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 Syllabus
For
B.Tech – Chemical Engineering [R17]

[CHOICE BASED CREDIT SYSTEM]

(This Curriculum and Syllabi are applicable to Students admitted from the academic year 2017-2018 onwards)

SEPTEMBER 2021

Approved by Ninth Academic Council

DEPARTMENT OF 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):

PE01: To enable our graduates to excel in their field by keeping abreast of latest technologies.

PE02: To equip the graduates with unique leadership and interpersonal skills.

PE03: To empower the graduates to be able to explore innovative solutions to real life.

PE04: To enable them to pursue higher studies and explore new path in teaching and research.

PE05: To ensure that our graduates deliver their task with ethical dimension and contribute to societal growth.

PROGRAMME OUTCOMES (PO):

At the end of a programme Engineering Graduates will be able to:

a-l	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.

Program Educational Objectives (PEO)	**Programme Outcomes (PO)**											
	a	b	c	d	e	f	g	h	i	j	k	l
I	3	3	2	1	2	1	2	1	1	1	2	2
II	2	1	2	3	2	2	1	2	2	3	3	1
III	1	3	3	2	1	2	3	3	3	1	1	3
IV	3	2	2	2	3	3	1	1	2	3	2	2
V	2	1	1	1	1	3	3	2	2	1	3	1

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1: Accomplish the contemporary needs of Chemical and related industries.

PSO2: Contribute to multidisciplinary research using relevant Chemical Engineering tools.

PSO3: Acquire a working knowledge in professional courses and also frontier area of Chemical Engineering.

PSO4: Apply and develop relevant innovative projects to optimize Chemical process.

PROGRAM SPECIFIC OUTCOMES	**PROGRAMME OUTCOMES**											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
1	3	3	3	3	3	1	1	1	1	1	2	2
2	3	3	2	3	2	2	1	3	2	1	3	2
3	3	3	2	3	2	2	2	2	1	2	1	3
4	3	3	3	3	2	2	2	2	2	1	2	2

Contribution 1: Reasonable 2: Significant 3: Strong

NANDHA ENGINEERING COLLEGE (AUTONOMOUS), ERODE - 638 052

REGULATIONS - 2017 (R17) **CHOICE BASED CREDIT SYSTEM (CBCS)**

B.TECH - CHEMICAL ENGINEERING

CURRICULAM: I to VIII SEMESTERS **SYLLABUS:I to VIII SEMESTERS**

SEMESTER: I									
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17EYA01	Professional English – I	HS	-	4	2	0	2	3
2	17MYB01	Calculus and Solid Geometry	BS	-	5	3	2	0	4
3	17PYB01	Physics for Engineers	BS	-	3	3	0	0	3
4	17CYB01	Applied Chemistry	BS	-	3	3	0	0	3
5	17MEC01	Engineering Graphics	ES	-	4	2	0	2	3
6	17CSC01	Problem Solving and Python Programming	ES	-	3	3	0	0	3
PRACTICALS									
7	17GYP01	Physics and Chemistry Laboratory	BS	-	4	0	0	4	2
8	17CSP01	Problem Solving and Python programming Laboratory	ES	-	4	0	0	4	2
9	17GEP01	Personal Values	HS	-	2	0	0	2	0
			TOTAL		**32**	**16**	**2**	**14**	**23**

SEMESTER: II									
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17EYA02	Professional English – II (Embedded)	HS	17EYA01	4	2	0	2	3
2	17MYB02	Complex Analysis and Laplace Transforms	BS	17MYB01	5	3	2	0	4
3	17PYB06	Physics of Materials and Fluids	BS	17PYB01	3	3	0	0	3
4	17CYB03	Environmental Science	BS	-	3	3	0	0	3
5	17EEC01	Basic Electrical and Electronics Engineering	ES	-	3	3	0	0	3
6	17CHC01	Introduction to Chemical Engineering	ES	-	3	3	0	0	3
PRACTICALS									
7	17GYP02	Engineering Practices Laboratory	ES	-	4	0	0	4	2
8	17CHP01	Chemical Analysis Laboratory	ES	-	4	0	0	4	2
9	17GEP02	Inter Personal Values	HS	17GEP01	2	0	0	2	0
			TOTAL		**31**	**17**	**2**	**12**	**23**

SEMESTER : III									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17MYB03	Fourier Series and Partial Differential Equations	BS	17MYB02	4	2	2	0	3
2	17MEC07	Heat Power Engineering	ES	-	3	3	0	0	3
3	17CHC02	Industrial Chemistry	PC	-	3	3	0	0	3
4	17CHC03	Material Technology	PC	-	3	3	0	0	3
5	17CHC04	Chemical Engineering Fluid Mechanics	PC	-	4	2	2	0	3
6	17CHC05	Chemical Process Calculations	PC	-	4	2	2	0	3
PRACTICALS									
7	17CHP02	Chemical Technology Laboratory	PC	-	4	0	0	4	2
8	17CHP03	Fluid Mechanics Laboratory	PC	17CHC04	4	0	0	4	2
9	17GED02	Soft Skills - Reading and Writing	EEC	-	2	0	0	2	0
			TOTAL		**31**	**15**	**6**	**10**	**22**

SEMESTER : IV									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17MYB07	Numerical Methods	BS	-	4	2	2	0	3
2	17CHC06	Process Organic Synthesis	PC	-	3	3	0	0	3
3	17CHC07	Process Heat Transfer	PC	-	4	2	2	0	3
4	17CHC08	Mechanical Operations	PC	-	4	2	2	0	3
5	17CHC09	Chemical Engineering Thermodynamics	PC	17MEC07	4	2	2	0	3
6	E-1	Elective – I	PSE	-	3	3	0	0	3
PRACTICALS									
7	17CHP04	Physical and Organic Chemistry Laboratory	PC	-	4	0	0	4	2
8	17CHP05	Mechanical Operations Laboratory	PC	17CHC08	4	0	0	4	2
9	17GED01	Soft Skills – Listening and Speaking	EEC	-	2	0	0	2	0
10	17GED03	Personality and Character Development	EEC	-	2	0	0	2	0
			TOTAL		**34**	**14**	**8**	**12**	**22**

SEMESTER : V									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17CHC10	Mass Transfer – I	PC	17CHC05	4	2	2	0	3
2	17CHC11	Chemical Process Industries	PC	-	3	3	0	0	3
3	17CHC12	Chemical Reaction Engineering	PC	-	4	3	2	0	4
4	17CHC13	Chemical Equipment Design –I	PC	-	5	1	4	0	3
5	E-2	Elective – II	PSE	-	3	3	0	0	3
6	E-3	Elective – III	PSE	-	3	3	0	0	3
PRACTICALS									
7	17CHP06	Process Heat Transfer Laboratory	PC	17CHC07	4	0	0	4	2
8	17CHP07	Chemical Reaction Engineering Laboratory	PC	17CHC12	4	0	0	4	2
9	17GED07	Constitution of India	EEC	-	2	2	0	0	0
		TOTAL			**32**	**17**	**8**	**8**	**23**

SEMESTER : VI									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17CHC14	Mass Transfer –II	PC	17CHC10	6	2	2	2	4
2	17CHC15	Chemical Equipment Design - II	PC	17CHC13	5	1	4	0	3
3	17CHC16	Process Instrumentation Dynamics and Control	PC	-	4	2	2	0	3
4	17CHC17	Chemical Process Plant Safety and Hazard Analysis	PC	-	3	3	0	0	3
5	E-4	Elective – IV	PSE		3	3	0	0	3
6	E-5	Elective – V	PSE/OE		3	3	0	0	3
PRACTICALS									
7	17CHP08	Process Computation Laboratory	PC	-	4	0	0	4	2
8	17CHP09	Industrial Training	PC	-	0	0	0	2	1
9	17GED06	Comprehension	EEC	ALL CORE SUBJECTS	2	0	0	2	0
10	17GED08	Essence of Indian Traditional Knowledge	EEC	-	2	2	0	0	0
		TOTAL			**32**	**16**	**8**	**10**	**22**

SEMESTER : VII									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17CHC18	Process Engineering Economics and Management	PC	-	3	3	0	0	3
2	17CHC19	Transport Phenomena	PC	-	4	2	2	0	3
3	17CHC20	Process Modeling and Simulation	PC	-	6	2	2	2	4
4	E-6	Elective – VI	PSE /OE		3	3	0	0	3
5	E-7	Elective – VII	OE		3	3	0	0	3
PRACTICALS									
6	17CHP10	Process Dynamic and Control Laboratory	PC	17CHC16	4	0	0	4	2
7	17CHD01	Project work I	EEC	-	8	0	0	8	4
			TOTAL		**31**	**13**	**4**	**14**	**22**

SEMESTER : VIII									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	E-8	Elective – VIII	PSE	-	3	3	0	0	3
2	E-9	Elective – IX	OE	-	3	3	0	0	3
PRACTICALS-									
3	17CHD02	Project Work – II	EEC	17CHD01	16	0	0	16	8
			TOTAL		**22**	**6**	**0**	**16**	**14**

Total Credits: 23 + 23 + 22 + 22 + 23 + 22 + 22 + 14 = 171

HUMANITIES AND SOCIAL SCIENCES (HS)									
(a) Humanities and Social Sciences		Credit Distribution: 12-15		AICTE norm: 5 – 10%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	17EYA01	Professional English- I	HS	-	4	2	0	2	3
2	17EYA02	Professional English- II	HS	17EYA01	4	2	0	2	3
3	17GEP01	Personal values	HS	-	2	0	0	2	0
4	17GEP02	Inter Personal Values	HS	17GEP01	2	0	0	2	0

BASIC SCIENCES (BS)									
(a) Basic Sciences (BS)		Credit Distribution: 15-21		AICTE norm: 15 – 20%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	17MYB01	Calculus and Solid Geometry	BS	-	5	3	2	0	4
2	17PYB01	Physics for Engineers	BS	-	3	3	0	0	3
3	17CYB02	Applied Chemistry	BS	-	3	3	0	0	3
4	17GYP01	Physics and Chemistry Laboratory	BS	-	4	0	0	4	2
5	17MYB02	Complex Analysis and Laplace Transforms	BS	17MYB01	5	3	2	0	4
6	17PYB06	Physics of Materials and Fluids	BS	17PYB01	3	3	0	0	3
7	17CYB03	Environmental Science	HS	-	3	3	0	0	3
8	17MYB03	Fourier Series, Partial Differential Equations	BS	17MYB02	4	2	2	0	3
9	17MYB06	Numerical Methods	BS	-	4	2	2	0	3

ENGINEERING SCIENCES (ES)									
(a) Engineering Sciences (ES)		Credit Distribution: 15-21		AICTE norm: 15 – 20%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	17MEC01	Engineering Graphics	ES	-	4	2	0	2	3
2	17CSC01	Problem Solving and Python Programming	ES	-	3	3	0	0	3
2	17CSP01	Problem Solving and Python Programming Laboratory	ES	-	4	0	0	2	1
3	17EEC01	Basic Electrical and Electronics Engineering	ES	-	3	3	0	0	3
4	17CHC01	Introduction to Chemical Engineering	ES	-	3	3	0	0	3
5	17GYP02	Engineering Practices Laboratory	ES	-	4	0	0	4	2
6	17CHP01	Chemical Analysis Laboratory	ES	-	4	0	0	4	2
7	17MEC07	Heat Power Engineering	ES	-	3	3	0	0	3

PROFESSIONAL CORE (PC)									
PROFESSIONAL CORE (PC)		Credit Distribution: 63 - 72		AICTE norm: 30 – 40%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1.	17CHC02	Industrial Chemistry	PC	-	3	3	0	0	3
2.	17CHC03	Material Technology	PC	-	3	3	0	0	3
3.	17CHC04	Chemical Engineering Fluid Mechanics	PC	-	4	2	2	0	3
4.	17CHC05	Chemical Process Calculations	PC	-	4	2	2	0	3
5.	17CHP03	Fluid Mechanics Laboratory	PC	17CHC04	4	0	0	4	2
6.	17CHP02	Chemical Technology Laboratory	PC	-	4	0	0	4	2
7.	17CHC06	Process Organic Synthesis	PC	-	3	3	0	0	3
8.	17CHC07	Process Heat Transfer	PC	-	4	2	2	0	3
9.	17CHC08	Mechanical Operations	PC	-	4	2	2	0	3
10.	17CHC09	Chemical Engineering Thermodynamics	PC	17MEC07	4	2	2	0	3
11.	17CHP04	Physical and Organic Chemistry Laboratory	PC	-	4	0	0	4	2
12.	17CHP05	Mechanical Operations Laboratory	pc	17CHC08	4	0	0	4	2
13.	17CHC10	Mass Transfer - I	PC	17CHC05	4	2	2	0	3
14.	17CHC11	Chemical Process Industries	PC	-	3	3	0	0	3
15.	17CHC12	Chemical Reaction Engineering	PC	-	4	3	2	0	4
16.	17CHC13	Chemical Equipment Design -I	PC	-	5	2	2	0	3
17.	17CHP06	Process Heat Transfer Laboratory	PC	17CHC07	4	0	0	4	2
18.	17CHP07	Chemical Reaction Engineering Laboratory	PC	17CHC12	4	0	0	4	2
19.	17CHC14	Mass Transfer –II	PC	17CHC10	6	2	2	2	4
20.	17CHC15	Chemical Equipment Design -II	PC	17CHC13	4	2	2	0	3
21.	17CHC16	Process Instrumentation Dynamics and Control	PC	-	4	2	2	0	3
22.	17CHC17	Chemical Process Plant Safety and Hazard Analysis	PC	-	3	3	0	0	3
23.	17CHP08	Process Computation Laboratory	PC	-	4	0	0	4	2
24.	17CHP09	Industrial Training	PC	-					
25.	17CHC18	Process Engineering Economics and Management	PC	-	3	3	0	0	3
26.	17CHC19	Transport Phenomena	PC	-	3	3	0	0	3
27.	17CHC20	Process Modeling & Simulation	PC	-	4	2	2	2	4
28.	17CHP10	Process Dynamic and Control Laboratory	PC	17CHC16	4	0	0	4	2

LIST OF PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVES			Credit Distribution: 9 – 12			AICTE norm: 5 to 10%				
Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C	PREFERRED
1	17CHX01	Oil and Natural Gas Engineering	PSE	-	3	3	0	0	3	IV / V / VI
2	17CHX02	Biochemical Engineering	PSE	-	3	3	0	0	3	IV / V / VI
3	17CHX03	Instrumental Methods of Analysis	PSE	-	3	3	0	0	3	IV / V / VI
4	17CHX04	Food Technology	PSE	-	3	3	0	0	3	V/ VI/ VII
5	17CHX05	Fluid Movers	PSE	-	3	3	0	0	3	V/ VI/ VII
6	17CHX06	Petroleum Refining Engineering	PSE	-	3	3	0	0	3	V/ VI/ VII
7	17CHX07	Drugs and Pharmaceuticals Technology	PSE	-	3	3	0	0	3	VI / VII / VIII
8	17CHX08	Computational Fluid Dynamics in Chemical Engineering	PSE	-	3	3	0	0	3	VI / VII / VIII
9	17CHX09	Chemical Process Utilities	PSE	-	3	3	0	0	3	VI / VII / VIII
10	17CHX10	Separation and Purification Processes	PSE	-	3	3	0	0	3	VI / VII / VIII
11	17CHX11	Air Pollution and Control	PSE	-	3	3	0	0	3	VI / VII / VIII
12	17CHX12	Employability Skills	PSE	-	3	3	0	0	3	VI / VII / VIII
13	17CHX13	Polymer Technology	PSE	-	3	3	0	0	3	VI / VII / VIII
14	17CHX14	Pilot Plant and Scale up Methods	PSE	-	3	3	0	0	3	VI / VII / VIII
15	17CHX15	Power Plant Management	PSE	-	3	3	0	0	3	VI / VII / VIII
16	17CHX16	Pulp and Paper Technology	PSE	-	3	3	0	0	3	VI / VII / VIII
17	17CHX17	Heterogeneous Catalytic Reactions	PSE	-	3	3	0	0	3	VI / VII / VIII
18	17CHX18	Process Optimization	PSE	-	3	3	0	0	3	VI / VII / VIII
19	17GEA03	Total Quality Management	PSE	-	3	3	0	0	3	VI / VII / VIII
20	17CHX20	Multi component Distillation	PSE	-	3	3	0	0	3	VI / VII / VIII

21	17CHX21	Chemical Process Equipment and Auxiliaries	PSE	-	3	3	0	0	3	VI / VII / VIII
22	17CHX22	Drilling and Well Engineering	PSE	-	3	3	0	0	3	VI / VII / VIII
23	17GEA04	Engineering Ethics and Human Values	PSE	-	3	3	0	0	3	VI / VII / VIII
24	17CHX24	Design of Heat Exchangers	PSE	-	3	3	0	0	3	VI / VII / VIII
25	17CHX25	Design of Pressure Vessels and Piping	PSE	-	3	3	0	0	3	VI / VII / VIII
26	17CHX26	Drying Technology	PSE	-	3	3	0	0	3	VI / VII / VIII
27	17CHX27	Computational Techniques For Chemical Engineers	PSE	-	3	2	2	0	3	VI / VII / VIII
28	17CHX28	Internet of Things (IOT) In Chemical Process Industries	PSE	-	3	3	0	0	3	VI / VII / VIII
29	17MYB12	Basic Statistics and Numerical Analysis	PSE	-	3	3	0	0	3	VI / VII / VIII
30	17CAX11	Internet of Things	PSE	-	3	3	0	0	3	VI / VII / VIII

R17 - OPEN ELECTIVES										
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1.	17AGZ01	Baking and Confectionery Technology	OE	-	3	3	0	0	3	VII
1.	17AGZ01	Baking and Confectionery Technology	OE	-	3	3	0	0	3	VII
2.	17AGZ02	Food safety and quality control system	OE	-	3	3	0	0	3	VII
3.	17AGZ03	Farm Mechanization	OE	-	3	3	0	0	3	VIII
4.	17AGZ04	Processing of Fruits and Vegetables	OE	-	3	3	0	0	3	VIII
5.	17CHZ01	Waste Water Treatment	OE	-	3	3	0	0	3	VII
6.	17CHZ02	Piping Engineering	OE	-	3	3	0	0	3	VII
7.	17CHZ03	Process Automation	OE	-	3	3	0	0	3	VII
8.	17CHZ04	Process Instrumentation	OE	-	3	3	0	0	3	VII

9.	17CEZ01	Energy conservation in buildings	OE	-	3	3	0	0	3	VII
10.	17CEZ02	Air Pollution Management	OE	-	3	3	0	0	3	VIII
11.	17CEZ03	Building Services	OE	-	3	3	0	0	3	VIII
12.	17CEZ04	Road Safety Management	OE	-	3	3	0	0	3	VII
13	17CEZ05	Waste Management	OE	-	3	3	0	0	3	VII/VIII
14.	17CSZ01	Design Thinking	OE	-	3	3	0	0	3	VII
15.	17CSZ02	Digital Marketing	OE	-	3	3	0	0	3	VII
16.	17CSZ03	Software Engineering	OE	-	3	3	0	0	3	VIII
17.	17CSZ04	Unified Functional Testing	OE	-	3	3	0	0	3	VIII
18	17CSZ05	C Programming	OE	-	3	3	0	0	3	VI
19.	17CSZ06	Data Structures	OE	-	3	3	0	0	3	VI
20.	17CSZ07	Web Services using Java	OE	-	3	3	0	0	3	VI
21.	17ECZ01	Modern wireless communication system	OE	-	3	3	0	0	3	VII
22.	17ECZ02	Consumer Electronics	OE	-	3	3	0	0	3	VII
23.	17ECZ03	Automotive Electronics	OE	-	3	3	0	0	3	VIII
24.	17ECZ04	Electronic Testing	OE	-	3	3	0	0	3	VIII
25.	17EEZ01	Renewable Energy Technology	OE	-	3	3	0	0	3	VII
26.	17EEZ02	Smart Grid	OE	-	3	3	0	0	3	VII
27	17EEZ03	Energy Auditing, Conservation and Management	OE	-	3	3	0	0	3	VIII
28	17EEZ04	Electrical Machines	OE	-	3	3	0	0	3	VIII
29	17EIZ01	Autotronix	OE	-	3	3	0	0	3	VII
30	17EIZ02	Industrial Automation	OE	-	3	3	0	0	3	VII
31.	17EIZ03	Fiber Optic Sensors	OE	-	3	3	0	0	3	VIII
32.	17EIZ04	Ultrasonic Instrumentation	OE	-	3	3	0	0	3	VIII
33.	17ITZ01	Software Testing Tool	OE	-	3	3	0	0	3	VII

34.	17ITZ02	User Experience	OE	-	3	3	0	0	3	VII
35.	17ITZ03	Developing Mobile Apps	OE	-	3	3	0	0	3	VIII
36.	17ITZ04	Software Project Management	OE	-	3	3	0	0	3	VIII
37.	17ITZ05	Java Programming	OE	-	3	3	0	0	3	VII
38.	17MEZ01	Engineering Ergonomics	OE	-	3	3	0	0	3	VII / VIII
39.	17MEZ02	Energy Audit and Resource Management	OE	-	3	3	0	0	3	VII / VIII
40.	17MEZ03	Electric Vehicle Technology	OE	-	3	3	0	0	3	VII / VIII
41.	17MEZ04	Value Engineering	OE	-	3	3	0	0	3	VII / VIII
42.	17MEZ05	Smart Mobility	OE	-	3	3	0	0	3	VII / VIII
43.	17MEZ06	Smart Sensor Systems	OE	-	3	3	0	0	3	VII / VIII
44.	17MYZ01	Mathematical Structures	OE	-	3	3	0	0	3	VII
45.	17MYZ02	Optimization Techniques	OE	-	3	3	0	0	3	VII
46.	17MYZ03	Statics for Engineers	OE	-	3	3	0	0	3	VII
47.	17MYZ04	Statistics for Engineers	OE	-	3	3	0	0	3	VII
48.	17PYZ01	Nanomaterials	OE	-	3	3	0	0	3	VII
49.	17PYZ02	Nuclear physics and Reactors	OE	-	3	3	0	0	3	VII
50..	17PYZ03	Space science and technology	OE	-	3	3	0	0	3	VII
51	17CYZ01	Chemistry for Every Day Life	OE	-	3	3	0	0	3	VII
52	17CYZ02	E - Waste Management	OE	-	3	3	0	0	3	VII
53	17CYZ03	Industrial Chemistry	OE	-	3	3	0	0	3	VII
54	17EYZ01	Communicative Hindi	OE	-	3	3	0	0	3	VII
55	17EYZ02	Fundamentals of German	OE	-	3	3	0	0	3	VII
56	17EYZ03	Basics of Japanese	OE	-	3	3	0	0	3	VII
57	17EYZ04	Employability Enhancement and Analytical Skills	OE	-	3	3	0	0	3	VII
58	17EYZ05	Workplace Communication	OE	-	3	3	0	0	3	VII

59.	17GYZ01	Biology for Engineers	OE	-	3	3	0	0	3	VII
60.	17BMZ01	Health care technology	OE	-	3	3	0	0	3	VII
61.	17BMZ02	Telemedicine	OE	-	3	3	0	0	3	VII
62.	17BMZ03	Epidemiology and Pandemic Management	OE	-	3	3	0	0	3	VII
63	17BMZ04	Medical Ethics	OE	-	3	3	0	0	3	VII
64	17EYX01	Effective Communication	OE	-	3	3	0	0	3	VII
65	17AIZ01	Fundamentals of artificial intelligence and machine learning	OE	-	3	3	0	0	3	VII
66	17AIZ02	Data science fundamentals	OE	-	3	3	0	0	3	VII
67	17AIZ03	Introduction to Business analytics	OE	-	3	3	0	0	3	VIII
68	17AIZ04	Augmented reality/virtual reality technologies	OE	-	3	3	0	0	3	VII

(b) Additional Open Electives for Chemical Engineering program.

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1.	17CSX31	Problem Solving and Programming	OE	-	3	3	0	0	3	V/VI
2.	17ITX26	Problem Solving and Algorithmic Skills	OE	-	3	3	0	0	3	V/VI

EMPLOYABILITY ENHANCEMENT COURSES (EEC)										
Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C	P. S
1	17GED02	Soft Skills Reading and	EEC	-	2	0	0	2	0	III
2	17GED01	Soft Skills –Listening and Speaking	EEC	-	2	0	0	2	0	IV
3	17GED03	Personality and Character Development	EEC	-	2	0	0	2	0	IV
4	17GED06	Comprehension	EEC	All core subjects	2	0	0	2	0	VI
5	17GED07	Constitution of India	EEC	-	2	2	0	0	0	V

6	17GED08	Essence of India Traditional Knowledge	EEC	-	2	2	0	0	0	VI
7	17CHD01	Project work I	EEC	-	8	0	0	8	4	VII
8	17CHD02	Project work II	EEC	17CHD01	16	0	0	16	8	VIII

Honor Degree Courses									
Vertical I - Energy Engineering									
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	17CHX29	Bioenergy Technologies	-	-	3	3	0	0	3
2	17CHX30	Renewable Energy Resources	-	-	3	3	0	0	3
3	17CHX31	Energy Storage Technologies	-	-	3	3	0	0	3
4	17CHX32	Waste Management and Energy Recovery	-	-	3	3	0	0	3
5	17CHX33	Power Plant Engineering	-	-	3	3	0	0	3
6	17CHX34	Non Renewable Energy Sources	-	-	3	3	0	0	3
7	17CHX35	Energy Management	-	-	3	3	0	0	3
8	17CHX36	Thermal Energy Conservation Techniques	-	-	3	3	0	0	3

Vertical II - Biochemical Engineering									
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	17CHX37	Biochemistry	-	-	3	3	0	0	3
2	17CHX38	Bioprocess Principles and Technology	-	-	3	3	0	0	3
3	17CHX39	Fermentation and Bioprocessing	-	-	3	3	0	0	3
4	17CHX40	Bioseparation and Downstream Processing	-	-	3	3	0	0	3
5	17CHX41	Enzyme Immobilization Technology	-	-	3	3	0	0	3
6	17CHX42	Bioreactor Design	-	-	3	3	0	0	3
7	17CHX43	Environmental Biotechnology	-	-	3	3	0	0	3
8	17CHX44	Industrial Biotechnology	-	-	3	3	0	0	3

Minor Degree Courses									
CHEMICAL ENGINEERING									
SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
1	17CHM01	Introduction to Chemical Engineering	-	-	3	3	0	0	3
2	17CHM02	Basic Process Calculations	-	-	3	3	0	0	3
3	17CHM03	Heat Transfer Operations	-	-	3	3	0	0	3
4	17CHM04	Mass Transfer Operations	-	-	3	3	0	0	3
5	17CHM05	Fluid Moving Machinery	-	-	3	3	0	0	3
6	17CHM06	Process Plant Utilities	-	-	3	3	0	0	3
7	17CHM07	Process Plant Safety	-	-	3	3	0	0	3
8	17CHM08	Engineering Economics and Management	-	-	3	3	0	0	3

SUMMARY

SL. No.	SUBJECT AREA	CREDITS AS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1	HS	3	3	0	0	0	0	0	0	06
2	BS	12	10	3	3	0	0	0	0	28
3	ES	8	10	3	0	0	0	0	0	21
4	PC	0	0	16	16	17	16	12	0	77
5	PSE	0	0	0	3	6	3	3	3	18
6	OE	0	0	0	0	0	3	3	3	9
7	EEC	0	0	0	0	0	0	4	8	12
	TOTAL	23	23	22	22	23	22	22	14	171
	Non Credit / Mandatory (EEC)	1	1	1	2	1	2	-	-	-

17EYA01– PROFESSIONAL ENGLISH – I *(Common to All Branches)*					
			L	**T**	**P**	**C**
			2	**0**	**2**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 1**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program Outcomes**
1.0	To articulate and enunciate words and sentences clearly and efficiently using grammatical structures.	**1.1**	The students will be able to construct clear, grammatically correct sentences using a variety of sentence structures and appropriate vocabulary.		**i,l**
2.0	To acquire information through listening and apply it to persuade or articulate one's own point of view.	**2.1**	The students will be able to utilize listening skills to articulate one's own point of view in different circumstances.		**d,j,k,l**
3.0	To enable students to express themselves fluently and appropriately in social and professional contexts.	**3.1**	The students will be able to apply appropriate communication skills across settings, purposes, and audiences.		**d,j,k,l**
4.0	To summarize and paraphrase information in a text through reading skills.	**4.1**	The students will be able to distinguish main ideas and supporting details and employ active reading strategies to understand texts at the maximum level.		**d,j,k,l**
5.0	To understand different techniques and contents based on the written communication.	**5.1**	The students will be able to equip themselves with writing skills needed for academic as well as workplace contexts.		**d,j,k,l**

UNIT I - FOCUS ON LANGUAGE	**(6+6)**
Parts of Speech – Articles - Primary Auxiliaries – Modal Auxiliaries - Questions ('Yes/No' & 'Wh' Type) – Negatives - Prepositions – Conjunctions - Tenses (Simple, Continuous, Perfect, Perfect Continuous) - Vocabulary (Synonyms & Antonyms) - Homophones – Homonyms - One Word Substitution	
UNIT II – LISTENING FOR EFFECTIVENESS	**(6+6)**
Listening to Short Conversations or Monologues - Listening to Verbal and Non-Verbal Communication – Listening to Announcements - Listening and Note-taking – Listening to Telephonic Conversations – Listening to TED/ Ink talks- Intensive listening to fill in the gapped text	

UNIT III – COMMUNICATION BOOSTERS	(6+6)
Introducing Oneself – Exchanging Personal information (Likes & Dislikes) – Talking about Family & Friends - Asking about Routine Actions and Expressing Opinions - Participating in Short Conversations - Situational Talk	
UNIT IV – PROFESSIONAL READING	**(6+6)**
Skimming – Scanning (Short Texts and Longer Passages) – Inferring Technical Texts – Reading for Interrogation – Reading Newspaper, Advertisements and Interpreting – Practicing Speed Reading - Reading Comprehension (Multiple choice / Short / Open ended Questions) - Gap Filling	
UNIT V – TECHNICAL CORRESPONDENCE	**(6+6)**
Seeking Permission for Industrial Visit & In-plant Training – Checklist – Instruction - E-mail Writing - Report Writing (Accident & Survey)	

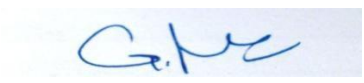
LIST OF SKILLS ASSESSED IN THE LABORATORY

1. Language Skills.
2. Listening Skills.
3. Speaking Skills.
4. Reading Skills
5. Writing Skills

TOTAL (L:30+ P:30) = 60 PERIODS

TEXT / REFERENCE BOOKS:

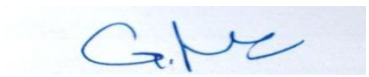
1. Sudharshana, N.P and Saveetha.C. “English for Technical Communication”. Cambridge University Press, New Delhi,2016.
2. Jackman, Vanessa and Russell ,Whitehead. “Cambridge English Business Preliminary Practice Tests”. Oxford University Press, New Delhi, 2016.
3. Rizvi, Ashraf M. “Effective Technical Communication”. Tata McGraw Hill Publishing Company Limited, New Delhi, 2006.
4. Hewings, M. “Advanced English Grammar”. Cambridge University Press, Chennai,2000.



17MYB01 - CALCULUS AND SOLID GEOMETRY (Common to all Branches)					
		L	T	P	C
		3	2	0	4
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To develop the use of matrix algebra techniques those are needed by engineers for practical applications.	**1.1**	Apply the concept of orthogonal reduction to diagonalise the given matrix.	**a,b,c,e,g,i,k**	
2.0	Use the techniques, Skills and Engineering tools necessary for engineering practice, with Geometric concepts.	**2.1**	Have knowledge about the geometrical aspects of sphere.	**a,b,c,e,f,i,k**	
3.0	To improve their ability in solving geometrical applications of differential calculus problems.	**3.1**	Find the radius of curvature, circle of curvature and centre of curvature for a given curve.	**a,b,c,i,k**	
4.0	To learn the important role of Mathematical concepts in engineering applications with the functions of several variables.	**4.1**	Classify the maxima and minima for a given function with several variables, through by finding stationary points.	**a,b,c,d,k**	
5.0	To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.	**5.1**	Demonstrate the use of double and triple integrals to compute area and volume.	**a,b,c,d,f,i,k**	

UNIT I –MATRICES	**(9+6)**
Characteristic Equation-Eigen values and Eigen vectors of a matrix –Properties(statement only)- Cayley Hamilton Theorem and its applications- Orthogonal transformation of a symmetric matrix to a diagonal form - Quadratic form-Reduction of a Quadratic form to canonical form by orthogonal transformation.	
UNIT II - ANALYTICAL GEOMETRY OF THREE DIMENSIONS	**(9+6)**
Equation of a Plane –Angle between two planes- Equation of straight lines-Coplanar lines- skew lines-Equation of a sphere – Orthogonal spheres.	
UNIT III - GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS	**(9+6)**
Curvature – Curvature in Cartesian co-ordinates-Centre and Radius of curvature-Circle of curvature-Evolutes and Involutes-Envelopes.	

UNIT IV - FUNCTIONS OF SEVERAL VARIABLES	(9+6)
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+6)**
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:30) = 75 PERIODS	
Note : Simulation of Engineering Problems (Qualitative Analysis) using open source software	
TEXT BOOKS: 1. Veerarajan.T, "Engineering Mathematics for Semester I &II ", Third Edition, Tata McGraw Hill,2014. 2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & sons, 2013 3. Dr.B.S.Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna publications, 2012.	
REFERENCES: 1. Kandasamy .P, Thilagavathy .K ,Gunavathy .K , "Engineering Mathematics for first Year", 9th Rv. Ed., S.Chand& Co Ltd, 2013. 2. N.P.Bali, Manish Goyal, "A text book of Engineering Mathematics: Sem-II", 5th Edition,Laxmi Publications.2011. 3. Glyn James, "Advanced Engineering Mathematics", 7thEdition, Wiley India, (2007).	



17PYB01- PHYSICS FOR ENGINEERS *(Common to All Branches except CSE and IT)*				
L	**T**	**P**	**C**
3	**0**	**0**	**3**
PREREQUISITE : NIL	**QUESTION PATTERN: TYPE - 1**		

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To provide the basic ideas in all the kinds of engineering branches	**1.1**	Acquire knowledge regarding Acoustics and ultrasonic	**a,d**
2.0	To develop the skills of the students in physics under various applications	**2.1**	Applying knowledge in the fields of optics & laser technology	**a,e**
3.0	To cultivate the censor designing ability of the students	**3.1**	Design the sensors using the knowledge of fiber optics	**d,e**
4.0	To provide knowledge in wave and particle physics	**4.1**	Gain the knowledge of wave, particle nature and matter waves	**b,d**
5.0	To provide the fundamental knowledge in basics of crystals	**5.1**	Analyze the different kind of crystal structures and crystal growth	**A**

UNIT I - ULTRASONICS & ACOUSTICS	**(9)**
Ultrasonics: Introduction - Properties of Ultrasonics- Magnetostriction and piezo electric methods. Measurement of velocity using acoustic grating- Ultrasonic A B C scan methods - Sonogram. Acoustics: characteristics of musical sound – loudness – Weber – Fechner law – absorption coefficient – reverberation – reverberation time –Factors affecting acoustics of buildings and their remedies.	
UNIT II – OPTICS & LASER TECHNOLOGY	**(9)**
Interference: Air wedge – theory – uses – testing of flat surfaces – determination of thickness of a thin wire. Types of lasers – Nd – YAG laser – CO_2 laser – semiconductor laser (homojunction&hetrojuction). Applications: Determination of particle size using laser - Holography – construction – reconstruction – Lasers in industry (Material Processing) and Medical field (Surgery)	

UNIT III - FIBER OPTICS AND SENSORS	(9)
Principle of light transmission through fiber - expression for acceptance angle and numerical aperture – Fabrication of optical fibers- Double crucible method - types of optical fibers (material, refractive Index profile and mode) fiber optic communication system. Splicing – Applications of optical fiber - Sensors- temperature-pressure sensor and displacement sensor Medical Endoscope.	
UNIT IV –WAVE AND PARTICLE PHYSICS	**(9)**
Development of quantum theory – de Broglie wavelength – properties of matter waves - G.P Thomson experiment - Schrödinger's wave equation – time dependent – time independent wave equations – physical significance – applications – particle in a one dimensional potential box - Compton Effect – theory and experimental verification.	
UNIT V - CRYSTALOGRAPHY	**(9)**
Lattice – unit cell – Brava is lattices – lattice planes – Miller indices – 'd' spacing in cubic lattice – calculation of number of atoms per unit cell – atomic radius – coordination number – packing factor for SC, BCC, FCC and HCP structures – Crystal growth techniques- solution, melt (Czochralski) and vapour growth techniques(qualitative)	
	TOTAL (L:45)= 45 PERIODS

TEXT BOOKS:

1. V. Rajendran," Engineering Physics", Tata McGraw-Hill, New Delhi, 2011.
2. G Senthilkumar. " Engineering Physics " VRB Publishers, 2011

REFERENCES:

1. R. K. Gaur and S. L. Gupta, "Engineering Physics", DhanpatRai Publishers, New Delhi, 2006.
2. M. N. Avadhanulu and P. G. Kshirsagar, "A Textbook of Engineering Physics", S. Chand & Company Ltd., New Delhi, 2005.
3. P. K. Palanisami, "Physics for Engineers" Vol. 1, SciTech Pub. (India) Pvt. Ltd., Chennai, 2002.

17CYB01 - APPLIED CHEMISTRY *(Common to MECH, CIVIL, AGRI & CHEMICAL ENGG. Branches)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		**Course Outcomes**		**Related Program outcomes**
1.0	To understand the principles of water characterization and treatment methods	**1.1**	Apply knowledge of fundamental principles of chemistry	**a,b,c,l**
2.0	To introduce the basic concepts of electrode potential and batteries	**2.1**	Define and solve engineering problems, including the utilization of creative and innovative skills	**a,d,e,g,d**
3.0	To understand the principles and applications of corrosion	**3.1**	Gain practical experience with chemical process equipment as well as to analyze and interpret data	**a,b,e,l**
4.0	To gain knowledge on engineering materials and industrial importance of fuels and combustion	**4.1**	Understand the impact of engineering solutions in a global, economic, environmental and societal content	**a,c,f,g**
5.0	To understand the concept of various analytical techniques	**5.1**	Understand the concept of engineering materials	**a,e,h,l**

UNIT I : WATER TECHNOLOGY	**(9)**
Hardness - types - estimation by EDTA method - 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 : ELECTROCHEMISTRY	**(9)**
Electrochemistry - electrode potential - Nernst equation and problems - Reference electrode - standard hydrogen electrode - calomel electrode - potentiometric titration (redox) - conductometric titration (strong acid – strong base) - Batteries - types - lead acid battery – fuel cell – hydrogen and oxygen fuel cell.	

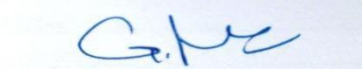
UNIT III : CORROSION SCIENCE	(9)
Corrosion - definition – types - chemical and electrochemical corrosion (mechanism) – Galvanic corrosion – Differential aeration corrosion - Pitting corrosion – Factors influencing corrosion- Corrosion control - sacrificial anode method.	
UNIT IV : FUELS AND COMBUSTION	**(9)**
Fuels -Solid fuels - coal - proximate analysis - metallurgical coke - manufacture by Otto-Hoffmann method - Liquid fuels - synthetic petrol - Fischer Tropsch and Bergius processes - knocking - octane number - cetane number - -Gaseous fuels - water gas - producer gas - Combustion - flue gas analysis - Orsat apparatus.	
UNIT V : ANALYTICAL TECHNIQUES	**(9)**
Colorimetry - principles – estimation of Iron by colorimetry – UV–Visible spectroscopy – principles - instrumentation (block diagram only) - IR spectroscopy – principles - instrumentation (block diagram only) - Flame Photometry – principles - instrumentation (block diagram only) - estimation of sodium by flame photometry – Atomic absorption spectroscopy – principles - instrumentation (block diagram only) - estimation of nickel by atomic absorption spectroscopy.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

1. Dr.Ravikrishnan.A, "Engineering chemistry I & Engineering Chemistry II, SriKrishnaHitech Publishing chem Co. Pvt Ltd., 13th ed., Chennai, 2014.
2. P.C. Jain.and Monica Jain, "Engineering Chemistry",Vol I & II, DhanpatRaiPub,Co., New Delhi,15th ed., 2013.

REFERENCES:

1. S.S. Dara, "A Text book of Engineering Chemistry",S.Chand& Co. Ltd., New Delhi, 2014.
2. N. Krishna murthy, D. Vallinayagam, "Engineering chemistry" PHI Learning Pvt Ltd., 2014.
3. B. Sivasankar, "Engineering Chemistry", Tata McGraw-Hill Pub. Co. Ltd., New Delhi ,2012.



17MEC01- ENGINEERING GRAPHICS *(Common to All Branches except CSE and IT)*					
			L	**T**	**P**	**C**
			2	**2**	**0**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 2**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		**Course Outcomes**		**Related Program outcomes**
1.0	To gain knowledge about conic sections and plane curves	**1.1**	The Students can be able to construct conic sections and special curves of required specifications	**a, c, d, e, i, k, l**
2.0	To learn the concept of first angle projection of points, lines and plane	**2.1**	The Students can be able to apply the concept of first angle projection to create project of straight lines, planes, solids and section of solids	**a, c, d, i, k, l**
3.0	To understand and familiarize with the projection of solids	**3.1**	The Students can be able to develop a surface drawing of a solid model with given dimensions	**a, c, d, e, i, k, l**
4.0	To learn the concept of sectioning of solids and developing the surfaces	**4.1**	The Students can be able to build orthographic, isometric projections of a three dimensional object	**a, c, d, i, k, l**
5.0	To understand the orthographic, isometric and perspective projections of three dimensional objects	**5.1**	The Students can be able to make use of the knowledge of engineering drawing to create physical models	**a, c, d, i, k, l**

CONCEPTS AND CONVENTIONS:

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 : FIRST ANGLE PROJECTION OF POINTS, LINES AND PLANE **(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, cone and truncated solids when the axis is inclined to both the principal planes 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 cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes.	
UNIT V : ISOMETRIC, ORTHOGRAPHIC AND PERSPECTIVE PROJECTIONS	**(6+6)**
Principles of isometric projection - Isometric scale - Isometric projections of lines, plane figures, simple solids and truncated solids - Prisms, pyramids, cylinders, cones - combination of two solid objects in simple vertical positions - Free hand sketching of Orthographic views from Isometric views of objects. Perspective projection of simple solids - Cube, Prisms and pyramids by visual ray method	
TOTAL (L:30 T:30) : 60 PERIODS	

TEXT BOOKS:

1. N.S Parthasarathy and Vela Murali, "Engineering Drawing", Oxford University Press, 2015
2. K.Venugopal and V.Prabhu Raja, "Engineering Graphics", New Age International (P) Limited, 2013.

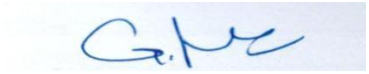
REFERENCES:

1. K. V.Natarajan, "A text book of Engineering Graphics", 28th Edition, Dhanalakshmi Publishers, Chennai, 2015.
2. N.D.Bhatt and V.M.Panchal, "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
3. M.B.Shah and B.C.Rana, "Engineering Drawing", Pearson, 2nd Edition, 2009.
4. K.R.Gopalakrishna., "Engineering Drawing" (Vol I&II combined) Subhas Stores, Bangalore, 2007
5. Luzzader, Warren.J., and Duff, John M,''Fundamentals of Engineering Drawingwith an introduction to Interactive Computer Graphics for Design and Production", Eastern Economy Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2005
6. Dr. M. Saravanan, Dr. M. ArockiaJaswin and J. Bensam Raj, "Engineering Graphics", Tri Sea Publications.

INSTRUMENT: ***Use of Mini drafter is compulsory***

Special points applicable to End Semester Examinations on Engineering Graphics:

1. The answer paper shall be of A3 size drawing sheets.
2. Minimum one question and not more than two questions from a unit.
3. Question paper consists of Part A and Part B.
4. Part A: One compulsory question carries 20 marks from any one of five units.
5. Part B: 4 out of 8 open choice questions carry 20 marks each.



17CSC01 - PROBLEM SOLVING AND PYTHON PROGRAMMING *(Common to MECH, CIVIL, AGRI & CHEMICAL ENGG. Branches)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 1**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To gain knowledge about the basics of computer	**1.1**	The students will be able to understand the working of computers		**a,c,j,k**
2.0	To educate about problem solving strategies	**2.1**	The students will be able to solve problems using various strategies		**a,c,j**
3.0	To impart the fundamental concepts of Python Programming	**3.1**	The students will be able to understand the basics of Python Programming constructs		**a,b,c,j,k**
4.0	To gain exposure about string manipulation, list, and tuples	**4.1**	The students will be able to realize the need of strings, list, and tuples		**a,b,c,k**
5.0	To get knowledge about dictionaries, function and modules	**5.1**	The students will be able to design programs involving dictionaries and function		**a,b, c,k**

UNIT I BASICS OF COMPUTERS	**(9)**
Computer Basics - Applications and characteristics of Computer – Generations of Computers - Computer organization - Computer Software -Types of software - Software Development steps – Basic Internet Terminologies.	
UNIT II PROBLEM SOLVING STRATEGIES	**(9)**
Number System and Arithmetic - Algorithms, building blocks of algorithms (instructions/statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), simple strategies for developing algorithms (iteration, recursion). – Programming Errors – Programming Paradigm.	
UNIT III INTRODUCTION TO PYTHON	**(9)**
History – Features – Execution of python program – Flavors of Python – Comments - Data Types - Built-in data types– Sequences - Literals– Operators – Input and Output Statements - Conditional Statements : if – if-else – Nested if-else – For – While – Nested loops – Break – Continue - pass - assert – return	

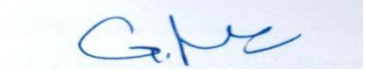
UNIT IV STRINGS, LISTS AND TUPLES	(9)
Strings and Characters: Creating – Length – Indexing – Slicing – Repeating – Concatenation – Comparing - Removing Spaces - Finding Sub Strings - Counting Substrings in a String - Strings are Immutable - Replacing a String with another String - Splitting and Joining Strings - Changing Case of a String - Checking Starting and Ending of a String - Formatting the Strings - Working with Characters - Sorting Strings - Searching - Finding Number. Lists: Creating Lists – Updating - Concatenation - Repetition - Methods – Sorting. Tuples: Creating - Accessing – Operations – Functions - Nested Tuples - Inserting Elements, Modifying Elements, Deleting Elements from a Tuple.	
UNIT V DICTIONARIES AND FUNCTIONS	**(9)**
Dictionaries: Operations – Methods - Using for Loop with Dictionaries – Sorting the Elements of a Dictionary using Lambdas - Converting Lists and Strings into Dictionary - Passing Dictionaries to Functions - Ordered Dictionaries. Functions: Defining – Calling – Returning - Pass by Object Reference – Formal, Actual, Positional, Keyword, Default & Variable Length Arguments - Local and Global Variables - Recursive Functions - Lambdas - Function Decorators.	
	TOTAL (L: 45) = 45 PERIODS

TEXT BOOKS:

1. Ashok.N.Kamthane, “Computer Programming”, 2nd ed., Pearson Education (India), 2012.
2. Dr. R. NageswaraRao, “Core Python Programming”, Dreamtech Press, ed., 2017

REFERENCES:

1. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, Cengage Learning, 2012.
2. Wesley J. Chun, “Core Python Programming”, Pearson Education, 2nd ed., 2010.



17GYP01 - PHYSICS AND CHEMISTRY LABORATORY *(Common to All Branches except CSE and IT)*					
			L	**T**	**P**	**C**
			0	**0**	**4**	**2**
PREREQUISITE: NIL					
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To provide the basic practical exposure to all the engineering and technological streams in the field of physics.	**1.1**	Acquire the fundamental knowledge in optics such as interference, Diffraction and Understand about the spectral instruments etc		**a,b,d,g,l**
2.0	To provide the basic practical exposure to all the engineering and technological streams in the field of chemistry	**2.1**	Gain the basic knowledge about handling the laser light and Identify the basic parameters of an optical fibre		**a,b,d,g**
3.0	The students are able to know about the water containing impurities and some physical parameters	**3.1**	Analyze the properties of matter with sound waves		**a,b,d**
4.0	To gain the knowledge about light, sound, laser, fiber optics and magnetism	**4.1**	Apply knowledge of measurement of hardness producing ions, chloride, alkalinity, DO, conductance, EMF and pH		**a,b,d,g**
5.0	To develop the knowledge of conductometric titration and viscometry	**5.1**	Understand the impact of water quality and solve engineering problems		**a,b,d,g**

LIST OF EXPERIMENTS

PHYSICS LABORATORY- I (Any Five)

1. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
2. Determination of thickness of a thin wire – Air wedge method.
3. Determination of laser parameters - wavelength, particle size and angle of divergence of a Laser.
4. Determination of acceptance angle and numerical aperture of an optical fiber.
5. Determination of wavelength of mercury spectrum – spectrometer grating.
6. Determination of Young's modulus of the material – non uniform bending.
7. Determination of Band Gap of a semiconductor material.
8. Determination of viscosity of liquid – Poiseuille's method.

9. Solar cell – VI characteristics
10. V-I characteristics of PN junction diode.
11. Determination of thermal conductivity of a bad conductor – Lee's Disc method.

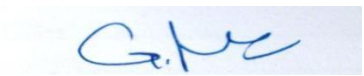
CHEMISTRY LABORATORY- I (Any Five)

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. Conductometric titration of strong acid vs strong base.
5. Estimation of iron content of the given solution using potentiometer.
6. Determination of strength of given hydrochloric acid using pH meter
7. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
8. Estimation of iron content of the water sample using spectrophotometer

TOTAL (P:60) = 60 PERIODS

REFERENCES/MANUALS/SOFTWARE:

1. Lab Manual



17CSP01 - PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY *(Common to MECH, CIVIL, AGRI & CHEMICAL ENGG. Branches)*					
			L	**T**	**P**	**C**
			0	**0**	**4**	**2**
PRE REQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To identify and understand word document and excel sheets.	**1.1**	The student will be able to use MS Word and MS Excel for document preparation.		**a,c,j**
2.0	To impart the fundamental concepts of Python Programming	**2.1**	The students will be able to understand the basics of Python Programming constructs		**a,b,k**
3.0	To gain exposure about string manipulation, list, and tuples	**3.1**	The students will be able to realize the need of string manipulation, list, and tuples		**a,b,c,i,k**
4.0	To get knowledge about dictionaries, function and modules	**4.1**	The students will be able to design programs involving dictionaries, function and modules		**a,b,c,i,k**
5.0	To learn about exception handling	**5.1**	The students will be able to develop simple programs with exception handling		**a,b,e,i**

Word Processing
1. Document creation, Text manipulation with Scientific notations. 2. Table creation, Table formatting and Conversion. 3. Mail merge and Letter preparation
Spread Sheet
4. Chart - Line, XY, Bar and Pie. 5. Formula - formula editor
RAPTOR –Tool
6. Drawing - flow Chart
Python-Programming

7. Program Using Operators
8. Program Using Conditional Statements
9. Program Using Looping
10. Program Using Strings
11. Program Using Lists
12. Program Using Dictionaries
13. Program Using Functions

HARDWARE / SOFTWARE REQUIRED FOR A BATCH OF 30 STUDENTS

Hardware

- LAN System with 33 nodes (OR) Standalone PCs – 33 Nos,Printers – 3 Nos.

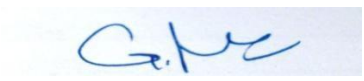
Software

- OS – Windows / UNIX Clone
- Application Package – Office suite
- RAPTOR –Tool

TOTAL (P:60) = 60 PERIODS

REFERENCES/MANUALS/SOFTWARE:

1. Lab Manual/software



17GEP01 - PERSONAL VALUES *(Common to All Branches)*					
			L	**T**	**P**	**C**
			0	**0**	**2**	**1**
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To make students to learn individual in knowing them self	**1.1**	Become an individual in knowing the self		**a, f**
2.0	To enable the student to understand Gratitude, Truthfulness, Punctuality, Cleanliness & fitness.	**2.1**	Acquire and express Gratitude, Truthfulness, Punctuality, Cleanliness &fitness.		**a, g**
3.0	To enable the student to understand physical exercise and breathing techniques	**3.1**	Practice simple physical exercise and breathing techniques		**a, c**
4.0	To make the students to Yoga asana which will enhance the quality of life.	**4.1**	Practice Yoga asana which will enhance the quality of life.		**a, c, f**
5.0	To motivate the students to Practice Meditation and get benefited	**5.1**	Practice Meditation and get benefited.		**a, f**

Values through Practical activities:

.Knowing the self

Introduction to value education - Need & importance of Value education – Knowing the self – realization of human life – animal instinct vs sixth sense.

2. Mental Health

Evolution of senses – functioning steps of human mind – Body and Mind coordination - Analysis of thoughts – moralization of desires– autosuggestions – power of positive affirmations. – Meditation and its benefits.

3.Physical Health

Physical body constitution– Types of food - effects of food on body and mind – healthy eating habits – food as medicine– self healing techniques.

4. Core value Self love&Self care:

Gratitude - Happiness - Optimistic –Enthusiasm – Simplicity – Punctual - Self Control - Cleanliness & personal hygiene - Freedom from belief systems.

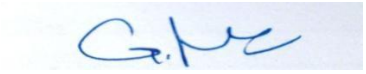
5. Fitness

Simplified physical exercises – Sun salutation - Lung strengthening practices: Naadisuddhi pranayama – Silent sitting and listening to nature – Meditation.

TOTAL(P:30): 30 PERIODS

REFERENCES:

1. Know Yourself — Socrates – pdf format at www.au.af.mil/au/awc/awcgate/army/rotc_self-aware.pdf.
2. Steps to Knowledge: the book of Inner Knowing – pdf format at www.newmessage.org/wp content/uploads/pdfs/books/stk_nkl_v1.5.pdf.
3. Promoting Mental Health - World Health Organization – pdf.
4. www.who.int/mental_health/evidence/mh_promotion_book.pdf
5. Learning to be: A Holistic and Integrated Approach to Values – UNESCO pdf format at www.unesdoc.unesco.org/ images/ 0012/001279/127914e.pdf
6. Personality Development by Swami Vivekananda -www.estudantedavedanta.net/personality-development.pdf



17EYA02 – PROFESSIONAL ENGLISH – II *(Common to All Branches)*					
			L	**T**	**P**	**C**
			2	**0**	**2**	**3**
PREREQUISITE : 17EYA01		**QUESTION PATTERN : TYPE - 1**				
COURSE OBJECTIVES AND OUTCOMES:						
Course Objectives		**Course Outcomes**			**Related Program Outcomes**	
1.0	To enable students to get familiar with words, phrases and sentences relevant to the immediate communication tasks.	**1.1**	The students will be able to communicate using a variety of sentence structures and appropriate vocabulary.		**i,j**	
2.0	To help students to develop their listening skills and comprehend them by asking questions.	**2.1**	The students will be able to comprehend conversations and short talks delivered in English and respond accordingly.		**i,j,k,l**	
3.0	To enhance students' speaking skills by making them to participate in Technical Presentation, Group Discussion, etc.	**3.1**	The students will be able to speak appropriately and effectively in various situations.		**i,j,k,l**	
4.0	To inculcate reading habit and to develop effective reading skills.	**4.1**	The students will be able to employ active reading strategies to understand texts at the maximum level.		**i,j,l**	
5.0	To foster the ability to write convincing Job Application and effective Formal Letters.	**5.1**	The students will be able to equip themselves with writing formal letters and winning Job Application.		**i,j,k,l**	

UNIT I - LANGUAGE DEVELOPMENT	**(6+6)**
Vocabulary (Prefixes & Suffixes) - Active Voice and Passive Voice - Impersonal Passive Voice – Conditional Clauses – Subject - Verb Agreement - Direct and Indirect Speech - Idioms and Phrases - Discourse Markers - Error Spotting	
UNIT II – LISTENING COMPREHENSION	**(6+6)**
Listening for Specific Information and Match / Choose / Fill in the texts - Short Films, News, Biographies, Roles and Responsibilities in Corporate, Funny Shows – Listening to Iconic Speeches and making notes – Listening to Interviews	

UNIT III – ACQUISITION OF ORAL SKILLS	**(6+6)**
Describing a Person - Making Plans – Asking for and Giving Directions - Talking about Places - Talking over Phone – Narrating Incidents – Introduction to Technical Presentation - Story Telling – Group Discussion	
UNIT IV – READING NUANCES	**(6+6)**
Intensive Reading – Extensive Reading – Finding key information in a given text - Reading and Understanding Technical Articles - Reading and Interpreting Visual Materials	
UNIT V – EXTENDED WRITING	**(6+6)**
Job Application with Resume – Recommendation – Inviting Dignitaries - Accepting & Declining Invitation - Paragraph Writing (Topics and Images)	

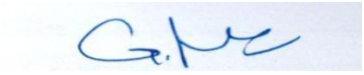
LIST OF SKILLS ASSESSED IN THE LABORATORY

1. Language Skills.
2. Listening Skills.
3. Speaking Skills.
4. Reading Skills
5. Writing Skills

TOTAL (L:30 P:30) = 60 PERIODS

TEXT / REFERENCE BOOKS:

1. Kumar, Suresh. E. "Engineering English". Orient Blackswan : Hyderabad, 2015.
2. Raman, Meenakshi and Sangeetha Sharma. "Technical Communication Principles and Practice". Oxford University Press: New Delhi, 2014.
3. Board of Editors. "Fluency in English – A Course Book for Engineering and Technology". Orient Blackswan: Hyderabad, 2016.
4. Comfort, Jeremy, et al. "Speaking Effectively: Developing Speaking Skills for Business English". Cambridge University Press: Cambridge, 2011.



17MYB02 - COMPLEX ANALYSIS AND LAPLACE TRANSFORMS *(Common to All branches)*					
			L	**T**	**P**	**C**
			3	**2**	**0**	**4**
PREREQUISITE : 17MYB01		**QUESTION PATTERN : TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To expose the concepts of differential equations.	**1.1**	Predict the suitable method to solve second and higher order differential equations		**a,b,c,d,f,i,k**
2.0	To communicate the problem solutions using correct Mathematical terminology of vector calculus.	**2.1**	Apply the concepts of Differentiation and Integration to Vectors.		**a,b,c,f,g,k**
3.0	Apply rigorous and analytic approach to analyse the conformal mapping.	**3.1**	Compute an analytic function, when its real or imaginary part is known.		**a,b,c,d,e,i,k**
4.0	Acquiring the knowledge of evaluating contour integrals using residue theorem.	**4.1**	Identify the Singularities and its corresponding Residues for the given function.		**a,b,c,d,e,k**
5.0	Apply the concepts of Laplace transforms & its applications to various problems related to Engineering.	**5.1**	Predict a suitable method to evaluate the Contour integration.		**a,b,c,d,e,f,i,k**

UNIT I - ORDINARY DIFFERENTIAL EQUATIONS	**(9+6)**
Higher order linear differential equations with constant coefficients - Method of variation of parameters Cauchy's and Legendre's Equations.	
UNIT II - VECTOR CALCULUS	**(9+6)**
Gradient and Directional derivative -Divergence and Curl – Irrotational, solenoidal and scalar potential – Line integral over a plane curve-Surface Integral and Volume Integral-Green's theorem in a plane-Gauss divergence theorem and Stokes Theorem (Excluding Proofs)-Simple Applications Involving Square, Rectangles, Cube and Parallelopiped.	
UNIT III- ANALYTIC FUNCTIONS	**(9+6)**
Functions of a complex variable-Analytic functions– Necessary and sufficient conditions of Cauchy's - Riemann Equations in Cartesian Coordinates (Excluding Proofs) – Properties of Analytic Functions – Harmonic conjugate – Construction of an analytic function by Milne's Thomson Method– Conformal mapping :w = c+z , cz, 1/z and Bilinear Transformation.	

UNIT IV - COMPLEX INTEGRATION	(9+6)
Statement and Simple applications of Cauchy's integral theorem and Cauchy's integral formula(Excluding Proofs) – Taylor's and Laurent's Series Expansions - Singularities - Residues – Cauchy's Residue theorem (Statement only) – Evaluation of contour integration over unit circle and semi circle (Excluding poles on Real axis).	
UNIT V- LAPLACE TRANSFORM	**(9+6)**
Condition for existence - Transforms of Elementary functions –Basic Properties- First & Second Shifting Theorems (Statement only) –Transforms of derivatives and integrals- Transform of periodic functions - Initial and Final value Theorems. Inverse Laplace transforms -Convolution theorem (Statement only) – Solution of linear second order Ordinary differential equations with constant coefficients using Laplace transforms.	
TOTAL (L: 45 T:30) = 75 PERIODS	
Note : Simulation of Engineering Problems (Qualitative Analysis) using open source software	

TEXT BOOKS

1. Dr.B.S.Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna publications, 2012.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & sons, 2013.
3. Veerarajan.T, "Engineering Mathematics for Semester I & II", Third Edition, Tata McGraw Hill,2014

REFERENCES

1. N.P.Bali, Manish Goyal, "A text book of Engineering Mathematics: Sem-II", 5thEdition,Laxmi Publications.2011.
2. Kandasamy .P, Thilagavathy .K ,Gunavathy .K , "Engineering Mathematics for first Year", 9thRv. Ed S.Chand& Co Ltd, 2013.
3. Glyn James, "Advanced Engineering Mathematics", 7thEdition, Wiley India, (2007).

17PYB06- PHYSICS OF MATERIALS AND FLUIDS *(B.Tech- Chemical Engineering)*				
L	**T**	**P**	**C**
3	**0**	**0**	**3**
PREREQUISITE: 17PYB01	**QUESTION PATTERN : TYPE – 1**		

COURSE OBJECTIVES AND OUTCOMES

	Course Objectives		Course Outcomes	Related Program outcomes
1.0	To provide the basic ideas in electrical conduction, conductors, semiconductors and nano technology	**1.1**	Acquire knowledge about conductors, semiconductors and super conductors	**a,b**
2.0	To gain fundamental knowledge about thermal physics	**2.1**	Understand the various form of heat conduction and thermal conductivity of good and bad conductors	**a,b**
3.0	To gain the knowledge in the field of fluid physics and its importance.	**3.1**	Acquire knowledge about flow of liquids and liquids viscosities	**a,b,e**
4.0	To provide education modern engineering materials engineering applications.	**4.1**	the different types of Material testing under NDT	**a,b,e**
5.0	To understand the basics of nanotechnology and its applications	**5.1**	Knowledge of new engineering materials and recent trends in nanotechnology	**a,b**

UNIT I - CONDUCTING, SEMICONDUCTING & SUPER CONDUCTING MATERIALS	**(9)**
Conducting Materials: Postulates of classical free electron theory- derivation of electrical conductivity of metals Derivation of thermal conductivity – Weidman-Franz law- verification. **Semiconducting Materials** : Elemental and compound semiconductors - Intrinsic semiconductor- extrinsic semiconductors- Hall effect –determination of Hall coefficient – Applications. **Super Conducting Materials**: Properties - Types of super conductors- – BCS theory of superconductivity- Magnetic **Levitation** Train- Applications of superconductors.	
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 - radial flow of heat-expression for thermal conductivity of rubber- experimental determination-practical applications of conduction.	

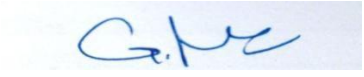
UNIT III - FLOW OF LIQUIDS AND VISCOSITY	(9)
Fluids– Coefficient of viscosity – factors of affecting viscosity – buoyancy - streamline and turbulent flow – Reynold number – Poiseuille's equation for the flow of liquid through a tube- motion of a rigid body in a viscous medium – Experimental determination of viscosity of a liquid. – Comparison of viscosities- Ostwald's Viscometer.	
UNIT IV – MATERIAL TESTING MECHANISMS	**(9)**
Testing of materials – classification of tests – destructive test – tensile test on a metal – hardness test – Non Destructive Testing-Various steps involved in NDT process- X-ray radiographic technique – displacement method – merits, demerits and application of X-ray radiography – X-ray fluoroscopy – liquid penetrant method – advantages, disadvantages and application	
UNIT V -MODERN ENGINEERING MATERIALS &NANOTECHNOLOGY	**(9)**
Metallic glasses: preparation, properties and applications. Shape Memory Alloys (SMA): Characteristics, properties of Ni-Ti alloy, application, advantages and disadvantages of SMA. Nanomaterials: synthesis – plasma arcing – chemical vapour deposition – sol gel – electrodeposition – ball milling - properties of nanoparticles and applications. Carbon nanotubes: fabrication – arc method – pulsed laser deposition – structure – properties and application.	
	TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:

1. V.Rajendran, "Engineering Physics", Tata McGraw-Hill. New Delhi.2011
2. P.K.Palanisami, "Physics for Engineers-Volume I", Scitech publications (India) Pvt.Ltd, Chennai, 2002

REFERENCES:

1. Jacob Millman, Charistos C Halkilas, SatyabrataJit "Electronic Devices & Circuits", Tata McGraw Hill Education Private Limited, 2010, Third Edition.
2. Ben G.Streetman, Sanjay Banerjee, "Solid State Electronic Devices", Pearson Education, 2006, Fifth Edition.
3. G.Senthil Kumar, N.Iyandurai, "Physics-II", VRB Publishers, 2005-2006, Revised Edition.
4. S.O. Pillai, "Solid State Physics", New Age International Publications, New Delhi, 2010.



17CYB03 ENVIRONMENTAL SCIENCE *(Common to All Branches)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PREREQUISITE: NIL		**QUESTION PATTERN : TYPE – 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		**Course Outcomes**		**Related Program outcomes**
1.0	To understand the constitutes of the environment	**1.1**	Design a system, component, or process to meet desired needs.	b,c,l
2.0	The students should be conversant with valuable resources	**2.1**	Identify, formulate, and solve environmental engineering problems	d,i
3.0	To know about the role of a human being in maintaining a clean environment.	**3.1**	Understand the professional and ethical responsibility as related to the practice of environmental engineering and the impact of engineering solutions in a global context.	e,f,g,h
4.0	To maintain ecological balance and preserve bio-diversity.	**4.1**	Use the techniques, skills, and modern engineering tools necessary for environmental engineering practice.	a,e,f
5.0	To get knowledge about the conservation of environment for the future generation.	**5.1**	Acquire the knowledge of information technology in environmental science.	a,c,g,i,k

UNIT I : INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES	**(9)**
Environment: Scope – importance - need for public awareness - Forest resources - Use-over exploitation-deforestation - Water resources - use-over utilization of surface and ground water - conflicts over water - Mineral resources - use-exploitation-environmental effects of extracting and using mineral resources - Food resources - world food problems changes caused by agriculture - Effects of modern agriculture - fertilizer-pesticide problems - Energy resources - Renewable energy sources - solar energy - wind energy. Land resources - land degradation - soil erosion - Role of an individual in conservation of natural resources.	
UNIT- IIECOSYSTEMS AND BIODIVERSITY	**(9)**
Concepts of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Food chains- food webs - types of ecosystem - structure and functions of forest ecosystem and river ecosystem – Biodiversity - value of biodiversity - consumptive use-productive use - social values - ethical values - aesthetic values - Hotspots of biodiversity -Threats to biodiversity - Habitat loss - poaching of wildlife and man wildlife conflicts- Conservation of biodiversity - In-situ and Ex-situ conservation of biodiversity.	

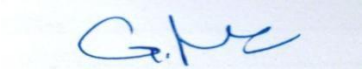
UNIT III : ENVIRONMENTAL POLLUTION	(9)
Pollution: Causes - effects and control measures of Air pollution - Water pollution - Soil pollution and Noise ollution - Solid waste management - Causes - effects -control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Disaster managements - Floods - cyclone- landslides.	
UNIT IV : SOCIAL ISSUES AND THE ENVIRONMENT	**(9)**
Water conservation - rain water harvesting - global warming - acid rain - ozone layer depletion - Environment protection act - Air (Prevention and control of pollution) Act - Water (prevention and control of pollution) Act - Green Chemistry – Principle of Green chemistry – Application of Green chemistry.	
UNIT V : HUMAN POPULATION AND THE ENVIRONMENT	**(9)**
Population growth - variation among nations - Population explosion - Family welfare programme - Human ights - HIV/AIDS – Human health and environment - women and child welfare - Role of information technology in environment and human health.	
TOTAL = 45 PERIODS	

TEXT BOOKS:

1. AnubhaKaushik and C.P. Kaushik, Environmental Science and Engineering, New Age International Publishers, New Delhi (2015)
2. Dr.A.Ravikrishan, Envrionmental Science and Engineering., Sri Krishna Hitech Publishing co. Pvt. Ltd., Chennai,12th Edition (2016)

REFERENCES:

1. Masters, Gilbert M, "Introduction to Environmental Engineering and Science", Second Edition, Pearson Education, New Delhi (2012).
2. Santosh Kumar Garg, Rajeshwarigarg, smfRanjniGarg "Ecological and Environmental Studies" Khanna Publishers, NaiSarak, Delhi (2014).
3. Miller T.G. Jr., "Environmental Science", Tenth Edition, Wadsworth Publishing Co. (2015).



17EEC01 - BASIC ELECTRICAL AND ELECTRONICS ENGINEERING *(Common to AGRI. and CIVIL Branches)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To impart knowledge on electric circuit laws, single phase circuits and measuring instruments.	**1.1**	Apply the basic laws and investigates the behavior of electric circuits by analytical instruments.	**a,b,d,f**
2.0	To learn the basic principles of electrical machines and their performance.	**2.1**	Identify the electrical components and explore the characteristics of electrical machines.	**a,b,d,f**
3.0	To expound the fundamentals of semiconductor and applications.	**3.1**	Analyze the various characteristics of semiconductor devices and applications.	**a,b,c,e,f**
4.0	To introduce the fundamentals of digital circuits, combinational and sequential circuit.	**4.1**	Expose the concept of digital electronics	**a,c,e,f**
5.0	To impart knowledge on communication systems.	**5.1**	Understand the fundamental of communication systems.	**a,c,e,f**

UNIT I - ELECTRICAL CIRCUITS & MEASURMENTS	**(9)**
Ohm's Law – Kirchhoff's Laws – Mesh and Nodal analysis– Introduction to AC circuits – Power and Power factor - Classification of instruments – Operating principles of moving coil, moving iron instruments and dynamometer type wattmeter - Induction type energy meter.	
UNIT II - ELECTRICAL MACHINES	**(9)**
DC Generator - DC Motor - Single phase transformer - Single phase induction motor: construction, principle of operation, basic equations and applications.	
UNIT III - SEMICONDUCTOR DEVICES AND APPLICATIONS	**(9)**
Introduction - Characteristics of PN junction diode and Zener diode – Half wave and Full wave rectifier – Bipolar junction transistor: CB, CE, CC configurations and characteristics.	

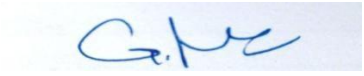
UNIT IV - DIGITAL ELECTRONICS	(9)
Binary number system - Logic gates – Boolean laws –Half and Full adders – Introduction to sequential circuits: Flip-Flops (RS, D, T and JK), shift registers and counters - ADC and DAC.	
UNIT V - FUNDAMENTALS OF COMMUNICATION ENGINEERING	**(9)**
Introduction - Elements of communication systems - Amplitude and Frequency modulation -Demodulation - Communication systems: Radio, TV, ISDN, Microwave, Satellite and Optical fibre. (Block Diagram Approach only)	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, "Electrical Machines "Basic Electrical and Electronics Engineering", McGraw Hill Education(India) Private Limited, Third Reprint ,2016.
2. R.Muthusubramaian, S.Salivahanan and K.A.Muraleedharan, "Basic Electrical, Electronics and Computer Engineering", 2nd ed., Tata MCGraw Hill. 2012.

REFERENCE BOOKS:

1. Sedha R.S., "Applied Electronics", S. Chand & Co., 2008.
2. Mittle and V. N. Mittle, "Basic Electrical Engineering", Tata McGraw Hill Edition, New Delhi, 2005.
3. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson India, 2011.
4. NageswaraRao.T, "Circuit Theory", A.R. Publications, Chennai, 2014.



17CHC01 -INTRODUCTION TO CHEMICAL ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 1**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the basic concepts of chemical process industries	**1.1**	Understand the concepts of unit operations and unit processes.		**a,d,f**
2.0	To learn the fundamentals of mechanical operations and their significance in chemical industries	**2.1**	Apply the principles of size reduction, separation and transportation for handling solids in Chemical process industries.		**b,c,d,f**
3.0	To gain exposure over fluid properties and types of fluids	**3.1**	Comprehend the importance of fluid properties, types of fluids and select the manometers for pressure measurement		**a,b,c,d**
4.0	To understand the heat transfer mechanisms and the types of heat exchange equipments	**4.1**	Familiarize with modes of heat transfer and acquire knowledge on types of heat exchangers.		**b,c,d,f**
5.0	To have a basic idea on process calculations carried out in chemical industries.	**5.1**	Understand and apply the concepts of units and dimensions, mole, weight percentage, mole percentage in process calculations.		**a,b,c**

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.	
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.	

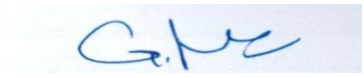
UNIT III : FUNDAMENTALS OF FLUID MECHANICS	(9)
Definition of fluids-compressible and incompressible fluids-Physical properties of fluids-density, specific weight, specific volume, viscosity-Compressible fluids and incompressible fluids-ideal and real fluids-Pressure Measurement Manometers-U-tube manometer.	
UNIT IV : BASICS OF HEAT TRANSFER	**(9)**
Heat Transfer –Modes of heat transfer-Principles of conduction, convection and radiation - 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 Hill Book.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



17GYP02 – ENGINEERING PRACTICES LABORATORY *(Common to All Branches)*					
			L	**T**	**P**	**C**
			0	**0**	**4**	**2**
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program Outcomes**
1.0	To provide hands on training on various basic engineering practices in Civil Engineering	**1.1**	The students will be able to understand various civil engineering practices like plumbing, carpentry and relevant tools		**a, d, f, i, k, l**
2.0	To provide hands on training on various basic engineering practices in Mechanical Engineering	**2.1**	The students will be able to understand various manufacturing processes like welding, machining and sheet metal work		**a, d, f, i, k, l**
3.0	To understand the basic working principle of electric components	**3.1**	The students will be able to do residential house wiring and Measure energy and resistance to earth of an electrical equipment		**a, e, f, h**
4.0	To understand the basic working principle of electronic components	**4.1**	The students will be able to perform the assembling and testing of the PCB based electronic circuits.		**a, j, k, l**
5.0	To develop the skill to make / operate/ utilize the simple engineering components	**5.1**	The students will be able to make / operate / utilize the simple engineering components		**e, j**

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 Works: a. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings b. Study of pipe connections requirements for pumps and turbines c. Preparation of plumbing line sketches for water supply and sewage works d. Hands-on-exercise: Basic pipe connections - Mixed pipe material connection - Pipe connections with different joining components e. Demonstration of plumbing requirements of high-rise buildings	

Carpentry using Power Tools only:

a. Study of the joints in roofs, doors, windows and furniture
b. Hands-on-exercise: Planning, Tee joints

II - MECHANICAL ENGINEERING PRACTICE	**(15)**

Welding:

a. Preparation of edges for welding and study of welding symbols
b. Arc welding- butt joints, lap joints and tee joints
c. Gas welding
d. Study of standard size of bars, rods, sections, sheet metals
e. Study of work piece types and parameters of welding such as welding current, air gap, filler metal

Basic Machining:

a. Facing & Plain turning
b. Drilling Practice
c. Study of different types of screw drivers, screws, bolts and nuts

Sheet Metal Work:

a. Model making using bending and forming - Trays, cone
b. Study of thickness gauges, wire gauges

GROUP - B (ELECTRICAL AND ELECTRONICS)

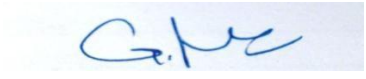
I - ELECTRICAL ENGINEERING PRACTICE	**(15)**

a. Residential house wiring using switches, fuse, indicator, lamp and energy meter
b. Fluorescent lamp wiring
c. Stair case wiring
d. Measurement of electrical quantities - voltage, current, power& power factor in RLC circuit
e. Measurement of energy using single phase energy meter
f. Measurement of resistance to earth of electrical equipment.

II - ELECTRONICS ENGINEERING PRACTICE	**(15)**

a. Study of Electronic components - Resistor (Colour coding), Inductor, Capacitor.
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



17CHP01 –CHEMICAL ANALYSIS LAB					
			L	T	P	C
			0	0	4	2
Prerequisite: NIL					
Course objectives and outcomes					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To develop practical skills of students on Viscometers, Flash and Fire point etc.	**1.1**	Familiarization with equipments like Viscometers, Flash and Fire point etc.		**a,b,c,e**
2.0	To provide hands on exposure to determine acid, iodine value of oils and perform cement analysis	**2.1**	Determine acid value and iodine value of oils and perform cement analysis		**a,b,c,e,f**
3.0	To understand and perform coal and soap analysis	**3.1**	Undergo proximate, ultimate analysis of coal and estimate the total acid and alkali content in soap		**a,b,c,e,f**
4.0	To develop knowledge on flue gas analysis and phenol estimation	**4.1**	Perform flue gas analysis by Orsat's apparatus and estimation of phenol		**a,b,c,e,f**
5.0	To gain idea on determination of calorific value using Bomb calorimeter and nitrite content in water	**5.1**	Conduct experiment to predict calorific value using Bomb calorimeter amount of nitrite in water		**a,b,c,e,f**

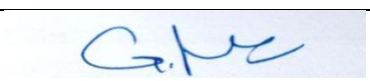
LIST OF EXPERIMENTS
CHEMICAL ANALYSIS LABORATORY(Any Eight)

1. Determination of Redwood / Saybolt numbers, and viscosity index of Lubricating oils
2. Determination of flash point, fire point, cloud and pour point of oils
3. Oil Analysis
4. Cement Analysis
5. Coal Analysis
6. Soap Analysis
7. Flue gas analysis by Orsat's apparatus
8. Estimation of phenol.
9. Determination of calorific value using bomb calorimeter
10. Determination of nitrite in water.

TOTAL (P:60) = 60 PERIODS

REFERENCES/MANUALS/SOFTWARE:

1. Lab Manual

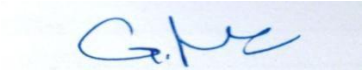


17GEP02-INTERPERSONAL VALUES *(Common to All Branches)*					
			L	**T**	**P**	**C**
			0	**0**	**2**	**1**
PREREQUISITE: 17GEP01					
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To know interpersonal values	**1.1**	Develop a healthy relationship & harmony with others	**I**	
2.0	To train the students to maneuver their temperaments.	**2.1**	Practice respecting every human being	**f,I**	
3.0	To achieve the mentality of appreciating core values of a person.	**3.1**	Practice to eradicate negative temperaments	**j,k,I**	
4.0	To analyze the roots of problems and develop a positive attitude about the life.	**4.1**	Acquire Respect, Honesty, Empathy, Forgiveness and Equality	**j,I**	
5.0	To understand the effects of physical activities on mental health.	**5.1**	Practice Exercises and Meditation to lead a healthy life and Manage the cognitive abilities of an Individual	**I**	

UNIT I – INTRODUCTION	**(9)**
Introduction to interpersonal values – Developing harmony with others –Healthy relationship – Need & importance of interpersonal values for dealing with others and team - Effective communication with others.	
UNIT II - MANEUVERING THE TEMPERAMENTS	**(9)**
From Greed To Contentment - Anger To Tolerance -Miserliness To Charity – Ego To Equality - Vengeance To Forgiveness.	
UNIT III - CORE VALUE	**(9)**
Truthfulness **-** Honesty –Helping–Friendship – Brotherhood – Tolerance –Caring & Sharing – Forgiveness – Charity –Sympathy –– Generosity – Brotherhood -Adaptability.	
UNIT IV – PATHWAY TO BLISSFUL LIFE	**(9)**
Signs of anger – Root cause – Chain reaction – Evil effects on Body and Mind – Analyzing roots of worries – Techniques to eradicate worries.	

UNIT V -THERAPEUTIC MEASURES	(9)
Spine strengthening exercises - Nero muscular breathing exercises - Laughing therapy – Mindfulness meditation.	
TOTAL(P:30): 30 PERIODS	

1. Interpersonal Skills Tutorial (Pdf Version) – TutorialsPoint www.tutorialspoint.com/interpersonal_skills/interpersonal_skills_tutorial.pdf
2. Interpersonal Relationships At Work - Ki Open Archive - Karolinska www.publications.ki.se/xmlui/bitstream/handle/10616/39545/thesis.pdf?sequence=1
3. Values Education For Peace, Human Rights, Democracy – UNESCO. www.unesdoc.unesco.org/images/0011/001143/114357eo.pdf
4. Maneuvering Of Six Temperaments - Vethathiri Maharishi. www.ijhssi.org/papers/v5(5)/F0505034036.pdf
5. The Bliss of Inner Fire: Heart Practice Of The Six. – Wisdom Publications - www.wisdompubs.org/sites/.../Bliss%20of%20Inner%20Fire%20Book%20Preview.pd



17MYB03- FOURIER SERIESAND PARTIAL DIFFERENTIAL EQUATIONS *(Common to BE - MECH , CIVIL,CHEMICAL & AGRI Branches)*					
			L	**T**	**P**	**C**
			2	**2**	**0**	**3**
PREREQUISITE : 17MYB02		**QUESTION PATTERN: TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To acquire knowledge to solve half range Fourier series and harmonic analysis.	**1.1**	Ability to have fundamental understanding of Fourier series and give Fourier expansions of a given function.		**a,b,c,d,k,l**
2.0	To understand the concept of Fourier transforms and enhance the problem solving skill.	**2.1**	Apply transform techniques to solve engineering problems.		**a,b,c,f,g**
3.0	To introduce how to solve linear partial differential equations with different methods.	**3.1**	Analyze and simulate the first and second order linear partial differential equations.		**a,b,c,i,k,l**
4.0	To get the analytical solution for second and higher order homogeneous linear PDE's.	**4.1**	Demonstrate a firm understanding of the solution techniques for homogeneous linear PDE's.		**a,b,c,d,e,l**
5.0	To solve different forms of wave and heat equations.	**5.1**	Ability to apply partial differential techniques to solve the physical engineering problems.		**a,b,c,d,k**

UNIT - I FOURIER SERIES	**(6+6)**
Dirichlet's conditions - 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 (π, degree and T- forms).	
UNIT - II FOURIER TRANSFORMS	**(6+6)**
Fourier integral theorem (statement only) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem.	
UNIT- III FIRST ORDER NON LINEAR PARTIAL DIFFERENTIAL EQUATIONS	**(6+6)**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of standard types of first order partial differential equations: (i) f(p,q)=0, (ii) Clairaut's type, (iii) f(z,p,q) = 0, (iv) f(x,p) = g(y,q).	

UNIT IV LINEAR PARTIAL DIFFERENTIAL EQUATIONS	(6+6)
General solution of Lagrange's linear equation Pp+Qq = R - Solutions of simultaneous equations dx/P=dy/Q =dz/R by the method of grouping & method of multipliers-Homogeneous linear partial differential equations of second and higher order with constant coefficients (R.H.S = 0, e^{ax+by}, cos(ax+by), sin(ax+by), $x^r y^s$).	
UNIT- V APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	**(6+6)**
Classification of second order quasi linear partial differential equations - Solutions of one dimensional wave equation(zero and Non-zero Boundary conditions) - One dimensional heat equation(Reduced to zero & non zero temperature)- Steady state solution of two dimensional heat equation (Finite and infinite plate).	
..	
TOTAL (L: 30 T:30) = 60 PERIODS	

TEXT BOOKS

1. Veerarajan,T. " (Transforms and Partial Differential Equations)", 2nded., Tata McGraw Hill, New Delhi,Second reprint, 2015.
2. Kandasamy, P., Thilagavathy, K., and Gunavathy, K**.,** "Engineering Mathematics; Volume III", S. Chand & Co Ltd., 2008.

REFERENCES

1. Goyal. Manish and Bali, N.P, "A Textbook of Engineering mathematics", 6thed., Laxmi Publication (P) Ltd. New Delhi, 2012.
2. Grewal, B.S. "Higher Engineering Mathematics", 42nded., Khanna publishers, New Delhi, 2012.
3. Kreyszig, Erwin. "Advanced Engineering Mathematics", 9thed., Wiley Publications, New Delhi, 2006.

17MEC07- HEAT POWER ENGINEERING *(Chemical Engineering only)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PRE- REQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To acquire knowledge on the first law of thermodynamics	1.1	Understand the conceptual laws of thermodynamics for application in thermodynamic cycles	**a, b, c, d, i, k, l**	
2.0	To acquire knowledge of thermo dynamic cycles and its efficiency	2.1	The students will be able to explain different thermodynamic cycles	**a, d, i, l**	
3.0	To introduce the properties of steam and energy conservation opportunities in steam systems	3.1	The students will be able to understand the steam distribution and utilization systems to identify the energy conservation opportunities	**a, d, i**	
4.0	To introduce types of boilers, mounting and accessories	4.1	The students will be able to understand the basics of boilers and perform simple calculations of boiler efficiencies	**a, d, e, i, k, l**	
5.0	To acquire knowledge of turbines and vacuum systems	5.1	Comprehend principles of steam turbines and calculation of turbine efficiencies and understand	**a, d, i, l**	

UNIT I - LAWS OF THERMODYNAMICS	**(9)**
Property, state, path and process, quasi-static process, work, Energy. Thermodynamic systems-closed, open and isolated. Zeroth, First and Second laws of Thermodynamics (Basic concepts only), Internal energy, Specific heat capacity and Enthalpy.	
UNIT II - THERMODYNAMIC CYCLES	**(9)**
Air standard Cycles: Carnot, Otto, Diesel and Combined cycle; Brayton and Rankine cycles – cycle efficiencies.	
UNIT III - 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 IV - 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 V - 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.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOK:

1. Rajput R.K., "Thermal Engineering", 10th Edition, Laxmi Publications, 2010.
2. Rudramoorthy R., "Thermal Engineering", 4thEdition, Tata McGraw Hill PublishingCompany, New Delhi, 2006.

REFERENCES:

1. Kothandaraman, C.P., Domkundwar and Domkundwar, "Course in Thermodynamics and HeatEngines", 3rdEdition, DhanpatRai& Sons, New Delhi, 2011.
2. Ballaney P.L., "Thermal Engineering", Khanna Publishers, New Delhi, 2005.

17CHC02 - INDUSTRIAL CHEMISTRY				
L	T	P	C	
3	0	0	3	
PREREQUISITE : NIL	**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand the basic concepts of Phase rule	**1.1**	Apply the phase rule concepts to material technology, thermodynamics systems and phase equilibria.	**a,d,f**
2.0	To gain exposure to kinetics and thermo chemistry	**2.1**	Understand kinetics and theory of reaction rates for application in reactor design	**b,c,d,f**
3.0	To understand colloids and catalysis applied in process industries	**3.1**	Understand the basic principles of catalysis and colloids to apply for their application in chemical engineering practice	**a,b,c,d**
4.0	To have a basic idea on carbohydrates, properties of amino acids	**4.1**	Understand the classification and composition of carbohydrates and amino acids	**b,c,d,f**
5.0	To impact knowledge on organic reactions	**5.1**	Use the concepts of reaction mechanism in order to explain the reactivity and the role of reactants in organic reactions.	**a,b,c**

UNIT I -PHASE RULE	**(9)**
Definition-derivation-application of phase rule to water system-thermal analysis-cooling curves-two component Systems-eutectic and compound formation.	
UNIT II -KINETICS AND THERMO CHEMISTRY	**(9)**
Energy surfaces and related concepts-Transition state theory and related topic, postulates and Principles related to kinetic analysis, Kinetic experiments; Introduction to Thermo-chemistry- Thermo-chemistry of stable Molecules and Reactive Intermediates.	

UNIT III - SURFACE CHEMISTRY AND CATALYSIS	(9)
Adsorption, Chemisorptions, Application of adsorption of gases by solids, Freundlich adsorption isotherm, Langmuir's theory of adsorption, BET Theory of multilayer adsorption, Adsorption from solutions, Gibbs adsorption isotherm- Homogeneous catalysis , Bronsted and Lewis Acid/Base Catalysis, Oxidation, Hydrogenation , Cracking – Application of catalysis in industries.	
UNIT IV - CARBOHYDRATES AND POLYMER CHEMISTRY	**(9)**
Mono, Disaccharides and Polysaccharides – Glucose, Starch and Cellulose – Derivatives of Cellulose – Structural aspects & industrial uses of starch & cellulose. Classification and properties of amino acids- Introduction- Classification of polymers- Determination of molar masses of macromolecules, Industrial application of polymers.	
UNIT V - ORGANIC REACTIONS	**(9)**
Mechanism of Electrophilic reaction – Friedel craft reaction, RiemerTimenn Reaction, Beckmann rearrangements; Mechanism of Nucleophilic reactions – Aldol condensation, Perkins reaction, Benzion condensation; Mechanism of Free radical reaction Alkanes, Addition of HBR on Alkanes in presence of peroxide, Thermal halogenations reaction.	
TOTAL(L:45)= 45 PERIODS	

TEXT BOOKS:

1. K.S.Tewari&N.K.Vishnoi, "A Textbook of Organic Chemistry ", 4thEdition, Vikas Publishing House, New Delhi, 2017.
2. B.R.Puri ,L.R.Sharma , M.S.Pathani, "A Textbook of Principles of physical chemistry", 6thEdition, Vikas Publishing House, New Delhi, 2016.

REFERENCES:

1. Eric V.Ansyln and Dennis A. Dougherty," Modern Physical Organic Chemistry", University ScienceBooks, 2006 .
2. Rajbir Singh, "Physical Organic Chemistry", Mittal Publications, 2002.

17CHC03 - MATERIAL TECHNOLOGY					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To provide the ideas, Materials of construction of process industries.	**1.1**	Understand the properties of Iron and its alloys, Stainless Steel and their application in chemical process industries.		**a,d,f**
2.0	To develop the skills of the students in selection of Materials in process industries.	**2.1**	Comprehend the criterion for selection of materials for chemical process industries		**b,c,d,f**
3.0	To learn the non ferrous metals and its alloys used in process industries.	**3.1**	Gain an insight into the properties of non ferrous metals and its alloys for applications in chemical process industries.		**a,b,c,d**
4.0	Use the techniques, skills and Engineering practice in process industries.	**4.1**	Apply the knowledge about various materials used in chemical process industries.		**b,c,d,f**
5.0	To enable to students to express Material for special Applications.	**5.1**	Select materials for high temperature and sour service		**a,b,c**

UNIT I - IRON AND ITS ALLOYS	**(9)**
Materials- types and properties ; Iron carbide phase diagram, Pig, cast and wrought iron , steels – properties and application in chemical industries ;deformation of metal-recovery and re-crystallization.	
UNIT II - STAINLESS STEEL	**(9)**
Special steels and alloys –grades, general criterion of selection of materials of construction in process industries and its applications.	
UNIT III - NON FERROUS METALS	**(9)**
Nickel, Aluminium, Copper, Chromium, Lead, Titanium, Zinc, Magnesium and their alloys ; Applications in process industries	

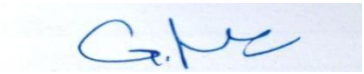
UNIT IV - ORGANICS, COMPOSITES AND MATERIALS FOR SPECIAL APPLICATIONS	(9)
Polymers, Resins, composites, Wood, Rubber, Silicones and carbon as material of construction in chemical process industries. Bio materials-bio ceramics and polymers, paints and coatings, material for bio medical , space and cryogenics, introduction to sour service	
UNIT V - REFRACTORIES AND GLASSES	**(9)**
Refractories-Introduction –Description of important Refractories - Refractories used in various furnaces and industries. Glasses-Properties of Glass-Manufacture of Glass-Types of Glasses.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

1. James A. Lee, "Materials Technology ", McGraw Hill, 2003.
2. O.P.Gupta, "Fuels Furnaces and Refractories", 6th edition, Kanna Publication, 1989.

REFERENCES:

1. Frank Rumford, "Chemical Engineering Materials", Nabu Press,2018.
2. Donald Askeland and Wendelin Wright., "Essentials of Materials Science and Engineering " 3rd edition,Cengage Learning,2013.
3. Agrawal B.K., "Introduction to Engineering Materials", 1stedition, Tata McGraw Hill,2007.



17CHC04 - CHEMICAL ENGINEERING FLUID MECHANICS					
		L	T	P	C
		2	2	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand the basic concepts of fluid statics and dimensional analysis	1.1	Understand the concept of fluid statics and its applications; Apply the principles of dimensional analysis for engineering applications.	**a, b, c, d**
2.0	To learn the fluid flow operations in pipes and basic equations associated with flow through pipes.	2.1	Analyze the types of fluid flow in pipes; Understand the basic equations in fluid flow operations.	**a, b, c, d, f**
3.0	To gain knowledge over packed and fluidized beds used in process industries.	3.1	Retrieve and apply the concepts of flow around solids in packed and fluidized beds.	**a, b, c, ,e, f**
4.0	To understand the types of flow measuring devices and to determine coefficient of discharge.	4.1	Appraise and select the flow measuring devices in process industries.	**a, b, c, d,**
5.0	To gain knowledge over classification of fluid moving machinery and their performance analysis.	5.1	Analyze the performance of fluid moving machinery and appraise the types of valves and pipe fittings in process industries.	**a, b, c, d, i**

UNIT I - FLUID STATICS AND DIMENSIONAL ANALYSIS	**(6+6)**
Types of fluids based on rheological behavior; 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+6)**
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+6)**
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+6)
Classification and Selection of flow meters; Principle, working and applications of Venturimeter, Orifice meter, rotameter 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+6)**
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:30) = 60 PERIODS	

TEXT BOOKS:

1. McCabe W.L, Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 7thEdition,McGraw Hill InternationalEdition,NewYork,2006.
2. Noel De Nevers, "Fluid Mechanics for Chemical Engineers", 3rdEdition,McGrawHill, NewYork, 2004.

REFERENCES:

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

17CHC05- CHEMICAL PROCESS CALCULATIONS					
		L	T	P	C
		2	2	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To provide basic idea of basic chemical calculations.	1.1	Understand and apply composition of mixtures/solution and determine Pressure, volume and temperature of glass using equation of state		**a,b,c,d**
2.0	To gain fundamental knowledge and apply material balance without chemical reaction in process industry	2.1	Apply the law of conversion of mass for different batch and continues unit operations		**a,b,c,d**
3.0	To understand the material balance with chemical reaction in process industry	3.1	Apply the law of conversion of mass for unit processes and evaluate yield, conversion, recycle ratio/purge/bypass of chemical reactors		**a,b,c,d,e**
4.0	To Provide education and understand the apply energy balance in system	4.1	Apply energy balance for reacting system and understand the effect of temperature and pressure on heat of reaction		**a,b,c,d,f**
5.0	To learn the combined material and energy balances specific industries	5.1	Evaluate the combined material and energy balance of specific industries and understand industrial need for material and energy balance		**a,b,c,,e,f**

UNIT I - BASIC CHEMICAL CALCULATIONS	**(6+6)**
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	**(6+6)**
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 humidities; Use of psychometric chart;	

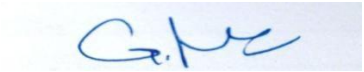
UNIT III - MATERIAL BALANCE WITH CHEMICAL REACTION	(6+6)
Material balance for the systems involving chemical reaction; limiting and excess reactants- yield and selectivity. Bypass, recycle and purging.	
UNIT IV - COMBUSTION	**(6+6)**
Fuels and combustion; calculation of theoretical and excess air from combustion of solids, liquid and gaseous fuels. Composition of fuels. Composition of fuel gases by Orsat analyzer. Heat capacity of solids, liquids, gases and solution, evaluation of enthalpy. Heat of reaction, formation, combustion, solution and mixing. Effect of pressure and temperature on heat of reaction.	
UNIT V -MATERIAL AND ENERGY BALANCES FOR PROCESS INDUSTRIES	**(6+6)**
Material and Energy balance for Magnesium sulfate and Nitric acid production.	
TOTAL(L:30:T:30) = 60 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 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", 8th edition,Prentice Hall of India, New Delhi, 2013.
2. Richard M.Felder Ronald W .Rousseau, "Elementary Principles of Chemical Process", 3rd edition, 2005.



17CHP02-CHEMICAL TECHNOLOGY LABORATORY				
	L	T	P	C
	0	0	4	2

PREREQUISITE: NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To gain idea on determination of chemical oxygen demand of given sample, pH measurements	1.1	Understand the impact of COD, pH measurements on given sample and solving the engineering problems	**a,b,c,d**
2.0	To develop practical skills of students on chloride content, purity of washing soda.	2.1	Determine the available chlorine content in bleaching powder, purity of washing soda.	**a,b,c,d**
3.0	To understand properties of oil, soap analysis.	3.1	Conduct experiment to predict aniline point of oil, Saponification of oil	**a,b,c,d**
4.0	To provide hands on exposure to determine purity of glycerol, strength of hydrogen peroxide.	4.1	Perform to determination of purity of glycerol, hydrogen peroxide strength.	**a,b,c,d,f**
5.0	To understand molecular weight using viscometer, conductivity measurement of electrolyte solution.	5.1	Conduct experiment to predict molecular weight, conductivity of electrolyte solution	**a,b,c,d,f**

LIST OF EXPERIMENTS
CHEMICAL TECHNOLOGY LABORATORY(Any Ten)

1. Determination of COD of water samples chlorine
2. Determination of Melting point of given fuel sample
3. Determination of available chlorine in bleaching powder
4. Determination of purity of washing soda
5. Determination of aniline point of given fuel sample
6. Determination of saponification value of oil
7. Estimation of purity of glycerol
8. Estimation of strength of hydrogen peroxide
9. Determination of Mno2 in the given ore
10. Determination of the molecular weight of the polymer by viscometer
11. Conductivity measurements of an electrolytic solution
12. Estimation of sulphur present in coal

TOTAL(P:60)= 60 PERIODS

REFERENCES/MANUALS/SOFTWARE:
1. Lab Manual

17CHP03 – FLUID MECHANICS LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE: 17CHC04					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To determine the coefficient of discharge of variable head and variable area flow meters	1.1	Determine the coefficient of discharge of venture meter, orifice meter, rotameter, open drum orifice and V-notch.		**a,b,c,d**
2.0	To understand the relation between friction factor and Reynolds number for the flow through closed pipes	2.1	Verify the Moody's chart for flow through straight pipe/concentric pipes and helical coil		**a,b,c,d**
3.0	To determine the energy loss for the flow through valves and pipe fittings	3.1	Predict the frictional loss coefficient for different valves and pipe fittings		**a,b,c,d**
4.0	To study the pressure drop and superficial velocity for flow past immersed bodies.	4.1	Determine the pressure drop through packed bed and minimum fluidization velocity in fluidized bed		**a,b,c,d,f**
5.0	To test the performance of centrifugal and reciprocating pump	5.1	Draw the characteristics curves of centrifugal pump and reciprocating pump		**a,b,c,d,f**

LIST OF EXPERIMENTS

FLUID MECHANICS LABORATORY(Any Ten)

1. Determination of coefficient of discharge of variable head flow meters
2. Determination of coefficient of discharge of variable area flow meters
3. Determination of coefficient of discharge of notch
4. Determination of coefficient of discharge of orifice in open drum
5. Verification of Moody's plot for flow through straight pipe
6. Verification of Moody's plot for flow through concentric pipes
7. Verification of Moody's plot for flow through Spiral and helical coil
8. Determination of frictional loss coefficient of valves and pipe fittings

9. Determination of pressure drop in packed bed 10. Determination of minimum fluidization velocity flow through fluidized bed 11. Characteristics curves of centrifugal pump 12. Characteristics curves of reciprocating pump
TOTAL(P:60)= 60 PERIODS

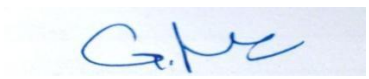
REFERENCES/MANUALS/SOFTWARE:
1. Lab Manual

17GED02 – SOFT SKILLS – READING AND WRITING					
			L	T	P	C
			0	0	2	0
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - NIL**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To recollect the functional understanding of parts of speech and basic grammar.	**1.1**	The Students can be able to Apply the knowledge to identify the parts of speech and construct the sentences.		**a,b,d,l**
2.0	To acquire the reading skills through cloze texts, matching and multiple choice modes.	**2.1**	The Students can be able to Develop the reading skills through cloze texts, matching and multiple choice modes.		**a,d,e**
3.0	To enhance the writing skills for a variety of purposes.	**3.1**	The Students can be able to Interpret effectively through writing for a variety of purposes.		**a,f,k**

UNIT I - GRAMMAR	**(10)**
Articles - Adjectives - Conjunctions - Prepositions - Idioms & Phrases.	
UNIT II - READING	**(10)**
Part I : Matching 7 sentences to four short texts Part II: Text with sentences missing Part III: Text with multiple choice questions Part IV: Text with multiple choice gaps Part V: Identification of additional unnecessary words in text	
UNIT III- WRITING	**(10)**
Part I : E-mail writing, Writing short notes, Memo, Agenda & Minutes Part II: Report Writing, Complaint Letter, Writing Proposals	
TOTAL (L: 30) = 30 PERIODS	

REFERENCES:

1. Murphy, Raymond, "Essential Grammar in Use", Cambridge University Press, UK, 2007.
2. Whitby, Norman, "Business Benchmark Pre - Intermediate to Intermediate Preliminary", 2nd ed., Cambridge University Press, 2013



17MYB07- NUMERICAL METHODS *(Common to BE CIVIL / CHEMICAL)*					
			L	**T**	**P**	**C**
			2	**2**	**0**	**3**
PREREQUISITE:		**QUESTION PATTERN: TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To derive appropriate numerical methods to solve algebraic and transcendental equation.	**1.1**	solve an algebraic or transcendental equation using an appropriate numerical method		**a,b,d,k,l**
2.0	To find the Lagrange Interpolation Polynomial for any given set of points.	**2.1**	Numerically approximate functions with Lagrange polynomials		**a,e,l**
3.0	To apply several methods of numerical differentiation and integration, including Romberg integration.	**3.1**	Understand and apply appropriate techniques for numerical differentiation and integration.		**a,c,d,l**
4.0	To find numerical solution of a differential equation by Euler's, Modified Euler's, Predictor Corrector and Runge- Kutta Methods.	**4.1**	Make use of numerical methods in the solution of ordinary differential equations which are useful in solving engineering problems		**a,b,e,l**
5.0	To Use finite differences for interpolation and differentiation.	**5.1**	Solve initial value problem ordinary differential equations with explicit or implicit methods as appropriate. .		**a,b,d,l**

UNIT I - SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS	**(6+6)**
Solution of equation – Method of criteria for convergence –– Newton Raphson method – Solution of linear system by Gaussian elimination– Iterative methods: Gauss-Seidel method —– Eigen value of a matrix by power method for symmetric matrix.	
UNIT II - INTERPOLATION AND APPROXIMATION	**(6+6)**
Divided differences in unequal intervals —– Lagrangian Polynomials–Newton's forward and backward difference formulas for equal intervals.	

UNITIII - NUMERICAL DIFFERENTIATION AND INTEGRATION	(6+6)
Numerical integration by Trapezoidal and Simpson's 1/3 rule – Romberg's method – Two and Three point Gaussian quadrature formulae – Double integrals using trapezoidal and Simpson's rules.	
UNIT IV - INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS	**(6+6)**
Single step methods: Taylor series method – Euler's method– Modified Euler method for first order equation – Fourth order Runge–Kutta method for solving first order equations –Multistep methods: Adam's and Milne's predictor and corrector methods.	
UNIT V - BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS	**(6+6)**
Finite difference solution of one dimensional heat equations using Crank-Nicolson, Bender Schmidt methods Onedimensional wave equation and two dimensional Laplace equations using Liebmann's iteration process.	
TOTAL (L:30+ T:30) : 60 PERIODS	

TEXT BOOKS:

1. T. Veerarajan. and T. Ramachandran., "Numerical Methods with programming in C", 2nded., Tata McGraw-Hill, 2006, First reprint2007.
2. P. Kandasamy, K.Thilagavathy and K. Gunavathy, "Numerical Methods – Vol IV", S.Chand& Co. Ltd., New Delhi, 2003, reprint 2007.

REFERENCES:

1. K. SankarRao, "Numerical Methods for Scientists and Engineers", 3rded., Prentice Hall of India, New Delhi, 2007,10threprint 2012.
2. B.S.Grewal, "Numerical Methods in Engineering & Science",Khanna publishers, New Delhi, 2012.
3. E. Balagurusamy, "Numerical Methods", Tata McGraw-Hill, New Delhi, 1999, 25threprint 2008.
4. M.K Venkatraman, "Numerical Methods", National Publication, New Delhi, 2000, reprint 2005.

17CHC06- PROCESS ORGANIC SYNTHESIS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To learn the principle of nitration and manufacture of amino compounds	1.1	Understand the various unit process in synthesis of organic compounds		**a, b, c, d**
2.0	To have a basic ideas about production and properties of hydrogenation and alkylation	2.1	Understand the application of organic compounds in various industries		**a, b, c**
3.0	To understand types of oxidation hydrolysis processes, Esterification of organic compounds	3.1	Analysis chemicals reaction and reaction conditions		**a, b, c, e, f**
4.0	To develop knowledge about halogenation, sulfonation and sulfation	4.1	Identify reaction schemes and mechanisms for a number of important reaction used in organic synthesis		**a, b, c, e, f**
5.0	To provide fundamental knowledge of dye and drug synthesis	5.1	Understand the synthesis of important dyes and drugs		**a, b, c, d, e**

UNIT I - NITROGEN AND AMINATION	**(9)**
Principle of Nitrogen –N-nitro compounds and nitration esters, industrial equipment and processes. Amination; methods – reduction and Ammonolysis. Catalytic reaction, manufacture of amino compounds	
UNIT II - HYDROGENATION AND ALKYLATION	**(9)**
Production and properties of hydrogen, Catalytic hydrogenation and hydrogenolysis; Methanation and Fischer-Tropschreaction. Types and factors affecting alkylation, industrial alkylation process	
UNIT III - OXIDATION ,HYDROLYSIS AND ESTERFICATION	**(9)**
Types of oxidation reaction – liquid-phase and Vapour-phase; Hydrolysis process and equipments. Esterification of inorganic and organic acids application in chemical industries	
UNIT IV - HALOGENATION, SULFONATION AND SULFATION	**(9)**
Halogenation; Chlorination reaction; sulfonation and sulfation ; desulfonation reactions	

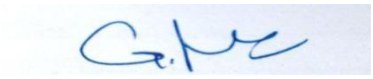
UNIT V - DYE AND GRUG SYNTHESIS	(9)
Synthesis of dyes; Congo red, triphenylmethane dyes –malachite green, Para Rosaniline Alizarain, Eosin; drug synthesis –Sulphanilamide, Chloroquinine, Penicillin, Erythromycin.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOK:

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.



17CHC07-PROCESS HEAT TRANSFER					
		L	T	P	C
		2	2	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 4**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand nature and modes of heat transfer	1.1	Understand the fundamental principles of conduction	**a, b, c, d**
2.0	To gain explosive nature and forced convections and dimensional analysis	2.1	Acquire knowledge in convection and radiation heat transfer	**a, b, c, d, e**
3.0	To provide fundamentals of radiation concepts and nature of thermal radiations	3.1	Familiarize with the fundamentals of radiation and radiation shield	**a, b, c, d, f**
4.0	To have a basic idea of heat transfer with phase change and design evaporator	4.1	Apply the knowledge of heat transfer in the design of evaporators, boiling and condensation	**a, b, c, d, e, f**
5.0	To gain idea of different types of heat exchanger and performances	5.1	Design and analyze the performance of heat exchangers	**a, b, c, d, e**

UNIT I - CONDUCTION	**(6+6)**
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; fundamental concepts in extended surface heat transfer: introduction to transient heat conduction	
UNIT II – CONVECTION	**(6+6)**
Nature and forced convection –Application of dimensional analysis for convection dimensionless number, Reynolds and Colburn analogy, j^H factor, Equation for forced convection under laminar and turbulent flow condition in pipes, equation for natural convection in verticals plates and vertical and horizontal cylinders.	

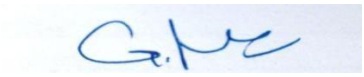
UNIT III - RADIATION	(6+6)
Concepts and nature of thermal radiation, concepts of black and grey bodies; Stefan Boltzmann, Kirchhoff's, Plank's and Wien laws Radiation between surface configuration factor; radiation shield.	
UNIT IV - HEAT TRANSFER WITH PHASE CHANGE	**(6+6)**
Introduction to boiling and condensation, condensers – vertical and horizontal types, evaporator – types and methods of feed – steam economy and surface economy and surface area calculation for single effect evaporator	
UNIT V - HEAT EXCHANGERS	**(6+6)**
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:30 T:30) = 60 PERIODS	

TEXT BOOKS:

1. YunusA.Cengel, "Heat Transfer: A practical approach ",2nd edition .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", 6th edition, Elsevier publications, 2006.



17CHC08– MECHANICAL OPERATIONS					
		L	T	P	C
		2	2	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand how the solids are characterized and methods for storage and transportation of solids	1.1	Demonstrate the knowledge of particle characterization, size analysis, storage and transportation of solids	**a, b, c, d**
2.0	To gain knowledge over size reduction equipments and industrial screens	2.1	Appraise and select the size reduction equipments and industrial screens	**a, b, c**
3.0	To obtain idea on the mechanical separation equipments in process industries	3.1	Understand and select the mechanical separation equipments based on surface properties of solids	**a, b, c, d, e, f**
4.0	To gain knowledge over filtration and types of industrial filters	4.1	Exhibit the principle of filtration and types of industrial filters	**a, b, c, d**
5.0	To understand and compare mixing and agitation process	5.1	Compare and recognize mixing and agitation equipments	**a, b, c, d, f**

UNIT I - CHARACTERISTICS AND HANDLING OF PARTICULATE SOLIDS	**(6+6)**
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	**(6+6)**
Laws of size reduction; classification, principle and working of size reduction equipments; screening- screen effectiveness- industrial screening equipments	
UNIT III - MECHANICAL SEPARATIONS	**(6+6)**
Principles and equipment for gravity settling, sedimentation, thickening, centrifugal separation, froth flotation, magnetic and electrostatic separators, heavy media separations	

UNIT IV - FILTRATION	(6+6)
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	**(6+6)**
Principles,typesandequipmentformixing;Impellers,powerrequirementforagitation; Mixer for powders and pastes, equipment for blending and kneading	
	TOTAL(L:30+T:30) = 60 PERIODS

TEXT BOOKS:

1. Coulson J.M.and Richardson J.F.,"Chemical Engineering", Volume II, 5th Edition, Elsevier publication,2006.
2. G.G. Brown "Unit Operations " 1st edition , CBS Publishers,2005

REFERENCES:

1. .Badger WalterL.and BancheroJulius 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 &SonsInternational Edition, 2008.

17CHC09-CHEMICAL ENGINEERING THERMODYNAMICS					
		L	T	P	C
		2	2	0	3
PREREQUISITE : 17MEC07		**QUESTION PATTERN: TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To Have a basic concepts and laws of thermodynamics	1.1	Apply thermodynamic concepts and the laws of thermodynamics to various systems and processes		**a, b, c, d**
2.0	To learn the fundamental properties of Real gases and thermodynamics formulation	2.1	Evaluate the PVT behavior of ideal and real gases		**a, b, d**
3.0	To gain exposure to properties of solution	3.1	Understand the properties of solution and determine the partial molar properties from mixture properties and vice- versa		**a, b, d, e, f**
4.0	To understand the Phase equilibrium between phase and engineering systems	4.1	Apply chemical reaction equilibrium between phase to engineering system with two or more coexisting phases		**a, b, c, d, e, f**
5.0	To develop knowledge on chemical reaction equilibrium for homogenous reactions	5.1	Apply chemical reaction equilibrium for thermodynamic analysis of homogeneous reaction		**a, b, c, d, e**

UNIT I - LAWS OF THERMODYNAMICS	**(6+6)**
Basic concepts; Zeroth laws; First law; application to non-flow and flow processes; second law –heat engine, Carnot cycle and theorem, Entropy calculation; third laws of thermodynamics.	
UNIT II - PROPERTIES OF REAL GASES AND THRMODYNAMICS FORMULATIONS	**(6+6)**
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	
UNIT III - PROPERTISE OF SOLUTIONS	**(6+6)**
Partial molar properties Chemical potential, Fugacity and Activity coefficient; Gibbs-Duhem equation enthalpy and Gibbs free energy change in mixing of ideal solution	

UNIT IV -PHASE EQUALIBRIA	(6+6)
Phase equilibrium and stability criteria for equilibrium between phases in single and multi-component non-reacting system; vapor –liquid equilibrium of binary ideal and non-ideal solution; Azeotropes; Raoult's law and Henry's law; P-x-y and T-x-y diagrams using Antoine equations	
UNIT V - CHEMICAL EQUILIBRIA	**(6+6)**
Criteria of equilibrium; standard free energy change and reaction equilibrium constant; effect of temperature and pressure on reaction equilibrium constant homogenous chemical reactions thermodynamics analysis and prediction of equilibrium composition	
	TOTAL(L:30:T:30) = 60 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. SmithJ.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.KyleB.G.,"Chemical and Process Thermodynamics",3rd Edition,Prentice Hall IndiaPvt.ltd., New Delhi,1999

17CHP04-PHYSICAL AND ORGANIC CHEMISTRY LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To gain knowledge and estimate the turbidity of water	1.1	Handle Nephelometer to estimate the turbidity of water		**a, b, c, d**
2.0	To understand amount of nitrogen presentation urea	2.1	Perform the experiment on nitrogen content in urea		**a, b, c, d**
3.0	To import knowledge handle UV Spectrophotometer and flame photometer	3.1	Utilize UV Spectrophotometer and flame photometer to estimate the ions in solution		**a, b, c, d, e, f**
4.0	To Prepare organic compounds	4.1	Prepare m-Dinitrobenzene and Benzoic Acid from organic chemicals		**a, b, c, d, e, f**
5.0	To learn basic principle involved in analysis and synthesis of different organic derivatives	5.1	Identify the nature and functional groups of organic compounds		**a, b, c, d, e, f**

LIST OF EXPERIMENTS

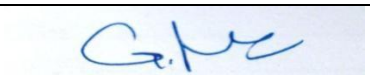
PHYSICAL AND ORGANIC CHEMISTRY(Any Ten)

1. Determination of carbohydrates from unknown organic compounds
2. Identification of acids from unknown organic compounds
3. Determination of ester from unknown organic compounds
4. Estimation of amine from unknown organic compounds
5. Estimate the amount of nitrogen in urea by kjeldahls methods
6. Estimate the ions present in given solution using UV—visible spectrophotometer
7. Determine the amount of sodium and potassium ions present in water using flame photometer
8. Polarimetry inversion of cane sugar
9. Turbidity and colour of waste water
10. Preparation of meta di nitro benzene from nitro benzoate
11. Preparation of benzoic acids from ethyl benzoate.
12. Preparation of benzoic acid from benzaldehyde

TOTAL (P:60) = 60 PERIODS

Reference:

1. Lab manual



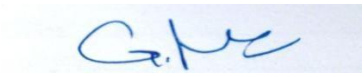
17CHP05 – MECHANICAL OPERATIONS LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE: 17CHC08					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To determine power requirements and crushing laws constants using Jaw and Roll Crusher	1.1	Assess power requirements and crushing laws constant using Jaw and Roll Crusher.		**a, b, c, d**
2.0	To predict the critical speed and work index by using Ball mill	2.1	Determine the critical speed and assess work index by using Ball mill		**a, b, c, d**
3.0	To find the average particle size and specific surface area by conducting Sieve Analysis, Beaker Decantation and Air Permeability experiments	3.1	Estimate average particle size and specific surface area by conducting Sieve Analysis, Beaker Decantation and Air Permeability experiments		**a, b, c, d**
4.0	To determine specific cake and filter medium resistance using Filter press, Leaf filter and Rotary drum filters.	4.1	Estimate specific cake and filter medium resistance using Filter press, Leaf filter and Rotary drum filters.		**a, b, c, d, f**
5.0	To design a thickener by conducting batch sedimentation test and to determine the efficiency of cyclone separator	5.1	Design a thickener using batch sedimentation test data and assess the efficiency of cyclone separator		**a, b, c, d, f**

LIST OF EXPERIMENTS

MECHANICAL OPERATIONS LABORATORY (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 particle size distribution and the average particle size using Beaker decantation
6. Determination of the specific cake resistance and filter medium resistance using plate and frame filter press
7. Determination of the specific cake resistance and filter medium resistance using vacuum leaf filter
8. Determination of the separation efficiency of cyclone separator

9. Determination of minimum thickener area by batch sedimentation test 10. Determination of the specific surface area of the given powder using air permeability apparatus 11. Determination of the specific cake resistance and filter medium resistance using rotary drum filter 12. Determination of separation efficiency of froth flotation apparatus. 13. Determination of Power Consumption & Power Number by using Mixing apparatus.
TOTAL (P:60) = 60 PERIODS
Reference:
1. Lab manual

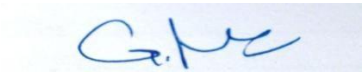


17GED01 - SOFT SKILLS-LISTENING AND SPEAKING					
			L	T	P	C
			0	0	2	0
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - NIL**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To recollect the functional understanding of basic grammar and its structure.	**1.1**	Apply the knowledge of basic grammar to classify the types of verbs and questions and to construct the sentences.	**i,k,l**	
2.0	To acquire the listening skills through note completion, matching and multiple choice modes.	**2.1**	Develop the listening skills through note completion, matching and multiple choice modes.	**i,k,l**	
3.0	To develop speaking skills through self introduction, short talk and topic discussion.	**3.1**	Organize a presentation on the given topic.	**i,k,l**	

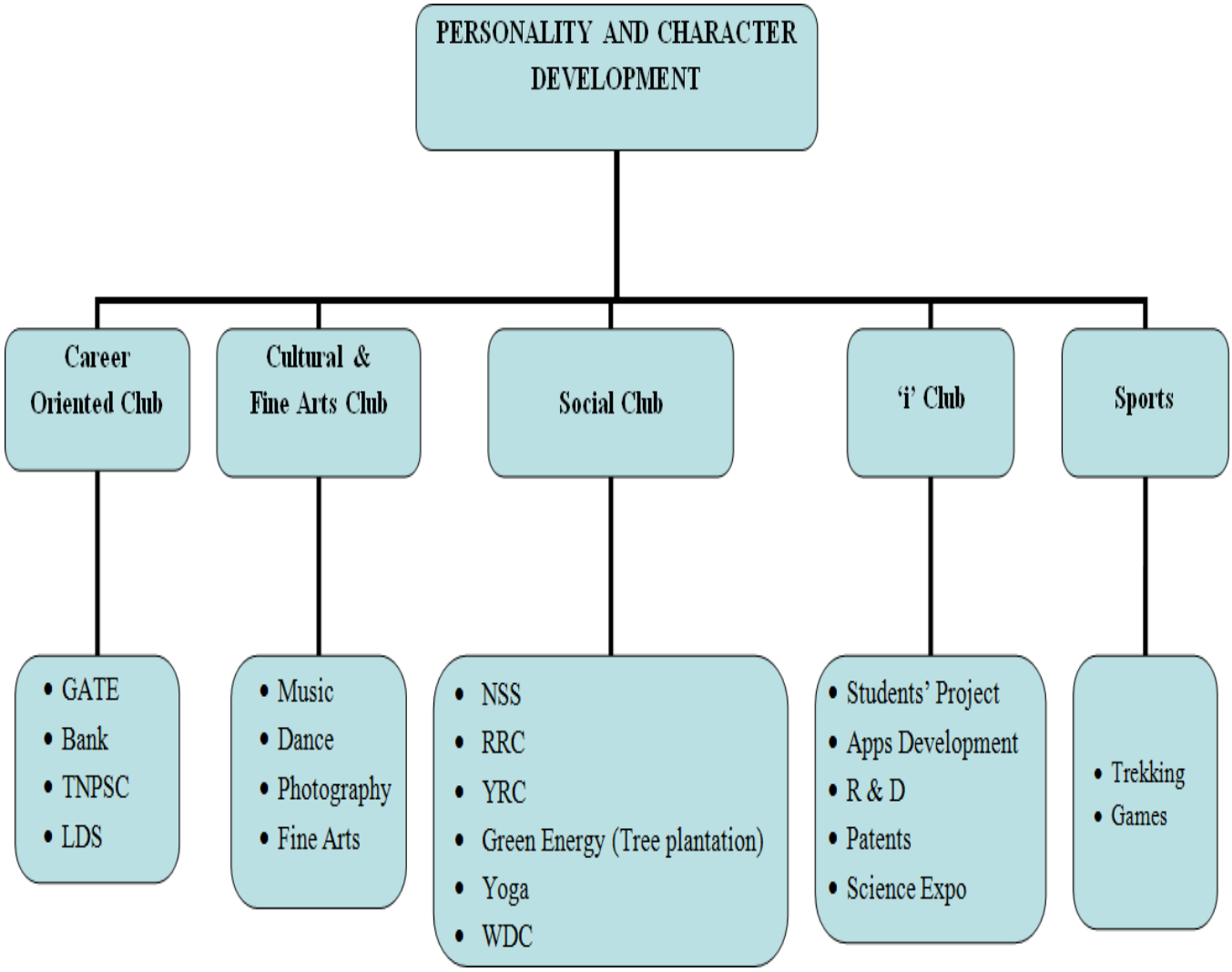
UNIT I - GRAMMAR	**(10)**
Tenses - Verb (Auxiliary and Modal) - 'Yes/No' Type Questions - Reported Speech - Gerund - Phrasal Verbs	
UNIT II - LISTENING	**(10)**
Part I : Note completion Part II: Matching Part III: Multiple Choice	
UNIT III- SPEAKING	**(10)**
Part I : Self Introduction Part II: Short talk on business topics Part III: Discussion in pairs	
TOTAL (L: 30) = 30 PERIODS	

REFERENCES:

1. Murphy, Raymond, "Essential Grammar in Use", Cambridge University Press, UK, 2007
2. Whitby, Norman ,"Business Benchmark Pre- Intermediate to Intermediate Preliminary, 2nd ed., Cambridge University Press, 2013.



17GED03 - PERSONALITY AND CHARACTER DEVELOPMENT				
	L	T	P	C
	0	0	1	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)

17CHC10 – MASS TRANSFER I					
		L	T	P	C
		2	2	0	3
PREREQUISITE : 17CHC05		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the basic concepts of diffusion and its measurement.	**1.1**	Understand diffusion operations in gases liquids and solids.		**a, b,c**
2.0	To understand the mass transfer coefficients and their theories of mass transfer	**2.1**	Understand the concept of interphase mass transfer coefficients and equipment		**b, c, d**
3.0	To gain knowledge over humidification and dehumidification and application in process industries.	**3.1**	Understand the concept humidifiers and cooling towers.		**a, b, c, d**
4.0	To understand the mechanism of drying and types of drying equipment	**4.1**	Retrieve and apply the knowledge gained in mass transfer to perform simple calculations in drying		**a, b, c, d**
5.0	To gain knowledge over crystallization and its application.	**5.1**	Apply the knowledge gained in mass transfer to perform simple calculations in crystallization process		**a, b, c, d**

UNIT I : DIFFUSION	**(12)**
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 : MASS TRANSFER COEFFICIENTS AND THEORIES OF MASS TRANSFER	**(12)**
Interphase mass transfer -local and overall mass transfer co-efficient, mass transfer in laminar and turbulent flow. Mass transfer theories. Co-current and counter-current operations-Equilibrium and operating line concept-Equipment for gas liquid contactors- NTU and HTU concept.	
UNIT III : HUMIDIFICATION	**(12)**
Basic concepts and terminologies, Adiabatic saturation process and theory of wet bulb temperature, psychrometric chart construction. Humidification and dehumidification operations calculations. Types of cooling towers, spray chambers and spray ponds.	
UNIT IV : DRYING	**(12)**
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 V : CRYSTALLIZATION	(12)
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.	
TOTAL(L:30 T:30) = 60 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 MeeraSheriffa 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.

17CHC11 – CHEMICAL PROCESS INDUSTRIES					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand the role of chemical engineer in process industries	**1.1**	Understand the concept block diagram and can differentiate the unit processes and unit operations.	**a, f, g, l**
2.0	To gain the knowledge about the inorganic chemicals production and applications	**2.1**	Understand the production of inorganic chemicals and its importance.	**a, f, g, k**
3.0	To gain knowledge over the pharmaceuticals industry and importance	**3.1**	Bain knowledge about pharmaceuticals and purpose using it	**a, f, l**
4.0	To gain knowledge about starch and sugar industry	**4.1**	Understand the method of producing starch and sugar.	**a, f, i**
5.0	To understand the concept of refining crude petroleum and production of polymers	**5.1**	Gain knowledge about the various processes involved in petroleum refining	**a, f, g**

UNIT I : INDUSRIAL GASES AND ACIDS	**(9)**
The role and job opportunities of Chemical Engineers in process industries, Concept of industrial and instrumentation air. Manufacture and applications of producer gas, natural gas, coke oven gas, Hydrochloric, Sulfuric and Phosphoric acid-Nitric acid	
UNIT II : INORGANIC CHEMICAL INDUSTRY	**(9)**
Manufacture Soda ash, Sodium bicarbonate, Chlorine and Caustic soda, Bleaching powder.	
UNIT III : PHARMACEUTICAL INDUSTRY	**(9)**
Antibiotics – penicillin – production, Applications of Streptomycin, tetracylines, chloramaphenicol, Synthetic drugs - Sulfa drugs, Anti TB drugs. Vitamins.	
UNIT IV :SUGAR AND STARCH INDUSTRY	**(9)**
Sucrose – methods of production, Starch – maize, dextrin from starch. Dialdehyde starch, starch phosphate.	
UNIT V :PETROLEUM INDUSTRY	**(9)**
Petroleum – Chemical composition, classification. Refinery process, Naptha - Cracking, reforming. Polymerization – olefins. Petrochemicals – LDPE, HDPE and polypropylene	
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

17CHC12 – CHEMICAL REACTION ENGINEERING					
		L	T	P	C
		2	2	0	4
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 4**			
Course Objectives and outcomes					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the basic concepts of chemical kinetics studies and types of reactions.	**1.1**	Understand the concept of stoichiometric equations, order of reaction and chemical kinetic theories.		**a, b, c, d**
2.0	To learn the mass and energy balance of ideal reactors of batch and continues operations.	**2.1**	Understand the performance equations of ideal reactors.		**a, b, d**
3.0	To gain knowledge over multiple rectors with series/parallel configurations.	**3.1**	Apply knowledge of performance studies to compare reactors of different types in series and parallel.		**a, b, d, e**
4.0	To understand the types of multiple reactions.	**4.1**	Learn the concepts of multiple reactions involved in PFR and MFR.		**a, b, d, e**
5.0	To gain knowledge of non-isothermal and adiabatic reactor performance.	**5.1**	Analyze the performance of reactors under steady state non-isothermal conditions.		**a, b, d**

UNIT I : FUNDAMENTAL CONCEPTS AND CHEMICAL KINETICS	**(12)**
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	**(12)**
Chemical reactors: Batch reactors, performance equation. Advantages and disadvantages of Batch reactors, Space time and space velocity. Simple calculations. CSTR, performance equation, Conversion yield.	
UNIT III : DESIGN OF MULTIPLE REACTORS	**(12)**
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.	

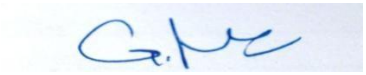
UNIT IV : DESIGN FOR MULTIPLE REACTIONS	(12)
Series reactions , parallel reactions , series-parallel reactions , qualitative discussion about product distribution in mixed flow reactor and plug flow reactor, quantitative treatment of product distribution in mixed flow reactor and plug flow reactor, overall fractional yield ,instantaneous fractional yield, selectivity.	
UNIT V :BASIC CONCEPTS OF NON-IDEAL FLOW	**(12)**
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, problems.	
TOTAL(L:30 T:30)= 60 PERIODS	

TEXT BOOKS:

1. H.S. Fogler, Elements of Chemical Reaction Engineering, 3rd Ed., Prentice Hall India Pvt. Ltd., New Delhi,2001
2. Octave 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.



17CHC13 –CHEMICAL EQUIPMENT DESIGN - I					
		L	T	P	C
		0	6	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
Course Objectives and outcomes					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	Design machine elements; Develop Process Flow Diagrams and Piping Instrumentation Diagrams	**1.1**	Able to design machine elements; Develop Process Flow Diagrams and Piping Instrumentation Diagrams		**a, b, c, d**
2.0	Understand the basic design of various reactors.	**2.1**	Able to design various reactors used in chemical industry.		**b, c, d**
3.0	Understand thermal design of heat exchangers	**3.1**	Able to design heat exchangers for chemical process		**a, b, c, d, f**
4.0	Perform the process design of evaporators	**4.1**	Able to design evaporators for chemical process		**a, b, c, g**
5.0	Perform design calculations of crystallizers and centrifuges	**5.1**	Able to design crystallizers and centrifuges for chemical process		**a, b, c, i**

UNIT I : DESIGN BASICS	**(12)**
Basic design and drawing considerations of machine elements (bolts, nuts), PFD- Flow sheet presentation-computer aided flow sheets, PID-Mechanical design of piping systems and piping design.	
UNIT II : REACTOR DESIGN	**(12)**
Design equation for batch reactor, plug flow reactor and continuous stirred tank reactor. Reactors in series and parallel.	
UNIT III : HEAT EXCHANGERS	**(12)**
Design of Heat Exchangers - Shell and tube – Heat transfer area, Pressure drop on shell side and tube side. Double pipe heat exchangers – overall heat transfer coefficient, heat transfer area.	
UNIT IV : EVAPORATORS AND CONDENSERS	**(12)**
Design of single and double effect Evaporators - capacity and steam economy. Design of Condensers-Pressure drop in condensers.	

UNIT V : CRYSTALLIZERS AND CENTRIFUGE	(12)
Design of Crystallizers - yield of crystals – tip speed - wash liquor requirement – length of crystallizer. Design of centrifuge –separating power- tubular and disk centrifuge.	
TOTAL(T:60) = 60 PERIODS	

TEXT BOOKS:

1. Thakore S.B. and Bhatt B.I., "Introduction to Process Engineering and Design", 2nd Reprint, Tata McGraw-Hill Publishing Company Ltd., 2009
2. Towler C. Gavin and Sinnott Ray, "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design", 2nd Edition, Elsevier, 2008

REFERENCES:

1. Sinnot R.K., "Chemical Equipment Design: Chemical Engineering", Volume - 6, 4th Edition, Elsevier-Butterworth, 2005
2. Joshi M.V. and Mahajan V.V., "Process Equipment Design", 3rd Edition, Macmillan India Ltd., 1996

17CHP06 – PROCESS HEAT TRANSFER LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE: NIL					
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To determine individual and overall heat transfer coefficient using packed column and thermal conductivity of a material	**1.1**	Determine heat transfer coefficient for packed column apparatus and determine the thermal conductivity of given material		**b, e, g**
2.0	To estimate individual heat transfer coefficient under forced convection	**2.1**	Evaluate the performance and determine individual and overall HTC		**a, e, i,**
3.0	To study the radiation heat transfer and calculate Stefan-Boltzmann constant		Able to understand radiation heat transfer		**a, b, e, i**
4.0	To estimate the HTC for heat transfer through heat exchangers.	**4.1**	Estimate the HTC for heat transfer through double pipe heat exchangers and shell and tube heat exchangers.		**b, i, k**
5.0	To estimate steam economy and efficiency of an evaporator	**5.1**	Appraise the performance of evaporator and determine steam economy		**b, e, i,**

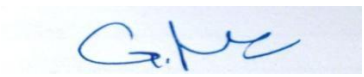
PROCESS HEAT TRANFER LABORATORY(ANY TEN)

LIST OF EXPERIMENTS:

1. Estimation of individual and overall heat transfer coefficient for heat transfer in Packed Column
2. Estimation of unsteady state temperature values using transient heat conduction experiment- constant flux and constant temperature.
3. Estimation of individual heat transfer coefficient under forced convection heat transfer.
4. Estimation of individual heat transfer coefficient under natural convection heat transfer.
5. Estimation of individual and overall heat transfer coefficient for heat transfer in shell and tube heat exchanger
6. Estimation of individual and overall heat transfer coefficient for heat transfer in double pipe heat exchanger
7. Estimation of individual heat transfer coefficient and fin efficiency for heat transfer through extended surface
8. Estimation of steam economy and efficiency of an evaporator
9. Heat transfer studies in pool boiling
10. Estimation of individual heat transfer coefficient for heat transfer through horizontal and vertical condenser

11. Estimation of individual and overall heat transfer coefficient for heat transfer in jacketed vessel 12. Estimation of thermal conductivity of a material. 13. Studies on radiation heat transfer 14. Determination of Stefan Boltzmann constant using Stefan Boltzmann experiment
TOTAL (P:60) = 60 PERIODS

REFERENCES/MANUALS/SOFTWARE:
1. Lab Manual



17CHP07 – CHEMICAL REACTION ENGINEERING LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE: 17CHC12					
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To determine the rate constant of batch reactor for reversible and irreversible reactions.	**1.1**	Determine the rate constant and order of the reaction.		**a, b, c, d**
2.0	To understand the behaviour of PFR and MFR using step input.	**2.1**	Verify the dispersion number of PFR and MFR.		**a, b, d, i**
3.0	To determine performance of combined reactors.	**3.1**	Predict the percentage conversion of reactions carried out in combined reactors.		**a, b, e, i**
4.0	To study the chemical kinetics of PFR and MFR.	**4.1**	Determine the rate constant, reactor size and conversion.		**b, d, e, i**
5.0	To test the performance of multiple reactors	**5.1**	Determine the rate constant and performance studies of multiple reactors.		**b, d, i**

LIST OF EXPERIMENTS

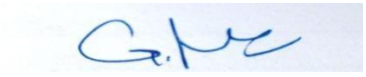
CHEMICAL REACTION ENGINEERING LABORATORY(Any Ten)

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

TOTAL (P:60) = 60 PERIODS

REFERENCES/MANUALS/SOFTWARE:

1. Lab Manual



17GED07- CONSTITUTION OF INDIA					
		L	T	P	C
		2	0	0	0
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To educate about the Constitutional Law of India	**1.1**	The students will be able to Gain Knowledge about the Constitutional Law	f, h, l	
2.0	To motivate students to Understand the Fundamental Rights and Duties of a citizen	**2.1**	The students will be able to Understand the Fundamental Rights and Duties of a citizen	f, g, h	
3.0	To make students to understand about Federal structure of Indian Government	**3.1**	The students will be able to Apply the concept of Federal structure of Indian Government	f, g, h	
4.0	To understand about Amendments and Emergency provisions in the Constitution	**4.1**	The students will be able to Analyze the Amendments and Emergency provisions in the Constitution	f, g, h	
5.0	To educate a holistic approach in their life as a Citizen of India	**5.1**	The students will be able Develop a holistic approach in their life as a Citizen	f, h, l	

UNIT I - Introduction to Indian Constitution	**(6)**
Meaning of the constitution law and constitutionalism - Historical perspective of the Constitution - Salient features and characteristics of the Constitution of India	
UNIT II - Fundamental Rights	**(6)**
Scheme of the fundamental rights - Right to Equality - Fundamental Right under Article 19 - 102 Scope of the Right to Life and Liberty - Fundamental Duties and its legal status - Directive Principles of State Policy – Its importance and implementation	
UNIT III - Federal Structure	**(6)**
Federal structure and distribution of legislative and financial powers between the Union and the States - Parliamentary Form of Government in India - The constitutional powers and status of the President of India	
UNIT IV - Amendment to Constitution	**(6)**
Amendment of the Constitutional Powers and Procedure - The historical perspectives of the constitutional amendments in India	
UNIT V - Emergency Provisions	**(6)**
National Emergency, President Rule, Financial Emergency Local Self Government – Constitutional Scheme in India	
TOTAL = 30 PERIODS	

REFERENCES:

1. Constitution of India - Ministry of Law & Justice – PDF format awmin.nic.in/coi/coiason29july08.pdf
2. . Introduction to the Constitution of India by Durgadas Basu
3. The Constitution of India – Google free material - www.constitution.org/cons/india/const.html

7CHC14 – MASS TRANSFER II					
		L	T	P	C
		2	2	2	4
PREREQUISITE : 17CHC10		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand the choice of solvents and absorption towers.	**1.1**	Understand absorption operations	**a, b, c, e**
2.0	To understand the laws related to distillation and the methods of distillation	**2.1**	Understand the concept of distillation and their types.	**a, b, c, f**
3.0	To gain knowledge over analysis and different methods of Extraction	**3.1**	Understand the types of extraction and design of extraction column.	**a, b, c, e, f**
4.0	To understand the concept of isotherms and different adsorption column	**4.1**	Understand the principle of adsorption and their types applied in process industries	**a, b, c, d, f**
5.0	To gain knowledge over extraction and leaching and their application to industries	**5.1**	Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid and solid -liquid mixtures	**c, d, e, f**

UNIT I : ABSORPTION	**(12)**
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 II : DISTILLATION	**(12)**
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. Principles of extractive and azeotropic distillation.	
UNIT III : EXTRACTION	**(12)**
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.	

UNIT IV : ADSORPTION	(12)
Characteristics and choice of adsorbents, industrial applications. Adsorption isotherms & breakthrough curve. Single and multiple cross current and counter current operation. Principle of Membranes - concept of osmosis; reverse osmosis, electro dialysis and ultrafiltration.	
UNIT V :LEACHING	**(12)**
Leaching: Solid-liquid equilibria; calculations in single stage, multi stage cross-flow and counter current leaching. Industrial Leaching equipment.	

LIST OF EXPERIMENTS (ANY TEN) :

1. Determination of the diffusivity of the given liquid to air.
2. Estimation of Mass transfer co-efficient using Wetted wall column.
3. Conduction of batch drying test and estimation of the mass transfer coefficient and psychometric Ratio.
4. Verifying the Raleigh's equation for the given system using simple distillation setup
5. Determination of the activity coefficients & Van-Laar constant for the given system by performing VLE experiments
6. Determination of vaporization efficiency (Ev) and Thermal efficiency (Et) of the given system using steam distillation apparatus
7. 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
8. Conduction of Simple /Co-current /Counter – current Leaching studies
9. 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
10. Studying the concept of Surface Evaporation and finding the constants of Himus Equation
11. Verifying adsorption isotherms by Batch Adsorption tests
12. Conduction of drying experiments using Vacuum Dryer

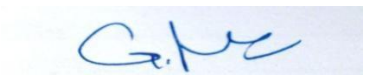
TOTAL(L:30 T:30 P:30) = 90 PERIODS

TEXT BOOKS:

1. Anantharaman N. and Meera Sheriffa Begum K.M., ―Mass Transfer: Theory and Practice‖, Prentice Hall of India, New Delhi, 2011.
2. Treybal Robert E., ―Mass Transfer Operations‖, 3rd Edition, McGraw-Hill Book Company Ltd., 1980.

REFERENCES:

1. Geankopolis C.J., ―Transport Processes and Separation Process Principles‖, 4th Edition, Prentice Hall of India, 2004
2. Coulson J.M. and Richardson J.F., ―Chemical Engineering‖, Volume I, Pergamon Press, 1977.



17CHC15 –CHEMICAL EQUIPMENT DESIGN-II					
			L	T	P	C
			0	6	0	3
PREREQUISITE : 17CHC13		**QUESTION PATTERN: TYPE - 3**			

Course Objectives and outcomes

Course Objectives		Course Outcomes		Related Program outcomes
1.0	Develop thermal design of distillation column	**1.1**	Able to calculate the number of plate and height of distillation column	**b, c, d, e**
2.0	Perform design calculations for absorption column	**2.1**	Able to Design absorption column by calculating height and number of plate of the column	**a, b, c, d, f**
3.0	Perform the process design of drying column	**3.1**	Able to design drying rate in the process calculation	**a, b, c, d**
4.0	Assess the design of pressure vessels	**4.1**	Able to design pressure vessels for chemical process	**a, c, d, e**
5.0	Understand the concepts involved in design of storage vessels.	**5.1**	Able to design storage vessels	**a, b, c, d**

UNIT I : DISTILLATION COLUMN	**(12)**
Binary continuous distillation – design methods for binary systems- McCabe-Thiele method- column sizing. Design procedure of Ponchon-Savarit method.	
UNIT II : ABSORPTION COLUMN	**(12)**
Packed column - Height of packing required- prediction of height of transfer units- column diameter- absorption factor- Plate column - number of plates.	
UNIT III :DRYERS	**(12)**
Introduction – rate of drying- time for drying, design of freeze dryer, Rotary dryer- length and diameter; Fluid bed dryer – area and diameter.	
NIT IV : TALL COLUMN AND PRESSURE VESSELS	**(12)**
Introduction – axial stress due to dead loads, pressures, longitudinal bending stresses due to dynamic loads, Design consideration. Pressure vessels – operating at low and elevated temperatures, Design of shell and its components.	

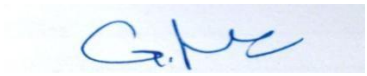
Unit V : STORAGE VESSELS	(12)
Storage vessels – fluids - volatile and non-volatile liquid, gases. Design of shell.	
TOTAL(T:60): 60 PERIODS	

TEXT BOOKS:

1. Walas, Stanley M., "Chemical Process Equipment Selection and Design", 3rd Edition, Butterworth - Heinemann, Boston, 2012
2. Lloyd E. Brownell and Edwin H. Young, " Process Equipment Design", John Wiley and Sons

REFERENCES:

1. Uzimann, "Principles of Chemical Reactor Analysis and Design", 2nd Edition, John Wiley and Sons, 2009
2. Nicholas P. Cherimisinoff., "Handbook of Chemical Processing Equipment", Butterworth, 2000



17CHC16 - PROCESS INSTRUMENTATION DYNAMICS AND CONTROL					
		L	T	P	C
		2	2	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the importance of measurement in process industries	**1.1**	Acquire the the importance of measurement in process industries		a, b, e
2.0	To know of systems and their responses to different input methods	**2.1**	Gain knowledge of systems and their responses to different input methods		b, c, d, e, l
3.0	To understand the principles of controllers and control elements for different applications & To development of block diagram	**3.1**	Comprehend the principles of controllers and control elements for different applications and development of block diagram		b, c, d, k
4.0	To study transient response & Stability of closed loop system	**4.1**	Gain familiarity with transient response & Stability of closed loops		c, d, k
5.0	To Understand frequency response and stability analyses & Exhibit familiarity with advance technique	**5.1**	Understand frequency response and stability analyses & Exhibit familiarity with advance technique		b, c, d, e, k

UNIT I : MEASUREMENT AND INSTRUMENTATION	**(12)**
Principles of measurements, static and dynamic characteristic classification instruments, measurements of temperature, pressure, fluid flow, level, viscosity and consistency and humidity of gases.	
UNIT II : OPEN LOOP	**(12)**
Laplace transformation and its application in process control. First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.	
UNIT III : CLOSED LOOPS	**(12)**
Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, transient response of closed-loop control systems and their stability.	
UNIT IV : FREQUENCY RESPONSE	**(12)**
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules.	

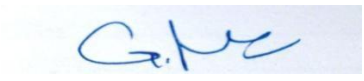
UNIT V : ADVANCED CONTROL SYSTEMS	(12)
Introduction to advanced control systems, cascade control, feed forward control. Control of distillation towers and heat exchangers, introduction to computer control of chemical processes.	
TOTAL (L:30 T:30) =60 PERIODS	

TEXT BOOKS:

1. Donald R. Coughanowr, Steven E. LeBlanc, "Process Systems Analysis and Control", 3rd Edition, Tata McGraw Hill Company Ltd., New Delhi, 2013.
2. Seborg D.E., Edgar D.F., Mellichamp D.A. and Doyle III F.J., "Process Dynamics and Control", 3rd Edition, Prentice Hall of India, 2011.

REFERENCES:

1. Stephanopoulos S.G., "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall of India, New Delhi, 2011.
2. BhagadeSudheer S. and NageshwarGovind Das, "Process Dynamics and Control", Prentice Hall of India, New Delhi, 2011.
3. Eckman, D.P., "Industrial Instrumentation", Wiley, 1978.



17CHC17 - CHEMICAL PROCESS PLANT SAFETY AND HAZARD ANALYSIS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the importance of safety in industry	1.1	Demonstrate the awareness of plant safety, plant layout and the usage of safety codes.		**b, d, e, g, i**
2.0	To learn about the plant layout and plant maintenance	2.1	Understand the selection and replacement of process equipment		**d, e, g, i, k**
3.0	To learn about the plant hazards	3.1	Exhibit the skill in classifying chemical, fire, explosion hazards		**a, d, e, f, i, k**
4.0	To learn about risk analysis and assessment, hazard identification	4.1	Analyze the response to health hazards and to implement the effective process control		**d, e, g, i, k**
5.0	To learn about safe working rules and industrial act	5.1	Understand the rules and act framed by government for safe working environment		**d, e, g, i, j, k**

UNIT I– INTRODUCTION TO SAFETY PROGRAMMES	**(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 - SAFETY PROCEDURES	**(9)**
Plant maintenance, Personal protective equipment – Breathing and respiratory protection; Fire prevention – classification of fire – suppression – foam, dry chemical powder. Emergency planning.	
UNIT III PLANT 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 BOOK:

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.

17CHP08 – PROCESS COMPUTATION LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	Estimate the molecular weight, density, enthalpy of the reaction and cell potential using spread sheets	**1.1**	Use spread sheets to estimate the molecular weight, density, enthalpy of the reaction and cell potential		**b, c ,d**
2.0	Determine the concentration of species and solubility of solute in aqueous solutions using Newton Raphson method	**2.1**	Apply Newton Raphson method to determine the concentration of species and solubility of solute in aqueous solutions		**a, b, c, d**
3.0	Determine the free energy changes and equilibrium constant for a given reaction	**3.1**	Able to determine the free energy changes and equilibrium constant for a given reaction		**b, c, d, i**
4.0	Study the kinetics and rate of a reaction; Estimate heat transfer area using composite curve	**4.1**	Assess the kinetics and rate of a reaction and estimate heat transfer area by applying composite curve method		**b, c, d, e, i**
5.0	Apply MATLAB/ C program for design of shell and tube, double pipe heat exchangers, evaporators and condenser	**5.1**	Using MATLAB/ C program able to design shell and tube, double pipe heat exchangers, evaporators and condenser		**a, b, c, d, i**

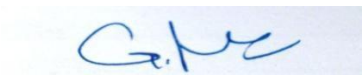
PROCESS COMPUTATION LABORATORY

LIST OF EXPERIMENTS:

1. Estimation of the following by using spread sheet
   (a) Molecular weight, density, enthalpy of the reaction
   (b) Volume of a Van der Waals gas as a function of pressure and temperature
   (c) Behavior of ideal gas volume based on temperature and pressure changes
2. Estimation of the following by using spread sheet
   (a) Cell potential
   (b) H+ ion for a given acid by successive approximation
3. Computing the following by using Newton- Raphson technique
   (a) Concentrations of all species
   (b) Solubility of solute in aqueous solution

4. Computing the free energy changes and equilibrium constant for the given reaction 5. Error calculation for given graphical representation using spread sheet 6. Linearization of given graphical data using spread sheet chart 7. Identification of the kinetics and rate of the given reaction 8. Identification of the total heat transfer area by using composite curve 9. Drawing of PFD and PID using CAD / MS office (Visio) 10. Design of Shell and Tube heat exchanger using MATLAB / C program 11. Design of Double pipe heat exchanger using MATLAB / C program 12. Design of Condenser using MATLAB / C program 13. Design of Single effect evaporator using MATLAB / C program 14. Estimation of Humidity 15. Mass transfer studies using breakthrough curve
TOTAL(P:60)= 45 PERIODS

REFERENCES/MANUALS/SOFTWARE:
1. Lab Manual



17CHP09 – INDUSTRIAL TRAINING				
	L	T	P	C
	0	0	2	1

PURPOSE

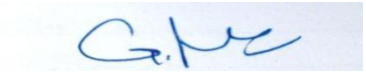
To provide hands-on experience on the principles and operations of any chemical process industry

INSTRUCTIONAL OBJECTIVES

1. Students have to undergo two week practical training in any Chemical process plant; so that they are made aware of the practical application of theoretical concepts studied in the class rooms.
2. Students have to undergo two-week practical training in any Chemical industry of their choice but with the approval of the department. At the end of the training, students should submit a report as per the prescribed format to the department.

ASSESSMENT PROCESS

This course is mandatory and the student has to pass the course to become eligible for the award of degree. The student shall make a presentation before a committee constituted by the department which will assess the student based on the report submitted and the presentation made. Marks will be awarded out of 100and appropriate grades assigned as per the regulations.

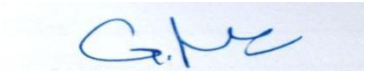


17GED06 - COMPREHENSION					
			L	T	P	C
			0	0	2	0
PREREQUISITE : ALL CORE SUBJECT					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To encourage the students to comprehend the knowledge acquired from the first Semester to Sixth Semester of B.Tech. Degree Course through periodic exercise.	1.1	The Student will be able to understand and comprehend any given problem related to Chemical Engineering field.	a,b	

METHOD OF EVALUATION:	**(30)**
The student will be assessed for his understanding of the basic principles of the core engineering subjects. The internal assessment for a total of 50 marks will be evaluated by a committee comprising of the faculty members of the department. The committee will conduct three written examinations of objective question type from the subjects (Test1 – Fluid Mechanics, Mecanical Operations and Process Calculations; Test 2 - Heat Transfer, Thermodynamics and Process Industries; Test 3 – Mass Transfer, Reaction Engineering and Process Control). The end semester examination, which carries a total of 50 marks, will be an objective question type examination conducted by a committee of one internal examiner appointed by the COE of our college.	
TOTAL (P: 30) = 30 PERIODS	

REFERENCES:

1. O. P. Gupta "Objective Type Questions and Answers in Chemical Engineering," Khanna Publication, 2018.
2. Dr.Ram Prasad "Objective Type Questions and Answers in Chemical Engineering," Khanna Publication, 2017.

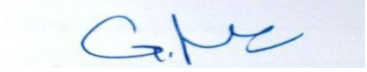


17GED08 - ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE					
			L	T	P	C
			2	0	0	0
PREREQUISITE : Nil					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To Understand the basics of Indian tradition and Indian traditional knowledge systems	**1.1**	The students will be able to Gain Knowledge about of Indian tradition and Indian traditional knowledge systems	a,f,h	
2.0	To know about basics of technologies and its scientific perspectives.	**2.1**	The students will be able to Understand basics of technologies and its scientific perspectives.	a, f	
3.0	To study the basics of Indian traditional health care ,	**3.1**	The students will be able to study the basics of Indian traditional health care	a,f,l	
4.0	To know the basics of Indian artistic tradition knowledge	**4.1**	The students will be able to know the basics of Indian artistic tradition	a,f,l	
5.0	To develop the basics of linguistic tradition	**5.1**	The students will be able To develop the basics of linguistic tradition	a,f,h	

UNIT I - Indian Tradition:	**(6)**
Fundamental unity of India, India's heroic role in world civilization, The Indian way of life, Introduction to Indian tradition, The Scientific Outlook and Human Values.	
UNIT II - Indian Knowledge System and Modern Science:	**(6)**
Relevance of Science and Spirituality, Science and Technology in Ancient India, Superior intelligence of Indian sages and scientists	
UNIT III - Indian Traditional Health Care:	**(6)**
Importance and Practice of Yoga, Pranayam and other prevailing health care techniques	
UNIT IV - Indian Artistic Tradition:	**(6)**
Introduction and overview of significant art forms in ancient India such as painting, sculpture, Civil Engineering, Architecture, Music, Dance, Literature etc	
UNIT V - Indian Linguistic Tradition:	**(6)**
Ancient Indian languages and literary Heritages, Phonology, Morphology, Syntax and Semantics	
TOTAL = 30 PERIODS	

Text Books:

1. Sivaramakrishnan, V., *Cultural Heritage of India- Course Material*, Bharatiya Vidya Bhavan, Mumbai 5th Edition, 2014
2. Swami Jitatmananda, *Modern Physics and Vedanta*, Bharatiya Vidya Bhavan, 2004.
3. Raman V.V., *Glimpses of Indian Heritage,* Popular Prakashan, 1993
4. Jha V.N., *Language, Thought and Reality*
5. Krishna Chaitanya, *Arts of India*, Abhinav Publications, 1987



17CHC18 - PROCESS ENGINEERING ECONOMICS AND MANAGEMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand basic of interest and capital cost	1.1	Able to understand value of money and depreciation with time		**a, b, d, e, h**
2.0	To understand the feasibility of project and selection for investment	2.1	Able to select profitable project and calculate economic balance sheet		**a, b, c, f, h, i**
3.0	To have a basic idea of economic balance	3.1	Can make economic balance on unit operations		**c, d, e, g, h, k**
4.0	To understand the various concepts of economics and management	4.1	Able to understand the theory behind Inventory Control and organization Types		**f, g, h, l, j, k**
5.0	To understand the principle of time study and production planning	5.1	Able to understand the theory behind the process development		**f, h, l, j, k**

UNIT I INTEREST AND PLANT COST	**(9)**
Time value of money - equivalence, Depreciation, Depletion, estimation of capital cost, Capital requirement for complete plant, cost indices, capital recovery.	
UNIT II COST ESTIMATION AND FINANCIAL RATIOS	**(9)**
Estimation of project profitability, process optimization, Investment alternatives, income statement and financial ratios, balance sheet preparation- problems.	
UNIT III ECONOMIC BALANCE	**(9)**
Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipments.	

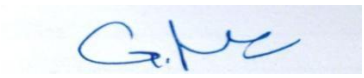
UNIT IV PRINCIPLES OF MANAGEMENT	(9)
Principles of management, planning, organizing, staffing, coordinating, directing, controlling and communicating. Types of organizations, Management information systems (MIS).	
UNIT V PRODUCTION PLANNING AND CONTROL	**(9)**
Work measurement techniques, motion study, principles of time study, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory and control, role of control charts in production and quality control.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, 2004.
2. Ahuja K.K, Industrial management, Khanna publishers, New Delhi, 1985.
3. Schweyer. H.E, "Process Engineering Economics", Mc Graw Hill, 1969.
4. Engineering economics, R.Panneersevam, eastern economy edition.

REFERENCES:

1. F.C. Jelen and J.H. Black, "Cost and Optimization Engineering", McGraw Hill, 3rd Edn., 1992



17CHC19 - TRANSPORT PHENOMENA					
		L	T	P	C
		2	2	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To develop a fundamental knowledge about the transport of momentum, energy and mass.	1.1	Understand the basic knowledge of momentum, heat and mass transport.	**a, c, d, e, f**	
2.0	To gain knowledge of the physical principles that governs momentum transport with emphasis on the mathematical formulation of the conservation principles.	2.1	Understand the knowledge of momentum transport	**a, b, c, e, g**	
3.0	To gain knowledge of the physical principles that governs the energy transport with emphasis on the mathematical formulation of the conservation principles.	3.1	Understand the knowledge of energy transport	**b, c, e, g**	
4.0	To gain knowledge of the physical principles that governs the mass transport with emphasis on the mathematical formulation of the conservation principles.	4.1	Understand the knowledge of mass transport	**b, c, e, g**	
5.0	To gain knowledge about transport in turbulent and boundary layer flow.	5.1	Understand the knowledge about transport in turbulent and boundary layer flow.	**c, e, f, g, h, l**	

UNIT I TRANSPORT PHENOMENA BY MOLECULAR MOTION	**(12)**
Vectors/Tensors, Newton's law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick's law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.	
UNITII ONE DIMENSIONAL MOMENTUM TRANSPORT	**(12)**
Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems.	

UNIT III ONE DIMENSIONAL HEAT TRANSPORT	(12)
Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations of change (non-isothermal), equation of motion for forced and free convection, equation of energy (non-isothermal).	
UNIT IV ONE DIMENSIONAL MASS TRANSPORT	**(12)**
Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalyst and the effectiveness factor, 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	**(12)**
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:30 T:30) = 60 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.

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 Mc-Graw Hill, 1983.

17CHC20 - PROCESS MODELING AND SIMULATION					
		L	T	P	C
		2	0	2	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the fundamentals of modeling and chemical kinetics.	**1.1**	Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics		**b, c, d, e**
2.0	To develop a mathematical model for fluid flow operations	**2.1**	Create mathematical models for fluid flow operations and various models on momentum transfer		**a, b, c, d, k**
3.0	To develop a mathematical model for heat flow operations	**3.1**	Understand the physical phenomena occurring in the heat transfer system		**a, b, c, d, k**
4.0	To develop a mathematical model for mass flow operations	**4.1**	Develop mathematical models for Distillation / Absorption / Extraction Columns		**a, b, c, d, k**
5.0	To create a mathematical model for reactor and process simulator.	**5.1**	Create the mathematical models for reactors and to know about the process simulators like ASPEN and HYSYS		**b, c, d, k**

UNIT I : INTRODUCTION TO MODELING	**(9)**
Physical, Mathematical and Chemical Systems Modeling; Principles of model Formulation; Representation of Model; Fundamental Laws; Types of Modeling Equations; Boundary Condition; Black Box Principles; Validation of Model and Application of Modeling and Simulation in Industries.	
UNIT II : MODELS IN FLUID FLOW OPERATIONS	**(9)**
Laminar flow in a Pipe, Narrow Slit and Gravity Flow Tank, Flow of the film on the Outside of a Circular Tube, Annular flow with Inner Cylinder Moving Axially, Flow between Coaxial Cylinders and Concentric Spheres, Creeping Flow Between Two Concentric Spheres, Parallel Disc Viscometer	
UNIT III : MODELS IN HEAT TRANSFER OPERATIONS	**(9)**
Steady state Heat Conduction Through a Hollow Cylindrical Pipe; Unsteady state Steam Heating of a Liquid; Two Heated Tanks; Counter Current Cooling of Tanks, Single-Component Vaporizer; Multicomponent Flash Drum; Double Pipe Heat Exchanger; Triple Effect Evaporator; Heat Transfer through extended surfaces(spine fin); Unsteady State Heat Transfer in a Tubular Gas Preheater.	
UNIT IV :MODELS IN MASS TRANSFER OPERATIONS	**(9)**
Multistage Absorption; Compartmental Distillation Model; Ideal Binary Distillation Column; Multicomponent Non Ideal Distillation Column; Batch Distillation with Holdup; Binary Continuous Distillation Column; Steady State Single and Multistage Extraction.	

UNIT V :MODELS IN REACTION ENGINEERING AND INTRODUCTION TO PROCESS SIMULATORS	(9)
Batch Reactor; Chemical Reaction with Diffusion in a Tubular Reactor; Series of Isothermal, Constant-Holdup CSTRs; CSTRs with Variable Holdups; Gas-Phase Pressurized CSTR; Non Isothermal CSTR; Introduction to Process Simulators like ASPEN PLUS and HYSYS.	

LIST OF EXPERIMENTS(Any Ten):

1. Estimation of physical property for a non data bank component
2. Analysis of physical properties and generation of T-x-y and P-x-y diagram for different systems
3. Calculation of Bubble Point and Dew Point Temperature/Pressure
4. Simulation of mixer and flash separator
5. Simulation of heat exchanger
6. Simulation of distillation rate
7. Simulation of batch and flow reactors
8. Simulation and analysis of absorption/extraction column
9. Sensitivity analysis and optimization of parameters
10. Simulation and analysis of simple flow sheets problems
11. Simulation of drying of solids
12. Design of heat exchangers and air cooler

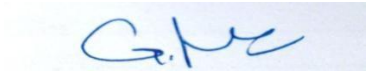
TOTAL(L:30 P:30) = 60 PERIODS

TEXT BOOKS:

1. Babu B.V., ―Process Plant Simulation‖, Oxford University Press, New Delhi, 2004
2. Luyben W.L., ―Process Modeling, Simulation and Control for Chemical Engineers‖, 2nd Edition, McGraw Hill Book Company, New York, 1990.

REFERENCES:

1. Amiya K. Jana, ―Chemical Process Modeling and Computer Simulation‖, Prentice Hall of India, 2014.
2. Gaikwad R.W. and Dhirendra, ―Process Modeling and Simulation‖, 2nd Edition, Denett and Company, Nagpur, 2006



17CHP10 – PROCESS DYNAMIC AND CONTROL LABORATORY

L	T	P	C
0	0	4	2

PREREQUISITE: 17CHC16

COURSE OBJECTIVES AND OUTCOMES

	Course Objectives		Course Outcomes	Related Program outcomes
1.0	To determine time constant for different chemical system	**1.1**	Determine. time constant for first order ad second order system	**d, e**
2.0	To study the response of liquid level system	**2.1**	Analyze the response of interacting & non-interacting level systems	**d, e**
3.0	To understand the response of different control system in process industries	**3.1**	Behavior & Performance analyses of P, PI, PD, PID & ON-OFF control in thermal, liquid, flow and pressure process	**a, d, e**
4.0	To study the performance characteristics of various control valves	**4.1**	Draw the performance characteristics of various control valves	**a, e**
5.0	To determine the optimum controller settings for controller & Application of Simulink (MAT LAB)	**5.1**	Evaluate the optimum controller settings for controller & Application of Simulink (MAT LAB)	**a, b, e**

LIST OF EXPERIMENTS

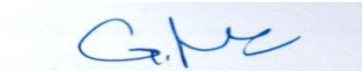
PROCESS DYNAMIC AND CONTROL LABORATORY(Any Ten)

1. Time constant evaluation of First order system
2. Time constant evaluation of dynamic manometer
3. Study the response of interacting level systems
4. Study the response of non-interacting level systems
5. ON-OFF control of thermal, level, pressure and flow process
6. Study the servo problem for different controller on thermal process
7. Performance comparison of P, PI, and PID controllers on flow control loop
8. Study the regulator problem with different controller on level process
9. Behavioural evaluation of P, PI and PID Controllers on pressure control loop
10. Verification of the flow coefficient and performance characteristics of various control valves
11. Estimation of optimum controller settings
12. Simulation study on the characteristic behaviour of higher order systems using MAT LAB

TOTAL (P:60) = 60 PERIODS

REFERENCES/MANUALS/SOFTWARE:

1. Lab Manual

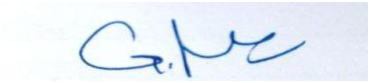


17CHD01– PROJECT WORK-I					
		L	T	P	C
		0	0	8	4
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE -NIL**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To practice the fundamental chemical engineering concepts and principles in addressing a real time situation autonomously or in a team.	**1.1**	The students will be able to study problems in the field of chemical Engineering through literature survey and its reviews.	**a, b, e, d**	
2.0	To develop an ability to solve problem by making a literature review and finding a solution for the same.	**2.1**	The students will be able Undertake problem identification, formulation and solution.	**a, b,**	
3.0	To Study various types of methodology based on the problem.	**3.1**	The students will be able to Design engineering solutions to complex problems utilizing a systems approach and develop projects	**a, c, d, f**	
4.0	To create platform to communicate and present the ideas in written and oral form	**4.1**	The students will be able to Communicate effectively and to present ideas clearly	**a, c, d, j**	
5.0	To create a team work to exhibit the knowledge and skills to contribute to the society.	**5.1**	The students will be able to demonstrate the knowledge, skills and work as a team to achieve common goal	**d, f, h**	

DESCRIPTION

Project work may be allotted to a single student or to a group of students not exceeding 4 per group. The title of project work is approved by head of the department under the guidance of a faculty member and student(s) shall prepare a comprehensive project report after completing the work to the satisfaction of the guide. The Head of the department shall constitute a review committee for project work. There shall be three reviews during the semester by the committee to review the progress. Student(s) shall make presentation on the progress made by him / her / them before the committee and evaluation is done as per Rules and Regulations.

TOTAL (P: 120) = 120 PERIODS

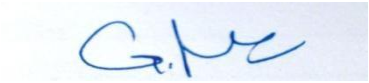


17CHD02 – PROJECT WORK-II					
		L	T	P	C
		0	0	16	8
PREREQUISITE : 17CHD01		**QUESTION PATTERN : TYPE -NIL**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To practice the fundamental chemical engineering concepts and principles in addressing a real time situation autonomously or in a team.	**1.1**	The students will be able to study problems in the field of chemical Engineering through literature survey and its reviews.	**a, b, e, d**	
2.0	To develop an ability to solve problem by making a literature review and finding a solution for the same.	**2.1**	The students will be able Undertake problem identification, formulation and solution.	**a, b,**	
3.0	To Study various types of methodology based on the problem.	**3.1**	The students will be able to Design engineering solutions to complex problems utilizing a systems approach and develop projects	**a, c, d, f**	
4.0	To create platform to communicate and present the ideas in written and oral form	**4.1**	The students will be able to Communicate effectively and to present ideas clearly	**a, c, d, j**	
5.0	To create a team work to exhibit the knowledge and skills to contribute to the society.	**5.1**	The students will be able to demonstrate the knowledge, skills and work as a team to achieve common goal	**d, f, h**	

DESCRIPTION

Project work may be allotted to a single student or to a group of students not exceeding 4 per group. The title of project work (same title as in project work-I if the same project is continued in project work-II or the title will be selected based on different project) is approved by head of the department under the guidance of a faculty member and student(s) shall prepare a comprehensive project report after completing the work to the satisfaction of the guide. The Head of the department shall constitute a review committee for project work. There shall be three reviews during the semester by the committee to review the progress. Student(s) shall make presentation on the progress made by him / her / them before the committee and evaluation is done as per Rules and Regulations.

TOTAL (P: 240) = 240 PERIODS



17CHX01 - OIL AND NATURAL GAS ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To impact knowledge of occurrence of petroleum and exploration	1.1	Understand the occurrence of petroleum, exploration techniques, types of rings and platforms.	**a, b, c, d**
2.0	To learn the composition and properties of natural gas	2.1	Examine the composition of natural gas, compression, purification, liquefaction and shale oil occurrence, extraction and purification.	**a, b, c, d**
3.0	To understand storage and transportation of natural gas	3.1	Understand the storage and transportation of natural gas and power generation in domestic and industrial needs.	**a, b, c, d, e, f**
4.0	To gain exposure about applied hydrodynamics in oil wells	4.1	Examine the hydrodynamics equation for flow through porous media, PVT properties of gas and multiphase flow correlations.	**a, b, c, d, e, f**
5.0	To explain safety environmental and economics of oil and gas.	5.1	Recognize legal aspects governing gas oil spill management and case studies.	**a, b, c, d, e, f**

UNIT I - OCCURRENCE AND EXPLORATION	**(9)**
Occurrence of petroleum: types of reservoirs; exploration methods. Drilling and production of crude and natural gas; types of rigs and platforms.	
UNIT II - NATURAL GAS	**(9)**
Composition and properties, compression and liquefaction of natural gas purification methods shale gas; occurrence, extraction and purification	
UNIT III - STORAGE AND TRANSPORTATION	**(9)**
Storage and transportation of natural gas application in chemical process power generation, domestic, industrial and transportation sector	

UNIT IV - APPLIED HYDRODYNAMICS IN OIL WELLS	(9)
Hydrodynamics equation for flow of fluids through porous media; PVT properties for oil gas system multiphase flow of fluids through porous media; PVT properties for oil gas system; Multiphase flow correlation to determine flow ratio and pressure traverse in flowing oil wells	
UNIT V - REGULATORY PROBLEMS	**(9)**
Safety, environmental and economic aspects of oil and gas exploration, oil spill management – Alaska and gulf of Mexico case studies.	
	TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:

1.Katz Donald L. and Lee Robert L, "Natural Gas Engineering ", McGraw Hill Punishing Company , New York ,1991

2 Medici M., "The Natural Gas Industry ", Newness-Butterworths, London,1974.

REFERENCES:

1. Economides M.J., and Daniel A, "Petroleum Production System", 2nd edition, Prentice Hall Petroleum Engineering Series, 2013
2. William C Lyons, Gary C Plisga, " Standard Hand Book of Petroleum and Natural gas Engineering", 2nd edition, Gulf Professional Publishing, 2004

17CHX02 - BIOCHEMICAL ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To Understand The Classification Of Microbes And Microbial Kinetics	1.1	Understand the growth kinetics of micro-organisms and immobilization techniques	**a, b, c, d**
2.0	To learn the enzymes and enzyme kinetics	2.1	Apply the knowledge of micro- organism and immobilization techniques	**a, b, c, d**
3.0	To have a basic idea of a fermentation and sterilization in biochemical engineering	3.1	Understand sterilization concept to design and analysis bioreactors	**a, b, c, d, e, f**
4.0	To gain a knowledge about transport in microbial systems	4.1	Understand the transport mechanism of oxygen inside the microbial cell	**a, b, c, d, e, f**
5.0	To gain have a basic idea of bioreactor and feeding mechanism	5.1	Apply the knowledge of industrial bioreactor and downstream processes in process industries	**a, b, c, d, e, f**

UNIT I - MICROBES AND MICROBIAL KINETICS:	**(9)**
Classification of microbes , typical growth characterizes of microbes, typical growth characteristic of microbial cells, immobilization techniques, factors affecting growth Monod model ; immobilized whole cells and their characteristics	
UNIT II - ENEYMES AND ENZYME KINETICS:	**(9)**
Classification of enzymes; mechanism of enzymatic reaction Michaelis – Menten kinetics ; enzyme inhibition ; industrial application of enzymes	
UNIT III - FERMENTATION AND STERILIZATION	**(9)**
Requirement of fermentation process; aerobic and anaerobic fermentation process ; solid state submerged fermentation; batch and continuous sterilization of air ,effect of sterilization on quality of nutrients	

UNIT IV - TRANSPORT IN MICROBIAL SYSTEM	(9)
Theories of diffusional mass transfer; mass transfer by convention measurement of K_{La}; oxygen transfer methodology ; factors affecting oxygen transfer rate	
UNIT V - BIOREACTOR	**(9)**
Classifications based on feeding mechanism; batch and continuous fed batch reactors solids removal; filtration; sedimentation; centrifugation; cell disruption; extraction membrane separation; Chromatography and drying	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Blanch, Harvey W.,and Clark Douglas S., "Biochemical Engineering" 2nd edition , CRC Press,1997
2. Bailey J.E and Ollis D.F, "Biochemical Engineering Fundamendals", 2nd edition, McGraw Hill, international edition, New York , 1986.

REFERENCES:

1. Lee James M., "Biochemical Engineering", Prentice Hall India, 1992.
2. Aiba S, Humphrey A.E, and Millos N.F, " Biochemical Engineering ", 2nd edition, Academic press, 1973.

17CHX03 - INSTRUMENTAL METHODS OF ANALYSIS				
	L	T	P	C
	3	0	0	3
PREREQUISITE : NIL	**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To learn the methods and techniques of materials sampling	1.1	Gain the knowledge about sampling and processing of materials	**a, b, c, d**
2.0	To understand the principles, working and applications of various chromatography methods.	2.1	Grasp the principles, working and applications of various chromatography methods	**a, b, c, d**
3.0	To gain a knowledge on particle size determination, properties and their analysis	3.1	Appreciate the particle size distribution and rheological behavior	**a, b, c, d, e, f**
4.0	To gain exposure about the principles and applications of various electro-analyticaltechniques	4.1	Gain knowledge about various electro-analytical techniques and their application	**a, b, c, d, e, f**
5.0	To have basic idea Principles and applications of various spectroscopic methods	5.1	Appreciate the principles and application of various spectroscopic methods	**a, b, c, d, e, f**

UNIT I - SAMPLING	**(9)**
Sampling procedures, Sampling of bulk materials, techniques of sampling-Solids, liquids and gases. Collection and processing of data.	
UNIT II – CHROMATOGRAPHIC METHODS	**(9)**
Chromatography: Principles, Working and applications of Paper chromatography, TLC, GLC, HPLC.	
UNIT III – PARTICLE SIZE ANALYSIS	**(9)**
Particle size determination, Rheological properties of liquids, Plastics and their analysis	

UNIT IV - ANALYTICAL TECHNIQUES	(9)
Electro-analytical techniques: Principle and applications of Potentiometry, Voltametery, Polorography, Coluometery and electro Gravimetry.	
UNIT V - 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.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Willard H.H., Merrit I., Dean J.A., and Settle F.A, "Instrumental Methods of Analysis ", 7th edition, CBS publishers New Delhi, 2012
2. Ewing Galen W., "Instrument Methods of Chemical Analysis "., 7th edition McGraw Hill company ,New Delhi,1985

REFERENCES:

1. Skoog D.A and West D.M "Fundamental of Analytical Chemistry", 7th edition, Saunders college publishing, New York,1996
2. Banwell.G.C, "Fundamentals of Analytical Chemistry ", Tata McGraw Hill, New Delhi, 2006.

17CHX04 - FOOD TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To familiarize General aspects of food industry and role of Chemical Engineers in Food industry.	1.1	Understand the concept of chemical engineer role in food industry.		**a, b, e, g**
2.0	To learn about composition and nutritional aspects of food	2.1	Gain knowledge about various unit operations involved in food processing.		**a, c, d, e, g**
3.0	To learn about Food deterioration, preservation and packing method.	3.1	Get the exposure on use of different chemical additives in foods during food processing and preservation.		**b, c, e, k**
4.0	To learn about various aspects of bakery, confectionery and chocolate products.	4.1	Gain knowledge about the various food industries like bakery, chocolate and dairy.		**c, d, e, k**
5.0	To learn about food packaging and waste disposal.	5.1	Understand the requirements for food packaging and waste disposal.		**b, d, e, g**

UNIT I – FOOD CONSTITUENTS AND QUALITY STANDARDS	**(9)**
Characteristics of food industry and role of Engineers, Constituents of food- Carbohydrates, Proteins, Fats and Oils and additional food constituents, Nutritive aspects of food constituents, Food additives, Quality factors in foods and Quality standards	
UNIT II - UNIT OPERATION IN FOOD PROCESSING	**(9)**
Material handling; Heat exchanging- Heating, Cooling, Evaporation, Drying; Forming, Milling and sieving, Controlling; Overlapping unit operations; Energy conservation and new processes.	
UNIT III – FOOD PRESERVATION	**(9)**
Preservation by heat and cold; Dehydration, concentration, drying, Irradiation and Microwave heating. Deteriorative factors and their control; Kinetics of chemical reactions in foods.	
UNIT IV - FOOD PRODUCTS	**(9)**
Bakery, confectionary and chocolate products, Soft and alcoholic beverages, Dairy products; Meat, Poultry and fish products, Cereal, grains, pulses, vegetables, fruits, and spices.	

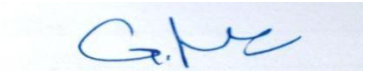
UNIT V - PACKING METHODS AND WASTE DISPOSAL	(9)
Principles of food packaging- Requirements of effective food packaging, Types of containers, Food packaging materials and forms, Labelling and Package testing,. Wastewater disposal and pollution control in food industry.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Fundamentals of Food Engineering by Stanley Charm.
2. Introduction to Food Engineering - R. Paul Singh, Dennis R.

REFERENCES:

1. Heid, J.L. and Joslyn, M.A., Fundamentals of Food Processing Operation, The AVI Publishing Co; Westport, 1967.
2. Heldman, D.R., Food Process Engineering, The AVI Publishing Co; Westport, 1975.
3. Hall, C.W; Farall, A.W. &Rippen, A.L; Encyclopaedia of Food Engineering, Van Nostrand - Reinhold.



17CHX05 – FLUID MOVERS							
				L	T	P	C
				3	0	0	3
PREREQUISITE : 17CHC04			**QUESTION PATTERN: TYPE - 3**				
Course Objectives and outcomes							
Course Objectives		**Course Outcomes**				**Related Program outcomes**	
1.0	To understand the theory, construction and performance of Hydraulic machineries	**1.1**	Able to select and asses the performance of different types of pumps			**a, ,c, d, e**	
2.0	To learn about power transmission and method of pump testing.	**2.1**	Familiarize with drives and power transmission of pumps and testing of pumps			**c, d, e, f**	
3.0	To understand the theory, construction and performance of compressors	**3.1**	Able to select and asses the performance of different types compressors			**a, d, e, f**	
4.0	To understand the types of flow measuring devices and to determine coefficient of discharge.	**4.1**	Familiarize with the types, theory and performance of blowers; Estimate the power requirement and efficiency of blowers			**b, c, d, f**	
5.0	To develop knowledge over theory, construction and performance analysis of fans.	**5.1**	Able to select and analyze the performance of different types of fans			**b, c, d**	

UNIT I : HYDRAULIC MACHINERIES	**(9)**
Centrifugal pump- Theory, design, performance and construction. Displacement pump-Theory, design and construction. Diaphragm pump, screw pump –construction and working, performance, installation and diagnostics. Jet pump- theory and applications.	
UNIT II : POWER TRANSMISSION AND PUMP TESTING	**(9)**
Pump drives and power transmission-pump drives and speed varying devices. Pump sealing- Centrifugal pump packing, mechanical seal and injection type shaft seals .Pump noise measurement- Noise measurement techniques, estimating pump noise level and noise control techniques. Pump testing- Classification of testing, test procedure and measurement.	
UNIT III : COMPRESSORS	**(9)**
Compressor Theory and types- Selection of compressors - Compressed air and air usage. Effect of operating conditions, Thermodynamic compression. Real gas effects. Description and control of surge in centrifugal and axial compressor. Multistage and intercooling Performance analysis of compressor.	
UNIT IV : BLOWERS	**(9)**
Theory and types of Blowers- Selection of blowers- Working Principle of a Centrifugal Blower. Cross flow blowers –Flow pattern and performance. Vortex Blowers – Flow pattern and performance. Velocity Triangle and Parametric Calculations: Work, Efficiency, and Number of Blades and Impeller sizes.	

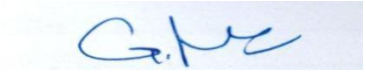
UNIT V : FANS	(9)
Theory and types of Fans -Fan law- Conversion of fan performance, speed and size. Fan selection- Axial and centrifugal. Specific speed. Fan Performance and efficiency. Drives for Fans. Fanless air movers. Ventilation and duct system Performance testing of fan. Case study- VSD application, cooling towers and Humidification plant.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Giampaolo Tony "Compressor Handbook - Principles and Practices" Fairmount Press Incorporation, 2010
2. Igor J. Karassik, Joseph P. Messina, Paul Cooper, Charles C. Healdhe "Pump Handbook", 4th Edition, McGraw-Hill Company, New York, 2008.

REFERENCES:

1. Frank P. Bleier, "Fan Handbook – Selection, Application and Design", 2nd Edition, Mc-Graw Hill Companies Inc., 1997
2. Christie J. Geankoplis, "Transport Processes and Unit Operations", Prentice Hall of India, 1993



17CHX06 – PETROLEUM REFINING ENGINEERING				
L	T	P	C
3	0	0	3

PREREQUISITE : NIL	QUESTION PATTERN: TYPE - 3

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand the origin of petroleum fraction and primary refining methods.	**1.1**	Understand the concept of formation of crude oil and initial reforming process.	**a, b, c, e**
2.0	To learn the cracking process for crude oil.	**2.1**	Understand the cracking process of higher petroleum fractions to lower fractions.	**a, b, c, f**
3.0	To gain knowledge over purification of petroleum products.	**3.1**	Apply knowledge of unit processes for sulphur removal, wax removal and oil/water separation.	**a, b, c, f, g**
4.0	To understand the types of petroleum products from Naphtha.	**4.1**	Learn the petrochemicals derived from naphtha using thermal treatment.	**b, c, e, f**
5.0	To gain knowledge over petrochemicals production methods with process flow diagrams.	**5.1**	Understand the process flow diagrams of the petrochemicals production and its applications.	**a, b, c, d, e, f**

UNIT I : CRUDE PROCESSING	**(9)**
Pretreatment of crude for Refining – Dehydration and desalting, Refining of Petroleum – Atmospheric (ADU) and Vacuum Distillation (VDU).	
UNIT II : CRACKING	**(9)**
Need and significance, types and functions of Secondary Processing. Cracking, Thermal Cracking and Visbreaking. Catalytic Cracking Conditions, Types and Processes- Fixed Bed Cracker, Fluid Catalytic Cracking (FCC).	
UNIT III : PURIFICATION TECHNIQUES	**(9)**
Treatment Techniques: Removal of Sulphur Compounds, Solvent Treatment Processes, De-waxing, Clay Treatment and Hydro-fining.	
UNIT IV : REFORMING	**(9)**
Theory, Reaction Conditions and Catalyst for Catalytic Reforming, Platforming, HoudriForming, Rhein Forming. Naphtha Cracking, Feedstock Selection and Effect of Steam.	

UNIT V :PETROCHEMICALS	(9)
Production of Petrochemicals like Dimethyl Terephathalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate(MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol.	
TOTAL(L:45)= 45 PERIODS	

TEXT BOOKS:

1. BhaskaraRao, B. K., "Modern Petroleum Refining Processes", 2nd Edn., Oxford and IBH Publishing Company, New Delhi, 1990.
2. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edn., McGraw Hill, New York,1985.

REFERENCES:

1. BhaskaraRao, B. K. "A Text on Petrochemicals", 1st Edn.,Khanna Publishers, New Delhi, 1987.
2. H. Steiner, Introduction to petrochemicals Industry', Pergamon, 1961.
3. Wiseman. P., Petrochemicals, UMIST Series in Science and Technology.

7CHX07 - DRUGS AND PHARMACEUTICALS TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the basic concepts of drugs and pharmaceuticals.	**1.1**	Understand the concept of drugs manufacturing and its applications.		**a, b, c**
2.0	To learn the principles of pharmaco-kinetics and its mechanism.	**2.1**	Understand the Drug Metabolism and pharmaco–kinetics principles		**a, b, c, h**
3.0	To gain knowledge over unit processes for product formulation.	**3.1**	Apply knowledge of unit processes and analytical methods to develop new processes and product formulations.		**a, b, c, f, h**
4.0	To understand the stages of quality control and assurance of drugs.	**4.1**	Demonstrate statistical quality control procedure and quality assurance programmes in various stages of pharmaceutical process.		**a, b, c, h**
5.0	To gain knowledge over pharma products applications and analysis.	**5.1**	Analyze the pharma products using modern techniques.		**b, c, h**

UNIT I : INTRODUCTION TO DRUGS AND PHARAMACEUTICALS	**(9)**
Classification of drugs - Development of drugs and pharmaceutical industry; organic therapeutic agents.	
UNIT II : DRUG METABOLISM AND PHARMACO KINETICS OF MICROBIOLOGICAL PRODUCTS	**(9)**
Drug metabolism; physic-chemical principles; pharma kinetics-action of drugs on human bodies, Antibiotics-gram positive, gram negative and broad spectrum antibiotics; hormones.	
UNIT III : UNIT PROCESSES IN DRUGS AND PHARAMACEUTICALS	**(9)**
Chemical conversion processes; alkylation; carboxylation, condensation, cyclisation, dehydration, esterification, halogenations, oxidation, sulfonation, coplex, chemical conversions fermentation.	
UNIT IV : MANUFACTURING PRINCIPLES & PACKING AND QUALITY CONTROL	**(9)**
Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parential solutions, oral liquids; injections; ointments; Packing; packing techniques; quality control.	

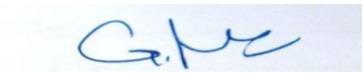
UNIT V :PHARMACEUTICAL PRODUCTS & ANALYSIS	(9)
Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others. Particle size distribution. Analytical methods and tests for various drugs and pharmaceuticals – spectroscopy, HPLC, fluorimetry, polarimetry.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Gaurav agarwal and Atul koushik, Pharmaceutical Technology I, CBS Publishers; 1ST edition (2012)
2. Rawlines, E.A.; " Bentleys Text book of Pharmaceutics ", III Edition, BailliereTindall, London, 1977.

REFERENCES:

1. Yalkonsky, S.H.; Swarbick. J.; " Drug and Pharamaceutical Sciences ", Vol. I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. "Remingtons Pharmaceutical Sciences ", Mack Publishing Co., 1975.



17CHX08 – COMPUTATIONAL FLUID DYNAMICS IN CHEMICAL ENGINEERING					
			L	T	P	C
			3	0	0	3
PREREQUISITE: NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To Understand the governing equations and models for fluid flow and heat transfer problems	**1.1**	Develop models for fluid flow and heat transfer problems		**a, b, c ,d**
2.0	To understand finite volume method for developing solution of steady flows	**2.1**	Apply finite volume method for developing solution of steady state diffusion and convection diffusion problems		**b, c, d, e**
3.0	To demonstrate the application of SIMPLER, SIMPLEC and PISO algorithms for solution of industrial and R & D problems	**3.1**	Apply SIMPLER, SIMPLEC and PISO algorithms for solution of industrial and R & D problems		**b, c, d, e, f**
4.0	To attain the knowledge of algorithms in solving unsteady flow heat conduction and convection diffusion problems	**4.1**	Solve unsteady flow heat conduction and convection diffusion problems		**c, d, e, f**
5.0	To explore the nature and different models for turbulence flow	**5.1**	Comprehend the nature and different models for turbulence flow		**a, c, e, f**

UNIT I : CONSERVATION LAWS OF FLUID MOTION	**(9)**
Introduction to CFD, 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 : FINITE VOLUME METHOD FOR STEADY FLOWS	**(9)**
Finite volume method for one-dimensional, two-dimensional and three-dimensional steady state diffusion, steady one-dimensional convection and diffusion, the central differencing scheme. Properties of discretization schemes, assessment of the central differencing scheme for convection-diffusion problems, the upwind differencing scheme, the hybrid differencing scheme, the power-law scheme and QUICK schemes for convection-diffusion problems.	

UNIT III : 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 TDMA to two-dimensional and three-dimensional problems	
UNIT IV : FINITE VOLUME METHOD FOR UNSTEADY FLOWS	**(9)**
One-dimensional unsteady heat conduction, implicit method for two-and three-dimensional problems, discretization of transient convection-diffusion equation, transient convection-diffusion using QUICK differencing, solution procedures for unsteady flow calculations, steady state calculations using pseudo-transient approach	
UNIT V : TURBULENCE AND ITS MODELS	**(9)**
Transition from laminar to turbulent flow, characteristics of simple turbulent flows, effect of turbulence on properties of the mean flow, turbulent flow calculations, Reynolds-averaged Navier-Stokes equations and classical turbulence models – Mixing Length Model; K-ε Model; Reynolds Stress Equation Model; Algebraic Stress Equation Model.	
	TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:

1. Anderson John D., "Computational Fluid Dynamics-The Basics with Applications", 1st Edition, Tata-McGraw Hill Publisher, 2012
2. Versteeg H.K. and Malalasekara W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd Edition, Pearson Education Ltd., 2007

REFERENCES:

1. Muralidhar K. and Sundarajan T., "Computational Fluid Flow and Heat Transfer", 2nd Edition, Alpha Science International, 2003
2. Fletcher C.A.J., "Computational Techniques for Fluid Dynamics", Volume I & II, Springer Series, Springer-Verlag, Berlin, 2003

17CHX09 - CHEMICAL PROCESS UTILITIES					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To learn the importance of compressed air, Psychrometric and PSA systems	**1.1**	recognize the importance of compressed air, humidification and dehumidification process and PSA systems	a, b, g
2.0	To learn the requirement of water and steam i process industries	**2.1**	Comprehend the water treatment and steam utilization practices in process industries	a, b, l
3.0	To understand the vacuum systems for different chemical processes	**3.1**	Select suitable vacuum systems for different chemical processes	a, f, g
4.0	To study the principles of refrigeration process for application in chemical process industries	**4.1**	Grasp the principles of refrigeration process for application in chemical process industries	a, f, g
5.0	To know the importance of insulation and inert gases& To find the critical thickness of insulation; Gain an insight into the characteristics of	**5.1**	Understand the importance of insulation and calculate critical thickness of insulation; Gain an insight into the characteristics of inert gases.	a, f, g, l

UNIT I : AIR AND 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 : WATER AND 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.	

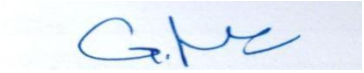
UNIT V : INSULATION AND INERT GAS	(9)
Importance of insulation. Insulation materials for high, intermediate, low and very low temperatures. Calculation of critical thickness of insulation. Properties of inert gases and their uses	
LECTURE(L:45)=45 PERIODS	

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. Eskel Nordell, "Water treatment for industrial and other uses", Reinhold Publishing Corporation, New York, 1961



17CHX10 – SEPARATION AND PURIFICATION PROCESSES					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	Students will gain a basic knowledge about recent separation methods.	1.1	Understand the separation processes for selecting optimal process for new and innovative applications.	**a, b, d, e, g**	
2.0	To gain a knowledge about various membrane separation techniques	2.1	Able to select a suitable membrane separation technique.	**a, c, d, e, g, h**	
3.0	To gain a knowledge about adsorption and chromatography separation technique.	3.1	Understand the adsorption separation process and chromatography methods.	**c, e, f, g, h**	
4.0	To learn about various separation technique available in process industries.	4.1	Can apply the latest concepts like super critical fluid extraction, pervaporation, lyophilisation etc., in Chemical process industries.	**c, d, e, g**	
5.0	To learn about modern separation technique.	5.1	Understand Innovative techniques of controlling and managing oil spills.	**b, c, e, f, h, j**	

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, Nanofiltration, 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, Dielectrophoresis, Electrodialysis, 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	

TEXTBOOKS

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.

17CHX11 – AIR POLLUTION AND CONTROL					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
Course Objectives and outcomes					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To know about air pollution sources and its effect	**1.1**	Know about the various sources of air pollution and its effect		**b, c, f**
2.0	To understand the the chemical and physical properties of gases; Gain knowledge about the design and performance of incinerators	**2.1**	Analyze the chemical and physical properties of gases; Able to design incinerators		**a, b, c, f**
3.0	To explore the fundamentals of particulate matter and to design absorber air pollution control	**3.1**	Asses the fundamentals of particulate matter and design absorber to control air pollution		**a. b, c, f**
4.0	To understand the design of air cleaning equipments and evaluate their performance	**4.1**	Perform the design of air cleaning equipments and evaluate their performance		**b, c, f**
5.0	To know about air pollution regulation and different laws related to air pollution and control	**5.1**	Remember the air pollution regulation and different laws related to air pollution and control		**a, b, c, e, f**

UNIT I : AIR POLLUTION	**(9)**
Air Pollution-Sources and Effects Definitions, Scope, Air Pollutants – Classifications – Natural and Artificial – Primary and Secondary, Sources of air pollution- stationary and mobile sources. Effects of Air pollutants on humans, materials and vegetation. Global effects of air pollution – Green House effect, Heat Islands, Acid Rains, Ozone Holes etc.	
UNIT II : FUNDAMENTALS OF GASES AND INCINERATORS	**(9)**
Measurement fundamentals – Chemicals and Physical properties – Phase equilibrium- Conservation laws, Incinerators- Design and performance – Operation and maintenance	
UNIT III : ABSORBER DESIGN AND BASICS OF PARTICULATE MATTERS	**(9)**
Absorbers – Design operation and improving performances of absorbers, Particle collection mechanisms– Fluid particle dynamics – Particle size distribution – Collection efficiency	
UNIT IV : AIR POLLUTION CONTROL EQUIPMENTS	**(9)**
Gravity settling chambers, Electrostatic precipitators, Bag houses – Design and Performance equations- Operation and maintenance	

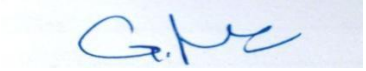
UNIT I : AIR POLLUTION REGULATIONS	(9)
Air pollution Regulatory framework - History – Regulator system – Laws and Regulations – Clean air act – Provisions for recent developments	
	TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:

1. M.N Rao and H.V.N Rao, Air Pollution, , 2007, Tata McGraw- Hill Publishing Company Limited, New Delhi.
2. R.K Trivedy and P.K Goel, An Introduction to Air Pollution, 2009, BS Publications, Hyderabad

REFERENCES:

1. Noel de Nevers, "Air Pollution Control Engineering", 2nd Edition, Waveland Pr Inc., 2010
2. Rao M.N. and Rao H.V.N., "Air Pollution", 1st Edition, McGraw Hill Education India Pvt. Ltd., 2001



17CHX12 – EMPLOYABILITY SKILLS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
Course Objectives and outcomes					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To develop verbal, non verbal, written and communication skills	**1.1**	Apply verbal, non verbal, written and communicationskills during employment		**d, e, h, i**
2.0	To understand the importance of team work and collaboration skills and develop decision making ability	**2.1**	Perform in a team with collaboration and ability to make decision in work place		**d, e, h, i**
3.0	To improve their level of critical thinking to solve problems in chemical industries	**3.1**	React under critical situation and able to solve problem arising out of it in chemical industries		**d, e, h, i**
4.0	To develop the leadership and assertiveness skills	**4.1**	Apply the leadership and assertiveness skills in work place		**d, e, h, i**
5.0	To uplift the computer literacy with emphasis on solving problems through chemical engineering software/simulation	**5.1**	Apply computer literacy in solving problems through chemical engineering software/simulation		**b, c, d, e, h, i**

UNIT I : COMMUNICATION SKILLS	**(9)**
Verbal Communication: oral, telephone TV/internet, self-introduction, delivering talks in seminars, non-verbal communications: body language, gestures. Written communication: Ability to prepare CV, write formal business letters. Writing technical articles for journals and magazines. Ability to describe technical problems and situations occurring in chemical industries. Presentation Skills: Power point presentation and interaction with audience. Listening skills: listening to technical lectures and conversations and ability to comprehend. News documentary new product development	
UNIT II : INTERPERSONAL SKILLS	**(9)**
Negotiation: stages of negotiation, formal and informal negotiation, interests/positions in negotiation. Attributes of successful negotiation. Team work and collaboration skills: Definition of team, Roles of team members, Elements of successful team work, group exercises. Discipline and communication in teams. Building Rapport, Rapport behavior. Tact and diplomacy: Strategies for Tact and diplomacy Decision making: definition, stages of decision making, strategies for making sound decision. Time management: Importance, principles and Prioritization of jobs-Exercises	

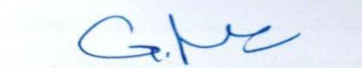
UNIT III : CRITICAL THINKING AND PROBLEM SOLVING	(9)
Principles of Critical examination, brain storming Delphi's method. Stages and methods of solving problem, problem solving tools, divergent, lateral and strategies thinking examples from process industries. Stress: causes stress and awarding	
UNIT IV : LEADERSHIP SKILLS	**(9)**
Definition of leader/leadership, styles of leadership, steps in developing leadership. Delegation organization, emotional intelligence, charisma. Assertiveness skills: types of human behavior self-esteem, self-confidence. Techniques of assertiveness, dealing with non-assertiveness, criticisms. Complaining effectively	
UNIT V : I.T. SKILLS	**(9)**
Computer literacy: ability to use desktop, PC, laptop and tablet. Intelligent mobile phone and android applications. Word processing and spread sheet applications in chemical engineering. Elementary awareness about C, C++ and chemical engineering software like Aspen, HYSIS, MAT lab and HTRI	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Hariharan S.I., Sundarajan N. and Shanmugapriya S.P., "Soft Skills", Mjp Publishers, 2011.
2. RaoM.S.,"Soft Skills - Enhancing Employability: Connecting Campus with Corporate", 2011

REFERENCES:

1. Barun K. Mitra, "Personality Development and Soft Skills", 2011.
2. David W.G. Hind and Stuart Moss, "Employability Skills", Business Education Publishers 2005



17CHX13 – POLYMER TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
Course Objectives and outcomes					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To Understand the principles and classify polymerization processes	**1.1**	Understand the principles and classify polymerization processes		**a, b, c, d, f**
2.0	To understand the the structure and properties of polymers	**2.1**	Explain the structure and properties of polymers		**a, b, d, f**
3.0	To explore the principles and methods of moulding plastics	**3.1**	Assess the principles and methods of moulding plastics		**a, b, d, f**
4.0	To understand the characterization techniques for polymers using microscopic and spectroscopic instruments	**4.1**	Comprehend the characterization techniques for polymers using microscopic and spectroscopic instruments		**a, b, c, d**
5.0	To know the properties and manufacturing processes of polymers	**5.1**	Describe the properties and manufacturing processes of polymers		**a, b, c, d, f**

UNIT I : INTRODUCTION TO POLYMERIZATION	**(9)**
Monomer; functionality and degree of polymerizations; polymers and their classification; Types of polymerization and mechanisms: addition; condensation and copolymerization, bulk, solution, emulsion and suspension polymerizations	
UNIT II : STRUCTURE AND PROPERTIES OF POLYMERS	**(9)**
Structure of polymers: linear, branched and cross linked; Characterization of polymers: molecular weight, crystallinity, glass transition and mechanical properties Ultrasonic waves; Photo degradation, High energy radiation, Oxidative and hydrolytic	
UNIT III : PLASTICS AND METHODS	**(9)**
Introduction to plastics: Anti-oxidants and stabilizers, polymer additives; fillers, plasticizers; colorants. Moulding methods: Injection; compression transfer and Blow moulding, Processing techniques: Calendaring; casting; extrusion; thermoforming; foaming	
UNIT IV : CHARACTERIZATION TECHNIQUES	**(9)**
Chemical analysis of polymer; X-ray diffraction, Microscopic technique: Light scattering, SEM; Spectroscopic methods: IR, NMR. Thermal analysis: DSC, DTA and TGA.	

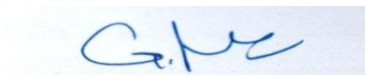
UNIT V :INDUSTRIAL POLYMERS	(9)
Polyethylene; HDPE, LDPE; Polymethylmethacrylate and Polycarbonates, ABS Plastics, Epoxy resins; Rubbers: Natural rubber, Synthetic rubber: Chloroprene rubber and SBR.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Gowarikar V.R., Viswanathan N.V., and JayadevSreedhar, "Polymer Science", 9th Reprint, New Age International Pvt. Ltd., India, 1996.
2. Rodriguez. F., Cohen, C., Ober, C, Archer, L.A., "Principles of Polymer Systems", 5th Edition, Taylor and Francis, Great Britain, London, 2003

REFERENCES:

1. Williams D.J., "Polymer Science and Engineering", Prentice Hall, New York, 1971.
2. Arora M.G. and Singh M., "Polymer Chemistry", Anmol Publications Pvt. Limited, 2003



17CHX14 – PILOT PLANT AND SCALE UP METHODS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
Course Objectives and outcomes					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the the principles of pilot plants, models, similarity and scale up methods	**1.1**	Comprehend the principles of pilot plants, models, similarity and scale up methods		**a, b, c, d, f**
2.0	To appraise the problems in scale-up of mixing and heat transfer equipment	**2.1**	Solve the problems in scale-up of mixing and heat transfer equipment		**a, b, c, d, f**
3.0	To explore the scale-up of methods for columns and dryers	**3.1**	Able to scale-up of columns and dryers		**a, b, c, d, e**
4.0	To explore the scale-up of methods for dryers different types of reactors	**4.1**	Able to scale-up of different types of reactors		**a, b, c, d, e**
5.0	To understand scale-up of ball mills, furnaces, screw extruders, etc	**5.1**	Examine the scale-up of ball mills, furnaces, screw extruders, etc		**a, b, c, d, f**

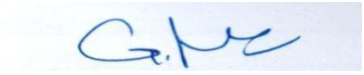
UNIT I : SCALE UP METHODS AND DIMENSIONAL ANALYSIS	**(9)**
Principles of Similarity, Pilot Plants and Models, Introduction to Scale-up Methods, Dimensional Analysis, Regime Concept, Similarity Criterion and Scale up Methods used in Chemical Engineering	
UNIT II : MIXING PROCESSES	**(9)**
Scale-up relationships, Scale-up of polymerization units, Continuous stages gas-liquid slurry processes, Liquid-liquid emulsions.	
UNIT III : HEAT AND MASS TRANSFER EQUIPMENT	**(9)**
Typical Problems in Scale-up of Mixing Equipment and Heat Transfer Equipment Distillation Column and Packed Towers: Scale-up of Distillation Columns and Packed Towers for Continuous and Batch Processes and Dryers	
UNIT IV : REACTORS	**(9)**
Scale-up Techniques available for Tubular Reactor, CSTR and Catalytic Reactors	
UNIT V : MISCELLANEOUS EQUIPMENT	**(9)**
Pressure Jet Nozzle and Centrifugal Disk Atomizers and Screw Extruders, Furnaces and Kilns, Analogue Models, Limitations of Scale up Techniques	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Marko Zlokarnik, “Scale-up in Chemical Engineering.", Wiley-VCH, Germany, 2002
2. Johnstone R.E. and Thring M.W., “Pilot Plants Models and Scale-up methods in Chemical Engineering”, McGraw Hill, New York, 1962.

REFERENCES:

1. Lee James M., “Biochemical Engineering”, Prentice Hall, 1992 Donald G. Jordan, "Chemical Process Development", Part-1 and 2, Intersciences Publishers, 1988
2. Marko Zlokarnik, “Dimensional Analysis and Scale-up in Chemical Engineering", Springer - Verlag, Berlin, Germany, 1986



17CHX15 – POWER PLANT MANAGEMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To learn principles of power plant operations and boilers	1.1	Gain the knowledge about principles of power plant and boilers	**a, b, c, d**	
2.0	To understand the principles, working and applications of various power plant components.	2.1	Grasp the principles, working and applications of various power plant components.	**a, b, c, d**	
3.0	To gain knowledge on nuclear and hydel power plants	3.1	Familiarize with the nuclear and hydel power plants	**a, b, c, d, e, f**	
4.0	To gain exposure the principles of selection operation and design features of diesel and gas turbine power systems	4.1	perceive the principles of selection operation and design features of diesel and gas turbine power systems	**a, b, d, e, f**	
5.0	To gain an insight into the importance of energy and economic viability of alternate energy sources	5.1	Comprehend economic viability of various alternate energy sources.	**a, b, d, e, f**	

UNIT I - INTRODUCTION TO POWER PLANTS AND BOILERS	**(9)**
Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine Combined Power cycles , Co Generation Systems , Load duration Curves Steam boilers and cycles – High pressure Super Critical and – Fluidized Bed Boilers	
UNIT II – STEAM POWER PLANT COMPONENTS	**(9)**
Fuel preparation and ash handling ,Combustion Equipment for coal oil and gas, Draught- Different Types, Pollution Control Equipment , Surface Condenser types, Cooling Towers	
UNIT III – NUCLEAR AND HYDEL POWER PLANTS	**(9)**
Nuclear Energy-Fission, Fusion Reaction, Types of Reactors, Waste disposal and Safety. Hydel Power plant-Essential elements, Selection of turbines, governing of Turbines- Micro hydel plants	

UNIT IV - DIESEL AND GAS TURBINE POWER PLANT	(9)
Types of Diesel plants, components , Selection of Engine type, applications-Gas turbine power plant- Fuels, open and closed Cycles- Reheating, Regeneration and inter cooling . Combined cycle plants.	
UNIT V - ALTERNATE ENERGY SOURCES AND ECONOMICS	**(9)**
Solar Geo thermal- OTEC- Tidel, Wind, Pumped storage systems, Cost of Electric Energy- Fixed and operating costs - Types tariffs- Economics of load sharing, Energy Conservation opportunities in power plants.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Rajput R.K., Power Plant Engineering, 4th Edition, Laxmi Publications, New Delhi, 2007.
2. Nag P.K ,‖Power Plant Engineering‖, 3rd Edition, Tata McGraw-Hill Company, New Delhi, 2007.

REFERENCES:

1. Ramalingam K.K., ―Power Plant Engineering‖, Scitech Publications, 2002.
2. Rai G.D., ―Introduction to Power Plant Technology‖, Khanna Publishers, 1995.

17CHX16 – PULP AND PAPER TECHNOLOGY					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

Course Objectives and outcomes

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To Understand the various methods of wood preparation and pulping	**1.1**	Recognize various methods of wood preparation and pulping	**a, b, c, f**
2.0	To describe the knowledge of processing and bleaching of pulp in paper making process	**2.1**	Apply the knowledge of processing and bleaching of pulp in paper making process	**b, c, f**
3.0	To analyze the finishing and surface treatment of various grades of paper	**3.1**	Comprehend the finishing and surface treatment of various grades of paper	**a, b, c, f**
4.0	To explore knowledge on various methods for testing of pulp and paper	**4.1**	Exhibit familiarity with various methods for testing of pulp and paper	**b, c, f**
5.0	To understand the type of pollution and apply appropriate techniques to control pollution	**5.1**	Identify the type of pollution and apply appropriate techniques to control pollution	**a, b, c, e, f**

UNIT I : WOOD PREPARATION AND PULPING METHODOLOGY	**(9)**
Pulp and Paper: Importance and definitions- Characteristics of wood - Wood as resource- Wood harvesting, handling and storage- Chemistry and Process description of Mechanical pulping, Sulfite pulping and Kraft pulping.	
UNIT II : PROCESSING AND BLEACHING OF PULP	**(9)**
Processing of pulp- Cooking, Defibering, Deknotting ,Washing, Screening and Thickening- Bleaching- Oxygen bleaching, Chlorine-dioxide bleaching, Hydrosulfite bleaching, Peroxide bleaching, Ozone bleaching – Stock preparation for paper making	
UNIT III : PAPER MANUFACTURE OPERATIONS	**(9)**
Secondary fiber processing- Paper manufacture operations- Wet and dry end operations- Surface treatments and finishing operations -Specific paper and board grades.	
UNIT IV : PROPERTIES AND TESTING OF PULP AND PAPER	**(9)**
Properties of pulp and paper-Testing of pulp and paper : Objectives and procedures–Introduction to paper end uses- Process control- Quality assurance.	

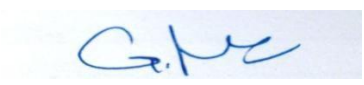
UNIT V : POLLUTION ABATEMENT	(9)
Water pollution control: Source, Standards and regulations, Monitoring and testing, Process- Air pollution control: Source, Standards and regulations, Monitoring and testing, Process.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

1. Smook G.A., "Handbook for Pulp & Paper Technologists", 3rd Edition, Angus Wilde Publications, Incorporation, 2003
2. Kenneth W. Brittt, "Handbook of Pulp and Paper Technology", 2nd Revised Edition, John Wiley & Sons, 1971.

REFERENCES:

1. Austin, G.T., "Shreve's Chemical Process Industries", 5th Edition, McGraw-Hill International Book Company, Singapore, 1984
2. Kent J.A., "Riggel's Hand Book of Industrial Chemistry", Van Nostrant Reinhold, 1974



17CHX17 – HETEROGENOUS CATALYTIC REACTIONS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the reactor performance based on RTD studies.	**1.1**	Understand the concept of different models in the reactor design to determine the performance based on RTD.		**a, b, c, d**
2.0	To learn the reaction steps of homogeneous catalytic reactions and non catalyticfluid – solid reactions.	**2.1**	Understand the kinetic studies on homogeneous catalytic reactions with different models.		**a, b, c, d**
3.0	To understand the concepts of diffusion mechanism over catalyst in the reactor.	**3.1**	Apply knowledge of diffusion effects during heterogeneous reactions and its effect in packed beds.		**a, b, c, d, e**
4.0	To understand the diffusion and reaction kinetics based on type of catalyst and its effectiveness.	**4.1**	Apply the concepts of diffusion mechanism in catalyst and determine the reaction limiting regimes.		**a, b, c, d, f**
5.0	To gain knowledge of design reactors and its application.	**5.1**	Apply the knowledge for design of heterogeneous reactors.		**a, b, c, d, e, f**

UNIT I : NON-IDEAL REACTORS	**(9)**
Tanks in series model, Dispersion model, The Residence Time Distribution as a factor of performance, residence time functions and relationship between them in reactor, basic models for non-ideal flow, conversion in non-ideal reactors.	
UNIT II : KINETIC STUDIES OF HETEROGENEOUS REACTIONS	**(9)**
Steps in catalytic reactions, rate limiting steps, Langmuir-Hinshelwood model, Rideal-Eiley mechanism, steady state approximation, Model Descrimination, noncatalytic fluid-solid reactions, shrinking and unreacted core model.	
UNIT III : EXTERNAL DIFFUSION EFFECTS ON HETEROGENEOUS REACTIONS	**(9)**
Diffusion Fundamentals, Binary Diffusion, External-Resistance to Mass transfer, Mass and heat transfer coefficients in packed beds.	

UNIT IV : DIFFUSION AND REACTIONS IN CATALYSTS	(9)
Diffusion and Reaction kinetics in spherical catalyst pellets, Internal and overall effectiveness factor, Estimation of diffusion and reaction-controlling regimes.	
UNIT V :ANALYSIS AND DESIGN OF HETEROGENEOUS REACTORS	**(9)**
Isothermal and adiabatic fixed bed reactors, non-isothermal and non-adiabatic fixed bed Reactors, Multiphase Reactors: Two-phase fluidized bed model, slurry reactor model, trickle bed reactor model. Industrial applications	
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. J.M. Smith, Chemical Engineering Kinetics, 2nd Ed., McGraw-Hill, 1981.

REFERENCES:

1. Gilbert F Froment, Kenneth B Bischoff and Juray D Wilde "Chemical Reactor Analysis and Design", Wiley, New York (2010).
2. Carberry, J. J., “Chemical and Catalytic Reaction Engineering”, Dover Publications, 2001.

17CHX18 - PROCESS OPTIMIZATION					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program outcomes
1.0	Students will gain knowledge about process modeling and optimization	1.1	Able to design experiments and formulate models of chemical processes/equipment.	**a, b, e, g**
2.0	To learn about basic concepts of process optimization	2.1	Able to understand and formulate various optimization methods.	**a, c, d, g, l**
3.0	To learn about single variable optimization problem	3.1	Able to understand and formulate single variable problem.	**c, d, g, l**
4.0	To learn about multi variable optimization technique.	4.1	Able to understand and formulate multi variable problem	**c, d, g, h, j**
5.0	To gain a basic knowledge about the applications of process optimization problem	5.1	Understand optimization of process variables to get maximum yield/conversion, product mix pattern product distribution etc	**c, d, e, f, h, j**

UNIT I OBJECTIVE AND FORMULATION OF OPTIMIZATION	**(9)**
Objective and Introduction, Objective Function and Decision variables, Inequality and Equality Constrains in Models Formulation of the Objective Function, Lower and Upper Bounds, Selecting Functions to Fit Empirical Data, Factorial Experimental Designs, Degrees of Freedom, Economic Objective Functions, Measures of Profitability	
UNIT II BASIC CONCEPTS OF OPTIMIZATION	**(9)**
Necessary and sufficient conditions for optimum; region elimination methods; interpolation methods; direct root methods.	
UNIT III OPTIMIZATION OF UNCONSTRAINED FUNCTIONS	**(9)**
One-Dimensional Search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods of Unidimensional Search.	
UNIT IV UNCONSTRAINED MULTIVARIABLE OPTIMIZATION	**(9)**
Linear Programming (LP) and Applications Geometry of Linear Programs, Basic Linear Programming Definitions and Results, Simplex Algorithm, Barrier Methods, Sensitivity Analysis, Linear Mixed Integer Programs. Introduction to Non linear Programming with Constraints and Mixed-Integer Programming.	

UNIT V APPLICATION OF OPTIMIZATION IN CHEMICAL ENGINEERING	(9)
Examples of Optimization in Chemical Processes like optimizing recovery of waste heat, Optimal Shell and Tube Heat Exchanger Design, Optimal Design and Operation of binary Distillation Column, Optimal pipe diameter etc. Flow sheet Optimization - Case studies.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Seider W.D., Seader J.D. and Lewin D.R., "Product and Process Design Principles-Synthesis, Analysis, and Evaluation", 2nd Edition, 2008, John Wiley and Sons Inc
2. Edger T.F., Himmelblau D.M. and Lasdon L.S., "Optimization of Chemical Processes", 2nd Edition, 2001, McGraw- Hill.

REFERENCES:

1. Kalyan Moy Deb "Optimization for Engineering Design", 2nd Edition, 2009, Prentice Hall of India.
2. Gupta P.K, Hira D.S, Problems in Operations Research – First Edition 1991, S.Chand& Company Ltd. New Delhi.

17GEA03 – TOTAL QUALITY MANAGEMENT (Common to all Engineering and Technology branches)				
L	**T**	**P**	**C**
3	**0**	**0**	**3**

PREREQUISITE : NIL	**QUESTION PATTERN: TYPE 3**

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		**Course Outcomes**		**Related Program outcomes**
1.0	To Understand the meaning of quality and its importance	**1.1**	Understand the meaning of quality and its importance	**d, e, g, h, j**
2.0	To Know the principles of total quality management and peculiarities of their implementation	**2.1**	Implement the principles of total quality management and address the peculiarities in it.	**d, e, g, h, j**
3.0	To Develop in-depth knowledge on various tools and techniques of quality management	**3.1**	Assess various tools and techniques of quality management	**d, e, g, h, j**
4.0	To Learn the applications of quality tools and techniques in both manufacturing and service industry	**4.1**	Apply quality tools and techniques in both manufacturing and service industry	**d, e, g, h, j**
5.0	To Develop analytical skills for investigating and analyzing quality management issues in the industry	**5.1**	Analyze quality management issues in the industry and suggest solutions to those issues	**d, e, g, h, j**

UNIT I : QUALITY PRINCIPLES AND CONCEPTS	**(9)**
Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs, Basic concepts of Total Quality Management, Historical Review. Principles of TQM, Leadership – Concepts, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation	
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, Benefits. Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development	
UNIT III : TQM PROCESS CONTROL TOOLS	**(9)**
The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools	
UNIT IV : TQM TOOLS	**(9)**
Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA, Poka Yoke	

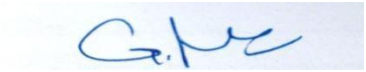
UNIT V :QUALITY SYSTEMS	(9)
Need for ISO 9000 and Other Quality Systems, ISO 9000:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, Introduction to TS 16949, QS 9000, ISO 14000, ISO 18000, ISO 20000, ISO 22000.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Besterfield, Dale H. et al., "Total Quality Management", 3rd Edition (Revised), Pearson Education, 2011.
2. Subburaj Ramasamy, "Total Quality Management", Tata McGraw Hill, New Delhi, 2008

REFERENCES:

1. Suganthi L. and Samuel A. Anand, "Total Quality Management", PHI Learning, New Delhi, 2011
2. Feigenbaum A.V., "Total Quality Management", 4th Edition, Tata McGraw Hill, New Delhi, 2004



17CHX20 - MULTICOMPONENT DISTILLATION					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To learn about VLE calculations like determination bubble point and dew point for multicomponent systems using K-values and relative volatility	1.1	Able to determine bubble point and dew point for multicomponent mixtures using K-values and relative volatility.		**a, b, c, d, g**
2.0	To learn about different shortcut procedures to calculate the equilibrium stages for given separation.	2.1	Able to determine minimum reflux ratio, minimum no. of stages, feed tray location, and distribution of key components using various shortcut methods.		**a, c, d, e, g**
3.0	To learn about various rigorous calculations methods like Lewis Matheson method, Thiele –Geddes method, BP method, Tridiagonal Matrix method.	3.1	Able to determine the number of stages in multi-stage multicomponent towers by various rigorous calculation methods.		**b, c, e, f, h, j**
4.0	To learn about multicomponent flash vaporization, steam distillation and differential distillation. Basic concepts and details of azeotropic distillation and extractive distillation.	4.1	Able to make calculations of multicomponent single stage operations like flash vaporization, differential distillation and steam distillation.		**b, c, d, e, g, l**
5.0	To learn about concepts for tray design and tray column sizing. Different packing types, packing hydraulics. Calculations for packing efficiency, concept of HTU and HETP concepts.	5.1	Able to carry out the design of azeotropic distillation and extractive distillation systems. Design a tray and packed columns accounting efficiency terms.		**b, c, d, e, f, g, j**

UNIT-I: INTRODUCTION TO DISTILLATION	**(8)**
Vapor liquid equilibrium (VLE) – 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-Azeotropes- Key fractionation concepts – Approximate material balance.	
UNIT-II:SHORT CUT METHODS FOR STAGE AND REFLUX REQUIREMENTS	**(8)**
Pseudobinary systems-Hengstebeck method; Emperical Methods: Various methods for calculation of minimum reflux ratio- Fenske equation for minimum number of stages- FUG method-Erbar and Maddox method-Krkbride equation for feed plate location-Distribution of non-key components: Hengstebeck and Geddes method.	

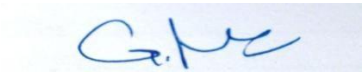
UNIT-III: RIGOROUS DISTILLATION CALCULATIONS	(10)
Basic concepts –Rigorous computational methods- Lewis- Matheson method and its variations-Thiele- Geddes method and its variations- B. P. method – Tridiagonal matrix method- Computations using computer programming.	
UNIT-IV: MULTICOMPONENT SINGLE STAGE OPERATIONS	**(10)**
Flash vaporization- Raleigh distillation and steam distillation. Azeotropic and extraction distillation: Concepts- Configurations and case studies.	
UNIT-V: COLUMN DESIGN AND OPERATIONS	**(9)**
The common tray types-Tray capacity limits-Tray hydraulic parameters- Flow regimes on trays. Tray column sizing & tray efficiency: Tray design and tray efficiency fundamentals- Predictions of tray efficiency. Packing types- Classifications-Packing objectives- Packing hydraulics- Comparing tray and packing-Sizing of packed column. Packing efficiency & predictions: The transfer unit concept-The HETP concept – Factors affecting HETP – HETP Predictions- Mass transfer models – Rules of thumb – Data interpolation.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Seader, J.D, and Henley E.J., "Separation Process Principles", John Wiley & Sons, Inc.
2. King, C.J., "Separation Processes", McGraw-Hill, Inc.
3. Holland, "Multicomponent Distillation", Prentice-Hall, Inc.
4. Smith, B.D., "Design of Equilibrium Stage Processes", McGraw-Hill BookCo. Inc.
5. Hengstebeck, R.J., "Distillation: Principals and Design Procedures", Reinhold Book Co.
6. Coulson, J.M. and Richardson, J.F., "Chemical Engineering", Volume 6, Pargamon Press

REFERENCES:

1. Distillation Principles and Processes, Sydney Young, White Mule Press, 2011.
2. Distillation Tray Fundamentals, M. J. Lockett, Cambridge University Press, 2009.
3. Fundamentals of Multicomponent Distillation, C. D. Holland, McGraw-Hill, 1997.
4. Distillation Design in Practice, L. M. Rose, Elsevier, 1985.
5. Elements of Fractional Distillation, C.S. Robinson, E. R. Gilliland, 4th Edition, 1950.



17CHX21 - CHEMICAL PROCESS EQUIPMENT AND AUXILLARIES					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To learn the basic knowledge of particulate solids handling methods	1.1	Understand the knowledge of characteristics, handling and storage of particulate solids		**a, c, f, g, i**
2.0	To learn about the equipments used in petroleum industry	2.1	Understand the working and selection of machinery equipments		**c, d, i, k**
3.0	to learn about the different types valves and its application	3.1	Understand the selection and importance of valves used in petroleum industry		**b, c, d, e, k**
4.0	To learn about the various types of dryer used in petroleum process	4.1	Understand the selection of usage of dryer with case studies		**b, c, d, i, k**
5.0	To learn about the importance of various types petroleum processing equipments	5.1	Understand the knowledge of various utility equipments		**c, d, e, l, k,**

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 - ROTARY EQUIPMENT	**(9)**
Pumps –Turbines – Blowers – Compressors – Fans – Concept – Working and application.	
UNIT III - INDUSTRIAL VALVES	**(9)**
Needle valves – Globe, gate and ball valves – Butterfly valves – Check and needle valves – Piping system.	
UNIT IV - INDUSTRIAL DRYERS	**(9)**
Rotary fluid bed – Spray and freeze dryers – Electro osmotic dryers – Rotary dryer – Case Studies.	

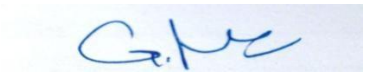
UNIT V - PROCESS UTILITY EQUIPMENTS	(9)
Vacuum devices – Filters – Cooling towers – Refrigeration systems – Flare system – Equipment for waste water treatment systems.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

1. Thomas, C.E., "Process Technology – Equipment and systems", Uhai Publishing, Inc., 2002.
2. Walas, S.M., "Chemical Process Equipment", Butterworth – Heinemann Oxford Publishing Ltd., 1999.

REFERENCES:

1. Sahu, G.K., "Hand Book of Piping Design", New Age International Publishers, 2005
2. Ludwig, E.E., "Applied Process Design for Chemical and Petrochemical Plants", Vol. I and III, Gulf Professional Publishing, 2002.
3. Perry, R.H. and Green, D.W., "Perry's Chemical Engineer's Hand Book", 7th Edition, McGraw Hill – International, 1997.



17CHX22 - DRILLING AND WELL ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the basic knowledge of drilling and migration of fluids	1.1	Understand the basic concept of drilling and fluid behavior	**a, b, c, d**	
2.0	To understand the drilling methods and equipments used	2.1	Understand the selection of drilling methods and design of equipments used	**c, d, e, g**	
3.0	To learn about the drill bits types and its selection.	3.1	Understand and analyze the importance of selecting drill bits the drilling fluid	**b, c, d, e, f**	
4.0	To learn about the types methods of wells and cementing	4.1	Analyze the well types and importance of casing and cementing	**c, f, g, k**	
5.0	To understand the safe drilling operation and environmental effects	5.1	Understand the safety to be followed at the well site and environment impact.	**b, e, f, k**	

UNIT I -DRILLING GEOLOGY, OIL AND GAS MIGRATION	**(9)**
Rock Strengths and Stresses, Hydrostatic Pressure Forced by a Fluid. Rock Properties, Primary Migration, Reservoir Rock, Seal Rock and Secondary Migration. Reservoir Drives, Problems Related Fluids in the Reservoir.	
UNIT II -PLANNING AND DRILLING OF WELL	**(9)**
Well Proposal, Gathering Data, Designing the Well, Drilling the Well and Testing the Well. Planning of Well, Hole and Casing Sizes and Drilling the Well. Selecting a suitable Drilling Rig, Classification of Drilling Rig, Rig Systems and Equipments.	
UNIT III -DRILL BITS AND DRILLING FLUIDS	**(9)**
Roller Cone Bits, Fixed Cutter Bits and Cone Bits. Optimizing Drilling Parameters- Grading the Dull Bit and Bit Selection. Functions of Drilling Fluid, Basic Mud Classification Designing the Drilling Fluid.	
UNIT IV -DIRECTIONAL DRILLING, CASING, CEMENTING AND EVALUATION	**(9)**
Controlling the Well Path of a Deviated Well, Horizontal Wells and Multi Lateral Well. Importance of Casing in a Well, Designing the Casing String, Role of the Cement Outside the Casing, Mud Removal, Cement Design, Running and Cement Casing and other Cement Jobs. Evaluation Techniques, Physical Sampling at Surface and Down hole, Electrical Logging and Production testing.	

UNIT V - MANAGING DRILLING OPERATIONS, SAFETY AND ENVIRONMENTALISSUES	(9)
Personnel involved in Drilling Operation, Decision Making at the Well site and in the Office, Estimating the Well Cost. Safety Meetings, New Comers on the Rig, Training and Certification, Permit to Work Systems, Safety Alerts, Safety Equipments, Minimizing Spills and Environmental Impact Studies.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

1. Rabia.H. 'Oil Well Drilling Engineering, Principles And Practices' Graham And Trotman Ltd. 1985.
2. D.P Helander 'Fundamentals Of Formation Evaluation'

REFERENCES:

1. Standard Handbook of Petroluem and Natural Gas Engineering, 2nd Edition, William CLyons, Gary C Pilisga, Gulf Professional Publishing
2. Devereux, S., "Drilling Technology", PennWell Publishing Company, 1999.
3. Devereux, S., "Practical Well Planning and Drilling", PennWell Corporation, 1998.
4. Azar, J.J. and G. Rabello Samuel, "Drilling Engineering", PennWell Corporation, 1937.

17GEA04 – ENGINEERING ETHICS AND HUMAN VALUES
(Common to all Engineering and Technology branches)

L	T	P	C
3	0	0	3

PREREQUISITE : NIL	**QUESTION PATTERN: TYPE 3**

Course Objectives and outcomes

	Course Objectives		Course Outcomes	Related Program outcomes
1.0	To understand the components of ethics and human values	**1.1**	Aware of components of ethics and human values	**c, d, e, g**
2.0	To understand the knowledge interpersonal and organizational issues in ethics	**2.1**	Handle the knowledge interpersonal and organizational issues in ethics.	**c, d, e, g**
3.0	To develop knowledge on safety and risk analysis	**3.1**	Acquire knowledge on safety and perform risk analysis	**c, d, e, g**
4.0	To understand the responsibilities and rights in risky situation	**4.1**	Highlight the responsibilities and rights in risky situation	**c, d, e, g**
5.0	To understand the role of professional bodies and global issues	**5.1**	Identify the role of professional bodies and address global issues	**c, d, e, g**

UNIT I : HUMAN VALUES	**(9)**
Understanding: Morals – Values-Ethics–Honesty – Integrity – Work Ethic – Service Learning – Civic Virtue – caring – Sharing – Courage – Valuing Time – Co-operation – Commitment – Empathy –Self-Confidence – Character – Spirituality	
UNIT II : ENGINEERING ETHICS	**(9)**
Moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – consensus and controversy – Models of Professional Roles – theories about right action – Self-interest – customs and religion- uses of ethical theories. Meaning of Engineering experimentation - engineers as responsible experimentes	
UNIT III : SAFETY AND RISK ANALYSIS	**(9)**
Codes of ethics for engineers - a balanced outlook on law - the challenger case study. Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk, Bhobal Gas Tragedy and Chernobyl case studies	

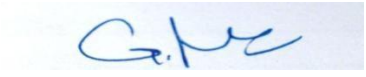
UNIT IV : RESPONSIBILITIES AND RIGHTS	(9)
Collegiality and loyalty – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – discrimination – Intellectual Property Rights (IPR) – Multinational corporations – Environmental ethics	
UNIT V : GLOBAL ISSUES	**(9)**
Computer ethics – weapons development-engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers(IETE).	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Martin Mike and Schinzinger Roland, "Ethics in Engineering", 4thEdtion, Tata McGraw-Hill, New Delhi, 2014.
2. Govindarajan M., Natarajan S., and Senthil Kumar V.S., "Engineering Ethics", Prentice Hall of India, New Delhi, Reprint 2013

REFERENCES:

1. Fleddermann Charles D., "Engineering Ethics", 4th Edition, Pearson Education/Prentice Hall, New Jersey, 2014
2. Harris Charles E., Protchard Michael S. and Rabins Michael J., "Engineering Ethics: Concepts and Cases", 4th Edition Wadsworth Thompson Learning, United States, 2008



17CHX24 - DESIGN OF HEAT EXCHANGERS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	fundamental knowledge of different type of heat exchangers used	1.1	Demonstrate a basic understanding of several types of heat exchangers	**a, d, e, g**	
2.0	To gain a knowledge about design and sizing of double pipe heat exchangers	2.1	Learn how to design and sizing of double pipe heat exchangers	**b, c, d, f, g, h**	
3.0	To gain a knowledge about design and sizing of shell and tube heat exchangers	3.1	Learn how to design and sizing of shell-and-tube heat exchangers	**b, c, d, e, f, g, j**	
4.0	To gain a knowledge about design and sizing of compact heat exchangers.	4.1	Learn how to design and sizing of compact heat exchangers	**b, c, d, f, g, h**	
5.0	To learn about heat transfer enhancement and selection of heat exchangers.	5.1	learn to select appropriate heat exchanger for the given application	**b, d, f, h, j**	

UNIT I : INTRODUCTION	**(10)**
Classification of heat exchanger, selection of heat exchanger, overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, fouling, cleanliness factor, percent over surface, techniques to control fouling, additives, rating and sizing problems, heat exchanger design methodology.	
UNIT II : DESIGN OF DOUBLE PIPE HEAT EXCHANGERS	**(9)**
Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop	
UNIT III : DESIGN OF SHELL & TUBE HEAT EXCHANGERS	**(10)**
Basic components, basic design procedures of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method.	

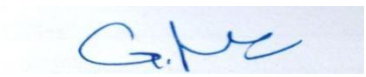
UNIT IV : DESIGN OF COMPACT HEAT EXCHANGERS	(8)
Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop	
UNIT V: HEAT TRANSFER ENHANCEMENT AND PERFORMANCE EVALUATION	**(8)**
Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis.	
TOTAL(L:45) = 45 PERIODS	

Text Books:

1. V V Mahjana and S B Umarji, Joshi's Process Equipment Design, Laxmi Publications; Fifth edition (2016)
2. Maidargi Suresh C, Chemical Process Equipment : Design And Drawing (Volume I), Phi Learning Pvt Ltd, Delhi

REFERENCES:

1. Richard Turton , Joseph A. Shaeiwitz, Chemical Process Equipment Design, Prentice Hall; 1 edition (February 11, 2017).
2. Gavin Towler Ph.D. and Ray Sinnott, Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design, Butterworth-Heinemann; 2 edition (January 27, 2012)



17CHX25 – DESIGN OF PRESSURE VESSELS AND PIPING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand the theory, concept of stresses in cylindrical, conical and spherical pressure vessels	**1.1**	Exhibit knowledge on stresses in cylindrical, conical and spherical pressure vessels	**a, b, c, d**
2.0	To learn about pressure vessel codes and their application in design	**2.1**	Familiarize with pressure vessel codes and their application in design	**a, b, c, d**
3.0	To understand the types of supports for vertical and horizontal vessels	**3.1**	Able to design the supports for vertical and horizontal vessels	**a, b, c, d, g**
4.0	To gain the concept on buckling of cylinders and design of stiffeners	**4.1**	Determine the buckling of cylinders and design stiffeners	**a, b, c, d**
5.0	To understand piping layout and design piping system as per piping code	**5.1**	Assess piping layout and design piping system as per piping code	**a, b, c, d, g**

UNIT I : STRESSES IN PRESSURE VESSELS	**(9)**
General theory of membrane stresses in vessel under internal pressure and its application to shells (cylindrical, conical and spherical) and end closures. Bending of circular plates and determination of stresses in simply supported and clamped circular plate. Thermal stresses, Stress concentration in plate having circular hole due to bi -axial loading, Excessive elastic deformation, Plastic instability, Brittle rupture and creep.	
UNIT II : DESIGN OF VESSELS USING CODES	**(9)**
Introduction to ASME codes for pressure vessel design, Pressure vessel and related components' design using ASME codes; Supports for short vertical vessels, Stress concentration at a variable thickness transition section in a cylindrical vessel; Design of nozzles. DIN codes.	
UNIT III : SUPPORTS FOR VERTICAL & HORIZONTAL VESSELS	**(9)**
Design of base plate and support legs. Types of anchor bolt, its material and allowable stresses. Design of saddle supports	
UNIT IV : OTHER DESIGN CONSIDERATIONS	**(9)**
Buckling phenomenon, Elastic Buckling of circular ring and cylinders under external pressure, Collapse of thick walled cylinders or tubes under external pressure, Effect of supports on Elastic Buckling of Cylinders, Design of circumferential stiffeners, Buckling under combined External pressure and Axial loading.	

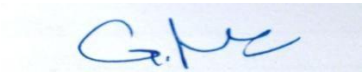
UNIT V : PIPING DESIGN	(9)
Flow diagram, Piping layout and piping stress analysis; Flexibility factor and stress intensification factor; Design of piping system as per B31.1 piping code. Piping components -bends, tees, bellows and valves. Types of piping supports and their behavior; Introduction to piping Codes and Standards.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Harvey J F, "Pressure vessel design", CBS Publication 1st edition 2001.
2. Stanley M Wales, "Chemical Process Equipment, Selection and Design", Butterworths, Series in Chemical Engineering, 1988.

REFERENCES:

1. Henry H Bednar, "Pressure vessel Design Hand book", CBS publishers and distributors Krieger Pub Co; 2 edition 1991
2. A. Keith Escoe" Mechanical Design Of Process Systems: Volume 1 - Piping & Pressure Vessels" CRC Press August 1988.



17CHX26 – DRYING TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	Understand moisture content, moisture removal and its requirement	**1.1**	Evaluate moisture content, moisture removal and its requirement	**a, b, c, d**	
2.0	Understand thermal properties related to drying	**2.1**	Measure thermal properties related to drying	**a, b, c**	
3.0	Select suitable dryer meeting requirement	**3.1**	Can select suitable dryer meeting requirement	**a, c, d**	
4.0	Predict the quality of dried products	**4.1**	Can judge quality of dried products	**a, c, d, f**	
5.0	Understand design of dryers hybrid drying technology	**5.1**	Can develop functional design of dryers assess novel and hybrid drying technology	**a, b, c, d**	

UNIT I : INTRODUCTION TO DRYING	**(9)**
Drying definition, Moisture removal and its need, Dehydration of food, Evaporation of water below its boiling point, Utilities of drying, Theoretical aspects of drying, Thermal properties related to drying of foods	
UNIT II : DRYING THEORY AND MECHANISMS	**(9)**
Drying process and methods, Drying rate periods –constant and falling rate periods and their calculation, Heat and mass transfer coefficient calculations, Capillary and diffusion theory, Thin layer and deep bed drying, Dryer performance indices –overall thermal efficiency, specific energy consumption, coefficient of performance.	
UNIT III : CLASSIFICATION AND SELECTION OF DRYERS	**(9)**
Classification and selection, Quality criteria for dryer selection- Basic construction and application of the dryers –Grain dryers, Tray dryers, Vacuum dryers, Spray dryers, Fluidized bed dryers, Freeze dryers, Flash Dryers, Super-heated steam drying, Solar energy based dryers, Osmotic Dehydration, Drum dryer.	

UNIT IV : PROPERTIES OF DRIED PRODUCTS	(9)
Physical, Chemical and Microbiological characteristics of dehydrated foods, Re-hydration ratio, size and density, shelf-life, water activity, Microbial stability of selected foods.	
UNIT V : DRYER DESIGN ANDEMERGING TRENDS IN DRYING TECHNOLOGIES	**(9)**
Basic design steps and calculations –Tray dryer, Vacuum dryer, Freeze dryer, fluidized bed dryer –Novel drying techniques, Hybrid dryers, Energy and environment conservation	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Arun S. Mujumdar ”Handbook of Industrial Drying” CRC Press,2014
2. C. M. van 't Land“Drying in the process industry” Wiley Publications, 2011

REFERENCES:

1. Perry R.H. and Green D.W., “Perry’s Chemical Engineers’ Hand Book”, McGraw Hill, New Delhi, 2009
2. McCabeW.L.,SmithJ.C.andHarriotP.,“UnitOperationsinChemicalEngineering”, 7thEdition,McGraw HillInternationalEdition,NewYork,2006

17CHX27 COMPUTATIONAL TECHNIQUES FOR CHEMICAL ENGINEERS					
		L	T	P	C
		2	2	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 1**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To make the students to know about basics of MATLAB commands.	**1.1**	The students will be able to use the basic MATLAB commands.	**a, b, c, d, e**
2.0	To introduce MATLAB programming concepts on array, algebra and vectors	**2.1**	The students will be able to do simple matrix, algebraic and vector calculations using MATLAB commands.	**a, b, c, d, e**
3.0	To introduce the MATLAB commands on differential and integral equations.	**3.1**	The students will be able to solve the differential and integral equations using MATLAB commands.	**a, b, c, d, e**
4.0	To know the plot commands in MATLAB.	**4.1**	The students will be able to generate plots and export this for use in reports and presentations.	**a, b, c, d, e**
5.0	To introduce Simulink blocks and models.	**5.1**	The students will be able to run the Simulink file for the transfer functions.	**a, b, c, d, e**

UNIT I - BASIC COMMANDS	**(12)**
Introduction - Menus and the Toolbar, Built-in Library Functions – Basic mathematical functions, variables - Logical Operators and Functions - Conditional Statements – if loops, for Loops, while Loops.	
UNIT II –ARRAY, ALGEBRA, VECTOR AND PLOTS	**(12)**
Array operations and manipulations - Matrix operations, functions - Algebric equations. xy Plotting Functions - Plot Types - Interactive Plotting, Three-Dimensional Plots, Linear and Non linear equations - Interpolation and polynomial curve fitting.	
UNIT III – DIFFERENTIAL AND INTEGRAL EQUATIONS	**(12)**
Numerical Differentiation – ordinary and partial differential equations, First-Order Differential Equations, Higher Order Differential Equations - Numerical Integration and Interpolation.	

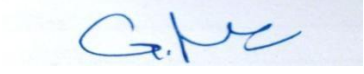
UNIT IV - SIMULINK	(12)
Introduction to Simulink - Simulation Diagrams - Commonly used blocks – Arranging and connecting the blocks – Specifying the parameter in the block-Transfer Function Models - Running the Simulink file.	
UNIT V APPLICATIONS IN CHEMCAL ENGINEERING	**(12)**
Reactors – Dynamics, Bubble point and dew point calculations, Volume of Non ideal gases from Various equations of State, Laplace domain dynamics.	
TOTAL (L:45 T:15)= 60 PERIODS	

TEXT BOOKS:

1. Bruce A Finlayson, 'Introduction to Chemical Engineering Computing" Wiley,
2. Pallab Ghosh, "Numerical, symbolic and statistical computing for Chemical Engineers using MATLAB" PHI

REFERENCES:

1. Kamal I.M, Al Malah, "MATLAB Numerical Methods with Chemical Engineering Applications" McGraw Hill
2. M. Chidambaram, "Mathematical Modelling and Simulation in Chemical Engineering" Cambridge.
3. Donald R Coughanowr, "Process system analysis and control" McGraw-Hill Education, 3e.



17CHX28 INTERNET OF THINGS (IOT) IN CHEMICAL PROCESS INDUSTRIES					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 1**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To make the students to know about basics of Electrical and Electronic devices	**1.1**	The students will be able to understand basics of Electrical circuits and Electronic devices		**a, c, d, i**
2.0	To make the students to know about basics and block diagram of IoT	**2.1**	The students will be able to understand IOT characteristics and its essential components		**a, b, d, e**
3.0	To make the students to know about Arduino processor and working of Analog and Digital I/O pins	**3.1**	The students will be able to describe Arduino processor and working of Analog and Digital I/O pins		**a, b, c, g**
4.0	To make the students to know about Raspberry pi and its interface with other devices	**4.1**	The students will be able to understand Raspberry pi and its interface with other devices		**a, b, c, j**
5.0	To make the students to know the industry related IOT devices.	**5.1**	The students will be able to understand the application of IOT in industries.		**a, b, c, d, e**

UNIT I : BASIC ELECTRICAL CIRCUITS AND ELECTRONICS	**(9)**
Introduction - current, voltage and resistance - analog and digital signal - conductors Vs insulators - KCL- KVL - basic electronics components - calculating equivalent resistance for series and parallel circuits - Ohm's law - color coding for a resistor - LED - LCD - LDR	
UNIT II : FUNDAMENTALS OF INTERNET OF THINGS	**(9)**
Introduction - definition and characteristics of Internet of Things - general block diagram and essential components of IOT - role of microprocessor and micro controller - communication of things - IOT connection with internet	

UNIT III : ARDUINO PROCESSOR	(9)
Introduction to Arduino processor - general block diagram - working of analog and digital I/O pins - Serial (UART), I2C Communications and SPI communication - Arduino Boards: Mega, Due, Zero and 101 - prototyping basics - technical description - setting up Arduino IDE - Introduction to Arduino programming.	
UNIT IV : RASPBERRY PI	**(9)**
Technical description of Raspberry Pi - comparison of Raspberry Pi Vs Arduino - operating systems for RPi - preparing SD card for Pi - connecting Raspberry Pi as PC - exploring Raspberry Pi environment - logical design using Python. Industry 4.0	
UNIT V – CHEMICAL PROCESS INDUSTRIES	**(9)**
Quality Assurance - Remote sensors and actuators for process level, pressure, temperature and flowrate control.Predictive Maintenance – Mechanical damage sensors, Operational Intelligence – Smart fire alarm.Energy Management- fouling of systems, age of catalyst and external environment. Supplt chain management and logistics.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOK:

1. ArshdeepBahga and Vijay Madisetti, "Internet of Things - A hands-on approach", Universities Press, 2015.

2. Sabina Jeschke, Christian Brecher, Houbing Song and Danda B. Rawat, “Industrial Internet of Things - Cybermanufacturing Systems”, Springer International Publishing Switzerland, 2017

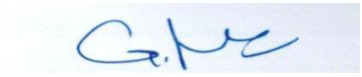
REFERENCES :

1. Muthusubramanian. R, Salivahanan. S and Muraleedharan. K. A, “Basic Electrical, Electronics and Computer Engineering”, Tata McGraw Hill, 2nd edition, 2006.

2. Olivier Hersent, David Boswarthick and Omar Elloumi, “The Internet of Things: Key applications and Protocols”,Wiley Publications 2nd edition, 2013.

3. Marco Schwartz, “Internet of Things with the Arduino Yun”, Packt Publishing, 2014.

4. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, Wiley Publications, 2012.



17MYB12 BASIC STATISTICS AND NUMERICAL ANALYSIS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - IV**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	Understanding of statistical fundamentals to interpret data	**1.1**	The students will be able to use statistical tools to solve problems from different fields.		**a,i,l**
2.0	Find numerical approximations to the roots of an equation by Newton method, numerical solution to a system of linear equations by Gaussian Elimination and Gauss-Seidel.	**2.1**	The students will be able to acquaint the basic concepts in numerical methods and their uses.		**a,k,l**
3.0	Find the Lagrange Interpolation Polynomial for any given set of points.	**3.1**	The students will be able to represent the data and find the intermediate values, when huge amounts of experimental data are involved, the methods discussed on interpolation will be useful in constructing approximate polynomial.		**a,e,l**
4.0	Apply several methods of numerical integration, including Romberg integration.	**4.1**	The students will be able to explain the consequences of finite precision and the inherent limits of the numerical methods considered and by using differentiation and integration.		**a,c,d,l**
5.0	Find numerical solution of a differential equation by Euler's, Predictor Corrector and Runge-Kutta Methods	**5.1**	The students will be able to understand the solution of ordinary differential equations will be useful in attempting any engineering problem.		**a,i,l**

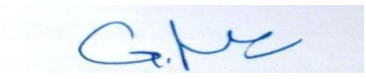
UNIT I - BASIC STATISTICS	**(9)**
Measures of central tendency-Arithmetic mean and its properties, weighted arithmetic mean, Geometric mean, Harmonic mean, Median, Mode.	
UNIT II - SOLUTION OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS	**(9)**
Solution of equation – Newton Raphson method – Solution of linear system by Gaussian elimination and Gauss – Jordon method – Iterative methods: Gauss-Seidel method.	
UNIT III - INTERPOLATION AND APPROXIMATION	**(9)**
Divided differences in unequal intervals – Lagrangian Polynomials — Newton's forward and backward difference formulas for equal intervals.	
UNIT IV - NUMERICAL DIFFERENTIATION AND INTEGRATION	**(9)**
Numerical Differentiation using interpolation formulae – Numerical integration by Trapezoidal and Simpson's 1/3 rule – Romberg's method – Two and Three point Gaussian quadrature formulae.	
UNIT V - INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS	**(9)**
Single step methods: Taylor series method – Euler's method for first order equation – Fourth order Runge – Kutta method for solving first order equations – Multistep methods: Milne's predictor and corrector methods.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. S.C.Gupta and V. K. Kappor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 11th ed., 2002.
2. T. Veerarajan and T. Ramachandran., "Numerical Methods with programming in C", 2nd ed., Tata McGraw-Hill, 2006, First reprint 2007.
3. P. Kandasamy, K.Thilagavathy and K. Gunavathy, "Numerical Methods – Vol: IV", S.Chand & Co. Ltd. New Delhi, 2003, Reprint 2007.

REFERENCES:

1. C.F Gerald and P.O Wheatley, "Applied Numerical Analysis", 7th ed., Pearson Education Asia, New Delhi 2007.
2. K. Sankar Rao, "Numerical Methods for Scientists and Engineers", 3rd ed., Prentice Hall of India, New Delhi, 2007, 10th reprint 2012.
3. E. Balagurusamy, "Numerical Methods", Tata McGraw-Hill, New Delhi, 1999, 25th Reprint 2008.
4. M.K Venkatraman, "Numerical Methods" National Publication, New Delhi, 2000, Reprint 2005.
5. B.S.Grewal, "Numerical Methods in Engineering & Science", Khanna Publisher, New Delhi, 2012.



17CAX11 – INTERNET OF THINGS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 1**			
COURSE OBJECTIVES AND OUTCOMES:					

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To make the students to know about basics of Electrical and Electronic devices	**1.1**	The students will be able to understand basics of Electrical circuits and Electronic devices	**a,c,d,i**
2.0	To make the students to know about basics and block diagram of IoT	2.1	The students will be able to understand IOT characteristics and its essential components.	**a,b,d,e**
3.0	To make the students to know about Arduino processor and working of Analog and Digital I/O pins	3.1	The students will be able to describe Arduino processor and working of Analog and Digital I/O pins	**a,b,c,g**
4.0	To make the students to know about Raspberry pi and its interface with other devices	4.1	The students will be able to understand Raspberry pi and its interface with other devices	**a,b,c,j**
5.0	To motivate the students to implement the IoT using Arduino/ Raspberry Pi.	5.1	The students will be able to implement a IoT system using Arduino/Raspberry Pi.	**a,f,k,l**

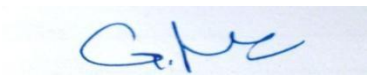
UNIT I - BASIC ELECTRICAL CIRCUITS AND ELECTRONICS	**(9)**
Introduction - Current, voltage and resistance - Analog and Digital Signal - conductors Vs Insulators – KCL- KVL - Basic Electronics components - calculating equivalent resistance for series and parallel circuits- Ohm's law- Color coding for a resistor – LED – LCD - LDR.	
UNIT II - INTRODUCTION TO INTERNET OF THINGS	**(9)**
Introduction - Definition and characteristics of Internet of Things - General Block Diagram and essential components of IOT - Role of microprocessor & Micro controller- communication of things - IOT connection with internet.	
UNIT III- ARDUINO PROCESSOR	**(9)**
Introduction to Arduino processor- General Block diagram- Working of Analog and Digital I/O pins- Serial (UART) , I2C Communications and SPI communication - Arduino Boards: Mega, Due, Zero and 101 - Prototyping basics - Technical description - Setting Up Arduino IDE- Introduction to Arduino programming.	
UNIT IV - RASPBERRY PI	**(9)**
Technical Description of Raspberry Pi - comparison of Raspberry Pi Vs Arduino - Operating Systems for RPi - Preparing SD Card for Pi - Connecting Raspberry Pi as PC - Exploring Raspberry Pi Environment- Logical design using Python.	
UNIT V- APPLICATIONS OF IOT	**(9)**
Various Real time applications of IoT- automation - Smart Parking - Environment: Weather monitoring system - Agriculture: Smart irrigation – Domain Specific applications - Case Studies.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things-A hands-on approach", Universities Press, 2015.

REFERENCES :

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, “Basic Electrical, Electronics and Computer Engineering”,Tata McGraw Hill, Second Edition, (2006).
2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key applications and Protocols”, Wiley Publications 2nd edition, 2013.
3. Marco Schwartz, ― Internet of Things with the Arduino Yun, Packt Publishing, 2014.
4. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley Publications, 2012.



17CSX31- PROBLEM SOLVING AND PROGRAMMING					
			L	T	P	C
			3	0	0	3
PREREQUISITE : 17CSC01 / 17CSC02		**QUESTION PATTERN : TYPE 1**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program Outcomes**
1.0	To gain knowledge about the basics of programming	**1.1**	The students will be able to understand the basics of Python Programming constructs.		**a,c,l**
2.0	To gain exposure about selection structure	**2.1**	The students will be able to design programs involving selection structure		**a,b,c,d,l**
3.0	To get knowledge about repetition structure, function and modules	**3.1**	The students will be able to design programs involving function, modules and loops.		**a,b,c,d,k,l**
4.0	To gain exposure about string	**4.1**	The students will be able to realize the need of strings.		**a,b,c,d,k,l**
5.0	To get knowledge about mutable and Immutable types	**5.1**	The students will be able to realize the need of list, tuples and dictionary.		**a,b,c,d,k,l**

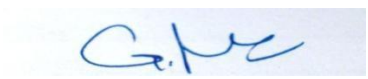
UNIT I - INTRODUCTION TO BASICS OF PROGRAMMING	**(9)**
Basics - Variables and Assignment - Basic Data Types- Comments - Operators - print() - Floats	
UNIT II - SELECTION STRUCTURE	**(9)**
Introduction to Selection Structure - if statements, else statements, nested elif statements, truthy and falsey values, Control Structure	
UNIT III - VALUE – REPETITION AND RETURNING STRUCTURE	**(9)**
Loops - while loops, for loops - Nested Loops - Functions - modules - variable scope	
UNIT IV - DATA AND STRING PROCESSING	**(9)**
Strings - Accessing the Strings - Traversing the Strings - Working with Strings - Formatting Strings	
UNIT V - MUTABLE AND IMMUTABLE TYPES AND METHODS	**(9)**
Introduction to lists, indexing and slicing of list, del and list methods, Tuples, Dictionary and its methods.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Dr. R. Nageswara Rao, —Core Python Programming, Dreamtech Press, 2017 Edition.
2. Reema Thareja - Problem Solving and Programming – Python, Oxford University Press, 2nd Edition.

REFERENCES:

1. Wesley J. Chun, —Core Python Programming, Pearson Education, 2nd edition, 2010.



17ITX26- PROBLEM SOLVING AND ALGORITHMIC SKILLS					
		L	T	P	C
		3	0	0	3
PREREQUISITE: NIL		**QUESTION PATTERN : TYPE - 1**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To impart fundamental concepts of OOP using python	**1.1**	The students will be able to understand the basics of object oriented concepts in python.	**a,c,l**
2.0	To gain exposure about inheritance and polymorphism	**2.1**	The students will be able to develop applications using inheritance and polymorphism	**a,b,c,d,e,k,l**
3.0	To understand the abstract data types and tree data structures	**3.1**	The students will be able to implement the ADTs and trees	**a,b,c,d,e,k,l**
4.0	To see how graphs and heaps can be used to solve a wide variety of problems	**4.1**	The students will be able to design graph abstract data type and heap	**a,b,c,d,e,k,l**
5.0	To understand the sorting techniques and shortest path algorithms.	**5.1**	The students will be able to implement the sorting techniques and shortest path algorithms.	**a,b,c,d,e,k,l**

UNIT I - MOTIVATION OF FUNDAMENTAL CONCEPT IN PROGRAMMING	**(9)**
Implementation of Classes and Objects in Python - Class Attributes and Instance Attributes - 'self ' parameter - Static Methods and Instance Methods - init() method	
UNIT II - ADVANCED FEATURES IN CONCEPT OF PROGRAMMING	**(9)**
Performing Abstraction and Encapsulation in Python - Single Inheritance - Multiple Inheritance - Multilevel Inheritance - Public, Protected and Private - Naming Conventions. Polymorphism- Overriding and the super() method - Diamond Shape Problem in Multiple Inheritance - Overloading an Operator - Implementing an Abstract Base Class (ABC)	
UNIT III - INTRODUCTION TO ALGORITHMIC THINKING AND PEAK FINDING	**(9)**
Array data structure - Linked List Data Structure and Its Implementation - Stacks and Queues - Binary Search Trees - Balanced Trees: AVL Trees and Red-Black Trees	
UNIT IV - MAPPING VALUES AND PRINCIPLE OF OPTIMALITY	**(9)**
Heaps - Heapsort Algorithm - Associative Arrays and Dictionaries - Ternary Search Trees as Associative Arrays - Basic Graph Algorithms - Breadth - First And Depth - First Search - Spanning Trees	
UNIT V - ANALYZING NUMBER OF EXCHANGES IN CRAZY-SORT	**(9)**
Shortest Path Algorithms, Dijkstra's Algorithm - Bellman-Ford Algorithm - Kruskal Algorithm - Sorting Algorithms- Bubble Sort, Selection Sort and Insertion Sort - Quicksort and Merge Sort, Non-Comparison Based Sorting Algorithms, Counting Sort and Radix Sort	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Dusty Phillips, Python 3 Object-oriented Programming, Packt Publishing, Second Edition.
2. Bradley N. Miller, David L. Ranum,- Problem Solving with Algorithms and Data Structures Using Python, Franklin, Beedle & Associates, 2011.

REFERENCES:

1. Mark Summerfield - Programming in Python 3, Pearson Education, 2nd Edition
2. Michael T. Goodrich, Irvine Roberto Tamassia, Michael H. Goldwasser, - Data Structures and Algorithms in Python‖, 2013 edition.

17CHX29 BIOENERGY TECHNOLOGIES					
			L	T	P	C
			3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To know about fundamental knowledge on classification, characterization and sources of biomass	1.1	The Students will be able to understand the fundamental knowledge on classification, characterization and sources of biomass	a, b, c, d, g	
2.0	To learn about the production of biogas	2.1	The Students will be able to learn the production of biogas	a, b, c, d,	
3.0	To gather knowledge about the operations of incineration and pyrolysis.	3.1	The Students will be able to gather knowledge on the operations of incineration and pyrolysis.	a, b, c, d, f, g	
4.0	To learn about the gasification of biomass	4.1	The Students will be able to learn the gasification of biomass	a, b, c, d, f, g	
5.0	To gain knowledge about the types of combustion of biomass	5.1	The Students will be able to knowledge on the types of combustion of biomass.	a, b, c, d, f, g	

UNIT I: BIOMASS SOURCES AND CLASSIFICATION	**9**
Biomass characteristics & preparation; Chemical composition and properties of biomass; Size reduction, Briquetting of loose biomass, Drying, Storage and handling of biomass.	
UNIT II: BIOGAS TECHNOLOGY	**9**
Feedstock for producing biogas; Microbial and biochemical aspects and operating parameters for biogas production, Kinetics and mechanism. Dry and wet fermentation, Digestors for rural application-High rate digesters for industrial waste water treatment.	
UNIT III: PYROLYSIS AND THERMO-CHEMICAL CONVERSION	**9**
Thermo-chemical conversion of lignocellulosic biomass. Incineration for safe disposal of hazardous waste, Biomass processing for liquid fuel production, Pyrolysis of biomass-pyrolysis regime, effect of particle size, temperature, and products obtained.	
UNIT IV: GASIFICATION OF BIOMASS	**9**
Thermochemical principles: Effect of pressure, temperature and introducing steam and oxygen. Design and operation of Fixed and Fluidised Bed Gasifiers, Safety aspects.	
UNIT V: COMBUSTION OF BIOMASS AND COGENERATION SYSTEMS	**9**
Combustion of woody biomass-theory, calculations and design of equipment, Cogeneration in biomass processing industries. Case studies: Combustion of rice husk, Use of bagasse for cogeneration.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS

1. Anju Dahiya, Bioenergy: Biomass to biofuels First Edition, Academic Press, 2014.
2. Li, Yebo, and Samir Kumar Khanal. Bioenergy: principles and applications. John Wiley &Sons, 2016.

REFERENCES

1. Vaughn C Nelson, Kenneth L. Starcher. Introduction to bioenergy. CRC Press, 2017.
2. Wall, Judy D., Caroline S. Harwood, and Arnold Demain. "Bioenergy." Bioenergy.. ASMPress, 2008

17CHX30 RENEWABLE ENERGY RESOURCES

L	T	P	C
3	0	0	3

PRE REQUISITE : NIL

	Course Objectives		Course Outcomes	Related Program outcomes
1.0	To understand the fundamental knowledge on history, consumption of energy	1.1	The Students will be able to understand the fundamental knowledge on history, consumption of energy	a, b, c, d, g
2.0	To learn the production of solar energy	2.1	The Students will be able to learn the production of solar energy	a, b, c, d, f, g
3.0	To gather knowledge on the geothermal and bio energy	3.1	The Students will be able to gather knowledge on the geothermal and bio energy	a, b, c, d, g
4.0	To understand the production of wind energy and their utilization	4.1	The Students will be able to understand the production of wind energy and their utilization	a, b, c, d
5.0	To gain knowledge on the production and utilization of tidal energy	5.1	The Students will be able to knowledge on the production and utilization of tidal energy	a,b, c, d, f

UNIT I: INTRODUCTION	**9**
Past, Today, and Future. A brief history of energy consumption. Energy &Environment. Renewable Energy – Quality, quantity, availability, advantageous and limitations	
UNIT II: SOLAR ENERGY	**9**
Sun and its Energy: Basics of Solar Energy. Solar Energy in the Past. Solar ThermalEnergy Solar Photovoltaic.	
UNIT III: BIO ENERGY & GEOTHERMAL ENERGY	**9**
Conversion. Bio degradation. Biogas generation. Fuelproperties. Biomass gasifier. Geothermal Resources, Geothermal Technologies.	
UNIT IV: WIND ENERGY	**9**
Wind Resources. Wind Turbines. Environmental Impact. Data and energy estimation. Conversion. Wind mill Performance and applications.	
UNIT V: TIDAL ENERGY	**9**
Ocean Energy Potential against Wind and Solar. Wave Characteristics and Statistics.Wave Energy Devices. Tide Energy Technologies. Ocean Thermal Energy. Osmotic Power.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS

1. Mukherjee, D., and S. Chakrabarti. *Fundamentals of renewable energy systems*. New AgeInternational, 2004.
2. Jenkins, Nicholas, and Janaka Ekanayake. *Renewable energy engineering*. CambridgeUniversity Press, 2017

REFERENCES

1. Kishore, V. V. N., ed. *Renewable energy engineering and technology: principles andpractice*. The Energy and Resources Institute (TERI), 2010.
2. Tiwari, Gopal Nath, and Rajeev Kumar Mishra. *Advanced renewable energy sources*. RoyalSociety of Chemistry, 2012

17CHX31 ENERGY STORAGE TECHNOLOGIES					
		L	T	P	C
		3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	to know about energy storage types and its necessity	1.1	The Students will be able to know about energy storage types and its necessity	a, b	
2.0	To know about storage of natural gases	2.1	The Students will be able to know about storage of natural gases	a, b, c, d, f, g	
3.0	To know about the storage of thermal energy	3.1	The Students will be able to know about the storage of thermal energy	a, b, c, d, f, g	
4.0	To know about the fundamental concepts of batteries	4.1	The Students will be able to know about the fundamental concepts of batteries	a, b, c, d, f, g	
5.0	To know about the various types of fuel cells	5.1	The Students will be able to know about the various types of fuel cells	a, b, c, d, f	

UNIT I: INTRODUCTION	**9**
The necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.	
UNIT II: NATURAL GAS STORAGE	**9**
General consideration, petroleum product storages, LPG storages, LNG storages, hydrogen storages, toxic storages, chlorine storages, ammonia storages, other chemical storages – underground storages–loading and unloading facilities–drum and cylinder storage – warehouse, storage hazard assessment of LPG and LNG	
UNUT III: THERMAL STORAGE	**9**
Types – Modelling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units -Modelling using the porous medium approach.	
UNIT IV: THE FUNDAMENTAL CONCEPT OF BATTERIES	**9**
measuring of battery performance, charging and discharging of a battery, storage density, energy density, Free energy, theoretical cell voltage, specific capacity, specific energy, energy density, memory effect, cycle life, shelf life, state of charge (SOC) and depth of discharge (DOD), internal resistance and Coloumbic efficiency and safety issues. Types of batteries – Primary and secondary batteries -Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide and modern batteries for example (i) zinc-Air (ii) Nickel Hydride, (iii) Lithium Battery	

UNIT V: FUEL CELL	9
History of the Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantage and drawback of each type.	
TOTAL (L:45) : 45 PERIODS	

TEXTBOOKS:

1. Energy Storage - Technologies and Applications by Ahmed Faheem Zobaa, InTech.
2. Fundamentals of Energy Storage by J. Jensen and B. Sorenson, Wiley-Interscience, New York,
3. Handbook of battery materials by C. Daniel, J. O. Besenhard,Wiley VCH Verlag GmbH & Co. KgaA
4. Electric & Hybrid Vehicles by G. Pistoia, Elsevier B. V.
5. Thermal energy storage: Systems and Applications by Dincer I. and Rosen M. A., Wiley pub.

REFERENCES

1. Energy Storage: Fundmentals, Materials and Applications, by Huggins R. A., Springer
2. Fuel cell Fundamentals by R. O'Hayre, S. Cha, W. Colella and F. B. Prinz, Wiley Pub.
3. Chemical and Electrochemical Energy System by R. Narayan and B. Viswanathan, University Press.
4. Battery Systems Engineering by C. D. Rahn and C. Wang, Wiley Pub.
5. Electrochemical Energy Storage for Renewable sources and grid balancing by P. T. Moseley and J. Garche, Elsevier Science
6. Compressed air energy storage by F. P. Miller, A. F. Vandome, M. B. John, VDM publishing

17CHX32 HYDROGEN AND FUEL CELL TECHNOLOGY					
			L	T	P	C
			3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To aware of alternate energy sources and its importance of it.	1.1	The Students will be able to aware of alternate energy sources and its importance of it.		a, b, c
2.0	To understand about the fuel cell kinetics	2.1	The Students will be able to understand the fuel cell kinetics		a, b, c f, g
3.0	To understand about the fuel cell characterization techniques	3.1	The Students will be able to able to understand the characterization techniques		a, b, c, d, f
4.0	To analyze about the renewable energy sources and storage	4.1	The Students will be able to analyze the renewable sources and storage		a, b, c, d, f, g
5.0	To understand about the applications of fuel cells in various fields.	5.1	The Students will be able to understand the applications of fuel cells in various fields.		a, b, c, d, f

UNIT I: INTRODUCTION	**9**
Overview of fuel cells: Low and high temperature fuel cells; Fuel cell thermodynamics - heat, work Potentials, prediction of reversible voltage, fuel cell efficiency, Types of fuel cells.	
UNIT II: FUEL CELL KINETICS	**9**
Fuel cell reaction kinetics - electrode kinetics, overvoltage, Tafel equation, charge transfer reaction, exchange currents, electro catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte	
UNIT III: CHARACTERIZATION TECHNIQUES	**9**
Fuel cell characterization - in-situ and ex-situ characterization techniques, i-V curve, frequency response analysis; Fuel cell modeling and system integration: - 1D model – analytical solution and CFD models.	
UNIT IV: RENEWABLE SOURCES	**9**
Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.	
UNIT V: APPLICATIONS OF FUEL CELL	**9**
Fuel cell power plants: fuel processor, fuel cell power section (fuel cell stack), power conditioner; automotive applications, portable applications	
TOTAL (L:45) : 45 PERIODS	

TEXTBOOKS

1. Gregor Hoogers, “Fuel Cell Technology Handbook”, CRC Press, 2003.
2. R.P. O'Hayre,S. Cha, W. Colella, F.B. Prinz, “Fuel Cell Fundamentals”, Wiley, 2006.
3. A. J.Bard, L. R. Faulkner, “Electrochemical Methods”, Wiley, 2004.

REFERENCES

1. S. Basu, “Fuel Cell Science and Technology”, Springer, 2007.
2. H. Liu, “Principles of Fuel Cells”, Taylor & Francis, 2006.

17CHX33 POWER PLANT ENGINEERING					
			L	T	P	C
			3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the fundamental knowledge on components, layouts and working of power plants	1.1	The Students will be able to understand the fundamental knowledge on components, layouts and working of power plants		a, b, c
2.0	To learn about the types, classification and usage of boilers	2.1	The Students will be able to learn the types, classification and usage of boilers		a, b, c, f, g
3.0	To gather knowledge on classification and usage of steam turbines	3.1	The Students will be able to gather knowledge on classification and usage of steam turbines		a, b, c, f
4.0	To understand about the types of gas turbines	4.1	The Students will be able to understand the types of gas turbines		a, b, c, g
5.0	To gain knowledge on the application of integration of various process in power plants	5.1	The Students will be able to knowledge on the application of integration of various process in power plants		a, b, c

UNIT I	**9**
Power Plants - Features, Components and Layouts - Working of Power Plants, Power PlantEconomics.	
UNIT II	**9**
Boiler Classification - Boiler Types - Fire Tube & Water Tube Boilers - Fluidized Bed Boilers - Positive Circulation Boilers - Thermal Liquid Heaters & Vaporizers	
UNIT III	**9**
Steam Turbines: Classification - Features - Working – Performance; Losses in Steam Turbines - Trouble Shooting	
UNIT IV	**9**
Gas Turbines: Classification and Comparison of Different Types Gas Turbine Power Plants Components - Economics & Future of Combined Cycles	

UNIT V	9
Integrated Gasification Combined Cycle (IGCC) – Indirect Fired Combined Cycle (IFCC) – Magneto Hydrodynamics (MHD) – Fuel Cells – Micro turbines– RDF based power plants.	
	TOTAL (L:45) : 45 PERIODS

TEXT BOOKS

1. Thomas C. Elliott ,"Standard Hand Book of Power Plant Engineering"
2. L.C.Witte, P.S.Schmidt, D.R.Brown, Industrial Energy Management and Utilisation, Hemisphere Publ, Washington, 1988.

REFERENCES

1. E L Wakil, "Power Plant Engineering", McGraw-hill Book Co, N.Y. 2001
2. Arora and Domkundwar, A course in Power Plant Engineering, Dhanpat Ra, N.Delhi.2003
3. Nag, P.K., "Power Plant Engineering", 2 nd Edition, TMH, 2001

17CHX34 NON-RENEWABLE ENERGY SOURCES					
		L	T	P	C
		3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the fundamental knowledge on petroleum and its products	1.1	The Students will be able to understand the fundamental knowledge on petroleum and its products	a, b, c	
2.0	To learn the usage of coal, types and its composition	2.1	The Students will be able to learn the usage of coal, types and its composition	a, b, c, f, g	
3.0	To gather knowledge on the properties, classification and products of natural gas	3.1	The Students will be able to gather knowledge on the properties, classification and products of natural gas	a, b, c, f, g	
4.0	To understand the fundamentals of nuclear engineering	4.1	The Students will be able to understand the fundamentals of nuclear engineering	a, b, c, g	
5.0	To gain knowledge on the usage of nuclear reactors, nuclear waste management and safety usage	5.1	The Students will be able to knowledge on the usage of nuclear reactors, nuclear waste management and safety usage	a, b, c	

UNIT I: INTRODUCTION
Origin of Petroleum, Composition, Extraction of Petroleum. Products of Petroleum refining: Diesel; Gasoline; LPG; Fuel oil; Tar; and Bitumen. Environmental Issues associated with petroleum resources.
UNUT II: TYPES OF COAL
Composition of coal; Oxygen content, Proximate and Ultimate Analysis of coal; Carbonization, Coal for generation of electricity, coal liquefaction, coal blending. Environmental Issues associated with usage of coal
UNIT III: NATURAL GAS
Resources of for Natural Gas, Properties and classification of natural gas, transporation of natural gas, products from natural gas, liquefied natural gas, chemicals from natural gas, shale gas; Environmental Issues associated with usage of coal.
UNIT IV: NUCLEAR ENGINEERING FUNDAMENTALS
Nuclear models, binding energy, Radio activity, half-life, mechanism of nuclear fission and fusion, decay chains, neutron reactions. Nuclear Fuels; Nuclear fuel reserves of Uranium and Thorium, Nuclear fuel cycles, characteristics, production and purification, other fuels Zirconium, Beryllium.
UNIT V: NUCLEAR ENERGY
Nuclear reactors and classification, boiling water reactors (BWR), pressurized heavy water reactor (PHWR), fast breeder reactor (FBR), basics of nuclear fusion reactor. Nuclear Power Plant -Waste Management and Safety
TOTAL (L:45) : 45 PERIODS

TEXT BOOKS

1. Breeze, Paul. Nuclear power. Academic Press, 2016.
2. Viswanathan, Balasubramanian. Energy sources: fundamentals of chemical conversionprocesses and applications. Newnes, 2016.
3.

REFERENCE

1. Rao, S., and B. B. Parulekar. "Energy Technology: Non-conventional, Renewable andConventional. " Khanna Publication, 3rd (2012

17CHX35 ENERGY MANAGEMENT					
			L	T	P	C
			3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To acquire the need of energy conservation	1.1	The student will be able to acquire the need of energy conservation		a, b, c
2.0	To analyze types and objectives of energy auditing	2.1	The student will be able to analyze types and objectives of energy auditing		a, b, c, f, g
3.0	To analyze the methods for reactive power compensation	3.1	The student will be able to analyze the methods for reactive power compensation		a, b, c, f
4.0	To analyze tools for economics of energy conservation	4.1	The student will be able to analyze tools for economics of energy conservation		a, b, c, g
5.0	To analyze the ECO (Energy Conservation opportunity) in mechanical systems such as boilers, pumps, compressors, water heaters etc.	5.1	The student will be able to analyze the ECO (Energy Conservation opportunity) in mechanical systems such as boilers, pumps, compressors, water heaters etc.		a, b, c, g

UNIT I	**9**
Importance of energy management, electric energy conservation, Energy auditing – methodology, System approach and End-use approach to efficient use of Electricity, Electricity tariff types, Types and objectives, audit instruments, specific energy analysis, Minimum energy paths, consumption models, Case study. Demand-side management.	
UNIT II	**9**
Electric motors- Energy efficient controls and starting -Motor Efficiency and Load Analysis- Energy-efficient motors-Case study; Load Matching and selection of motors-Variable speed drives.	
UNIT III	**9**
Reactive Power management-Capacitor Sizing-Degree of Compensation-Capacitor losses- Location-Placement Maintenance, case study. Peak Demand controls Methodologies- Types of Industrial loads-Optimal Load scheduling-case study.	
UNIT IV	**9**
ECO assessment and Economic methods- Simple payback period- time value of money-Net Present value-Internal rate of return Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues Luminaries, case study.	

UNIT V	9
Power Consumption in Compressors, Energy conservation measures. Water heating-Gysers-Solar Water Heaters- solar PV Systems.	
	TOTAL (L:45) : 45 PERIODS

TEXT BOOKS

1. Guide Book for National Certification Examination for Energy Managers & Energy Auditors – Bureau of Energy Efficiency, Ministry of Power, Govt of India.
2. Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI, 2006
3. Utilization, Generation & Conservation of Electrical Energy, Sunil S.Rao, Khanna publishers, 2007.

REFERENCES

1. Anthony J. Pansini, Kenneth D. Smalling, Guide to Electric Load Management., Pennwell Pub; (1998)
2. Partab H., 'Art and Science of Utilisation of Electrical Energy', Dhanpat Rai and Sons, New Delhi. 1975
3. Tripathy S.C., 'Electric Energy Utilization And Conservation', Tata McGraw Hill, 1991

17CHX36 THERMAL ENERGY CONSERVATION TECHNIQUES					
			L	T	P	C
			3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To learn about the basics of Energy and its various forms	1.1	The student will be able to understand the Principles of energy conservation and management		a, b, c
2.0	To Learn the present energy scenario and the need for energy conservation	2.1	The student will be able to Execute thermal energy auditing.		a, b, c, f, g
3.0	To Study the different measures for energy conservation and financial implications of various thermal utilities	3.1	Discuss financial aspects as far as Energy Conservation Schemes are concerned.		a, b, c, f
4.0	To Understand the energy crisis and environmental concerns associated with energy management, and the importance of energy conservation,	4.1	Apply the scientific knowledge for energy conservation and management in the thermal energy systems		a, b, c, f, g
5.0	To Apply energy conservation techniques in thermal systems	5.1	Discuss the most used energy planning and management systems		a, b, c, f

UNIT 1:	**9**
Basics of Energy and its various forms, Primary/Secondary Energy Sources, Energy crisis and environmental concerns. Principles of energy conservation and management, Energy Conservation, Energy Intensive Industries, Barriers, Energy Conservation Acts - Salient Features, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, Integrated energy policy, National action plan on climate change.	
UNIT II:	**9**
Energy audit, definition, need, types of the energy audit. Energy management (audit) approach - understanding energy costs, benchmarking, energy performance, optimizing the input energy requirements, energy audit instruments and metering, smart metering. Roles and responsibilities of an energy manager, Financial Analysis Techniques, CUSUM Technique, Energy Management Information Systems (EMIS), ESCO Concept, ESCO Contracts.	
UNIT III:	**9**
Energy conservation in boilers-Types of fuel used - properties of fuel- oil, coal and gas. Stoichiometry, Boiler efficiency-performance of a boiler, Heat Loss Estimation, Steam Traps, Steam Piping & Distribution. Thermic Fluid Heaters – Insulation & Refractories.	

UNIT IV:	9
Cogeneration – Principles & Operation, Power Ratio, Economics of Cogeneration Scheme, Case Study on Cogeneration, WHR – Sources & Grades, Types (Heat Wheel, Recuperators, Regenerators, Heat Pipe etc), Scheme Evaluation, Economics of WHR Systems. Thermal Energy Storage – Basics & Concepts as an ENCON scheme.	
UNIT V:	**9**
Energy conservation in refrigeration and air conditioning systems- EER / SEC Evaluation –. Types & Applications of Cooling Towers, Basics, Performance Analysis. DG Set – Performance Prediction, Cost of Power Generation. Energy conservation in Cooling Towers and DG set.	
TOTAL (L:45) : 45 PERIODS	

TEXTBOOKS

1. Diamant R.M.E., Total Energy, Pergamon, Oxford, 1970.
2. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management and Case study, Hemisphere, Washington, 1980.
3. Handbook on Energy Efficiency, TERI, New Delhi, 2001.
4. Trivedi P.R., Julka K.R., Energy Management, Commonwealth Publication, New Delhi, 1997

REFERENCES

1. Practical guide to energy conservation – a ready reckoner on energy conservation measures; Petroleum Conservation Research Association, 2009.
2. Reay D. Industrial energy conservation, Pergamon Press, 1979.
3. White L. C., Industrial Energy Management and Utilization; Hemisphere Publishers, 1988.
4. Eastop T. D. and Croft D. R., Energy Efficiency for Engineers and Technologists, Longman- Scientific and Technical Series, 1988.

17CHX37 BIOCHEMISTRY					
		L	T	P	C
		3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the basic concepts on carbohydrates.	1.1	The Students will be able to understand the basic concepts on carbohydrates.	a, b, c, d	
2.0	To learn the concepts of proteins	2.1	The Students will be able to learn the concepts of proteins	a, b, c, d	
3.0	To gather knowledge on importance of nucleic acids	3.1	The Students will be able to gather knowledge on importance of nucleic acids	a, b, c, d	
4.0	To understand the knowledge on lipids	4.1	The Students will be able to understand the knowledge on lipids	a, b, c, d	
5.0	To gather knowledge on intermediary metabolism and their pathways	5.1	The Students will be able to gather knowledge on intermediary metabolism and their pathways	a, b, c, d	

UNIT I: INTRODUCTION TO BIOMOLECULES AND CARBOHYDRATES	**9**
Basic principles of organic chemistry, role of carbon, types of functional groups, chemical, natureof water, pH and biological buffers, bio molecules structure and properties of Carbohydrates (mono, di, oligo & polysaccharides) Proteoglycans, glucosaminoglycans. mutarotation, glycosidic bond, reactions of monosaccharides, reducing sugars. Starch, glycogen, cellulose and chitin. Proteoglycans, glycosaminoglycans. hyaluronic acid, chondroitin sulfate	
UNIT II: STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES	**9**
Structure and properties of Important Biomolecules. **Lipids:** fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins. **Protein:** Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organizationprimary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determine of primary structure. **Nucleic acids:** purines, pyrimidines, nucleoside, nucleotide, RNA, DNA-Watson-Crick structure of DNA, reactions, properties, measurement, nucleoprotein complexes	
UNIT III: METABOLISM CONCEPTS AND CARBOHYDRATE METABOLISM	**9**
Functions of Proteins, Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Interconnection of pathways and metabolic regulation. Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt & glyoxalate shunt	

UNIT IV: INTERMEDIARY METABOLISM AND REGULATION	9
Fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.	
UNIT V: PROTEIN TRANSPORT AND DEGRADATION	9
Protein targeting, signal sequence, secretion; Folding, Chaperone and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. CoxW.H.Freeman and Company 2017
2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied(P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
4. Conn, E.E., etal., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.
5. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp693. John Wiley and Sons, New York. 1987.

REFERENCES

1. Berg, Jeremy M. et al. "Biochemsitry", 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., etal "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc.,2010.

17CHX38 BIOPROCESS PRINCIPLES AND TECHNOLOGY					
			L	T	P	C
			3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the fundamental knowledge on bioprocess technology	1.1	The Students will be able to understand the fundamental knowledge on bioprocess technology		a, b, c, d
2.0	To learn the production process of biomolecules	2.1	The Students will be able to learn the the production process of biomolecules		a, b, c, d
3.0	To gather knowledge on the operations of bioreactors and their purposes	3.1	The Students will be able to gather knowledge on the operations of bioreactors and their purposes		a, b, c, d, g
4.0	To understand the transportation processes in reactors and their behaviors	4.1	The Students will be able to understand the transportation processes in reactors and their behaviors		a, b, c, d, g
5.0	To knowledge on the biosafety and information on bioethics	5.1	The Students will be able to knowledge on the biosafety and information on bioethics.		a, b, c, d, h

UNIT I: INTRODUCTION TO BIOPROCESS	9
Biologists and Engineers, comparison of chemical and biochemical processing overview of biological basics, About cells and its growth, the stoichiometry of microbial growth and product Bioprocesses: Regulatory Constraints	
UNIT II: MEDIA FORMULATION AND DEVELOPMENT	9
Media formulation, Media Sterilization: Methods of heat sterilization of media, thermal death kinetics, design criteria, batch and continuous sterilization. Air Sterilization: Methods of air sterilization, mechanism of air sterilization, solid and liquid handling. Industrially fermented broth	
UNIT III: UNDERSTANDING BIOREACTORS	9
Purpose and importance of bioreactors, Classification of bioreactors, bioreactors for animal cells, bioreactors for plant cells, bioreactors for immobilized cells, operations of bioreactors, stirred tank reactor, plug flow reactor (PFR), fluidized bed reactor, bubble column, airlift reactor, Agitation, and Aeration: Mechanical agitation, power consumption in agitation, bubble aeration, bioreactors for waste management	

UNIT IV: TRANSPORT PROCESSES	9
Aspects of rheology, Fluid flow in packed-bed and Fluidized bed columns, Gas-liquid mass transfer in cellular systems Diffusivity and mechanism of mass transfer - derivation of the equations of mass transport by diffusion-stationary and unsteady mass transport by diffusion, mass transfer coefficient, macroscopic balances for mass transport. Mechanisms and applications of heat transfer-mode of heat transfer-conduction, convection and radiation, Application of Heat and Mass transfer in biochemical processes.	
UNIT V: BIOETHICS AND BIOSAFETY	9
Introduction to Bioethics. Social and ethical issues, the process of biotechnology involved ingenerating new forms of life for informed decision making, Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release into the environment.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Bailey, J. E., and D. F. Ollis. Biochemical Engineering Fundamentals. 2nd ed. New York,McGraw-Hill, 1986.
2. H. W. Blanch and D. S. Clark, Biochemical Engineering, Marcel, Dekker Inc., 1996.
3. Pauline M. Doran. Bioprocess Engineering Principles. 2nd ed. Elsevier Science &Technology Books. 1995

REFERENCES

1. Transport Phenomena, by Bird R.B., Steward W.E., and Lightfoot E.N., John Wiley &sons, Inc., New York, 2002
2. C J Geankoplis, Transport Processes and Separation Processes Principles, 4th Edition,New Jersey, PHI Publishers, 2010

17CHX39 FERMENTATION AND BIOPROCESSING					
		L	T	P	C
		3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the structural, functional properties of microbes	1.1	The Students will be able to understand the structural, functional properties of microbes	a, b, c, d	
2.0	To learn the growth kinetics of microorganisms	2.1	The Students will be able to learn the growth kinetics of microorganisms	a, b, c, d	
3.0	To understand the basic concepts in designing of fermenters	3.1	The Students will be able to understand the basic concepts in designing of fermenters	a, b, c, d, g	
4.0	To gather knowledge on the operation of control systems in fermentation and bioprocess industry	4.1	The Students will be able to gather knowledge on the operation of control systems in fermentation and bioprocess industry	a, b, c, d, e	
5.0	To acquire knowledge on the commodity, fermentation production and their production pathways	5.1	The Students will be able to acquire knowledge on the commodity, fermentation production and their production pathways	a, b, c, d, e	

UNIT I : FERMENTATION PROCESSES	**9**
Importance of fermentation, Fermentation and redox potential, solid-liquid fermentation, solid state fermentation, Kinetics of fermentations, Biosensors for fermentations, Production processes in fermentation.	
UNIT II: MICROBIAL GROWTH KINETICS	**9**
Diversity of patterns of microbial growth in situ and ex situ, Microbial growth under homogeneous conditions, Heterogeneous microbial growth, Growth kinetics, Derivation of mathematical models, and identification	
UNIT III: DESIGN OF FERMENTERS	**9**
Fermentation processes, Fermentation processes and microorganisms, Kinetics and stoichiometry, Mass balances and design for batch, continuous and fed-batch reactors, Comparison of batch, continuous and fed-batch reactors, Heat generation and heat balances, examples of industrial fermentation processes	
UNIT IV: INSTRUMENTATION AND CONTROL	**9**
Common Instruments for Process Automation — Temperature, Gas Flowrate, Liquid Flowrate, Off- Gas Analysis, pH, Dissolved Oxygen, Pressure, Foam Level, Stirring , Redox Potential, Advanced Instrumentation for Bioprocess Control and Automation - Flow Injection Analysis, Sequential Injection Analysis Fluorescence, Mass Spectrometry, Near Infrared Spectroscopy, Soft sensors, Biomass, Bioreactor automation	

UNIT V: FERMENTATION AND COMMODITY PRODUCTS	9
Engineering of Secretory Pathways, production of heterologous proteins, fungal, yeast fermentation of industrial products.	
	TOTAL (L:45) : 45 PERIODS

TEXTBOOKS:

1. Essentials in Fermentation Technology, Aydin Berenjian, Springer ,2019.
2. Principles of Fermentation Technology (Second Edition), Peter F. Stanbury, Allan Whitakerand Stephen J. Hall, Pergamon, 1995

REFERENCES:

1. Fermentation and Biochemical Engineering Handbook; Editors-in-Chief: Henry C. Vogeland Celeste M. Todaro, Third Edition, Elsevier, 2014.
2. Fermentation Biotechnology: Principles, Processes, and Products (Prentice Hall advancedreferences series), Owen P. Ward, Prentice Hall, 1989

17CHX40 BIOSEPERATION AND DOWNSTREAM PROCESSING

L	T	P	C
3	0	0	3

PRE REQUISITE : NIL

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand the basic concept of bio separation processes	1.1	The Students will be able to understand the basic concept of bio separation processes	a, b, c, d
2.0	To acquire knowledge on theory, design, and application of bioprocessing	2.1	The Students will be able to acquire knowledge on theory, design, and application of bioprocessing	a, b, c, d, g
3.0	To understand the basic concepts absorption and their problems in bioprocessing	3.1	The Students will be able to understand the basic concepts absorption and their problems in bioprocessing	a, b, c, d, g
4.0	To understand the basic concepts absorption and their problems in bioprocessing	4.1	The Students will be able to gather knowledge on extraction of bioproducts using different methods	a, b, c, d, e
5.0	To acquire knowledge on chromatography techniques and their analysis, membrane separation process	5.1	The Students will be able to acquire knowledge on chromatography techniques and their analysis, membrane separation process	a, b, c, d, e

UNIT I : INTRODUCTION	**9**
Introduction to By-products and Bioseparation: Range and characteristics of bio products, Characteristics of Fermentation Broth, Selection of unit operation with due consideration of the physical, chemical and biochemical aspects of biomolecules. Stages of Downstream Processing	
UNIT II: CENTRIFUGATION AND FILTRATION	**9**
Primary Separation: Removal of insoluble and Biomass (and particulate debris) separation techniques, Flocculation and sedimentation, Centrifugation-Ultracentrifugation, Gradient centrifugation, Filtration: Theory of Filtration, Pre-treatment of Fermentation Broth, Filter Media and Equipment, Conventional and Cross-flow Filtration, Continuous Filtration, Filter cake resistance, specific cake resistance, Washing and dewatering of filter cakes	
UNIT III: ABSORPTION	**9**
Gas Absorption: Solubility of gases in liquids, Effect of temperature and pressure on solubility, Ideal and Non-ideal solutions, Choice of solvent for gas absorption, absorption factor, stripping factor, minimum gas liq ratio, Single stage gas absorption Cross Current, Co- current, Countercurrent, Multistage Counter current Operation, Absorption with Chemical Reactions, Related problems	

UNIT IV: EXTRACTION	9
Liquid-Liquid Separation Process: Single Stage Operation, Equipments for liquid-liquid extraction. Types of extraction processes: Reactive extraction, Aqueous two-phase systems, Reverse micellar extraction, solid-liquid extraction, Supercritical fluid Extraction. Different types of extractors and designing of extractors. Distillation: Simple, Steam and Equilibrium distillation, Fractionation, Mccabe Thiele method, azotropes,	
UNIT V: CHROMATOGRAPHY AND MEMBRANE SEPARATION	9
Theory of chromatography, Shape and yield of a chromatographic peak, Binary chromatography, Hydrodynamic chromatography. Membrane-based bioseparation - Classification of membrane processes, Ultrafiltration, Microfiltration, Dialysis, Liquid membrane processes, Membrane chromatography, Electrophoresis, Affinity ultrafiltration, Field-flow fractionation	
TOTAL (L:45) : 45 PERIODS	

TEST BOOKS:

1. Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.
2. Roger G. Harrison, Paul Todd, ScottR. Rudge, Demetri P. Petrides, Bioseparations Scienceand Engineering, Oxford University Press
3. B.Shivshankar, Bioseparations: Principles and Techniques, Eastern Economy Edition, PHILearning Pvt. Ltd., Publishing House, New Delhi, 2012
4. Bioseparation & bioprocessing (2nd Ed) 2-Volume set, Ed SUBRAMANIAN Ganapathy,Wiley-VCH, (09-2007)

REFERENCES:

1. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley Interscience Publication, 1988.
2. R. K. Scopes, Berlin, Protein Purification: Principles and Practice, Springer, 1982.Scopes Ak, Protein Purification, IRL Press, 1993
3. Biotechnology: Bioprocessing, Rhem and Reed, Vol. 3, 1993
4. Separation and purification techniques in biotechnology, Fredreich Dechow, 1989

17CHX41 ENZYME IMMOBILISATION TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the basic knowledge on classification of enzymes and their nomenclature	1.1	The Students will be able to understand the basic knowledge on classification of enzymes and their nomenclature		a, b, c, d
2.0	To understand Enzymes, homogeneity, and heterogenicity	2.1	The Students will be able to understand Enzymes, homogeneity, and heterogenicity		a, b, c, d,
3.0	To understand structural, functional properties, and metabolic pathways of enzymes	3.1	The Students will be able to understand structural, functional properties, and metabolic pathways of enzymes		a, b, c, d, g
4.0	To learn immobilization procedures, and their different types.	4.1	The Students will be able to learn immobilization procedures, and their different types.		a, b, c, d, g
5.0	To knowledge on designing enzyme reactors.	5.1	The Students will be able to understand the designing of enzyme reactors.		a, b, c, d, e

UNIT I : INTRODUCTION	**9**
Catalysis and biocatalysis, Enzyme classification and nomenclature, enzyme structure, functionality and relationship, enzyme activity, enzyme sources, synthesis, recovery and purification, enzymes as process catalysts.	
UNIT II: HOMOGENEOUS ENZYME KINETICS	**9**
Hypothesis of enzyme kinetics, rapid equilibrium and steady-state hypothesis, determination of kinetic parameters, various types of kinetic inhibition, reactions with more than one substrate, effect of environmental variables- pH, temperature, and ionic strength.	
UNIT III: BASICS OF IMMOBILISATION	**9**
Immobilisation – Functional properties, Classification of Immobilisation techniques– Adsorption, matrix entrapment, crosslinking, covalent binding- advantages & disadvantages of each method, selection and characterisation of matrices for immobilisation, effect of physico chemical parameterson immobilised enzymes.	
UNIT IV: HETEROGENEOUS ENZYME KINETICS	**9**
Mass transfer effects in heterogeneous biocatalysis, partition effects, Immobilised enzyme kinetics-external (film) diffusion, internal (pore) diffusional kinetics, Thiele modulus and Effectiveness factor. Effects of electrostatic potential of the micro environment.	

UNIT V: ENZYME REACTORS & APPLICATION OF IMMOBILISED ENZYMES	9
Design of reactors with immobilised enzymes, Design of advanced immobilized enzyme systems, Application of immobilised enzymes in food industry, textile industry, Pharmaceutical industry & in medicine, in the production of biofuels, detergent industry, production of various bio-products, as biosensors	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. "Enzyme Technology" by M.F.Chaplin and C.Bucke, Cambridge University press, 1990.(Website for the book, www:lsbu.ac.uk/biology/enztech/)
2. "Biocatalysts and Enzyme Technology" by K. Buchholz,V. Kasche and U.T. Bornscheur, Wiley,2005

REFERENCES:

1. "Enzyme Technology", by Shanmugam,S. and Satish Kumar,T.,IK International Pvt. Ltd,New Delhi, 2008
3. Enzyme Biocatalysis: Principles and Applications' by A.Illanes, Springer,2008

17CHX42 BIOREACTOR DESIGN					
		L	T	P	C
		3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To compare kinetics and reaction rates for various bioreactor designs, based on operational mode and type of substrate.	1.1	The Students will be able to compare kinetics and reaction rates for various bioreactor designs, based on operational mode and type of substrate.		a, b, c, e
2.0	To differentiate and estimate productivity in commercial bioreactors- packed bed, fed batchreactors	2.1	The Students will be able to differentiate and estimate productivity in commercial bioreactors- packed bed, fed batch reactors		a, b, c, d, e, f, g
3.0	To helps to understand various requirements such as material of construction, valves, agitator, sensors etc	3.1	The Students will be able to helps to understand various requirements such as material of construction, valves, agitator, sensors etc		a, b, c, d, e, g
4.0	To understanding the mechanical design and heat transfer calculations for various type of bioreactor	4.1	The Students will be able to understanding the mechanical design and heat transfer calculations for various type ofbioreactor		a, b, c, d, e
5.0	To analyze immobilization techniques in reactors and use it for various applications	5.1	The Students will be able to analyze immobilization techniques in reactors and use it for various applications		a, b, c, d, e

UNIT I: BIOREACTOR DESIGN & MEDIA REQUIREMENTS	**9**
Microbial growth and product formation kinetics, Bioreactor Selection, Reactor operational mode and selection.	
UNIT II: DESIGN EQUATIONS FOR BIOREACTORS	**9**
Basic Design Equations/ Mole Balances: Batch, Fed-Batch and Repetitive Batch Reactors, Continuous: Stirred tank and tubular flow reactors, Microbial death kinetics, Design criterion for sterilization, Batch and continuous sterilization of medium, Multiple reactions-series, parallel and mixed-mode, Air sterilizatio	
Unit III: BIOREACTOR REQUIREMENTS	**9**
Process-General requirements; Basic design and construction of bioreactors and their ancillaries; Material of construction, Vessel geometry, Bearing Assemblies, Motor drives, Aseptic seals; Flow measuring devices, Valves, Agitator and Sparger Design, Sensors Non-isothermal homogeneous reactor systems. Adiabatic reactors, batch and continuous reactors, optimum temperature progression	

UNIT IV: DESIGN OF BIOREACTORS	9
Process and mechanical design of Bioreactors, volume, sparger, agitator-type, size and motor power, heat transfer calculations for coil and jacket, sterilization system, scale-up, scale down, bioinstrumentation and control.	
UNIT V: NOVEL BIOREACTORS DESIGN	9
Design of Immobilized enzyme packed bed Reactor. Fluidized bed reactors, Slurry Reactors, Airlift & Loop reactors, Packed bed and Hollow fiber membrane bioreactors, Bioreactors for waste treatment processes; SSF bioreactors. bioreactor design considerations for plant and animal cell cultures.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Bioprocess Engineering -Kinetics, Mass Transport, Reactors and Gene Expression Wolf R.Vieth A Wiley-Interscience Publication 1994
2. Chemical Kinetic Methods: Principles of relaxation techniques Kalidas C New AgeInternational 1996
3. Chemical Reactor Analysis and Design Forment G F and Bischoff K B John Wiley 1990

REFERENCE:

1. Bioprocess Engineering -Kinetics, Biosystems, sustainability and reactor Design, Shijie Liu,Elsevier Publication 2013.

17CHX43 ENVIRONMENTAL BIOTECHNOLOGY					
			L	T	P	C
			3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To learn about environmental systems and pollutants along with the existing and emerging technologies	1.1	Students will learn about environmental systems and pollutants along with the existing and emerging technologies that are important in the area of environment biotechnology.		a, b, c, d
2.0	To understand the importance of microbial diversity and technologies	2.1	Students will understand the importance of microbial diversity and technologies for environmental sustainability and processes.		a, b, c, d
3.0	To understand principles of waste water technologies	3.1	The Students will be able to understand principles 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.		a, b, c, e, f, g
4.0	To critically analyze relevant journal articles and investigate industrial applications of the concepts of biotechnology for effluent treatment.	4.1	The Students will be able to critically analyze relevant journal articles and investigate industrial applications of the concepts of biotechnology for effluent treatment.		a, b, c, d, f, g
5.0	To learn as to how they can manipulate, enhance or retard biological processes	5.1	Students should learn as to how they can manipulate, enhance or retard biological processes for bioremediation of natural sources and xenobiotic degradation.		a, b, c, g

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	

17CHX44 INDUSTRIAL BIOTECHNOLOGY					
			L	T	P	C
			3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To learn about basics of Industrial Biotechnology	1.1	The Students will be able to understand the basics of fermentation processes and metabolites.		a, b, c
2.0	To learn about the functions of microbes in Agriculture and Food Industry	2.1	The Students will be able to know about uses of Biofertilizers and biopesticides		a, b, c, f, g
3.0	To learn about the process technology for the production of cell biomass and primary metabolites	3.1	The Students will be able to understand the process technology used for the production of cell biomass and primary metabolites and its applications.		a, b, c, d, f
4.0	To learn about the microbial production of pharmaceuticals and other bioproducts	4.1	The Students will be able to understand the production of antibiotics and other bioproducts.		a, b, c, d, f
5.0	To learn about production and economics biofuels.	5.1	The Students will be able to know about the production of energy from biomass.		a, b, c, d, g

UNIT I: INTRODUCTION TO INDUSTRIAL BIOTECHNOLOGY	**9**
Overview of fermentation; solid and submerged fermentation, culture techniques batch, fed-batch and continuous; strain improvement, media optimization and types of industrial fermenter. Primary and secondary metabolites.	
UNIT II: MICROBES IN AGRICULTURE AND FOOD INDUSTRY	**9**
Biofertilizers and biopesticides, SCP, microbial production of wine, beer and vinegar; biopreservatives (Nisin), cheese, biopolymers (xanthan gum, PHB etc), vitamins; Bioflavours and biopigments, microbial pigments in textile and food industry.	
UNIT III: PROCESS TECHNOLOGY FOR THE PRODUCTION OF CELL BIOMASS AND PRIMARY METABOLITES	**9**
Ethanol, acetone butanol, citric acid, dextran and amino acids. Production of enzymes and specialty chemicals: Production of industrial enzymes such as proteases, amylases, lipases, cellulases, whole cell biocatalysis, Applications of bioconversion, transformation of steroids and sterols.	
UNIT V: MICROBIAL PRODUCTION OF PHARMACEUTICALS AND OTHER BIOPRODUCTS:	**9**
Antibiotics, enzyme inhibitors and specialty chemicals; production of Vitamins, glutamic acid, L-Lysine. Biotransformation of non-steroidal compounds, antibiotics, environmental toxicants.	
UNIT VI: BIOENERGY	**9**
Fuel from biomass, production and economics of biofuels, biogas, bio-refineries, Microbial Enhanced Oil Recovery (MEOR).	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS

1. Glazer AN, Nikaido H (2007): Microbial Biotechnology: Fundamentals of Applied Microbiology
2. Wulf Cruger and Anneliese Crueger (2003), Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation.
3. Malden MA (2001): Industrial Microbiology: An introduction; Blackwell Science (2001)

REFERENCES

1. H.W. Blanch, S. Drew, D.I.C.Wang and M. Moo-Young, Comprehensive Biotechnology: The Practice of Biotechnology: Current Commodity Products, Pergamon Press (1985).
2. C. Vogel and C.L. Tadaro, Fermentation and Biochemical Engineering Handbook: Principles, Process, Design and Equipment, Noyes Publications (1996).
3. P.F. Stansbury and A. Whitaker, Principles of Fermentation Technology: An Introduction to Current Concepts, Pergamon Press (1993).

17CHM01 FUNDAMENTALS OF CHEMICAL ENGINEERING					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To understand the basic concepts of chemical process industries	1.1	Understand the concepts of unit operations and unit processes.	A,b,d,f,g,h	
2.0	To learn the fundamentals of mechanical operations and their significance in chemical industries	2.1	Apply the principles of size reduction, separation and transportation for handling solids in Chemical process industries.	A,b,c,d,f,g,h	
3.0	To gain exposure over fluid properties and types of fluids	3.1	Comprehend the importance of fluid properties, types of fluids and select the manometers for pressure measurement	A,b,c,g	
4.0	To understand the heat transfer mechanisms and the types of heat exchange equipments	4.1	Familiarize with modes of heat transfer and acquire knowledge on types of heat exchangers.	A,b,c	
5.0	To have a basic idea on process calculations carried out in chemical industries.	5.1	Understand and apply the concepts of units and dimensions, mole, weight percentage, mole percentage in process calculations.	A,b,c,e,g	

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.	
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

17CHMO2 BASIC PROCESS CALCULATIONS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To provide basic idea of basic chemical calculations.	1.1	Understand and apply composition of mixtures/solution and determine Pressure, volume and temperature of glass using equation of state	a,b,c,f,g	
2.0	To gain fundamental knowledge and apply material balance without chemical reaction in process industry	2.1	Apply the law of conversion of mass for different batch and continues unit operations	a,b,c,d,f,g,k	
3.0	To understand the material balance with chemical reaction in process industry	3.1	Apply the law of conversion of mass for unit processes and evaluate yield, conversion, recycle ratio/purge/bypass of chemical reactors	a,b,c,d,f,g,k	
4.0	To Provide education and understand the apply energy balance in system	4.1	Apply energy balance for reacting system and understand the effect of temperature and pressure on heat of reaction	a,b,c,d,g,k	
5.0	To learn the combined material and energy balances specific industries	5.1	Evaluate the combined material and energy balance of specific industries and understand industrial need for material and energy balance	a,b,c,d,f,g,k	

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. Venkataramani V,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.

17CHM03 HEAT TRANSFER OPERATIONS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To understand nature and modes of heat transfer	1.1	Understand the fundamental principles of conduction	a, b, c, l	
2.0	To gain explosive nature and forced convections and dimensional analysis	2.1	Acquire knowledge in convection and radiation heat transfer	a, b, c, l	
3.0	To provide fundamentals of radiation concepts and nature of thermal radiations	3.1	Familiarize with the fundamentals of radiation and radiation shield	a, b, c, l	
4.0	To have a basic idea of heat transfer with phase change and design evaporator	4.1	Apply the knowledge of heat transfer in the design of evaporators, boiling and condensation	a, b, c, f, k, l	
5.0	To gain idea of different types of heat exchanger and performances	5.1	Design and analyze the performance of heat exchangers	a, b, c, f, k, l	

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.	

17CHM04 MASS TRANSFER OPERATIONS							
				L	T	P	C
				3	0	0	3
PREREQUISITE : NIL							
Course Objectives		Course Outcomes				Related Program outcomes	
1.0	To understand the basic concepts of diffusion and its measurement.	1.1	Understand diffusion operations in gases liquids and solids.			a, b, c, d, e, g, l	
2.0	To understand the mass transfer coefficients and their theories of mass transfer	2.1	Understand the concept of interphase mass transfer coefficients and equipment			a, b, c, d, e, g, l	
3.0	To gain knowledge over humidification and dehumidification and application in process industries.	3.1	Understand the concept humidifiers and cooling towers.			a, b, c, d, e, g, l	
4.0	To understand the mechanism of drying and types of drying equipment	4.1	Retrieve and apply the knowledge gained in mass transfer to perform simple calculations in drying			a, b, c, d, e, g, l	
5.0	To gain knowledge over crystallization and its application.	5.1	Apply the knowledge gained in mass transfer to perform simple calculations in crystallization process			a, b, c, d, e, g, l	

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 MeeraSheriffa 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.

17CHM05 FLUID MOVING MACHINERY					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
Course Objectives		Course Outcomes			Related Program outcomes
1.0	To understand the theory, construction and performance of Hydraulic machineries	1.1	Able to select and assesv the performance of different types of pumps		a, b, c, d, e
2.0	To learn about power transmission and method of pump testing.	2.1	Familiarize with drives and power transmission of pumps and testing of pumps		a, b, c, d, e
3.0	To understand the theory, construction and performance of compressors	3.1	Able to select and asses the performance of different types compressors		a, b, c, d, e
4.0	To understand the types of flow measuring devices and to determine coefficient of discharge.	4.1	Familiarize with the types, theory and performance of blowers; Estimate the power requirement and efficiency of blowers		a, b, c, d, e
5.0	To develop knowledge over theory, construction and performance analysis of fans.	5.1	Able to select and analyze the performance of different types of fans		a, b, c, d

UNIT I : HYDRAULIC MACHINERIES	(9)
Centrifugal pump- Theory, design, performance and construction. Displacement pump-Theory, design and construction. Diaphragm pump, screw pump –construction and working, performance, installation and diagnostics. Jet pump- theory and applications.	
UNIT II : POWER TRANSMISSION AND PUMP TESTING	(9)
Pump drives and power transmission-pump drives and speed varying devices. Pump sealing- Centrifugal pump packing, mechanical seal and injection type shaft seals .Pump noise measurement- Noise measurement techniques, estimating pump noise level and noise control techniques.	
UNIT III : COMPRESSORS	(9)
Compressor Theory and types- Selection of compressors - Compressed air and air usage. Effect of operating conditions, Thermodynamic compression. Real gas effects. Description and control of surge in centrifugal and axial compressor.	

UNIT IV : BLOWERS	(9)
Theory and types of Blowers- Selection of blowers- Working Principle of a Centrifugal Blower. Cross flow blowers –Flow pattern and performance. Vortex Blowers – Flow pattern and performance.	
UNIT V : FANS	(9)
Theory and types of Fans -Fan law- Conversion of fan performance, speed and size. Fan selection- Axial and centrifugal. Specific speed. Fan Performance and efficiency. Drives for Fans. Fanless air movers.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Giampaolo Tony “Compressor Handbook - Principles and Practices” Fairmount Press Incorporation, 2010
2. Igor J. Karassik, Joseph P. Messina, Paul Cooper, Charles C. Healdhe “Pump Handbook”, 4th Edition, McGraw-Hill Company, New York, 2008.

REFERENCES:

1. Frank P. Bleier, “Fan Handbook – Selection, Application and Design”, 2nd Edition, Mc-Graw Hill Companies Inc., 1997
2. Christie J. Geankoplis, “Transport Processes and Unit Operations”, Prentice Hall of India, 1993

17CHM06 PROCESS PLANT UTILITIES					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
Course Objectives		Course Outcomes			Related Program outcomes
1.0	To learn the importance of compressed air, Psychrometric and PSA systems	1.1	recognize the importance of compressed air, humidification and dehumidification process and PSA systems		a, c, d, g, l
2.0	To learn the requirement of water and steam i process industries	2.1	Comprehend the water treatment and steam utilization practices in process industries		a, c, d, g, l
3.0	To understand the vacuum systems for different chemical processes	3.1	Select suitable vacuum systems for different chemical processes		a, c, d, g, l
4.0	To study the principles of refrigeration process for application in chemical process industries	4.1	Grasp the principles of refrigeration process for application in chemical process industries		a, c, d, g, l
5.0	To know the importance of insulation and inert gases& To find the critical thickness of insulation; Gain an insight into the characteristics of	5.1	Understand the importance of insulation and calculate critical thickness of insulation; Gain an insight into the characteristics of inert gases.		a, c, d, g, l

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. Eskel Nordell, "Water treatment for industrial and other uses", Reinhold Publishing Corporation, New York, 1961

17CHM07 PROCESS PLANT SAFETY					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To understand the importance of safety in industry	1.1	Demonstrate the awareness of plant safety, plant layout and the usage of safety codes.	a, e, f, l, j	
2.0	To learn about the plant layout and plant maintenance	2.1	Understand the selection and replacement of process equipment	A, b, d, e, f	
3.0	To learn about the plant hazards	3.1	Exhibit the skill in classifying chemical, fire, explosion hazards	A, b, e, f, g	
4.0	To learn about risk analysis and assessment, hazard identification	4.1	Analyze the response to health hazards and to implement the effective process control	A, b, d, e, f, g	
5.0	To learn about safe working rules and industrial act	5.1	Understand the rules and act framed by government for safe working environment	A, e, f	

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. 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 BOOK:

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.

17CHM08 ENGINEERING ECONOMICS AND MANAGEMENT					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To understand basic of interest and capital cost	1.1	Able to understand value of money and depreciation with time	a, b, d, e, h	
2.0	To understand the feasibility of project and selection for investment	2.1	Able to select profitable project and calculate economic balance sheet	a, b, c, f, h, i	
3.0	To have a basic idea of economic balance	3.1	Can make economic balance on unit operations	c, d, e, g, h, k	
4.0	To understand the various concepts of economics and management	4.1	Able to understand the theory behind Inventory Control and organization Types	f, g, h, i, j, k	
5.0	To understand the principle of time study and production planning	5.1	Able to understand the theory behind the process development	f, h, i, j, k	

UNIT I TIME VALUE OF MONEY	(9)
Time value of money - equivalence, Supply and demand, Depreciation, Depletion, estimation of capital cost, Capital requirement for complete plant, cost indices, capital recovery.	
UNIT II COST ESTIMATION	(9)
Estimation of project profitability, process optimization, Investment alternatives, income statement, balance sheet preparation- problems.	
UNIT III ECONOMIC BALANCE	(9)
Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipments.	
UNIT IV PRINCIPLES OF MANAGEMENT	(9)
Principles of management, planning, organizing, staffing, coordinating, directing, controlling and communicating. Types of organizations.	

UNIT V PRODUCTION PLANNING AND CONTROL	(9)
Work measurement techniques, principles of time study, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory and control, role of control charts in production and quality control.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, 2004.
2. Ahuja K.K, Industrial management, Khanna publishers, New Delhi, 1985.
3. Schweyer. H.E, “Process Engineering Economics”, Mc Graw Hill, 1969.
4. Engineering economics, R.Panneersevam, eastern economy edition.

REFERENCE

1. F.C. Jelen and J.H. Black, “Cost and Optimization Engineering”, McGraw Hill, 3rd Edn., 1992