate curve, Batch Drying – material and energy balance - Theoretical estimation of drying time from rate data - determination of length of rotary dryer using rate concept - Mechanism and time of cross through circulation drying. Classification of dryers - Advance drying techniques such as freeze drying, microwave drying;	

UNIT V : CRYSTALLIZATION	(9)
Principle of crystallization - Equilibrium, theory of super saturation, nucleation and crystal growth, Batch and continuous operation - mass and energy balance - yield and purity of products; classification of crystallizers and crystallisation equipment.	
TOTAL(L:45 T:15) = 60 PERIODS	

TEXT BOOKS:

1. Treybal, R. E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill, 2017.
2. Narayanan K.V. and Lakshmi kutty, B "Mass Transfer – Theory and Applications", 1st Edition, CBS Publishers & Distributors Pvt Ltd, New Delhi, 2014.
3. Geankoplis, C.J., "Transport Processes and Unit Operations", 4 th Edition, Prentice Hall Inc., New Jersey, 2003.

REFERENCES:

1. Seader J.D. and Henley E.J., "Separation Process Principles", 4th Ed., John Wiley, 2016
2. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition., McGraw-Hill, 2005.
3. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, 5th Edition, Asian Books Pvt. Ltd., 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												
3			3										3	3
4		3											3	
5									3			3		
CO (W.A)	3	3	3						3			3	3	3

22CHC10 INSTRUMENTAL METHODS OF ANALYSIS					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : NIL					
Course Objective:	• Know the principle and importance of various analytical instruments used for the characterization of various materials. • Understand the basis processes and applications of various chemical analysis techniques.				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge to perform analytical instruments	Ap	20%
CO2	Apply knowledge to test and analyze the solid sample	Ap/An	20%
CO3	Apply knowledge to test and analyze the liquid sample	Ap/An	40%
CO4	Apply knowledge to test and analyze the gaseous sample	Ap/An	20%
CO5	Prepare a report on analysis of sample as per the standards/norms.	U	Internal Assessment

UNIT I: INTRODUCTION OF INSTRUMENTAL METHODS	(9)
Introduction-Methods of detecting analytes - Qualitative and Quantitative Analysis-Volumetric analysis – Gravimetry -Traditional analytical techniques - Spectroscopy, Crystallography, Electrochemical analysis and separation techniques	
UNIT II: MOLECULAR SPECTROSCOPY	(9)
Modern instrumental Methods of analysis - Principles and applications of UV-Visible Spectroscopy, IR Spectroscopy and Non –dispersive IR, Raman spectroscopy, NMR Spectroscopy, Atomic absorption spectroscopy, X-ray fluorescence and ION Chromatography	
UNIT III: THERMAL METHODS AND MORPHOLOGY ANALYSIS	(9)
Thermogravimetry: Principle, instrumentation and applications, factors affecting shapes of thermograms. Differential Thermal Analysis: Principle, instrumentation and applications. Differences between DSC and DTA. Application of DSC (Inorganic & Polymer samples). Morphology Analysis – Scanning Electron Microscopy – Transmission Electron Microscopy – Principle and Applications	
UNIT IV: CONDUCTANCE, POTENTIAL MEASUREMENT AND ELECTROPHORESIS	(9)
Definitions, conductance measurements, applications, Types, advantages and disadvantages of Conductometric titrations. Potential measurements, pH determination, Potentiometric Titrations. Basic principles of electrophoresis, theory and application of paper, starch gel, agarose, PAGE, SDS-PAGE electrophoresis.	

UNIT V: CHROMATOGRAPHIC METHODS	(9)
Introduction – Classification of chromatographic methods: Column chromatography, Thin Layer chromatography, Paper chromatography, Gas chromatography and High-Performance Liquid Chromatography (HPLC) – Principle, important components and their functions mode of separation, Instrumentation and applications	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Gurdeep R. Chatwal Shan K Anand, "Instrumental methods of Chemical Analysis", 5th Edition, Himalaya Publishing House, New Delhi, 2018
2. MuralidharanRao.D ,Swamy A.V.N , Dharaneeswaran Reddy D, "Instrumental Method of Analysis", CBS Publishers and Distributors, 2013.

REFERENCES:

1. Willard H.H., Merritt L.L., Dean J.A., and Settle F.A., "Instrumental Methods of Analysis", 7th Edition, C B S Publishers & Distributors, Delhi, 2004.
2. Daniel C. Harris, "Qualitative chemical analysis", 9th Edition, W. H. Freeman and Company, New York, 2015.

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												
4		2												
5						2							3	
CO (W.A)	3	2				2							3	

22CHC11 CHEMICAL PROCESS INDUSTRIES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : 22CHC01				
Course Objective:	• Impart knowledge about unit process and unit operations in various industries • Develop understanding of manufacturing process flow drawing for the manufacturing chemical processes, its applications and major engineering problems encountered in the process			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge of various unit operations and processes in production of inorganic chemicals	Ap	20%
CO2	Apply the knowledge of various unit operations and processes in the production of organic chemicals	Ap	30%
CO3	Solve the major engineering problems encountered in Chemical industries.	Ap	30%
CO4	Develop the process flow diagram for various products	Ap	20%
CO5	Make an oral presentation about the impact of hazardous chemicals on environment.	U	Internal Assessment

UNIT I: FUEL AND INDUSTRIAL GASES	(9)
Fuel Gases – Natural gas, Liquefied natural gas, Synthesis Gas. Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen – Argon.	
UNIT II: ACIDS AND CEMENT INDUSTRY	(9)
Sulfuric acid, Nitric acid and Phosphoric acid. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.	
UNIT III: PULP, PAPER, SUGAR AND STARCH INDUSTRIES	(9)
Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products, Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugar industry – Starch – Methods of production, Starch derivations.	
UNIT IV: FERTILIZER INDUSTRY	(9)
Major Components of Fertilizer industries – Nitrogen industries, ammonia, urea – Phosphorus industries, Single Super Phosphate, DAP, MAP and NPK – Potassium chloride, Potassium Sulphate – Liquid Fertilizers – Bio Fertilizers.	

UNIT V: POLYMERS	(9)
Polymers production: Fibers, Rubbers and Plastics. Acrylonitrile butadiene styrene (ABS), polyethylene - LDPE, HDPE, Polypropylene, PVC, PS, SAN, SBR, PAN, Nylon and Polycarbonates.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Austin G.T., —Shreve's Chemical Process Industries‖ , 5th Edition, McGraw-Hill International Book Company, Singapore, 2012.
2. GopalaRao M. and Marshall Sittig, — Dryden‘s Outlines of Chemical Technology‖ , 3rd Edition, East- West Press, New Delhi, 2008.

REFERENCES:

1. Mark W.V. and Bhatia S.C., —Chemical Process Industries‖ , Volume - I and II, 2nd Edition, CBS Publishers and Distributors, New Delhi, 2007.
2. Kent J.A., —Riggel's Hand Book of Industrial Chemistry‖ , Van Nostrant Reinhold, 1974.

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 (W.A)	3						3						3	

22CHP03 HEAT TRANSFER LABORATORY					
		L	T	P	C
		0	0	4	2
PRE-REQUISITE: 22CHC07					
Course Objective:	• To estimate individual and overall heat transfer coefficient through experiments. • To study the radiation heat transfer and calculate Stefan-Boltzmann constant. • To study the performance of heat exchangers and evaporators.				
Course Outcomes The Student will be able to		Cognitive Level			
CO1	Conduct experiments to analyze the heat transfer coefficients of various heat transfer operations.	Ap			
CO2	Conduct experiments and analyze the heat transfer rate of various heat transfer equipments.	Ap			
CO3	Analyze the effect of heat load on the liquids/solutions.	An			
CO4	Analyze the performance of various heat transfer equipments	An			
CO5	Perform in a team develop heat exchangers to meet given specifications using suitable engineering tool.	U			

LIST OF EXPERIMENTS (Any Ten)

1. Estimation of individual and overall heat transfer coefficient for heat transfer in shell and tube heat exchanger
2. Estimation of individual and overall heat transfer coefficient for heat transfer in double pipe heat exchanger
3. Estimation of individual heat transfer coefficient and fin efficiency for heat transfer through extended surface
4. Estimation of steam economy and efficiency of an evaporator
5. Heat transfer studies in pool boiling
6. Estimation of individual heat transfer coefficient for heat transfer through horizontal and vertical condenser
7. Estimation of individual and overall heat transfer coefficient for heat transfer in jacketed vessel
8. Estimation of thermal conductivity of a material.
9. Studies on radiation heat transfer
10. Estimation of individual and overall heat transfer coefficient for heat transfer in Packed Column
11. Estimation of unsteady state temperature values using transient heat conduction experiment constant flux and constant temperature.

12. Estimation of individual heat transfer coefficient under forced convection heat transfer. 13. Estimation of individual heat transfer coefficient under natural convection heat transfer. 14. Determination of Stefan Boltzmann constant using Stefan Boltzmann experiment
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
4		3												3
5					3				3					3
CO (W.A)	3	3			3				3					3

22CHP04 - MECHANICAL OPERATIONS LABORATORY					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : 22CHC05					
Course Objective:	• Develop sound practical knowledge on different types of mechanical operations equipments.				
Course Outcomes The Student will be able to		Cognitive Level			
CO1	Apply knowledge to perform the size analysis in solid- solid separation systems	Ap			
CO2	Estimate the separation characteristics of the equipments used in chemical industry	Ap			
CO3	Select different solid - fluid separation equipment used in various unit operations	An			
CO4	Analyze the size reduction ratio and various crushing parameters of crushing equipments	An			
CO5	Perform in a team to analyze the energy consumption of crushing equipments.	An			

LIST OF EXPERIMENTS (Any Ten)

1. Determination of the crushing law constants using Jaw crusher
2. Determination of the Reduction ratio using crushing rolls
3. Determination of the critical speed of ball mill
4. Determination of the average particle size using size analysis and finding the effectiveness of Screen
5. Determination of the specific cake resistance and filter medium resistance using plate and frame filter press
6. Determination of the specific cake resistance and filter medium resistance using vacuum leaf filter.
7. Determination of the specific cake resistance and filter medium resistance using vacuum rotary drum filter
8. Determination of minimum thickener area by batch sedimentation test
9. Determination of the separation efficiency of cyclone separator.
10. Determination of separation efficiency of froth flotation equipments.
11. Determination of the specific surface area of the given powder using air permeability apparatus.
12. Determination of Power Consumption & Power Number by using Mixing apparatus.

TOTAL(P:60) = 60 Periods

REFERENCE:
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
4		3												3
5									3					
CO (W.A)	3	3							3					3

22MAN08- SOFT / ANALYTICAL SKILLS – IV (Common to All Branches)				
	L	**T**	**P**	**C**
	1	**0**	**2**	**0**
PREREQUISITE : NIL				
Course Objective:	• To recollect the functional understanding of basic grammar and its structure • To enrich their knowledge and to develop their logical reasoning ability			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of Continuous Assessment test**
CO1	Construct the sentences with basic grammar.	U	40%
CO2	Analyze quantitative aptitude problems and find solutions.	Ap	30%
CO3	Develop the ability to solve problems through logical reasoning.	An	30%

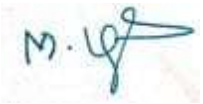
UNIT I - VERBAL	(5+10)
Articles - Fill in the blanks - Grammatical Error - Sentence improvement	
UNIT II - APTITUDE	(5+10)
Speed and Distance-Time and Work- Mixture And Alligations- Permutation and Combinations	
UNIT III - LOGICAL AND REASONING	(5+10)
Seating Arrangement- Directions and Distance- Non verbal Reasoning	
TOTAL (L:45) = 45 PERIODS	

REFERENCES:

3. Murphy, Raymond. *English Grammar in Use*. Fourth Edition, Cambridge University, 2012.
4. Dr. R.S. Aggarwal. *A Modern Approach to Verbal & Non-Verbal Reasoning.* S Chand and Company Limited, New Delhi, 2014.
3. Aggarwal, Ashish. *Quick Arithmetic.* S Chand and Company Limited, 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									2	3				
2		2		2										
3		2		2										
CO (W.A)		**1**		**1**					**1**	**1**				



 # - Applicable for 2022-2026 batch students

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:

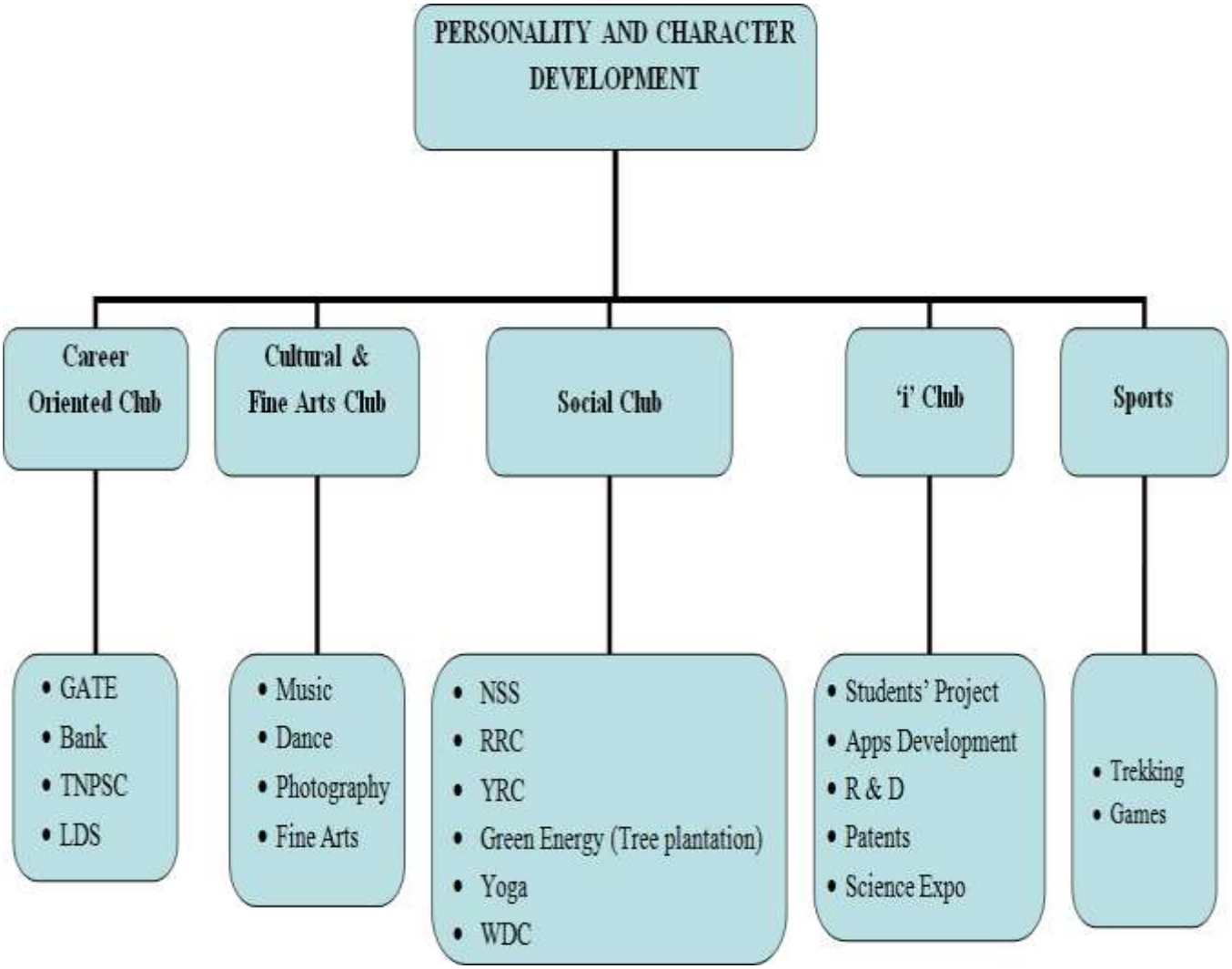
1. Rizvi, M.Ashraf. *Effective Technical Communication.* Tata McGraw-Hill Education, 2017.
2. Aggarwal R S. *Quantitative* Aptitude for Competitive Examinations. S.Chand Publishing
3. Company Ltd(s)., 2022.
4. Sharma, Arun. *How to Prepare for Quantitative Aptitude for the CAT*. Tata McGraw – Hill
5. Publishing, 2022.
6. 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**				

##Ratified in Twelfth Academic Council
##Applicable for 2023-2027 batch students

22GED01 PERSONALITY AND CHARACTER DEVELOPMENT (Common to all Branches)				
	L	T	P	C
	0	0	I	0



*LDS - Leadership Development Skills

OBJECTIVES :				
Career Oriented Club	Cultural & Fine Arts Club	Social Club	'i' club	Sports
To provide support for identifying specific career field of interests and career path To provide support for preparing for competitive exams	To bring out the hidden talent of students in music, dance and other fine arts. To promote photography skill among the students To develop and enhance the performance of students by participating in various events To inculcate managerial capabilities such as event management and stage organization	To create social awareness and develop a sense of social and civic responsibility To inculcate socially and environmentally sound practices and be aware of the benefits To encourage the students to work along with the people in rural areas, thereby developing their character, social consciousness, commitment, discipline and being helpful towards the community.	To inculcate the basic concepts of innovation To foster the networking between students, build teams, exchange ideas, do projects and discuss entrepreneurial opportunities To enrich the academic experience, build competencies and relationships beyond the classroom	To provide opportunities to excel at sports To promote an understanding of physical and mental well-being through an appreciation of stress, rest and relaxation. To develop an ability to observe, analyze and judge the performance of self and peers in sporting activities. To develop leadership skills and nurture the team building qualities. Trekking: To provide opportunities to explore nature and educating about the purity of nature To improve physical and mental health.

OUTCOMES : At the end of this course, the students will be able to				
Find a better career of their interest. Make use of their knowledge during competitive exams and interviews.	Take part in various events Develop team spirit, leadership and managerial qualities	Develop socially responsive qualities by applying acquired knowledge Build character, social consciousness, commitment and discipline	Apply the acquired knowledge in creating better solutions that meet new requirements and market needs Develop skills on transforming new knowledge or new technology into viable products and services on commercial markets as a team	Demonstrate positive leadership skills that contribute to the organizational effectiveness Take part an active role in their personal wellness (emotional, physical, and spiritual) that supports a healthy lifestyle Create inclination towards outdoor activity like nature study and Adventure.

TOTAL [2 x (P: 15)]: 30 PERIODS

(Cumulatively for Two Semesters)

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

22MAN10R - COMMUNICATION AND QUANTITATIVE REASONING				
	L	T	P	C
	1	0	2	0

PREREQUISITE : Nil

Course Objective:	• To enhance the proficiency of the students in both spoken and written communication • To acquire skills required to solve quantitative aptitude problems

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in Continuous Assessment Test**
CO1	Converse and draft ideas clearly and persuasively in various contexts.	U	40%
CO2	Solve quantitative aptitude problems with confidence.	Ap	30%
CO3	Draw valid conclusions, identify patterns, and solve problems.	An	30%

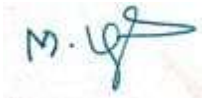
UNIT I - LANGUAGE BOOSTERS	**(5+10)**
JAM - General Topic Presentation - Group Discussion - Mock Interview - E Mail Writing - Essay writing	
UNIT II – APTITUDE	**(5+10)**
Mensuration - Area, Shapes, Perimeter - Races and Games - Data Interpretation on Multiple Charts.	
UNIT III - REASONING	**(5+10)**
Venn diagram - Syllogism - Data Sufficiency - 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. Arun Sharma. *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

22GEA01 UNIVERSAL HUMAN VALUES (For Common To All Branches)				
	L	T	P	C
	2	0	0	2
PRE-REQUISITE : NIL				
Course Objective:	• To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity. • To facilitate the development of a holistic perspective among students towards life and profession. • To highlight plausible implications of holistic understanding in terms of ethical human conduct. • To understand the nature and existence. • To understand human contact and holistic way of living			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Evaluate the significance of value inputs in formal education and start applying them in their life and profession.	E	Internal Assessment
CO2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.	Ap	
CO3	Analyze the value of harmonious relationship based on trust and respect in their life and profession	An	
CO4	Examine the role of a human being in ensuring harmony in society and nature.	Ap	
CO5	Apply the understanding of ethical conduct to formulate the strategy for ethical life and profession.	Ap	

UNIT I: INTRODUCTION-BASIC HUMAN ASPIRATION, ITS FULFILLMENT THROUGH ALL- ENCOMPASSING RESOLUTION	(6)
The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution as the activities of the Self, Self being central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution	
UNIT II: RIGHT UNDERSTANDING (KNOWING)- KNOWER, KNOWN & THE PROCESS	(6)
The The domain of right understanding starting from understanding the human being (the knower, the experiencer and the doer) and extending up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	
UNIT III: UNDERSTANDING HUMAN BEING	(6)
Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self	

UNIT IV: UNDERSTANDING NATURE AND EXISTENCE	(6)
A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, self- awareness and self-evaluation), particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).	
UNIT V: UNDERSTANDING HUMAN CONDUCT, ALL-ENCOMPASSING RESOLUTION AND HOLISTIC WAY OF LIVING	(6)
Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All- encompassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire Existence	
TOTAL (L:30) : 30 PERIODS	

TEXT BOOKS:

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course inHuman Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi

REFERENCES:

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
5. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
7. A N Tripathy, 2003, Human Values, New Age International Publishers
8. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists &Engineers, Oxford University Press
9. M Govindrajran, S Natrajan& V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
10. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books
12. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 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						2	2	3	2	2		3		
2						2	2	3	2	2		3		
3						2	2	3	2	2		3		
4						2	2	3	2	2		3		
5						2	2	3	2	2		3		
CO						2	2	3	2	2		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	

22GEA02- PRINCIPLES OF MANAGEMENT				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**
PRE-REQUISITE: -				

Course Objective:	• To provide with a foundational understanding of management concepts and practices. • To equip students with the knowledge and skills necessary to manage and lead organizations effectively, understanding both theoretical frameworks and practical applications in management. • To learn about various planning tools and decision-making processes crucial for organizational success. • To gain insights into human resource management functions. • To study effective communication strategies and the impact of information technology on communication and how effective control can lead to improved productivity and organizational performance.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply key management theories and practices to real-world business scenarios, demonstrating the ability to implement management functions.	Ap	20%
CO2	Analyze human resource management practices, evaluating how recruitment, training, performance appraisal, and employee relations contribute to organizational success.	An	30%
CO3	Evaluate strategic decisions and their impacts on organizational performance, the effectiveness of communication strategies and the use of information technology in facilitating efficient and effective communication within organizations.	E	30%
CO4	Create comprehensive strategic plans and organizational policies and design control systems to ensure continuous improvement in productivity and organizational performance.	C	20%
CO5	Engage in independent study as a member of a team and develop higher-order thinking skills that are crucial for effective management and leadership in complex organizational settings with assignments or case studies.	Ap	Internal Assessment

UNIT I - INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	**(9)**
Definition of Management - Science or Art - Manager Vs Entrepreneur - types of managers -managerial roles and skills - Evolution of Management - Scientific, human relations, system and contingency approaches - Types of Business organization- Organization culture and Environment - Current trends and issues in Management.	
UNIT II - PLANNING	**(9)**
Nature and purpose of planning - planning process - types of planning - objectives - setting objectives - policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.	

UNIT III - ORGANISING	(9)
Nature and purpose - Formal and informal organization - organization chart - organization structure - types - Line and staff authority - departmentalization -delegation of authority - centralization and decentralization -Job Design - Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management	
UNIT IV - DIRECTING	**(9)**
Foundations of individual and group behaviour - motivation -motivation theories - motivational techniques - job satisfaction - job enrichment - leadership - types and theories of leadership -communication - process of communication - barrier in communication - effective communication -communication and IT.	
UNIT V - CONTROLLING	**(9)**
System and process of controlling - budgetary and non-budgetary control techniques - use of computers and IT in Management control - Productivity problems and management - control and performance -direct and preventive control -reporting.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Harold Koontz, Heinz Weihrich and Mark V. Cannice "Essentials of Management: An International, Innovation, and Leadership Perspective", 11th Edition, Tata McGraw-Hill Education, 2021.
2. J.A.F. Stoner, R.E. Freeman, and Daniel R. Gilbert "Management", 6th Edition, Pearson Education, 2018.

REFERENCES:

1. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.
2. Robert Kreitner & Mamata Mohapatra, "Management", Biztantra, 2008.
3. Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management", 7th Edition, Pearson Education, 2011.
4. Tripathy PC & Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.

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	3										3			
2		3									3			
3										3				
4			3							3				
5											3	3		
CO (W.A)	3	3	3							3	3	3		

22GEA03- TOTAL QUALITY MANAGEMENT				
	L	T	P	C
	3	0	0	3

PREREQUISITE : -

Course Objective:	• To Recognize the importance of quality councils and strategic planning in TQM. • To Explore the elements and historical development of TQM. • To Foster employee involvement through motivation, empowerment, teamwork, and recognition. • To Implement continuous process improvement methods like Juran's Trilogy, PDSA Cycle, 5S, and Kaizen. • To Conduct quality audits and understand the introduction to other ISO standards like ISO 14000, IATF 16949, TL 9000, IEC 17025, ISO 18000, ISO 20000, ISO 22000, and ISO 21001.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Describe the elements and principles of Total Quality Management (TQM).	Ap	30%
CO2	Apply continuous process improvement methodologies such as Juran's Trilogy, PDSA Cycle, 5S, and Kaizen.	Ap	20%
CO3	Apply various quality tools and techniques in both manufacturing and service industry.	Ap	20%
CO4	Develop strong supplier partnerships and understand supplier selection, rating and relationship development.	An	20%
CO5	choose appropriate quality standards and implement them in the respective industry App.	E	10%

UNIT – I QUALITY CONCEPTS AND PRINCIPLES	**(9)**
Definition of Quality - Dimensions of Quality - Quality Planning - Quality Assurance and Control - Quality Costs with Case Studies - Elements / Principles of TQM - Historical Review – Leadership – Qualities / Habits - Quality Council - Quality Statements, Strategic Planning – Importance - Case Studies - Deming Philosophy - Barriers to TQM Implementation – Cases with TQM Success and Failures.	
UNIT – II TQM-PRINCIPLES AND STRATEGIES	**(9)**
Customer Satisfaction - Customer Perception of Quality - Customer Complaints - Customer Retention, Employee Involvement – Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal, Continuous Process Improvement - Juran's Trilogy - PDSA Cycle - 5S - Kaizen, Supplier Partnership - Partnering - Sourcing - Supplier Selection - Supplier Rating - Relationship Development, Performance Measures – Purpose – Methods - Cases.	
UNIT – III CONTROL CHARTS FOR PROCESS CONTROL	**(9)**
Basic Seven Tools of Quality and its Role in Quality Control, Statistical Fundamentals - Measures of Central Tendency and Dispersion, Population and Sample - Normal Curve - Control Charts for Variables and Attributes - Process Capability - Case Study- Introduction to Six Sigma.	

UNIT – IV TQM-MODERN TOOLS	(9)
New Seven Tools of Quality, Benchmarking - Need - Types and Process, Quality Function Deployment - House of Quality (HOQ) Construction - Case Studies, Introduction to Taguchi's Robust Design - Quality Loss Function - Design of Experiments (DOE), Total Productive Maintenance (TPM) - Uptime Enhancement, Failure Mode and Effect Analysis (FMEA) - Risk Priority Number (RPN) – Process - Case Studies.	
UNIT – V QUALITY SYSTEMS	**(9)**
Need for ISO 9000 and Other Quality Systems - ISO 9000: 2015 Quality System – Elements - Implementation of Quality System - Documentation - Quality Auditing, Introduction to ISO 14000 - IATF 16949 - TL 9000-IEC 17025 - ISO 18000 - ISO20000 - ISO 22000 - ISO21001. Process of Implementing ISO - Barriers in ISO Implementation.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOK:

1. Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, UrdhwareshеRashmi "Total Quality Management", 5th Edition, Pearson Education, Noida, 2018.

REFERENCES:

1. Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education, New Delhi, 2017.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, Cengage Learning, 2012.
3. David Goetsch & Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", 8th Edition, Pearson, 2017.

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	3													
2	3													
3	3													
4		3												
5	3				2									
CO (W.A)	3	3			2									

22GEA04- PROFESSIONAL ETHICS				
	L	T	P	C
	3	0	0	3
PREREQUISITE : -				
Course Objective:	• To develop students' ability to identify, analyse, and resolve ethical dilemmas in engineering contexts, fostering a commitment to professional responsibility, integrity, and ethical decision-making. • To provide engineering students with a comprehensive understanding of ethical principles and practices in the engineering profession. • To Familiarize students with key ethical theories, principles, and frameworks that guide ethical decision-making in professional practice. • To Foster the ability to communicate ethical concerns and collaborate effectively with diverse stakeholders, including colleagues, clients, and the public. • To Encourage students to uphold integrity, honesty, and accountability in their professional activities, fostering a culture of trust and reliability.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply ethical reasoning to evaluate and resolve these issues.	Ap	30%
CO2	Apply ethical principles and reasoning to analyze real-world case studies in engineering.	Ap	30%
CO3	Analyze the importance of ethics in professional practice.	An	20%
CO4	Develop the ability to make informed and ethical decisions in engineering practice.	An	10%
CO5	Recognize the importance of continuous learning and professional development in maintaining ethical standards.	E	10%

UNIT I: INTRODUCTION TO PROFESSIONAL ETHICS	**(9)**
Definition and Importance of Ethics, Ethical Theories and Principles, Ethics vs. Morals vs. Values, Role of Ethics in Engineering.	
UNIT II: PROFESSIONAL RESPONSIBILITY AND CODES OF CONDUCT	**(9)**
Professional Responsibility and Accountability, Codes of Conduct in Engineering (e.g., IEEE, NSPE), Conflicts of Interest and Whistleblowing, Case Studies.	
UNIT III: ETHICAL DECISION-MAKING AND PROBLEM-SOLVING	**(9)**
Ethical Decision-Making Models, Tools and Frameworks for Ethical Analysis, Resolving Ethical Dilemmas, Case Studies	
UNIT IV: LEGAL AND REGULATORY ASPECTS	**(9)**
Legal Frameworks Governing Engineering Practice, Intellectual Property Rights, Health, Safety, and Environmental Regulations, Case Studies.	

UNIT V: SOCIAL AND ENVIRONMENTAL RESPONSIBILITY	(9)
Social Responsibility of Engineers, Sustainable Engineering Practices, Impact of Engineering on Society and Environment, Case Studies.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Charles E. Harris Jr., Michael S. Pritchard, and Michael J. Rabins, "Engineering Ethics: Concepts and Cases" 6th edition, 2018.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering" 5th Edition 2010.
3. by M. Govindarajan, S. Natarajan, and V. S. Senthil Kumar,"Professional Ethics and Human Values",Ist Edition 2006.

REFERENCES:

1. Stephen H. Unger, "Engineering Ethics: Real-World Case Studies"
2. Online Ethics Center for Engineering and Science - www.onlineethics.org
3. National Society of Professional Engineers (NSPE) - www.nspe.org

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	3													
2	3													
3		3												
4		3												
5								3						
CO (W.A)	3	3						3						

22CHM01 FUNDAMENTALS OF CHEMICAL ENGINEERING					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : -					
Course Objective:	• To understand the basic concepts of chemical process industries • To have a basic idea on process calculations carried out in chemical industries.				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Understand the concepts of unit operations and unit processes.	AP	20%
CO2	Apply the principles of size reduction, separation and transportation for handling solids in Chemical process industries.	An	20%
CO3	Comprehend the importance of fluid properties, types of fluids and select the manometers for pressure measurement	Ap	40%
CO4	Familiarize with modes of heat transfer and acquire knowledge on types of heat exchangers.	An	20%
CO5	Understand and apply the concepts of units and dimensions, mole, weight percentage, mole percentage in process calculations.	U	Internal Assessment

UNIT I : BASICS OF CHEMICAL PROCESS INDUSTRIES	(9)
Unit process and unit operations concepts- Outlines of unit operations – Dying, evaporation, humidification, distillation, absorption, extraction and adsorption. Outlines of unit process- Calcination, Carbonylation, Combustion, Hydration, Dehydration, Hydrolysis, Nitration, Sulfonation, Polymerization.	
UNIT II : FUNDAMENTALS OF MECHANICAL OPERATIONS	(9)
Size reduction-Crushing and grinding, Equipments and Uses- Solid -fluid separations, Equipment and industrial uses, Gas-solid separations-Equipment and industrial uses. Solid handling-conveyors types and uses.	
UNIT III : FUNDAMENTALS OF FLUID MECHANICS	(9)
Definition of fluids-compressible and incompressible fluids-Physical properties of fluids-density, specific weight, specific volume, viscosity-Compressible fluids and incompressible fluids-ideal and real fluids-Pressure Measurement Manometers-U-tube manometer.	
UNIT IV : BASICS OF HEAT TRANSFER	(9)
Heat Transfer –Modes of heat transfer-Principles of conduction, convection and radiation – introduction to Various types of heat exchange equipments-cooler,condenser,chiller,exchanger-heater,reboiler-evaporator	

UNIT V :BASICS OF PROCESS CALCULATIONS	(9)
Basic concepts: Units and Dimensions, systems of units, conversion and conversion factors of units, concept of mole, weight percent, mole percent, simple problems.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

1. Dryden's Outlines of Chemical Technology for the 21st Century-GopalRao&Sittig-3rd Edition-Affiliated East West Press Pvt.Ltd, New Delhi.
2. Unit operations of chemical Engg.ByW.L.Mccabe and J.C .Smith-sixth edition-McGraw HillBook.co.Singapore-2001

REFERENCES:

1. Chemical Engineering Vol-1&II byJ.M.Coulson and J.F.Richordson-Sixth Edition Butterworth –New Delhi- 2000
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.
3. Unit Operations by G.G. brown-Wiley International Edition-1960

22CHM02 FLUID MECHANICS				
	L	T	P	C
	2	1	0	3
PRE-REQUISITE: -				
Course Objective:	• To understand the basic concepts of fluid statics and dimensional analysis • To understand the types of flow measuring devices and to determine coefficient of discharge. • To gain knowledge over classification of fluid moving machinery and their performance analysis.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Understand the concept of fluid statics and its applications; Apply the principles of dimensional analysis for engineering applications.	Ap	20%
CO2	Analyze the types of fluid flow in pipes; Understand the basic equations in fluid flow operations.	An	20%
CO3	Retrieve and apply the concepts of flow around solids in packed and fluidized beds.	Ap	40%
CO4	Appraise and select the flow measuring devices in process industries.	An	20%
CO5	Analyze the performance of fluid moving machinery and appraise the types of valves and pipe fittings in process industries.	U	Internal Assessment

UNIT I - FLUID STATICS AND DIMENSIONAL ANALYSIS	(6+3)
Introduction to Fluid statics, properties and Based problems; Hydrostatic equation and its applications; Pressure measurement – Manometers and its types - Decanters; Units and Dimensions; Dimensional analysis – Models and Similitude –Types and principles of Similarity;	
UNIT II - FLOW THROUGH CONDUITS	(6+3)
Types of flow – Shear stress distribution - Laminar and turbulent flow in pipes; Friction factor - Moody Chart – Losses in piping system; Introduction to Boundary layer; Flow through non-circular conduits; Basic equations - Continuity equation - Bernoulli's equation and its applications;	
UNIT III - FLOW AROUND SOLIDS	(6+3)
Drag and its types - Drag coefficient; Industrial applications of Packed and fluidized bed - Packing materials; Pressure drop across packed bed - Ergun's equation; Fluidization and its classification - Pressure drop across the fluidized bed – Minimum fluidization velocity- Motion of particles through fluids – Terminal settling velocity;	

UNIT IV - FLOW METERING	(6+3)
Classification and Selection of flow meters; Principle, working and applications of Venturimeter, Orificemeter, rotameters and pitot tube; Determination of discharge coefficient; Other meters: Anemometer - Mass flow meter - High viscous flow meter; Notches and weirs;	
UNIT V - FLUID MOVING MACHINERY	(6+3)
Classification and selection of fluid moving machinery; Principle, working and applications of Centrifugal pump and Reciprocating pump - Characteristics curves of centrifugal pump; Elementary principles of gear, air lift, diaphragm and submersible pumps; Types and application of valves and pipe fittings;	
TOTAL (L:30 + T:15) = 45 PERIODS	

TEXTBOOKS:

1. Dr. R.K.Banzal ,"A Textbook of Fluid Mechanics and Hydraulic Machines , Nineth edition.2010.
2. McCabe W.L, Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw Hill International Edition, New York, 2006.
3. Noel De Nevers,"Fluid Mechanics for Chemical Engineers", 3rd Edition, McGraw Hill, New York, 2004.

REFERENCES:

1. Cengel, Yunus and Cimbala John M, "Fluid Mechanics Fundamentals and Applications", 2nd Edition, Tata McGraw Hill Publishing Company, NewDelhi, 2006
2. J.M.Coulson and J.F.Richordson, "Chemical Engineering Vol - I & II", 6th Edition Butterworth –New Delhi-2000.

22CHM03 BASIC PROCESS CALCULATIONS					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : -					
Course Objective:	• To provide basic idea of basic chemical calculations. • To gain fundamental knowledge and apply material balance without chemical reaction in process industry • To learn the combined material and energy balances specific industries				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Understand and apply composition of mixtures/solution and determine Pressure, volume and temperature of glass using equation of state	Ap	20%
CO2	Apply the law of conversion of mass for different batch and continues unit operations	An	20%
CO3	Apply the law of conversion of mass for unit processes and evaluate yield, conversion, recycle ratio/purge/bypass of chemical reactors	Ap	40%
CO4	Apply energy balance for reacting system and understand the effect of temperature and pressure on heat of reaction	An	20%
CO5	Evaluate the combined material and energy balance of specific industries and understand industrial need for material and energy balance	U	Internal Assessment

UNIT I - BASIC CHEMICAL CALCULATIONS	(9)
Methods of expression; the ideal gas law; calculation of pressure, volume and temperature using ideal and Vander Waals equations. Use of partial pressure and pure component volume in gas mixture calculations; average molecular weight of gas mixture; density of gas mixture;	
UNIT II - MATERIAL BALANCE WITHOUT CHEMICAL REACTION	(9)
Stoichiometric principles, application of material balance to unit operation like Distillation, Evaporation, Crystallization, Drying, Extraction, Mixing/Blending and Absorption. Humidification and dehumidification basic concepts -calculation of absolute molal, relative and percentage humilities; Use of psychometric chart;	
UNIT III – HEAT CAPACITY	(9)
Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy.	

UNIT IV – ENERGY BALANCE	(9)
Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction. - Energy balance for systems with and without chemical reaction - Unsteady state energy balances	
UNIT V – COMBUSTION AND FLUE GAS ANALYSIS	(9)
Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from Orsat technique, problems on sulphur and sulphur burning compounds	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Bhatt B.L and Thakore S.B, "Stoichiometry", 5th edition, Tata McGraw Hill publishing company, New Delhi, 2017.
2. VenkataramaniV,Anantharaman N. and MeeraSheriffa Begum K.M, "Process Calculation ", 2nd edition, Prentice Hall of India , New Delhi ,2011.

REFERENCES:

1. Himmelblau D.M, "Basic Principle and calculation in Chemical Engineering", 8thedition,Prentice Hall of India, New Delhi, 2013.
2. Richard M.Felder Ronald W .Rousseau, "Elementary Principles of Chemical Process", 3rdedition, 2005.

22CHM04 HEAT TRANSFER OPERATIONS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : -

Course Objective:	• To understand nature and modes of heat transfer • To have a basic idea of heat transfer with phase change and design evaporator • To gain idea of different types of heat exchanger and performances

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Understand the fundamental principles of conduction	Ap	20%
CO2	Acquire knowledge in convection and radiation heat transfer	An	20%
CO3	Familiarize with the fundamentals of radiation and radiation shield	Ap	40%
CO4	Apply the knowledge of heat transfer in the design of evaporators, boiling and condensation	An	20%
CO5	Design and analyze the performance of heat exchangers	U	Internal Assessment

UNIT I - CONDUCTION	(9)
Nature and modes of heat transfer; concept of heat conduction – Fourier's law, thermal conductivity of materials , one dimensional steady heat conduction –through plane wall, composite plane wall, cylinder, composite cylinder, sphere and composite sphere. Relationship between individuals and overall heat transfer coefficient; critical thickness of insulation;	
UNIT II – CONVECTION	(9)
Nature and forced convection –Application of dimensional analysis for convection dimensionless number, Reynolds and Colburn analogy, jH factor, Equation for forced convection under laminar and turbulent flow condition in pipes.	
UNIT III - RADIATION	(9)
Concepts and nature of thermal radiation, concepts of black and grey bodies; Stefan Boltzmann, Kirchhoff's, Plank's and Wien laws Radiation between surface configuration factor; radiation shield.	
UNIT IV - EVAPORATORS	(9)
Introduction – Types of Evaporators (Standard vertical tube, long tube, Forced circulation)– Capacity – Steam economy – Boiling point elevation - Material and energy balance of single effect evaporator - surface area calculations for single effect evaporator - Theory of multiple effect evaporators.	

UNIT V - HEAT EXCHANGERS	(9)
Types of heat exchangers; LMTD; use of correction factor charts, fouling factor, surface area calculation for double pipe and shell and tube heat exchangers; effectiveness and number of transfer units – Wilson's plot.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. YunusA.Cengel, "Heat Transfer: A practical approach ",2ndedition .McGrawhill,2002.
2. Dutta Binary K, "Heat Transfer Principle and application", Prentice Hall of India, New Delhi, 2000.

REFERENCES:

1. J.P. Hollman,Souvik Bhattacharyya, "Heat Transfer " 10th Edition, McGrawhill,2011
2. Coulson J.M and Richardson J.F., "ChemicalEngineering Volume I", 6thedition, Elsevier publications, 2006.

22CHM05 MASS TRANSFER OPERATIONS					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : -					
Course Objective:	• To understand the basic concepts of diffusion and its measurement. • To gain knowledge over humidification and dehumidification and application in process industries. • To understand the mechanism of drying and crystallization				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Understand diffusion operations in gases liquids and solids.	Ap	20%
CO2	Understand the concept of interphase mass transfer coefficients and equipment	An	20%
CO3	Understand the concept humidifiers and cooling towers.	Ap	40%
CO4	Retrieve and apply the knowledge gained in mass transfer to perform simple calculations in drying	An	20%
CO5	Apply the knowledge gained in mass transfer to perform simple calculations in crystallization process	U	Internal Assessment

UNIT I : DIFFUSION	(9)
Diffusion in fluids - Molecular and eddy diffusion - Steady state diffusion under stagnant and laminar flow conditions -Diffusivity measurement and prediction-Diffusion in solids and its applications.	
UNIT II : DRYING	(9)
Theory and mechanism of drying, drying characteristics of materials, batch and continuous drying, Calculation of drying time under constant drying conditions, Different types of dryers and their applications.	
UNIT III : CRYSTALLIZATION	(9)
Principles of crystallization – methods of super saturation-law of crystal growth and growth coefficients, effect of tip speed. Calculations involving material and energy balances- Industrial crystallizers – Swenson, Oslo and their applications.	
UNIT IV : ABSORPTION	(9)
Choice of solvent, Co-current and counter-current operations, Tray tower absorber – Absorption factor – Calculation of number of theoretical stages, actual number of trays. Packed tower absorber – Tower packing and characteristics –Calculation of NTU, HTU and height of absorption towers.	

UNIT V : DISTILLATION	(9)
Vapour-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 Mc-Cabe - Thiele method for binary system.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. McCabe W.L., Smith J.C. and Harriot P., —Unit Operations in Chemical Engineering‖, 7th Edition, McGraw-Hill International Edition, New York, 2006.
2. Treybal Robert E., —Mass Transfer Operations‖, 3rd Edition, McGraw-Hill Book Company, 1980.

REFERENCES:

1. Anantharaman N. and Meera Sheriffa Begum K.M., —Mass Transfer: Theory and Practice‖, Prentice Hall of India, New Delhi, 2011.
2. Welty J.R., Wilson R.E. and Wicks C.E., —Fundamentals of Momentum Heat and Mass Transfer‖, 5th Edition, John Wiley, 2007.

22CHM06 CHEMICAL REACTION ENGINEERING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : -				
Course Objective:	• To understand the basic concepts of chemical kinetics studies and types of reactions. • To learn the mass and energy balance of ideal reactors of batch and continues operations. • To gain knowledge over multiple rectors with series/parallel configurations.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	The students will be able to understand the concept of stoichiometric equations, order of reaction and chemical kinetic theories.	Ap	20%
CO2	The students will be able to understand the performance equations of ideal reactors.	An	20%
CO3	The students will be able to apply knowledge of performance studies to compare reactors of different types in series and parallel.	Ap	40%
CO4	The students will be able to learn the concepts of multiple reactions involved in PFR and MFR.	An	20%
CO5	The students will be able to analyze the performance of reactors under steady state non-isothermal conditions.	U	Internal Assessment

UNIT I : FUNDAMENTAL CONCEPTS AND CHEMICAL KINETICS	(9)
Chemical Kinetics, Classification of chemical reactions, Rate, rate equation, rate constant, Order and Molecularity, activation energy, Arrhenius theory, collision theory ,transition state theory, Elementary and non-elementary reactions, half-life period, constant volume reaction- Irreversible unimolecular type first order reactions. Variable volume Batch reactor. Zero order reaction.	
UNIT II : DESIGN OF SINGLE IDEAL REACTORS	(9)
Chemical reactors: Batch reactors, performance equation. Advantages and disadvantages of Batch reactors, Space time and space velocity. Simple calculations. CSTR, performance equation, Conversion yield, Simple problems.	
UNIT III : DESIGN OF MULTIPLE REACTORS	(9)
Steady state Mixed flow reactors performance equation, Plug flow reactor Design equation, Mixed flow reactors in series and parallel connection, Plug flow reactors in series and parallel connection, reactors of different types in series. Simple problems	
UNIT IV : DESIGN FOR MULTIPLE REACTIONS	(9)
Series reactions, parallel reactions, series-parallel reactions, qualitative discussion about product distribution in mixed flow reactor, quantitative treatment of product distribution in mixed flow reactor, overall fractional yield ,instantaneous fractional yield, selectivity. Simple problems.	

UNIT V :BASIC CONCEPTS OF NON-IDEAL FLOW	(9)
Residence time distribution, RTD Measurement, Characteristics of a tracer, E curve, C curve and F curve, Mean residence time, The RTD in a plug flow reactor, State of aggregation of the flowing stream, Simple problems.	
TOTAL (L:45) : 45 PERIODS	
TEXT BOOKs:	
1. H.S. Fogler, Elements of Chemical Reaction Engineering, 3rd Ed., Prentice Hall India Pvt. Ltd., New Delhi,2001 2. O. Levenspiel, Chemical Reaction Engineering, 3rd Ed., Wiley Publications, 1999.	
REFERENCES:	
1. Gilbert F Froment, Kenneth B Bischoff and Juray D Wilde "Chemical Reactor Analysis and Design", Wiley, New York (2010). 2. J.M. Smith, Chemical Engineering Kinetics, 2nd Ed., McGraw-Hill, 1981. 3. P.V. Danckwerts, Gas-liquid reactions, Sharma and Doraiswamy Vols. I & II Froment and Bischoff.	

22CHM07 PROCESS PLANT UTILITIES					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : -					
Course Objective:	• To learn the requirement of air, water and steam in process industries • To understand the vacuum systems for different chemical processes				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Recognize the importance of compressed air, humidification and dehumidification process and PSA systems	Ap	20%
CO2	Comprehend the water treatment and steam utilization practices in process industries	An	20%
CO3	Select suitable vacuum systems for different chemical processes	Ap	40%
CO4	Grasp the principles of refrigeration process for application in chemical process industries	An	20%
CO5	Understand the importance of insulation and calculate critical thickness of insulation; Gain an insight into the characteristics of inert gases.	U	Internal Assessment

UNIT I : HUMIDIFICATION	(9)
Air, Compressed air, Types and characteristics of fans, blowers and compressors. Air drying systems. Humidification and dehumidification of air. Production of oxygen and nitrogen by PSA systems.	
UNIT II : HEATING SYSTEM	(9)
Source and characteristics of water; soft water, hard water and Demineralised water. Treatment of water for boiler and cooling towers. Fuel and its Classification; Properties of steam; waste heat boilers. Thermic fluid System for process applications. Steam trap - classification, selection and applications. Efficient use of steam in process plants;	
UNIT III : VACUUM SYSTEM	(9)
Selection of vacuum systems; types and characteristics of vacuum pumps, steam jet ejectors and auxiliaries. Process equipment under vacuum – Separation columns, Reactors, Evaporators and Dryers.	
UNIT IV : REFRIGERATION	(9)
Principles, compression and absorption refrigeration systems. Types and properties of refrigerants, eco-friendly refrigerants.	
UNIT V : INSULATION AND INERT GAS	(9)
Importance of insulation. Insulation materials for high, intermediate, low and very low temperatures. Calculation of critical thickness of insulation. Properties of inert gases and their uses	
LECTURE(L:45)=45 PERIODS	

TEXT BOOKS:

1. Lyle O., "Efficient use of steam", HMSO Publishers, 2000
2. Jack Broughton, "Process Utility System- Introduction to Design Operation and Maintenance", Institution of Chemical Engineers, UK, 1994.

REFERENCES:

1. Mcquiston F.C and Parker J., "Heating, Ventilating & Air Conditioning – Analysis and Design", 3rd Edition, John Wiley, New York, 1988.
2. EskelNordell, "Water treatment for industrial and other uses", Reinhold Publishing Corporation, New York, 1961

22CHM08 PROCESS PLANT SAFETY					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : -					
Course Objective:	• To understand the importance of safety in industry • To learn about the plant layout, maintenance and hazards • To learn about risk analysis and assessment, hazard identification				

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Demonstrate the awareness of plant safety, plant layout and the usage of safety codes.	Ap	20%
CO2	Understand the selection and replacement of process equipment	An	20%
CO3	Exhibit the skill in classifying chemical, fire, explosion hazards	Ap	40%
CO4	Analyze the response to health hazards and to implement the effective process control	An	20%
CO5	Understand the rules and act framed by government for safe working environment	U	Internal Assessment

UNIT I– INTRODUCTION TO SAFETY	(9)
Need for safety in industries –Good layout of plant - Safety measures in storage and transportation of chemicals. Color code for pipelines, safety symbols and codes – spill control.	
UNIT II – PLANT MAINTENANCE	(9)
Plant maintenance, Personal protective equipment – Breathing and respiratory protection; Fire prevention – classification of fire – suppression – foam, dry chemical powder. Fire extinguisher, Emergency planning.	
UNIT III – POTENTIAL HAZARDS	(9)
Potential hazards-Hazard classification chemical, mechanical, noise hazards – Hazards due to ammonia, chlorine, sulphuric acid. Safety data sheet.	

UNIT IV - HAZARD IDENTIFICATION AND CONTROL	(9)
HAZOP, Job safety analysis – Fault tree analysis – Event tree analysis – Failure modes and effect analysis Safety audit – Plant inspection –Past accident analysis–case study.	
UNIT V - LEGAL FRAMEWORK FOR SAFETY AND ENVIRONMENT	(9)
Rules – safe working environments – factories act – labour welfare act – ESI Act. Role of Government in safety organizations, OHSAS and ISO standards.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

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

REFERENCES:

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