YouChoose,WeDoIt

St.JOSEPH'S COLLEGE OF ENGINEERING

(AnAutonomousInstitution)

St. Joseph's Group of Institutions

Jeppiaar Educational Trust

OMR,Chennai-119.

REGULATIONS 2021
B. TECH. CHEMICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM

1. **Programme Educational Objectives (PEOs)**

Graduates of B. Tech. Chemical Engineering will

a) Apply principles of mathematics, science, and engineering to analyze and solve problems encountered in chemical engineering and relatedareas.

b) Think critically and creatively, especially about the use of technology to address local and global problems and become a socially responsible engineer by involving with community and professional organizations.

c) Exhibit professional, ethical codes of conduct, team work and continuous learning forcatering the ever changing needs of thesociety.

2. **Programme Outcomes (POs)**

On successful completion of the B. Tech. Chemical Engineering programme,

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.
4. Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to proceed valid conclusions.
5. Modern tool usage: create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

3. PEOs / POs Mapping

PEOs /POs	1	2	3	4	5	6	7	8	9	10	11	12
a	√	√	√	√								√
b			√	√	√	√	√				√	
c								√	√	√		

4. Semester Course wise POs Mapping

		Course Title	1	2	3	4	5	6	7	8	9	10	11	12
Year I	SEMESTER I	Communicative English						√	√	√	√			√
		Engineering Mathematics – I	√				√					√		
		Engineering Physics	√				√							
		Engineering Chemistry	√				√							
		Problem solving and Python Programming	√	√		√								
		Engineering Graphics	√	√		√								
		Problem solving and Python Programming Laboratory	√		√			√			√			√
		Physics and Chemistry Laboratory	√		√							√		

	SEMESTER II	Professional English						√	√	√		√		
		Engineering Mathematics – II	√				√							
		Physics of Materials	√		√								√	
		Environmental Science and Engineering	√		√									
		Basic Civil and Mechanical Engineering	√		√			√						
		Introduction to Chemical Engineering					√	√						
		Engineering Practices Laboratory	√		√			√				√		√
		Technical Analysis Laboratory	√		√									
Year II	SEMESTER III	Applied numerical analysis	√				√				√		√	
		Process Calculations	√		√	√	√	√		√				
		Fluid Mechanics for chemical Engineers	√		√	√	√	√						
		Principles of electrical and electronics engineering	√		√			√						√
		Solid Mechanics for technologists	√		√									
		Fluid Mechanics Laboratory	√	√		√					√			
		Electrical Engineering Laboratory	√	√		√				√				
	SEMESTER IV	Applied probability and statistics	√				√							
		Chemistry for chemical Engineers	√	√	√			√	√		√	√		
		Computer applications in Chemical Engineering (Integrated Lab)	√		√								√	
		Mechanical operations	√		√	√	√	√						
		Chemical Process Industries	√		√									
		Instrumental Methods Of Chemical Analysis	√		√	√	√	√						√
		Mechanical operations Laboratory												
		Professional Skills Laboratory	√								√			
Year III	SEMESTER V	Chemical Reaction Engineering I	√	√		√							√	
		Heat Transfer	√	√		√								
		Mass Transfer I				√	√	√	√					
		Heat and mass Transfer Laboratory	√		√	√	√	√						
		Computational Programming Laboratory for Chemical Engineers	√		√	√	√	√						
	SEMESTER VI	Chemical Reaction Engineering II	√		√	√	√	√	√				√	
		Mass Transfer II (Integrated Laboratory)	√		√	√	√	√	√					
		Chemical Engineering Thermodynamics	√			√	√	√						√
		Process Dynamics and Control												
		Process Economics and Industrial Management						√	√	√				
		Professional Ethical Practice	√		√	√	√	√						
		Chemical Reaction Engineering Laboratory	√		√	√	√	√					√	
Year IV	SEMESTER VII	Transport Phenomena	√		√	√	√	√						
		Chemical Process Equipment Design (Integrated Lab)	√		√	√	√	√	√		√			√
		Industrial Safety	√	√		√								
		Mini Project	√	√		√								
		Process Control and dynamics Laboratory	√		√	√	√	√	√		√			

		Internship	√	√		√								
	SEMESTER VIII	Project Work	√	√	√		√		√	√		√		

REGULATIONS 2021

B. TECH. CHEMICAL ENGINEERING - CHOICE BASED CREDIT SYSTEM

I TO VIII SEMESTERS (FULL TIME) CURRICULA AND SYLLABI

SEMESTER I

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	HS1101	Communicative English	4	0	0	3	3	HS
2	MA1102	Engineering Mathematics – I	4	0	0	4	4	BS
3	PH1103	Engineering Physics	3	0	0	3	3	BS
4	CY1104	Engineering Chemistry	3	0	0	3	3	BS
5	GE1105	Problem solving and Python Programming	3	1	0	4	3	ES
6	GE1102	Engineering Graphics	2	0	4	5	4	ES
	TOTAL CREDITS FOR THEORY		**19**	**0**	**4**	**22**	**20**	
LABORATORY								
7	GE1107	Problem solving and Python Programming Laboratory	0	0	4	4	2	ES
8	BS1108	Physics and Chemistry Laboratory	0	0	4	4	2	BS
	TOTAL CREDITS FOR LAB		**0**	**0**	**8**	**8**	**4**	
	SEMESTER TOTAL (THEORY + LABORATORY)		**19**	**0**	**12**	**30**	**24**	

SEMESTER II

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	HS1201	Professional English	4	0	0	4	3	HS
2	MA1202	Engineering Mathematics – II	4	0	0	4	4	BS
3	PH1255	Physics of Materials	3	0	0	3	3	BS
4	GE1204	Environmental Science and Engineering	3	0	0	3	3	HS
5	GE1205	Basic Civil and Mechanical Engineering	3	0	0	3	3	ES
6	CH1206	Introduction to Chemical Engineering	3	0	0	3	2	PC
	TOTAL CREDITS FOR THEORY		**22**	**0**	**0**	**20**	**18**	
LABORATORY								
8	GE1207	Engineering Practices Laboratory	0	0	4	4	2	ES
9	CH1208	Technical Analysis Laboratory	0	0	4	4	2	BS
	TOTAL CREDITS FOR LAB		**0**	**0**	**8**	**8**	**4**	
	SEMESTER TOTAL (THEORY + LABORATORY)		**22**	**0**	**8**	**28**	**22**	

SEMESTER III

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	MA1353	Applied numerical analysis	4	0	0	4	4	BS
2	CH1301	Process Calculations	3	1	0	4	4	PC
3	CH1302	Fluid Mechanics for chemical Engineers	3	0	0	3	3	PC
4	EE1353	Principles of electrical and electronics engineering	3	0	0	3	3	ES
5	CH1303	Solid Mechanics for technologists	3	0	0	3	3	ES
	TOTAL CREDITS FOR THEORY		**18**	**1**	**0**	**17**	**17**	
LABORATORY								
7	CH1307	Fluid Mechanics Laboratory	0	0	3	3	2	PC
8	EE1358	Electrical Engineering Laboratory	0	0	3	3	2	ES
	TOTAL CREDITS FOR LAB		**0**	**0**	**6**	**6**	**4**	
	SEMESTER TOTAL (THEORY + LABORATORY)		**18**	**1**	**6**	**23**	**21**	

SEMESTER IV

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	MA1452	Applied probability and statistics	4	0	0	4	4	BS
2	CH1401	Chemistry for chemical Engineers	3	0	0	3	3	BS
3	CH1402	Computer applications in Chemical Engineering (Integrated Lab)	3	0	2	5	4	PC
4	CH1403	Mechanical operations	3	0	0	3	3	PC
5	CH1404	Chemical Process Industries	3	0	0	3	3	PC
6	CH1405	Instrumental Methods Of Chemical Analysis	3	0	0	3	3	BS
	TOTAL CREDITS FOR THEORY		**21**	**0**	**2**	**21**	**20**	
LABORATORY								
8	CH1407	Mechanical operations Laboratory	0	0	3	3	2	PC
9	HS1310	Professional Skills Laboratory	0	0	2	2	1	EEC
	TOTAL CREDITS FOR LAB		**0**	**0**	**5**	**5**	**3**	
	SEMESTER TOTAL (THEORY + LABORATORY)		**21**	**0**	**7**	**26**	**23**	

SEMESTER V

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1501	Chemical Reaction Engineering I	3	0	0	3	3	PC
2	CH1502	Heat Transfer	3	0	0	3	3	PC
3	CH1503	Mass Transfer I	3	0	0	3	3	PC
4		Professional Elective I	3	0	0	3	3	PE
5		Open Elective I	3	0	0	3	3	OE
6		Audit course	2	0	0	0	0	AC
	TOTAL CREDITS FOR THEORY		**17**	**0**	**0**	**15**	**15**	
LABORATORY								
7	CH1507	Heat and mass Transfer Laboratory	0	0	3	3	2	PC
8	CH1508	Computational Programming Laboratory for Chemical Engineers	0	0	3	3	2	PC
	TOTAL CREDITS FOR LAB		**0**	**0**	**6**	**6**	**4**	
	SEMESTER TOTAL (THEORY + LABORATORY)		**17**	**0**	**6**	**21**	**19**	

SEMESTER VI

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1601	Chemical Reaction Engineering II	3	1	0	4	4	PC
2	CH1602	Mass Transfer II (Integrated Laboratory)	3	0	2	4	4	PC
3	CH1603	Chemical Engineering Thermodynamics	3	0	0	3	3	PC
4	CH1604	Process Dynamics and Control	3	0	0	3	3	PC
5	CH1605	Process Economics and Industrial Management	3	0	0	3	3	PC
6		Professional Elective II	3	0	0	3	3	PE
	TOTAL CREDITS FOR THEORY		**20**	**1**	**2**	**20**	**20**	
LABORATORY								
8	CH1607	Professional Ethical Practice	0	0	0	0	1	PC
9	CH1608	Chemical Reaction Engineering Laboratory	0	0	3	3	2	PC
	TOTAL CREDITS FOR LAB		**0**	**0**	**3**	**3**	**3**	
	SEMESTER TOTAL (THEORY + LABORATORY)		**20**	**1**	**5**	**23**	**23**	

SEMESTER VII

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1701	Transport Phenomena	3	0	0	3	3	PC
2	CH1702	Chemical Process Equipment Design (Integrated Lab)	3	0	2	5	4	PC
3	CH1703	Safety and Hazard analysis	3	0	0	3	3	PC
4		Professional Elective III	3	0	0	3	3	PE
5		Professional Elective IV	3	0	0	3	3	PE
6		Open Elective II	3	0	0	3	3	OE
	TOTAL CREDITS FOR THEORY		**20**	**0**	**2**	**20**	**19**	
LABORATORY								
8	CH1707	Mini Project	0	0	3	3	2	PC
9	CH1708	Process Control and dynamics Laboratory	0	0	3	3	2	PC
10	CH1709	Internship	0	0	0	0	1	EEC
	TOTAL CREDITS FOR LAB		**0**	**0**	**6**	**6**	**5**	
	SEMESTER TOTAL (THEORY + LABORATORY)		**20**	**0**	**8**	**26**	**24**	

SEMESTER VIII

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1801	Professional Elective V	3	0	0	3	3	PE
2	CH1802	Professional Elective VI	3	0	0	3	3	PE
	TOTAL CREDITS FOR THEORY		**8**	**0**	**0**	**6**	**6**	
LABORATORY								
4	CH1807	Project Work	0	0	20	20	12	EEC
	TOTAL CREDITS FOR LAB		**0**	**0**	**20**	**20**	**12**	
	SEMESTER TOTAL (THEORY + LABORATORY)		**8**	**0**	**20**	**26**	**18**	

PROFESSIONAL ELECTIVES (PE)

PROFESSIONAL ELECTIVE I, SEMESTER V

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1509	Chemical Works Organization and Management	3	0	0	3	3	PE
2	CH1510	Membrane Science and Engineering	3	0	0	3	3	PE
3	CH1511	Polymer Technology	3	0	0	3	3	PE
4	CH1512	Fundamentals of Thermodynamics	3	0	0	3	3	PE

PROFESSIONAL ELECTIVE II, SEMESTER VI

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1609	Industrial Air Pollution	3	0	0	3	3	PE
2	CH1610	Industrial Instrumentation	3	0	0	3	3	PE
3	CH1611	Electrochemical Engineering	3	0	0	3	3	PE
4	CH1612	Process Plant Utilities	3	0	0	3	3	PE

PROFESSIONAL ELECTIVE III, SEMESTER VII

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1710	Modern Separation Techniques	3	0	0	3	3	PE
2	CH1711	Waste Water Treatment	3	0	0	3	3	PE
3	CH1712	Fluidization Engineering	3	0	0	3	3	PE
4	CH1713	Distillation	3	0	0	3	3	PE

PROFESSIONAL ELECTIVE IV, SEMESTER VII

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1714	Piping and Instrumentation	3	0	0	3	3	PE
2	CH1715	Food Technology	3	0	0	3	3	PE
3	CH1716	Biochemical Engineering	3	0	0	3	3	PE
4	GE1003	Professional Ethics	3	0	0	3	3	PE

PROFESSIONAL ELECTIVE V, SEMESTER VIII

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1808	Optimization of Chemical Processes	3	0	0	3	3	PE
2	CH1809	Fermentation Engineering	3	0	0	3	3	PE
3	CH1810	Nuclear Engineering	3	0	0	3	3	PE
4	CH1811	Energy Technology	3	0	0	3	3	PE

PROFESSIONAL ELECTIVE VI, SEMESTER VIII

THEORY								
S No	**SUB CODE**	**COURSE TITLE**	**L**	**T**	**P**	**H**	**C**	**CATEGORY**
1	CH1812	Fertilizer Technology	3	0	0	3	3	PE
2	CH1813	Pulp and Paper Technology	3	0	0	3	3	PE
3	CH1814	Mixing Theory and Practice	3	0	0	3	3	PE
4	CH1815	Petroleum Refining and Petrochemicals	3	0	0	3	3	PE

LIST OF COURSES FOR OPEN ELECTIVE I, SEMESTER V

S No	SUB CODE	COURSE TITLE	L	T	P	H	C	CATEGORY
1	OCE103	Environmental Impact Assessments	3	0	0	3	3	OE
2	OCS101	Introduction to C Programming	3	0	0	3	3	OE
3	OEE105	Solar Energy Utilization	3	0	0	3	3	OE
4	OBT101	Industrial Biotechnology	3	0	0	3	3	OE
5	OBT102	Hazardous Waste Management	3	0	0	3	3	OE
6	OEE106	Energy Conservation and Management	3	0	0	3	3	OE

LIST OF COURSES FOR OPEN ELECTIVE II, SEMESTER VII

S No	SUB CODE	COURSE TITLE	L	T	P	H	C	CATEGORY
1	OBT103	Fuel Cell Chemistry	3	0	0	3	3	OE
2	OEE102	Renewable Energy Sources	3	0	0	3	3	OE
3	OME102	Design of Experiments	3	0	0	3	3	OE
4	OBT104	Biosensors	3	0	0	3	3	OE
5	OME106	Testing of Materials	3	0	0	3	3	OE
6	OBT105	Introduction to Nanoscience and Nanotechnology	3	0	0	3	3	OE

AUDIT COURSE

S No	SUB CODE	COURSE TITLE	L	T	P	H	C	CATEGORY
1	AD1001	Constitution of India	2	0	0	0	2	AC
2	AD1002	Value Education	2	0	0	0	2	AC
3	AD1003	Pedagogy Studies	2	0	0	0	2	AC
4	AD1004	Stress Management by Yoga	2	0	0	0	2	AC
5	AD1005	Personality Development Through Life EnlightenmentSkills	2	0	0	0	2	AC
6	AD1006	Unnat Bharat Abhiyan **(Syllabus is not prescribed by AICTE)**	2	0	0	0	2	AC
7	AD1007	Essence of Indian KnowledgeTradition	2	0	0	0	2	AC
8	AD1008	Sanga Tamil LiteratureAppreciation	2	0	0	0	2	AC

SUBJECT AREAWISE DETAILS

HUMANITIES AND SOCIAL SCIENCES (HS)

S No	SUB CODE	COURSE TITLE	L	T	P	H	C
1	HS1101	Communicative English	4	0	0	3	3
2	HS1201	Professional English	4	0	0	4	3
3	GE1204	Environmental Science and Engineering	3	0	0	3	3

BASIC SCIENCES (BS)

S No	SUB CODE	COURSE TITLE	L	T	P	H	C
1	MA1102	Engineering Mathematics – I	4	0	0	4	4
2	PH1103	Engineering Physics	3	0	0	3	3
3	CY1104	Engineering Chemistry	3	0	0	3	3
4	GE112	Physics and Chemistry Laboratory	0	0	4	4	2
5	MA1202	Engineering Mathematics – II	4	0	0	4	4
6	PH1255	Physics of Materials	3	0	0	3	3
7	CH1207	Technical Analysis Laboratory	0	0	4	4	2
8	MA1353	Applied numerical analysis	4	0	0	4	4
9	MA1452	Applied probability and statistics	4	0	0	4	4
10	CH1401	Chemistry for chemical Engineers	3	0	0	3	3
11	CH1405	Instrumental Methods Of Chemical Analysis	3	0	0	3	3

ENGINEERING SCIENCES (ES)

S No	SUB CODE	COURSE TITLE	L	T	P	H	C
1	GE1101	Python Programming	3	1	0	4	3
2	GE1102	Engineering Graphics	2	0	4	5	4
3	GE213	Python Programming Laboratory	0	0	4	4	2
4	GE1205	Basic Civil and Mechanical Engineering	3	0	0	3	3
5	GE1207	Engineering Practices	0	0	4	4	2
6	EE1353	Principles of electrical and electronics engineering	3	0	0	3	3
7	CH1303	Solid Mechanics for technologists	3	0	0	3	3
8	EE1358	Electrical Engineering Laboratory	0	0	3	3	2

PROFESSIONAL CORE (PC)

S No	SUB CODE	COURSE TITLE	L	T	P	H	C
1	CH1201	Introduction to Chemical Engineering	3	0	0	3	2
2	CH1301	Process Calculations	3	1	0	4	4
3	CH1302	Fluid Mechanics for chemical Engineers	3	0	0	3	3
4	CH1307	Fluid Mechanics Laboratory	0	0	3	3	2
5	CH1402	Computer applications in Chemical Engineering (Integrated Lab)	3	0	2	5	4
6	CH1403	Mechanical operations	3	0	0	3	3
7	CH1404	Chemical Process Industries	3	0	0	3	3
8	CH1407	Mechanical operations Laboratory	0	0	3	3	2
9	CH1501	Chemical Reaction Engineering I	3	0	0	3	3
10	CH1502	Heat Transfer	3	0	0	3	3
11	CH1503	Mass Transfer I	3	0	0	3	3
12	CH1507	Heat and mass Transfer Laboratory	0	0	3	3	2
13	CH1508	Computational Programming Laboratory for Chemical Engineers	0	0	3	3	2
14	CH1601	Chemical Reaction Engineering II	3	1	0	4	4
15	CH1602	Mass Transfer II (Integrated Laboratory)	3	0	2	4	4
16	CH1603	Chemical Engineering Thermodynamics	3	0	0	3	3
17	CH1604	Process Dynamics and Control	3	0	0	3	3
18	CH1605	Process Economics and Industrial Management	3	0	0	3	3
19	CH1607	Professional Ethical Practice	0	0	0	0	1
20	CH1608	Chemical Reaction Engineering Laboratory	0	0	3	3	2
21	CH1701	Transport Phenomena	3	0	0	3	3
22	CH1702	Chemical Process Equipment Design (Integrated Lab)	3	0	2	5	4
23	CH1703	Industrial Safety	3	0	0	3	3
24	CH1707	Mini Project	0	0	3	3	2
25	CH1708	Process Control Laboratory	0	0	3	3	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S No	SUB CODE	COURSE TITLE	L	T	P	H	C
1	HS1410	Professional Skills Laboratory	0	0	3	2	1
2	CH1709	Internship	0	0	0	0	1

3	CH1807	Project Work	0	0	20	20	12

SUMMARY

S. No.	Subject Area	Credits Per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	HS	3	6	-	-	-	-	-	-	9
2	BS	12	9	4	10	-	-	-	-	35
3	ES	9	5	8	-	-	-	-	-	22
4	PC	-	2	9	12	13	20	14	-	70
5	PE	-	-	-	-	3	3	6	6	18
6	OE	-	-	-	-	3	-	3	-	6
7	EEC	-	-	-	1	-	-	1	12	14
Total		24	22	21	23	19	23	24	18	174

SEMESTER I

HS1101	Communicative English	L	T	P	C
		3	0	0	3

Objectives

- ✓ To develop the basic reading and writing skills of first year engineering and technology students
- ✓ To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- ✓ To help learners develop their speaking skills and speak fluently in real contexts.
- ✓ To help learners develop vocabulary of a general kind by developing their reading skills

Course Outcomes (CO)

CO1	To familiarize the student's basic concepts of units, dimensions, and other technical terms, and enable them to do unit conversions.
CO2	To introduce the concepts of material balances by taking industrial examples and train in mathematical computations with respect to bypass, purging and recycle operations
CO3	To introduce the concept of ideal and non-ideal systems and related problems and training the students with combustion problems.
CO4	Effectively bring in the concept of energy balances and computations in various types of energy balance problems related to chemical industries.
CO5	To bring in the latest advancements in design and modelling, related process simulators and problems on non ideal systems.

UNIT - I	SHARING INFORMATION RELATED TO ONESELF/FAMILY& FRIENDS	9

Reading – critical reading – finding key information in a given text – shifting facts from opinions - Writing - autobiographical writing - developing hints. Listening- short texts- short formal and informal conversations. Speaking- basics in speaking - introducing oneself - exchanging personal information- speaking on given topics & situations Language development– voices- Wh- Questions- asking and answering-yes or no questions– parts of speech. Vocabulary development-- prefixes- suffixes- articles - Polite Expressions.

UNIT - II	GENERAL READING AND FREE WRITING	9

Reading: Short narratives and descriptions from newspapers (including dialogues and conversations); Reading Comprehension Texts with varied question types - Writing – paragraph writing - topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures –. Listening - long texts - TED talks - extensive speech on current affairs and discussions Speaking — describing a simple process — asking and answering questions - Language development – prepositions, clauses. Vocabulary development- guessing meanings of words in context —use of sequence words.

UNIT - III	GRAMMAR AND LANGUAGE DEVELOPMENT	9

Reading- short texts and longer passages (close reading) & making a critical analysis of the given text Writing — types of paragraph and writing essays — rearrangement of jumbled sentences.Listening: Listening to ted talks and long speeches for comprehension. Speaking- role plays -asking about routine actions and expressing opinions. Language development- degrees of comparison- pronouns- Direct vs. Indirect Questions. Vocabulary development – idioms and phrases- cause & effect expressions, adverbs.

UNIT - IV	READING AND LANGUAGE DEVELOPMENT	9

Reading- comprehension-reading longer texts- reading different types of texts- magazines. Writing- letter writing, informal or personal letters-e-mails-conventions of personal email- Listening: Listening comprehension (IELTS, TOEFL and others). Speaking -Speaking about friends/places/hobbies - Language development- Tenses- simple present-simple past- present continuous and past continuous- conditionals — if, unless, in case, when and others Vocabulary development- synonyms-antonyms- Single word substitutes- Collocations.

UNIT - V	EXTENDED WRITING	9

Reading: Reading for comparisons and contrast and other deeper levels of meaning — Writing- brainstorming - writing short essays — developing an outline- identifying main andsubordinate ideas- dialogue writing- Listening - popular speeches and presentations - Speaking - impromptu speeches & debates Language development-modal verbs- present/ past perfect tense - Vocabulary Development-Phrasal verbs- fixed and semi-fixed expressions

Total Periods: 45 PERIODS

Text Books:

1. Board of Editors. Using English A Course book for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad: 2020
2. Sanjay Kumar & Pushp Lata Communication Skills Second Edition, Oxford University Press 2015.
3. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

Reference Books:

1. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge,2011.
2. Means, L. Thomas and Elaine Langlois. English & Communication For Colleges. Cengage Learning ,USA: 2007
3. Redston, Chris &Gillies Cunningham Face 2 Face (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005
4. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011
5. Dutt P. Kiranmai and Rajeevan Geeta Basic Communication Skills, Foundation Books: 2013
6. John Eastwood et al : Be Grammar Ready: The Ultimate Guide to English Grammar, Oxford University Press: 2020.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	0	0	3	0	0	3	0	0	3	0	0	3	1	2
CO2	0	0	0	0	0	0	0	0	0	0	0	0	1	2
CO3	3	0	1	3	0	1	3	0	1	3	0	1	1	2
CO4	1	0	2	1	0	2	1	0	2	1	0	2	1	2
CO5	1	0	1	1	0	1	1	0	1	1	0	1	1	2

MA1102	Engineering Mathematics – I	L	T	P	C
		4	0	0	4

Objectives

- ✓ The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus.
- ✓ The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelingthe engineering problems mathematically and obtaining solutions.
- ✓ Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering.
- ✓ This is a foundation course of Single Variable and multivariable calculus plays an important rolein the understanding of science, engineering, economics and computer science, among other
- ✓ disciplines.

Course Outcomes (CO)		
CO1	To have a clear idea of matrix algebra pertaining Eigenvalues and Eigenvectors in addition dealing with quadratic forms.	
CO2	To understand the concept of limit of a function and apply the same to deal with continuity and derivative of a given function. Apply differentiation to solve maxima and minima problems, which are related to real world problems.	
CO3	To have the idea of extension of a function of one variable to several variables. Multivariable functions of real variables are inevitable in engineering.	
CO4	To understand the concept of integration through fundamental theorem of calculus. Also, acquire skills to evaluate the integrals using the techniques of substitution, partial fraction and integration by parts along with the knowledge of improper integrals.	
CO5	To do double and triple integration so that they can handle integrals of higher order which are applied in engineering field.	
UNIT - I	**MATRICES**	**12**
Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms		
UNIT - II	**CALCULUS OF ONE VARIABLE**	**12**
Limit of a function - Continuity - Derivatives - Differentiation rules – Interval of increasing and decreasing functions – Maxima and Minima - Intervals of concavity and convexity.		
UNIT - III	**CALCULUS OF SEVERAL VARIABLES**	**12**
Partial differentiation – Homogeneous functions and Euler‘s theorem – Total derivative – Changeof variables — Jacobians — Partial differentiation of implicit functions — Taylor‘s series for functions of two variables – Maxima and minima of functions of two variables – Lagrange‘s method of undetermined multipliers.		
UNIT - IV	**INTEGRAL CALCULUS**	**12**
Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.		
UNIT - V	**MULTIPLE INTEGRALS**	**12**
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Change of variables from Cartesian to polar in double integrals- Triple integrals – Volume of solids		
	Total Periods:	**60 PERIODS**

Text Books:

1. Grewal B.S., Higher Engineering Mathematics‖, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendental", Cengage Learning, 7th Edition, New Delhi,2015. [For Units I & III - Sections 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.2

Reference Books:

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition, 2016.
2. Jain R.K. and Iyengar S.R.K., ―Advanced Engineering Mathematics‖, Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., ―Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.

5. T. Veerarajan. Engineering Mathematics – I, McGraw Hill Education; First edition 2017.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	1	2	3	0	0	3	2	3	3	2	2
CO2	3	3	3	2	2	1	0	0	0	0	1	2	2	1
CO3	3	3	3	2	2	1	0	0	0	0	1	2	2	2
CO4	3	3	3	2	2	1	0	0	0	0	1	2	2	2
CO5	3	3	3	2	1	1	0	0	0	0	1	2	2	2

PH1103	Engineering Physics	L	T	P	C
		3	0	0	3

Objectives

To make the students conversant with

- ✓ Elastic properties of materials and various moduli of elasticity.
- ✓ Principles of laser and fiber optics and its various technological applications.
- ✓ Thermal conduction in solids, heat exchangers and its applications in various devices.
- ✓ Quantum concepts to explain black body radiation, Compton effect and matter waves.
- ✓ Various crystal structures, Miller indices and crystal growth techniques.

Course Outcomes (CO)

CO1	To understand the elastic property and stress strain diagram, determination of rigidity modulus by torsionalpendulum and Young's modulus by various methods.
CO2	To understand the principle of laser, Einstein's coefficients of laser action, semiconductor laser and its applications, optical fibers and their applications in sensors and communication system.
CO3	To understand the heat transfer through solids and the determination of thermal conductivity in a badconductor by Lee's disc method and radial flow of heat.
CO4	To know the quantum concepts and its use to explain black body radiation, Compton effect andwave equation for matter waves, tunnelling electron microscopy and its applications.
CO5	To understand the importance of various crystal structures, Miller indices and various growth techniques.

UNIT - I **PROPERTIES OF MATTER** **9**

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment – Practical applications of modulus of elasticity- I shaped girders - stress due to bending in beams.

UNIT - II **LASER AND FIBER OPTICS** **9**

Lasers : population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Nd-YAG Laser-Semiconductor lasers: homojunction and heterojunction – Industrial and medical applications of Laser– Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – losses associated with optical fibers – Fabrication of Optical fiber- Double crucible method-fibre optic sensors: pressure and displacement-Industrial and medical applications of optical fiber- Endoscopy-Fiber optic communication system.

UNIT - III	THERMAL PHYSICS	9

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation – heat conductions in solids – thermal conductivity –Rectilinear flow of heat-conduction through compound media (series and parallel)- Lee's disc method: theory and experiment - Radial flow of heat– thermal insulation – applications: heat exchangers, refrigerators, oven, Induction furnace and solar water heaters.

UNIT - IV	QUANTUM PHYSICS	9

Black body radiation – Planck's theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box – Electron microscope-tunnelling (qualitative) - scanning tunnelling microscope-Applications of electron microscopy.

UNIT - V	CRYSTAL PHYSICS	9

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures – Graphite structure-crystal imperfections: point defects, line defects – Burger vectors, stacking faults – growth of single crystals: solution and melt growth techniques- Epitaxial growth-Applications of Single crystal (Qualitative).

Total Periods:	45 PERIODS

Text Books:

1. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2017.
2. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2013.

Reference Books:

1. Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2019.
3. Tipler, P.A. & Mosca, G. "Physics for Scientists and Engineers with Modern Physics'. W.H.Freeman, 2014.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	3	2	2	1	3	2	1	2	3	2
CO2	3	3	3	2	3	2	2	1	2	2	2	1	2	2
CO3	3	3	2	2	2	1	2	1	2	1	1	2	2	2
CO4	3	3	2	2	2	1	1	1	1	1	1	3	3	3
CO5	3	3	3	3	2	1	2	1	3	1	1	3	3	3

CY1104	Engineering Chemistry	L	T	P	C
		3	0	0	3

Objectives

To make the student conversant with the

- ✓ Principles of water characterization and treatment for industrial purposes.
- ✓ Principles and applications of surface chemistry and catalysis.
- ✓ Phase rule and various types of alloys

- ✓ Various types of fuels, applications and combustion
- ✓ Conventional and non–conventional energy sources and energy storage device

Course Outcomes (CO)

CO1	Able to understand impurities in industrial water, boiler troubles, internal and external treatment methods of purifying water.
CO2	Able to understand concepts of absorption, adsorption, adsorption isotherms, application of adsorption for pollution abatement, catalysis and enzyme kinetics.
CO3	Able to recognize significance of alloying, functions of alloying elements and types of alloys, usesof alloys, phase rule, reduced phase and its applications in alloying.
CO4	Able to identify various types of fuels, properties, uses and analysis of fuels. They should be ableto understand combustion of fuels, method of preparation of bio-diesel, synthetic petrol.
CO5	Able to understand conventional, non-conventional energy sources, nuclear fission and fusion, power generation by nuclear reactor, wind, solar energy and preparation, uses of various batteries.

UNIT - I	**WATER AND ITS TREATMENT**	**9**

Hardness of water – Types – Expression of hardness – Units – Estimation of hardness by EDTA method – Numerical problems on EDTA method – Boiler troubles (scale and sludge, caustic embrittlement , boiler corrosion, priming and foaming) – Treatment of boiler feed water – Internal treatment (carbonate, phosphate, colloidal, sodium aluminate and calgon conditioning) – External treatment – Ion exchange process, Zeolite process – Desalination of brackish water by reverse Osmosis.

UNIT - II	**SURFACE CHEMISTRY AND CATALYSIS**	**9**

Surface chemistry : Types of adsorption – Adsorption of gases on solids – Adsorption of solute from solutions – Adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – Kinetics of uni-molecular surface reactions – Adsorption in chromatography – Applications of adsorption in pollution abatement using PAC.

Catalysis: Catalyst – Types of catalysis – Criteria – Contact theory – Catalytic poisoning and catalytic promoters – Industrial applications of catalysts – Catalytic convertor – Auto catalysis – Enzyme catalysis – Michaelis-Menten equation.

UNIT - III	**PHASE RULE AND ALLOYS**	**9**

Phase rule: Introduction – Definition of terms with examples – One component system – Water system – Reduced phase rule – Thermal analysis and cooling curves – Two component systems – Lead-silver system – Pattinson process.

Alloys: Introduction – Definition – Properties of alloys – Significance of alloying – Functions and effect of alloying elements – Nichrome, Alnico, Stainless steel (18/8) – Heat treatment of steel – Non-ferrous alloys – Brass and bronze.

UNIT - IV	**FUELS AND COMBUSTION**	**9**

Fuels: Introduction – classification of fuels – Comparison of solid, liquid, gaseous fuels – Coal – Analysis of coal (proximate and ultimate) – Carbonization – Manufacture of metallurgical coke (Otto Hoffmann method) – Petroleum – Cracking – Manufacture of synthetic petrol (Bergius process, Fischer Tropsch Process) – Knocking – Octane number

– Diesel oil – Cetane number – Compressed natural gas (CNG) – Liquefied petroleum gases (LPG) – Power alcohol and biodiesel.

Combustion of fuels: Introduction – Calorific value – Higher and lower calorific values – Theoretical calculation of calorific value – Ignition temperature – Spontaneous ignition temperature – Explosive range – Flue gas analysis by Orsat Method.

UNIT - V	NON–CONVENTIONAL ENERGY SOURCES AND STORAGE DEVICES	9

Nuclear energy – Fission and fusion reactions – Differences – Chain reactions – Nuclear reactors – Classification of reactors – Light water nuclear reactor for power generation – Breeder reactor – Solar energy conversion – Solar cells – Wind energy – Fuel cells – Hydrogen-oxygen fuel cell .

Batteries – Types of batteries - Alkaline batteries – Lead-acid, Nickel-cadmium and Lithium batteries

Total Periods: 45 PERIODS

Text Books:

1. P.C.Jain, Monica Jain, "Engineering Chemistry" 17th Ed., Dhanpat Rai Pub. Co., New Delhi, (2015).
2. S.S. Dara, S.S. Umare, "A text book of Engineering Chemistry" S.Chand & Co.Ltd., New Delhi (2020).
3. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India (P) Ltd. New Delhi, (2018).
4. P. Kannan, A. Ravikrishnan, "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company (P) Ltd., Chennai, (2009).

Reference Books:

1. B.K.Sharma "Engineering Chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2001).
2. B. Sivasankar "Engineering Chemistry" Tata McGraw–Hill Pub.Co.Ltd, New Delhi (2008).
3. Prasanta Rath, "Engineering Chemistry", Cengage Learning India (P) Ltd., Delhi, (2015).
4. Shikha Agarwal, "Engineering Chemistry–Fundamentals and Applications", Cambridge University Press, Delhi, (2015).
5. A. Pahari, B. Chauhan, "Engineering Chemistry", Firewall Media, New Delhi., (2010).
6. A. Sheik Mideen, Engineering Chemistry, Airwalk Publications, Chennai (2018)

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	3	2	3	2	2	2	2	2	2	2
CO2	3	3	2	2	2	2	2	1	1	1	1	2	2	2
CO3	3	3	3	3	3	2	2	1	2	2	2	2	2	2
CO4	3	3	3	2	2	3	3	2	2	3	2	2	3	2
CO5	3	2	3	3	3	3	3	2	2	2	2	2	3	2

GE1105	Problem Solving and Python Programming (Common for all branches of B.E. /B. Tech Programmes)	L	T	P	C
		3	0	0	3

Objectives

- ✓ To know the basics of algorithmic problem solving
- ✓ To write simple python programs
- ✓ To develop python program by using control structures and functions
- ✓ To use python predefined data structures
- ✓ To write file based program

Course Outcomes (CO)

CO1	Develop algorithmic solutions to simple computational problems

CO2	Develop simple console application in python	
CO3	Develop python program by applying control structure and decompose program into functions.	
CO4	Represent compound data using python lists, tuples, and dictionaries.	
CO5	Read and write data from/to files in Python.	
UNIT - I	**ALGORITHMIC PROBLEM SOLVING**	**9**
Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, Basic algorithms, flowcharts and pseudocode for sequential, decision processing and iterative processing strategies, Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.		
UNIT - II	**INTRODUCTION TO PYTHON**	**9**
Python Introduction, Technical Strength of Python, Python interpreter and interactive mode; Introduction to colab , pycharm and jupyter idle(s) ,values and types: int, float, boolean, string, and list; Built-in data types, variables, Literals, Constants, statements, Operators; Assignment, Arithmetic, Relational, Logical, Bitwise operators and their precedence, , expressions, tuple assignment; Accepting input from Console, printing statements, Simple 'Python' programs.		
UNIT - III	**CONTROL FLOW, FUNCTIONS AND STRINGS**	**9**
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: while, for; Loop manipulation using pass, break, continue, and else; Modules and Functions, function definition and use, flow of execution, parameters and arguments; local and global scope, return values, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.		
UNIT - IV	**LISTS, TUPLES, DICTIONARIES**	**9**
Lists: Defining list and list slicing, list operations, list slices, list methods, list loop, List Manipulation, mutability, aliasing, cloning lists, list parameters; Lists as arrays, Tuples: tuple assignment, tuple as return value, Tuple Manipulation; Dictionaries: operations and methods; advanced list processing – list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.		
UNIT - V	**FILES, MODULES, PACKAGES**	**9**
Files and exception: Concept of Files, Text Files; File opening in various modes and closing of a file, Format Operators, Reading from a file, Writing onto a file, File functions-open(), close(), read(), readline(), readlines(),write(), writelines(),tell(),seek(), Command Line arguments. Errors and exceptions, handling exceptions, modules, packages; introduction to numpy, matplotlib. Illustrative programs: word count, copy file.		
	Total Periods:	**45 PERIODS**

Text Books:

1. Reema Thareja, "Python Programming using problem solving approach", Oxford University Press, 2nd edition, 2018.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist‘‘, 2nd edition, Updated for Python 3, Shroff/O‘Reilly Publishers, 2016
3. (http://greenteapress.com/wp/thinkpython/)
4. Guido van Rossum and Fred L. Drake Jr, ―An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

Reference Books:

1. John V Guttag, ―Introduction to Computation and Programming Using Python‘‘, Revised and expanded Edition, MIT Press , 2013.
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3. Timothy A. Budd, ―Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd.,, 2015.
4. Kenneth A. Lambert, ―Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
5. Charles Dierbach, ―Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
6. Paul Gries, Jennifer Campbell and Jason Montojo, ―Practical Programming: An Introduction.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	-	2	-	-	2	3	2	-	2	1	1
CO2	3	3	3	-	2	-	-	2	3	2	-	2	1	1
CO3	3	3	3	-	2	-	-	2	3	2	-	2	1	1
CO4	3	3	3	-	2	-	-	2	3	2	-	2	1	1
CO5	3	3	3	-	2	-	-	2	3	2	-	2	1	1

GE1106	Engineering Graphics (Common for all branches of B.E. /B. Tech Programmes)	L	T	P	C
		2	4	0	4

Objectives

- ✓ To develop graphic skills for communication of concepts, ideas and design of engineering products.
- ✓ To inculcate drawing practice in standardized form whenever technical drawing is needed.
- ✓ To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination)

- ✓ Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering anddimensioning.

Course Outcomes (CO)

CO1	To understand the fundamentals and standards of Engineering graphics
CO2	To perform freehand sketching of basic geometrical constructions and multiple views of objects
CO3	To understand the concept of orthographic projections of lines and plane surfaces
CO4	To draw the projections of section of solids and development of surfaces
CO5	To visualize and to project isometric and perspective sections of simple solids

UNIT - I **PLANE CURVES AND FREEHAND SKETCHING** **7+12**

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloidal curves – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects (Draw without using drawing instruments)

UNIT - II	PROJECTION OF POINTS, LINES AND PLANE SURFACE	6+12
Orthographic projection- Principles-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 and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.		
UNIT - III	**PROJECTION OF SOLIDS**	**5+12**
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes when the solid is simply suspended by rotating object method.		
UNIT - IV	**PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENTOFSURFACES**	**5+12**
Sectioning of simple solids like prisms, pyramids, cylinder, 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 - Graphically finding the shortest distance connecting two points.		
UNIT - V	**ISOMETRIC AND PERSPECTIVE PROJECTIONS**	**6+12**
Principles of isometric projection – isometric scale –Isometric projections and isometric views of simple solids and truncated solids – Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.		
	Total Periods:	**90 PERIODS**

Text Books:

1. Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, Twenty ninth edition 2017
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2011.
3. S. Ramachandran and K. Pandian, "Engineering Graphics" Airwalk Publications; 8th edition 2014

Reference Books:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2018.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2018.
4. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Comput er Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2009.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	1	2	1	1	-	-	3	3	2	3	1	-
CO2	3	1	2	2	1	1	-	-	3	3	2	3	1	-
CO3	3	1	1	3	1	1	-	-	3	3	2	3	1	-
CO4	3	1	1	3	1	1	-	-	3	3	2	3	1	-
CO5	3	1	2	3	1	1	-	-	3	3	2	3	1	-

GE1107	**Problem Solving and Python Programming Laboratory** (Common for all branches of B.E. /B. Tech Programmes)	**L**	**T**	**P**	**C**
		0	4	0	2

Objectives

- ✓ To write, test, and debug simple Python programs.
- ✓ To implement Python programs with conditionals and loops.
- ✓ Use functions for structuring Python programs.
- ✓ Represent compound data using Python lists, tuples, and dictionaries.
- ✓ Read and write data from/to files in Python.

Course Outcomes (CO)

CO1	To develop simple console applications through python with control structure and functions
CO2	To understand the python built in data structures like lists, tuples, and dictionaries for representing compounddata.
CO3	Read and write data from/to files in Python and applications of python.

1. Write an algorithm, draw flowchart illustrating mail merge concept.
2. Write an algorithm, draw flowchart and write pseudo code for a real life or scientific or technical problems.
3. Scientific problem solving using decision making and looping.
   - ✓ Armstrong number, palindrome of a number, Perfect number.
4. Simple programming for one dimensional and two dimensional arrays.
   - ✓ Transpose, addition, multiplication, scalar , determinant of a matrix
5. Program to explore string functions and recursive functions.
6. Utilizing 'Functions' in Python
   - ✓ Find mean, median, mode for the given set of numbers in a list.
   - ✓ Write a function dup to find all duplicates in the list.
   - ✓ Write a function unique to find all the unique elements of a list.
   - ✓ Write function to compute gcd, lcm of two numbers.

7.Demonstrate the use of Dictionaries and tuples with sample programs.

8.Implement Searching Operations: Linear and Binary Search.

9.To sort the 'n' numbers using: Selection, Merge sort and Insertion Sort.

10.Find the most frequent words in a text of file using command line arguments.

11.Demonstrate Exceptions in Python.

12.Applications: Implementing GUI using turtle, pygame.

Total Periods:	**60 PERIODS**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

- ✓ Python 3 interpreter for Windows/Linux

Reference Books:

1. Reema Thareja, "Python Programming using problem solving approach", Oxford University Press, 2nd edition, 2018.
2. Allen B. Downey , " Think Python: How to Think Like a Computer Scientist", Second Edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016.
3. Shroff "Learning Python: Powerful Object-Oriented Programming; Fifth edition, 2013. David M.Baezly "Python Essential Reference". Addison-Wesley Professional; Fourth edition, 2009.
4. David M. Baezly "Python Cookbook" O'Reilly Media; Third edition (June 1, 2013)
5. http://www.edx.org

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	-	2	-	-	2	3	2	-	2	1	1
CO2	3	3	3	-	2	-	-	2	3	2	-	2	1	1
CO3	3	3	3	-	2	-	-	2	3	2	-	2	1	1

BS1108	Physics and chemistry laboratory	L	T	P	C
		0	4	0	2

Objectives

The students will be trained to perform experiments to study the following.

- ✓ The Properties of Matter
- ✓ The Optical properties, Characteristics of Lasers & Optical Fibre
- ✓ Electrical & Thermal properties of Materials
- ✓ Enable the students to enhance accuracy in experimental measurements.
- ✓ To make the student to acquire practical skills in the determination of water qualityparameters through volumetric analysis
- ✓ Instrumental method of analysis such as potentiometry, conductometry and pHmetry

Course Outcomes (CO)

CO1	Able to understand the concept about the basic properties of matter like stress, strain and types of moduli. Able to understand the procedure to estimate the amount of dissolved oxygen present in the water.
CO2	Able to understand the concept of optics like reflection, refraction, diffraction by using spectrometer grating. Able to understand the concept about measuring the conductance of strong acid and strong base and mixture of acids by using conductivity meter.
CO3	Able to understand the thermal properties of solids and to calculate thermal conductivity of a bad conductor. Able to understand the principle and procedure involved in the amount of chloridepresent in the given sample of water.

CO4	Able to understand the concept of microscope and its applications in determining the moduli. Able to understand the concept of determining the emf values by using potentiometer.
CO5	Able to calculate the particle size of poly crystalline solids. Able to understand the concept of determining the pH value and strength of a given acid sampleby using pH meter.
Total Periods:	**60 PERIODS**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

- ✓ Python 3 interpreter for Windows/Linux

LIST OF EXPERIMENTS – PHYSICS

(A minimum of 5 experiments to be performed from the given list)

1. Determination of Young's modulus of the material of the given beam by Non-uniform bending method.
2. Determination of rigidity modulus of the material of the given wire using torsion pendulum.
3. Determination of wavelength of mercury spectra using Spectrometer and grating.
4. Determination of dispersive power of prism using Spectrometer.
5. (a) Determination of wavelength and particle size using a laser.
   (b) Determination of numerical aperture and acceptance angle of an optical fibre.
   (c) Determination of width of the groove of compact disc using laser.
6. Determination of Young's modulus of the material of the given beam by uniform bending method.
7. Determination of energy band gap of the semiconductor.
8. Determination of coefficient of thermal conductivity of the given bad conductor using Lee's disc.

DEMONSTRATION EXPERIMENT

1. Determination of thickness of a thin sheet / wire – Air wedge method

LIST OF EXPERIMENTS – CHEMISTRY

(A minimum of 6 experiments to be performed from the given list)

1. Estimation of HCl using Na2CO3 as primary standard and determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
10. Conductometric titration of strong acid vs strong base.

DEMONSTRATION EXPERIMENTS

1. Estimation of iron content of the water sample using spectrophotometer (1, 10- Phenanthroline / thiocyanate method).
2. Estimation of sodium and potassium present in water using flame photometer.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	2	2	2	1	1	1	3	2	2	3	2	2
CO2	3	1	2	1	1	1	1	1	2	1	1	2	2	2
CO3	3	1	2	1	2	2	2	1	2	1	1	1	2	2
CO4	3	2	1	1	2	1	1	1	2	1	1	2	2	1
CO5	3	2	1	1	1	2	2	1	2	1	2	1	2	1

SEMESTER II

HS1201	Professional English	L	T	P	C
		4	0	0	3

Objectives

The Course prepares second semester engineering and Technology students to:

- ✓ Develop strategies and skills to enhance their ability to read and comprehend Engineering and technology texts.
- ✓ Foster their ability to write convincing job applications and effective reports.
- ✓ Develop their speaking skills to make technical presentations, participate in group discussions.
- ✓ Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialization.

Course Outcomes (CO)

CO1	Speak clearly, confidently, comprehensibly, and communicate with one or many listeners using appropriate communicative strategies.
CO2	Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.
CO3	Read different genres of texts adopting various reading strategies.
CO4	Listen/view and comprehend different spoken discourses/excerpts in different accents
CO5	Identify topics and formulate questions for productive inquiry

UNIT - I	INTRODUCTION TO PROFESSIONAL ENGLISH	9

Listening: Listening to technical talks with comprehension tasks - Speaking – conversation methods in real life occurrences using expressions of different emotions and imperative usages - Reading – reading short technical texts from journals- newspapers- Writing- purpose statements – extended definitions – writing instructions – checklists- recommendations- Vocabulary Development- technical vocabulary Language Development – tenses- subject verb agreement - compound words.

UNIT - II	READING AND STUDY SKILLS	9

Listening-Listening Comprehension of a discussion on a technical topic of common interest by three or four participants (real life as well as online videos). -Speaking – describing a process- Reading: Practice in chunking and speed reading - Paragraphing- Writing- interpreting charts, graphs- Vocabulary Development: Important foreign expressions in Use, homonyms, homophones, homographs- easily confused words Language Development- impersonal passive voice, numerical adjectives.

UNIT - III	TECHNICAL WRITING AND GRAMMAR	9

Listening – listening to conversation – effective use of words and their sound aspects, stress, intonation & pronunciation - Speaking – mechanics of presentations -Reading: Reading longer texts for detailed understanding. (GRE/IELTS practice tests); Writing- Describing a process, use of sequence words- Vocabulary Development- sequence words- Informal vocabulary and formal substitutes-Misspelled words. Language Development- embedded sentences and Ellipsis.

UNIT - IV	**REPORT WRITING**	**9**

Listening – Model debates & documentaries and making notes. Speaking – expressing agreement/disagreement, assertiveness in expressing opinions-Reading: Technical reports, advertisements and minutes of meeting - Writing- email etiquette- job application – cover letter –Résumé preparation(via email and hard copy)- analytical essays and issue based essays--Vocabulary Development- finding suitable synonyms-paraphrasing- Language Development- clauses- if conditionals.

UNIT - V	**GROUP DISCUSSION AND JOBAPPLICATIONS**	**9**

Listening: Extensive Listening. (radio plays, rendering of poems, audio books and others) Speaking –participating in a group discussion - Reading: Extensive Reading (short stories, novels, poetry and others)– Writing reports- minutes of a meeting- accident and survey- Writing a letter/ sending an email to the Editor - cause and effect sentences -Vocabulary Development- verbal analogies. Language Development- reported speech.

Total Periods:	**45 PERIODS**

Text Books:

1. Board of editors. Fluency in English A Course book for Engineering and Technology. Orient Blackswan, Hyderabad: 2020.
2. Barun K Mitra, Effective Technical Communication Oxford University Press : 2006.
3. Sudharshana.N.P and Saveetha. C. English for Technical Communication. Cambridge University Press: New Delhi, 2016

Reference Books:

1. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice. Oxford University Press: New Delhi,2014.
2. Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015
3. Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
4. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007
5. Means, L. Thomas and Elaine Langlois, English & Communication For Colleges. Cengage Learning,USA: 2007.
6. Caroline Meyer & Bringi dev, Communicating for Results Oxford University Press: 2021.
7. Aruna Koneru, Professional Speaking Skills, Oxford University Press :2015.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	0	0	3	0	0	3	0	0	3	0	0	3	1	2
CO2	0	0	0	0	0	0	0	0	0	0	0	0	1	2
CO3	3	0	1	3	0	1	3	0	1	3	0	1	1	2
CO4	1	0	2	1	0	2	1	0	2	1	0	2	1	2
CO5	1	0	1	1	0	1	1	0	1	1	0	1	1	2

MA1202	**Engineering Mathematics – II** (Common to branches of B.E / B.Tech Programmes except AI&DS and AI&ML)	**L**	**T**	**P**	**C**
		4	0	0	4

Objectives

- ✓ This course is designed to cover topics such as Differential Equations, Vector Calculus, Complex Analysis and Laplace Transform.
- ✓ The various methods of complex analysis and Laplace transforms can be used for efficiently
- ✓ solving the problems that occur in various branches of engineering disciplines.

Course Outcomes (CO)

CO1	The students will be imbibed with techniques in solving ordinary differential equations that arises in most of the engineering problems
CO2	The students will be acquainted with the concepts of vector calculus like Gradient, Divergence, Curl, Directional derivative, Irrational vector and Solenoidal vector. The course gives an understanding of Vector integration, needed for problems in all engineering disciplines.
CO3	The students will develop an understanding of the standard techniques of complex variable and mapping so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow of electric current .
CO4	The student will be exposed to the concept of Cauchy's integral theorem, Taylor and Laurent expansions, Singular points, Application of residue theorem to evaluate complex integrals.
CO5	Students will understand the purpose of using transforms to create new domain in which can give easier ways to handle the problem that is being investigated.

UNIT - I	**ORDINARY DIFFERENTIAL EQUATIONS**	**12**

Higher order linear differential equations with constant coefficients - Method of variation of parameters– Homogenous equation of Euler's and Legendre's type – System of simultaneous first order linear differential equations with constant coefficients

UNIT - II	**VECTOR CALCUCUS**	**12**

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and simple application in evaluating line, surface and volume integrals.

UNIT - III	**COMPLEX VARIABLES**	**12**

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polarcoordinates (C-R equations) - Properties – Harmonic conjugates – Construction of analytic function (Milne-Thomson method) – Conformal mapping – Standard transformations W = Z +C, CZ, 1/Z - Bilinear transformation.

UNIT - IV	**COMPLEX INTEGRATION**	**12**

Cauchy integral theorem – Cauchy integral formula – Taylor and Laurent series – Singularities – Residues – Cauchy's Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour(excluding poles on the real line).

UNIT - V	**LAPLACE TRANSFORMS**	**12**

Existence conditions — Transforms of elementary functions — Transform of unit step function and unit impulse function - Basic properties - Shifting theorems – transforms of derivatives and integrals –Transform of periodic functions - Inverse transforms using properties, partial fractions and Convolution theorem — Application to solution of linear second order ordinary differential equations with constant coefficients.

Total Periods:	**60 PERIODS**

Text Books:

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 44th Edition, 2018.
2. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

Reference Books:

1. Bali N., Goyal M. and Watkins C., Advanced Engineering Mathematics, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2017.
2. Jain R.K. and Iyengar S.R.K., Advanced Engineering Mathematics , Narosa Publications, New Delhi , 3rd Edition, 2007.
3. O'Neil, P.V. Advanced Engineering Mathematics , Cengage Learning India Pvt., Ltd, New Delhi, 2007.
4. Sastry, S.S, Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd,4th Edition, New Delhi, 2014.
5. T. Veerarajan. Engineering Mathematics – II, McGraw Hill Education; First edition 2017.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	3	2	1	0	0	0	0	1	2	1	1
CO2	3	3	3	1	1	1	0	0	0	0	2	1	2	2
CO3	3	3	3	2	1	1	0	1	0	0	1	1	1	2
CO4	3	3	3	1	0	0	0	0	0	0	1	0	2	1
CO5	3	3	3	1	0	0	0	0	0	0	1	0	1	2

PH1255	**Physics of materials** (Common to BIO & CHEM)	**L**	**T**	**P**	**C**
		3	0	0	3

Objectives

To make the student conversant with the

- ✓ Electronic properties in metals, properties of superconductors and its applications.
- ✓ Intrinsic and extrinsic semi conductors, Hall effect, LED, organic LED and solar cells.
- ✓ Types of magnetic materials and their applications, types of polarization and application
- ✓ Types, synthesis, properties and applications of nanostructured materials.
- ✓ Importance of various new engineering materials like ceramics, SMA, metallic glasses andbiomaterials.

Course Outcomes (CO)

CO1	Have the knowledge about carrier density calculation in metals, properties of superconductorsand its applications.
CO2	Have the knowledge about carrier density calculation in intrinsic and extrinsic semiconductors,Hall effect, LED, OLED and solar cells.
CO3	Obtain the knowledge about magnetic and dielectric materials and their applications.
CO4	Explore the knowledge about types, synthesis, properties and applications of nanostructuredmaterials.
CO5	Understand the importance, properties and applications of various new engineering materialslike ceramics, SMA, metallic glasses and biomaterials.

UNIT - I	**CONDUCTING AND SUPERCONDUCTING MATERIALS**	**9**

Classical free electron theory – expression for electrical conductivity – thermal conductivity, Wiedemann-Franz law – electrons in metals: particle in a three-dimensional box (Qualitative) – degenerate states – Fermi-Dirac statistics – density of energy states – electron in periodic potential (concept only) – electron effective mass – concept of

hole – Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I andType II superconductors, High Tc superconductors – Magnetic levitation and SQUIDS.

UNIT - II	SEMICONDUCTING MATERIALS	9

Elemental Semiconductors – Compound semiconductors – Origin of band gap in solids (qualitative) – carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Hall effect – determination of Hall coefficient –LED – Organic LED-Solar cells.

UNIT - III	DIELECTRIC AND MAGNETIC MATERIALS	9

Dielectric materials – Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation –Frequency and temperature variation of dielectric materials- dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites - magnetoresistance - Giant magneto-resistance - Introduction to spintronics.

UNIT - IV	NANO MATERIALS	9

Nanoscience and technology – Surface to volume ratio – Classifications of nanostructured materials – nano particles – quantum dots, nanowires, ultra-thin films-multilayered materials.Bottom-up Synthesis –Top-down Approach: Co-Precipitation, Ultrasonication, ball Milling, sol- gel method-Properties: electrical, magnetic, catalytic and antimicrobial resistance – Applications of nanomaterials in agriculture and medicine.

UNIT - V	NEW MATERIALS AND APPLICATIONS	9

Metallic glasses – Shape memory alloys: Copper, Nickel and Titanium based alloys – graphene, graphene oxide and its properties – Ceramics: types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals – Biomaterials: hydroxyapatite – PMMA – Silicone – Sensors: Chemical Sensors - Bio-sensors – conducting and semiconducting polymers – Nano fluids-Electro andmagneto rheological fluids.

Total Periods:	45 PERIODS

Text Books:

1. Balasubramaniam, R. “Callister's Materials Science and Engineering”. Wiley India Pvt. Ltd. 2014.
2. Kasap, S.O. “Principles of Electronic Materials and Devices”. McGraw-Hill Education, 2017.
3. Wahab, M.A. “Solid State Physics: Structure and Properties of Materials”. Narosa Publishing House, 2009.

Reference Books:

1. Askeland, D. “Materials Science and Engineering”. Brooks/Cole, 2010
2. Raghavan, V. “Materials Science and Engineering : A First course”. PHI Learning, 2015.
3. Smith, W.F., Hashemi, J. & Prakash. R. “Materials Science and Engineering”. Tata McGraw Hill Education Pvt. Ltd., 2014.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	1	1	1	1	1	1	1	1	1	1	2	1
CO2	3	3	2	2	1	1	1	1	1	1	1	2	2	1
CO3	3	3	2	3	2	1	1	1	1	1	1	3	3	1
CO4	3	3	3	3	2	3	3	1	2	1	2	3	3	2
CO5	3	3	3	3	2	3	2	1	2	1	2	3	3	2

GE1204	Environmental science and engineering	L	T	P	C
		3	0	0	3

Objectives

- ✓ To study the inter relationship between living organisms and environment.
- ✓ To appreciate the importance of environment by assessing its impact on the human world; envisionthe surrounding environment, its functions and its value.
- ✓ To find and implement scientific, technological, economic and political solutions to environmental problems.
- ✓ To study the integrated themes and biodiversity, natural resources, pollution control and waste management.
- ✓ To study the dynamic processes and understand the features of the earth's interior and surface.

Course Outcomes (CO)

CO1	To obtain knowledge about environment, ecosystems and biodiversity.
CO2	To take measures to control environmental pollution.
CO3	To gain knowledge about natural resources and energy sources.
CO4	To find and implement scientific, technological, economic and political solutions to theenvironmental problems.
CO5	To understand the impact of environment on human population and human health.

UNIT - I ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY **11**

Definition, scope and importance of environment – Need for public awareness – Role of Individual in Environmental protection – Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Food chains, food webs and ecological pyramids – Ecological succession – Types, characteristic features, structure and function of forest, grass land, desert and aquatic (ponds, lakes, rivers, oceans, estuaries) ecosystem.

Biodiversity — Definition — Genetic, species and ecosystem diversity — Value of biodiversity – Consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega diversity nation – Hot spots of biodiversity – Threats to biodiversity– Habitat loss, poaching of wild life, human-wildlife conflicts – Wildlife protection act and forest conservation act –Endangered and endemic species – Conservation of biodiversity – In-situ and ex-situ conservation of biodiversity.

UNIT - II ENVIRONMENTAL POLLUTION **9**

Definition — Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management: causes, effects and control measures of municipal solidwastes – Problems of e-waste – Role of an

individual in prevention of pollution – Pollution casestudies – Disaster management – Floods, earthquake, cyclone, tsunami and landslides – Fieldstudy of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT - III	NATURAL RESOURCES	9

Forest resources: Uses and over-exploitation – Deforestation – Case studies – Timber extraction, mining, dams and their effects on forests and tribal people – Water resources – Use and overutilization of surface and ground water, floods, drought, conflicts over water – Dams: benefits and problems – Mineral resources: Uses and exploitation – Environmental effects of extracting and using mineral resources – Case studies – Food resources: World food problems – Changes caused by agriculture and overgrazing – Effects of modern agriculture: fertilizer–pesticide problems, water logging, salinity – Case studies – Energy resources: Growing energy needs – Renewable and non renewable energy sources – Use of alternate energy sources – Case studies – Land resources: Land as a resource – Land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles – Field study of local area to document environmental assets – River / Forest / Grassland / Hill / Mountain.

UNIT - IV	SOCIAL ISSUES AND THE ENVIRONMENT	8

From unsustainable to sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, case studies – Role of non-governmental organization – Environmental ethics – Issues and possible solutions – Climate change – Global warming – Acid rain, Ozone layer depletion –Nuclear accidents and holocaust – Case studies – Wasteland reclamation – Consumerism and waste products – Principles of Green Chemistry – Environment protection act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife protection Act – Forest conservation Act – Enforcement machinery involved in environmental legislation– Central and state pollution control boards–
National Green Tribunal – Public awareness.

UNIT - V	HUMAN POPULATION AND THE ENVIRONMENT	8

Population growth – Variation among nations – Population explosion – Family welfare programme – Environment and human health – Human rights – Value education – HIV /AIDS – COVID 19 – Women and child welfare – Role of information technology in environment and human health – Case studies

Total Periods:	**45 PERIODS**

Text Books:

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2014).
2. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, (2004).
3. Dr. A. Sheik Mideen and S.Izzat Fathima, "Environmental Science and Engineering", Airwalk Publications, Chennai, (2018).

Reference Books:

1. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India Pvt Ltd, New Delhi, (2007).
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press (I) Pvt, Ltd, Hyderabad, (2015).
3. G. Tyler Miller, Scott E. Spoolman, "Environmental Science", Cengage Learning India Pvt. Ltd, Delhi, (2014).
4. R. Rajagopalan, 'Environmental Studies - From Crisis to Cure', Oxford University Press, (2005).
5. Anubha Kaushik , C.P. Kaushik, "Perspectives in Environmental Studies", New Age International Pvt. Ltd, New Delhi, (2004).
6. Frank R. Spellman, "Handbook of Environmental Engineering", CRC Press, (2015).

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	3	3	3	3	3	2	2	2	3	2	2
CO2	3	2	3	3	2	3	3	3	3	2	2	3	2	2
CO3	3	3	2	2	3	3	2	2	1	2	1	3	2	2
CO4	3	3	3	3	1	2	3	3	2	2	2	2	2	1
CO5	3	2	3	2	3	3	3	2	2	2	2	3	3	2

GE1205	Basic civil and mechanical engineering (Common to BioTech, CHEMICAL, EEE, EIE)	L	T	P	C
		3	0	0	3

Objectives

- ✓ The objective of this course is to introduce basic knowledge on Civil Engineering Materials, Surveying, Foundations, Civil Engineering Structures, IC Engine, Working Principle of Power Plant,Accessories Of Power Plant, Refrigeration And Air Conditioning System

Course Outcomes (CO)

CO1	To impart basic knowledge on Civil and Mechanical Engineering.
CO2	To familiarize the materials and measurements used in Civil Engineering.
CO3	To provide the exposure on the fundamental elements of civil engineering structures.
CO4	To enable the students to distinguish the components and working principle of power plant, ICengines
CO5	To provide the exposure on the fundamental elements of R & AC system.

UNIT - I **SCOPE OF CIVIL AND MECHANICAL ENGINEERING** **6**

Overview of Civil Engineering - Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering

Overview of Mechanical Engineering - Mechanical Engineering contributions to the welfare of Society – Specialized sub disciplines in Mechanical Engineering - Production, Automobile, Energy Engineering - Interdisciplinary concepts in Civil and Mechanical Engineering.

UNIT - II **SURVEYING AND CIVIL ENGINEERING MATERIALS** **9**

Surveying: Objects – classification – principles – measurements of distances – angles –leveling – determination of areas– contours - examples.

Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel – timber - modern materials

UNIT - III **BUILDING COMPONENTS AND STRUCTURES** **12**

Foundations: Types of foundations - Bearing capacity and settlement – Requirement of good foundations.

Civil Engineering Structures: Brick masonry – stonemasonry – beams – columns – lintels – roofing flooring – plastering – floor area, carpet area and floor space index - Types of Bridges and Dams – water supply - sources and quality of water - Rain water harvesting - introduction to high way and rail way.

UNIT - IV **INTERNAL COMBUSTION ENGINES AND POWER PLANTS** **12**

Classification of Power Plants - Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines — Four stroke and two stroke cycles — Comparison of four stroke and two stroke engines — Working principle of steam, Gas, Diesel, Hydro - electric and Nuclear Power plants –- working principle of Boilers, Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps

UNIT - V	REFRIGERATION AND AIR CONDITIONING SYSTEM	6
Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system– Layout of typical domestic refrigerator–Window and Split type room Air conditioner.		
	Total Periods:	**45 PERIODS**

Text Books:

1. Shanmugam G and Palanichamy MS ,"Basic Civil and Mechanical Engineering", Tata McGraw Hill PublishingCo.,NewDelhi,1996.

Reference Books:

1. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2010.
2. Ramamrutham S.,"Basic Civil Engineering", Dhanpat Rai Publishing Co.(P) Ltd.1999.
3. Seetharaman S.,"BasicCivil Engineering",AnuradhaAgencies,2005.
4. ShanthaKumar SRJ.,"Basic Mechanical Engineering", Hi-tech Publications, Mayiladuthurai, 2000.
5. Venugopal K. and Prahu Raja V., "Basic Mechanical Engineering", Anuradha Publishers, Kumbakonam,2000.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	2	3	3	3	-	3	2	2	3	2	2
CO2	3	2	3	3	3	3	2	-	2	1	1	3	3	2
CO3	3	2	3	3	2	3	2	-	3	2	1	3	3	2
CO4	3	2	3	2	2	3	2	-	3	2	2	3	3	2
CO5	3	2	3	2	2	3	2	-	2	2	1	3	2	2

CH1206	INTRODUCTION TO CHEMICAL ENGINEERING	L	T	P	C
		3	0	0	2

Objectives

- ✓ To understand the overview of Chemical Engineering
- ✓ To gain knowledge on role of basic sciences in Chemical Engineering
- ✓ To know about the various unit operations and unit process in Chemical Engineering
- ✓ To understand the importance of computer applications in Chemical Engineering
- ✓ To know about the future and various opportunities for Chemical Engineers

Course Outcomes (CO)

CO1	To Learn about basics of chemical Engineering
CO2	To Understand the concept of components of chemical Engineering
CO3	To learn about the Unit Operation and Unit Processes of chemical Engineering
CO4	To Understand the role of various disciplines in chemical Engineering
CO5	To learn about paradigm shifts, Opportunities in chemical Engineering.

UNIT - I	**INTRODUCTION**	**5**
Historical overview of Chemical Engineering – Chemistry and Chemical Engineering - Chemical process industries– Chemical Engineering in everyday life - Recent developments in Chemical Engineering		
UNIT - II	**ROLE OF BASIC SCIENCES IN CHEMICAL ENGINEERING**	**12**
Units and dimensions - Role of physics, chemistry, biology, mathematics in Chemical Engineering – Concepts of fluid flow- Velocity and stress field - Newtonian and non-Newtonian fluids - Scope of thermodynamics; laws of thermodynamics – Chemical Kinetics- Rate equation, elementary, non-elementary reactions, order and molecularity		
UNIT - III	**REPRESENTATION OF UNIT OPERATIONS & FLOWSHEETING**	**12**
Description and representation of different Unit Processes and Unit Operations; Heat and mass transfer operation; Modes of heat transfer - Fourier's law of heat conduction; Fick's Law; Designing of equipment; Flow sheet representation of process plants, Evolution of an Industry		
UNIT - IV	**ROLE OF SOFTWARES & OTHER DISCIPLINES IN CHEMICAL ENGINEERING**	**10**
Role of Computers simulations (MATLAB, ASPEN PLUS, ASPEN HYSYS, ANSYS FLUENT) and their Applications; Role of Chemical Engineers in the area of Food, Medical, Energy, Environmental, Biochemical – Introduction to Process control		
UNIT - V	**FUTURE & RECENT ADVANCES IN CHEMICAL ENGINEERING**	**6**
Paradigm shifts in Chemical Engineering; Range of scales in Chemical Engineering; Opportunities for Chemical Engineers – Process Intensification, Biomass conversions		
	Total Periods:	**45 PERIODS**

Text Books:

1. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 7th Edition, Tata McGraw Hill, 2015.
2. Ghosal, S.K, Sanyal S.K. and Dutta.S, "Introduction to Chemical Engineering" TMH Publications, New Delhi, 2012.
3. Dryden, C.E., "Outlines of Chemicals Technology", Edited and Revised by Gopala Rao, M. and M.Sittig,2nd Edition, Affiliated East-West press, 2016.
4. Randolph Norris Shreve, George T. Austin, "Shreve's Chemical Process Industries", 5th edition, McGrawHill, 2020

Reference Books:

1. McCabe, W.L., Smith, J. C. and Harriot, P. "Unit operations in Chemical Engineering", McGraw Hill, 7th Edition, 2015.
2. Finlayson, B. A., "Introduction to Chemical Engineering Computing", John Wiley & Sons, New Jersey,2012.
3. Pushpavanam, S, "Introduction to Chemical Engineering", PHI Learning Private Ltd, New Delhi, 2012
4. Bhatt B. I. and Vora, S. M, "Stoichiometry", 4th edition, McGraw Hill, 2014.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	2	1	1	2	1	1	1	2	1	2	1	1
CO2	3	3	3	3	3	3	2	1	1	1	2	3	2	2
CO3	3	3	3	3	3	3	2	1	2	2	2	3	2	3
CO4	3	3	3	3	3	3	2	1	2	1	2	3	2	3
CO5	3	3	3	3	3	3	2	1	2	2	2	3	2	3

GE1207	Engineering Practices Laboratory	L	T	P	C
		0	4	0	2

Objectives

- ✓ To provide exposure to the students with hands on experience on various basic engineeringpractices in Civil, Mechanical, Electrical and Electronics Engineering

Course Outcomes (CO)

CO1	Able to fabricate carpentry components and pipe connections including plumbing works.
CO2	Able to use welding equipments to join the structures, carry out the basic machining operations,and make the models using sheet metal works.
CO3	Able to illustrate on centrifugal pump, air conditioner, operations of smithy, foundry and fittings.
CO4	Able to carry out basic home electrical works and appliances, measure the electrical quantities.
CO5	Able to elaborate on the electronic components and gates, soldering practices.

Total Periods: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 13

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:
Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 18

Welding:

(a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning
(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:
(b) Model making – Trays and funnels.
(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump

(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example –Exercise – Production of hexagonal headed bolt.

(b) Foundry operations like mould preparation for gear and step cone pulley.

(c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE 13

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE 16

1. Study of electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR

Total periods:60

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Quantity required
	CIVIL	
1.	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	**15 sets**
2.	Carpentry vice (fitted to work bench)	**15 Nos**
3.	Standard woodworking tools 15 Sets.	**15 Sets.**
4.	Models of industrial trusses, door joints, furniture joints	**5 each**
5.	**Power Tools:** (a) Rotary Hammer (b) Demolition Hammer (c) Circular Saw (d) Planer (e) Hand Drilling Machine (f) Jigsaw	**2 Nos**
	MECHANICAL	
1.	Arc welding transformer with cables and holders.	**5 Nos**
2.	Welding booth with exhaust facility.	**5 Nos**
3.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	**5 Sets**
4.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	**2 Nos**
5.	Centre lathe.	**2 Nos**
6.	Hearth furnace, anvil and smithy tools.	**2 Sets**
7.	Moulding table, foundry tools.	**2 Sets**
8.	Power Tool: Angle Grinder.	**2 Nos**
9.	**Study-purpose items:** centrifugal pump, air-conditioner.	**1 each**
	ELECTRICAL	
1.	Assorted electrical components for house wiring.	**15 Sets**
2.	Electrical measuring instruments.	**10 Sets**
3.	**Study purpose items:** Iron box, fan and regulator, emergency lamp.	**1 each**
4.	Megger (250V/500V).	**1 No.**
5.	**Power Tools:** (a) Range Finder (b) Digital Live-wire detector	**2 Nos**
	ELECTRONICS	
1.	Soldering guns 10 Nos.	**10 Nos.**
2.	Assorted electronic components for making circuits 50 Nos.	**50 Nos.**
3.	Small PCBs.	**10 Nos.**
4.	Multimeters	**10 Nos.**
5.	**Study purpose items:** Telephone, FM radio, low-voltage power supply	**1 each**

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	3	-	-	3	2	-	1	1	-	3	2	2
CO2	3	2	3	-	-	3	1	-	2	1	-	3	2	2
CO3	3	1	2	-	-	2	2	-	1	1	-	3	2	2
CO4	3	2	3	3	1	3	1	1	1	1	2	3	1	2
CO5	3	2	3	3	1	2	1	1	1	1	2	3	1	2

CH1208	Technical Analysis Laboratory	L	T	P	C
		0	4	0	2

Objectives

- ✓ To make the student acquire practical skills in the wet chemical and instrumental methods for quantitative estimation of nitrite in water, cement, oil, coal and Phenol.

Course Outcomes (CO)

CO1	Able to analyze oil, soap and bleaching powder
CO2	Able to analyze cement phenol and viscosity of sample
CO3	Able to analyze fuel and fertilizer.

LIST OF EXPERIMENTS

1. Oil Analysis: (3 experiments)
   (a) Acid value
   (b) Saponification value
   (c) Iodine value
2. Soap Analysis: (2 experiments)
   (a) Alkali Content
   (b) Fatty acid content of Soap
3. Estimation of purity of glycerol: by Dichromatic method
4. Analysis of water:
5. Determination chlorine demand in water : Estimation of residual chlorine in water by Volumetric method
6. Cement Analysis (3 experiments)
7. Estimation of silica content
8. Estimation of calcium oxide content
9. Estimation of mixed oxide content
10. Fertilizer Analysis: Estimation of Nitrogen in Urea by Kjeldals method
11. Estimation of Phenol
12. Estimation of available chlorine present in bleaching powder
13. Estimation of viscosity of given sample of oil
14. Estimation of flash point, fire point, cloud point, pour point of fuel
15. Estimation of aniline point of fuel
16. Applications: Implementing GUI using turtle, pygame.

Total Periods: 60 PERIODS

Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis, J Mendham & M Thomas, Pearson Publications, 2015.
2. Environmental pollution analysis, S.M.Khopkar, New age international, 2011
3. Manual of environmental analysis, N.C Aery, Ane books, 2014

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	2	1	3	3	2	3	1	3	3	3	3
CO2	2	2	2	2	1	3	3	2	3	1	3	3	3	3
CO3	2	2	2	2	1	3	3	2	3	1	3	3	3	3

SEMESTER III

MA1353	APPLIED NUMERICAL ANALYSIS	L	T	P	C
		4	0	0	4

Objectives

- ✓ To introduce the basic concepts of solving algebraic and transcendental equations.
- ✓ To introduce the numerical techniques of interpolation in various intervals in real life
- ✓ To acquaint the student with understanding of numerical techniques of differentiation and integration this plays an important role in engineering and technology disciplines.
- ✓ To acquaint the knowledge of various techniques and methods of solving ordinary differential equations
- ✓ To understand the knowledge of various techniques and methods of solving various types of partial differential equations

Course Outcomes (CO)

CO1	Do curve fitting , solve algebraic , transcendental equation and system of linear equations
CO2	Interpolate using standard methods like finite difference methods and cubic splines
CO3	Apply Numerical differentiation and integration for the observed data
CO4	Have an insight of finding the numerical solution of first order differential equation by Standard single step methods and multi step methods.
CO5	Understand the finite difference solution of second order ordinary differential equation and get the solution of the standard engineering partial differential equation by explicit method and implicit method

UNIT - I	CURVE FITTING AND SOLUTION OF EQUATIONS	12

Introduction – Method of least square -Curve fitting - Fitting a straight line and parabola -Calculation of sum of the squares of residuals. Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method– Iterative method - Gauss Seidel method

UNIT - II	INTERPOLATION AND APPROXIMATION	12

Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Difference operators and relations - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT - III	**NUMERICAL DIFFERENTIATION AND INTEGRATION**	**12**

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule and 3/8 rule – Romberg's Method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT - IV	**INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS**	**12**

Single step methods - Taylor's series method - Euler's method - Modified Euler's method–Fourth order Runge – Kutta method for solving first order equations -Multistep methods-Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

UNIT - V	**BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIALDIFFERENTIAL EQUATIONS**	**12**

Finite difference methods for solving second order two - point linear boundary value problems – Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain–One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

Total Periods:	**60 PERIODS**

Text Books:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 10th Edition, Cengage Learning, 2017.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi,2015.

Reference Books:

1. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia,New Delhi,2007.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia,7th Edition, New Delhi, 2007.
3. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall,1992.
4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 4th Edition, New Delhi,2018.
5. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	3	3	2	2	1	0	0	0	0	0	2	2	2
CO2	3	2	3	1	2	1	0	0	0	0	1	2	2	1
CO3	3	2	2	1	2	1	0	0	0	0	1	2	2	2
CO4	3	3	3	2	2	1	0	0	0	0	0	2	1	2
CO5	3	3	2	1	2	1	0	0	0	0	0	2	2	1

CH1301	Process Calculations	L	T	P	C
		3	1	0	4

Objectives

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

Course Outcomes (CO)

CO1	To familiarize the student's basic concepts of units, dimensions, and other technical terms, and enable them to do unit conversions.
CO2	To introduce the concepts of material balances by taking industrial examples and train in mathematical computations with respect to bypass, purging and recycle operations
CO3	To introduce the concept of ideal and non-ideal systems and related problems and training the students with combustion problems.
CO4	Effectively bring in the concept of energy balances and computations in various types of energy balance problems related to chemical industries.
CO5	To bring in the latest advancements in design and modelling, related process simulators and problems on non ideal systems.

UNIT - I **12**

Base and derived Units - Composition of Mixture and solutions - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT - II **12**

Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

UNIT - III **12**

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

UNIT - IV **12**

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy. Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems with and without chemical reaction - Unsteady state energy balances

UNIT - V **12**

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds - Application of Process simulators in energy and material balance problems.

Total Periods: 60 PERIODS

Text Books:

1. Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition, Tata McGraw-Hill (2004)
2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Sixth Edition, Prentice Hall Inc., 2003
3. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes",3rdEdn., John Wiley & Sons, New York, 2000.

Reference Books:

1. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, CBS publishers (1973).

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	1	0	1	2	1	1	1	2	2	1
CO2	2	3	3	2	1	0	1	2	1	1	1	2	3	2
CO3	3	3	3	2	1	0	1	1	2	1	1	2	3	2
CO4	3	3	3	3	1	0	1	1	2	1	1	2	3	3
CO5	3	3	3	3	3	0	3	1	2	1	1	2	3	3

CH1302	Fluid Mechanics for Chemical Engineers	L	T	P	C
		3	0	0	3

Objectives

- ✓ To acquire a sound knowledge on fluid properties, fluid statics, dynamic characteristics of fluid flow for through pipes and porous medium, flow measurement and fluid machineries

Course Outcomes (CO)

CO1	To gain engineering knowledge on types of fluids based on Newton's law of viscosity.
CO2	To educate the students about hydrostatic pressure distribution, manometry and law of conservation of mass.
CO3	To score engineering knowledge on analyzing the system using dimensional analysis and scale-up.
CO4	To be conversant with types of fluid flow and pressure drop involved with it, major losses and minor losses and flow through fluidized and packed beds.
CO5	Flow measurement techniques.

UNIT – I	INTRODUCTION	9

Methods of analysis and description - fluid as a continuum – Velocity and stress field -Newtonian and non-Newtonian fluids – Classification of fluid motion

UNIT – II	FLUID STATICS	9

Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometer – Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation and Navier-Stokes equation.

UNIT – III	DIMENSIONAL ANALYSIS	9

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations - similitude – relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies.		
UNIT – IV	**FLOW THROUGH PIPES**	**9**
Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.		
UNIT - V	**TRANSPORTATION OF FLUIDS**	**9**
Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics, and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors, and fans		
	Total Periods:	**45**

Text Books:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Second Edition, McGraw-Hill, (1991).
2. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005
3. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition ", John Wiley, 2006

Reference Books:

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.
2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999)

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	2	2	3	0	0	0	0	1	1	1	1	2	2
CO2	2	2	2	3	0	0	0	0	1	1	1	1	2	3
CO3	2	2	2	3	1	0	0	0	1	1	2	1	2	3
CO4	2	2	2	3	2	0	1	0	1	1	1	1	3	3
CO5	2	2	2	3	1	1	1	1	1	1	1	1	2	3

EE1353	**Principles of electrical and electronics engineering**	**L**	**T**	**P**	**C**
		3	0	0	3

Objectives

To impart knowledge on

- ✓ Electric circuit laws, single and three phase circuits and wiring
- ✓ Working Principles of Electrical Machines
- ✓ Various Electronic Devices and Measuring Instruments

Course Outcomes (CO)

CO1	To explain the basic laws and theorems used in Electrical circuits
CO2	To impart knowledge on single phase and three phase AC circuit and wiring

CO3	To comprehend the construction and working principle of Electrical machines	
CO4	To explain the fundamentals of semiconductor and applications.	
CO5	To impart knowledge on different measuring instruments	
UNIT – I	**ELECTRICAL CIRCUITS**	**9**
Basic principles involved in power generation, transmission and distribution, Basic circuit components - Ohms Law, Kirchoff's Law, steady state solution of DC circuits, Thevenin's Theorem, Norton's Theorem, Superposition Theorem, Maximum power transfer theorem.		
UNIT – II	**AC CIRCUITS**	**9**
Introduction to AC circuits – waveforms and RMS value – power and power factor, single phase and three-phase balanced circuits, housing wiring, industrial wiring, materials of wiring.		
UNIT – III	**ELECTRICAL MACHINES**	**9**
Construction, Principles of operation and characteristics of DC machines, Transformers (single and three phase), Synchronousmachines, single phase and three phase induction motors.		
UNIT – IV	**ELECTRONIC DEVICES AND CIRCUITS**	**9**
Types of Materials –Silicon & Germanium- N type and P type materials – PN Junction –Forward and Reverse Bias – Semiconductor Diodes –Bipolar Junction Transistor – Characteristics – transistor as an Amplifier –Introduction to operational Amplifier –Inverting Amplifier –Non Inverting Amplifier –DAC– ADC.		
UNIT – V	**MEASUREMENTS AND INSTRUMENTATION**	**9**
Introduction to transducers: pressure, temperature, position, electrical measurements, Classification of instruments – moving coil and moving iron Ammeter and Voltmeter – multimeters – dynamometer type Wattmeter – three-phase power measurements – energy meter – megger – instrument transformers (CT and PT)		
	Total:	**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. Thereja .B.L., "Fundamentals of Electrical Engineering and Electronics", S. Chand & Co. Ltd., 2008

Reference Books:

1. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007
2. John Bird, "Electrical Circuit Theory and Technology", Elsevier, First Indian Edition, 2006
3. Allan S Moris, "Measurement and Instrumentation Principles", Elsevier, First Indian Edition,2006
4. Rajendra Prasad, "Fundamentals of Electrical Engineering", Prentice Hall of India, 2006
5. V.K Mehta and Rohit Mehta, "Principle of Electrical Engineering", S.Chand & Company, 2008

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	2	1	3	1	1	1	1	1	1	3	2
CO2	3	3	3	2	1	3	1	1	1	1	1	1	3	2
CO3	3	3	2	2	1	3	1	1	1	1	1	1	3	2
CO4	3	3	2	2	1	1	1	1	1	1	1	1	3	2
CO5	3	3	2	1	1	1	1	1	1	1	1	1	3	2

CH1303	Solid Mechanics for technologists	L	T	P	C
		3	0	0	3

Objectives

- ✓ To obtain skill in creating database retrieval of data and to solve Mathematical models through linear and non-linear programming.

Course Outcomes (CO)

CO1	Students will be equipped with the software applications and the numerical solutions of chemical engineering problems.
CO2	To introduce the concept of Chemical Kinetics calculations and related problems and training the students with problems techniques.
CO3	To introduce the concepts of material balances by taking industrial examples and train in mathematical and Graphical representations of various Chemical Engineering problem in exercise and core subject's computations.
CO4	Effectively bring in the concept of computations in various types of problems related to chemical industries.
CO5	To bring in the latest advancements in design and modelling, related process simulators and problems on software systems.

UNIT - I	STRESS, STRAINAND DEFORMATION OF SOLIDS	9

Stress and Strain: Load and its effect, Types of stresses, Types of strain, Support and free body diagram, Hooke's law and simple problems – compound bars – thermal stresses – elastic constants and poission's ratio.

UNIT - II	TRANSVERSE LOADING ON BEAMS	9

Beams –support conditions–types of Beams –transverse loading on beams–shear force and bending moment in beams– analysis of cantilevers, simply – supported beams and over hanging beams – relationships between loading, S.F. and B.M.Inbeams and their applications– S.F.& B.M. diagrams

UNIT - III	DEFLECTIONS OF BEAMS	9

Double integration method – Macaulay's method –Area – moment theorems for computation of slopes and deflections in beams.

UNIT - IV	STRESSES IN BEAMS	9

Theory of simple bending – assumptions and derivation of bending equation (M/I=F/Y= E/R)– analysis of stresses in beams–loads carrying capacity of beams–proportioning beam sections – leaf springs – flitched beams.

UNIT - V	TORSION AND COLUMNS	9

Torsion of circular shafts – derivation of torsion equation (T/J = fs/R = Cθ/L) – stress and deformation in circular and hollow shafts – stresses and deformation in circular and hollow shafts–Euler's theory of long columns

Total Periods:	45

Text Books:

1. Junarkar, S. B., Mechanics of Structure Vol.1, 21st Edition, Character Publishing House, Anand, Indian, (1995).
2. William A.Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series.
3. McGraw Hill International Editions, Third Edition, 1994.
4. Bansal, R.K, Strength of Materials, Laxmi Publications(P) Ltd., Fourth Edition 2010

Reference Books:

1. Elangovan A. ,Thinma VisaiIyal (Mechanics of Solids in Tamil), Anna University, Madras, 1995.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	3	1	1	1	1	1	1	1	1	2	2
CO2	2	2	2	3	1	1	1	1	1	1	1	1	2	3
CO3	2	2	2	3	1	1	1	1	1	1	1	1	2	3
CO4	2	2	2	3	2	1	1	1	1	1	1	1	3	3
CO5	2	2	2	3	1	1	1	1	1	1	1	1	2	3

CH1307	Fluid Mechanics Laboratory	L	T	P	C
		0	0	3	2

Objectives

- ✓ To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

Course Outcomes (CO)

CO1	Identify and characterize of flow patterns and regimes
CO2	Calibrate flow measurement devices
CO3	Correlate the difference between fixed and fluidized bed columns and its application.
CO4	Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties
CO5	Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions

LIST OF EXPERIMENTS

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Viscometer
2. Venturi meter
3. Orifice meter
4. Rotameter

5. Weir
6. Open drum with orifice
7. Pipes and fittings
8. Helical and spiral coils
9. Centrifugal pump
10. Packed column
11. Fluidized bed

Total Periods:	**60 PERIODS**

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	2	2	3	0	0	0	0	1	1	1	1	2	2
CO2	2	2	2	3	0	0	0	0	1	1	1	1	2	3
CO3	2	2	2	3	1	0	0	0	1	1	2	1	2	3
CO4	2	2	2	3	2	0	1	0	1	1	1	1	3	3
CO5	2	2	2	3	1	1	1	1	1	1	1	1	2	3

EE1358	**Electrical Engineering Laboratory**	**L**	**T**	**P**	**C**
		0	0	3	2

Objectives

- ✓ To validate the principles studied in theory by performing experiments in the laboratory

Course Outcomes (CO)

CO1	Ability to perform DC Shunt and Series Motor characteristics and to analyse the speed control behaviour of DC shunt Motor.
CO2	Ability to perform the characteristics of DC Shunt generator on O.C and Load conditions.
CO3	Ability to perform Open circuit, Short Circuit and Load test on Single Phase Transformer.
CO4	Ability to perform regulation characteristics on the alternator and to analyse the V-curve and Inverted V-curve of a Synchronous motor.
CO5	Ability to perform the speed control behaviour of an induction motor and also to know the working principles of AC and DC motor starters.

LIST OF EXPERIMENTS

1. Load test on DC Shunt & DC Series motor
2. O.C.C & Load characteristics of DC Shunt and DC Series generator
3. Speed control of DC shunt motor (Armature, Field control)
4. Load test on single phase transformer
5. O.C & S.C Test on a single phase transformer
6. Regulation of an alternator by EMF & MMF methods.
7. V curves and inverted V curves of synchronous Motor
8. Load test on three phase squirrel cage Induction motor
9. Speed control of three phase slip ring Induction Motor

10. Study of DC & AC Starters

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	DC Shunt motor	2
2	DC Series motor	1
3	DC shunt motor-DC Shunt Generator set	1
4	DC Shunt motor-DC Series Generator set	1
5	Single phase transformer	2
6	Three phase alternator	2
7	Three phase synchronous motor	1
8	Three phase Squirrel cage Induction motor	1
9	Three phase Slip ring Induction motor	1

Total Periods: 60 PERIODS

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	1	3	1	3	2	1	2	2	2	3	3	3
CO2	3	3	1	3	1	3	2	1	2	2	2	3	3	3
CO3	3	3	1	3	1	3	2	1	2	2	2	3	3	3
CO4	3	3	1	3	1	3	2	1	2	2	2	3	3	3
CO5	3	3	1	3	1	3	2	1	2	2	2	3	3	3

SEMESTER IV

MA1452	Applied probability and statistics (Common to BIO, CHEM)	L	T	P	C
		4	0	0	4

Objectives

- ✓ This course aims at providing the required skill to apply the statistical tools in engineering problems.
- ✓ To introduce the basic concepts of probability and random variables.
- ✓ To introduce the basic concepts of two dimensional random variables.
- ✓ To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- ✓ To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

Course Outcomes (CO)

CO1	Get exposure to random variables and well-founded knowledge of standard distributions which can describe real life phenomena.	
CO2	Get ideas to handle situations involving more than one random variable	
CO3	Gain the knowledge on Large Samples and Small Samples. These concepts are very useful in biological, economical and social experiments and all kinds of generalizations based on information about a smaller sample and larger samples. Apply the appropriate test in the problems related with sampling.	
CO4	Apply the basic concepts of design of experiments and handle the same.	
CO5	Understand the concept of the Control charts to apply in the field of quality assessment, Production processes, to monitor process stability and control of the manufacturing product.	
UNIT - I	**PROBABILITY AND RANDOM VARIABLES**	**12**
Probability – The axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.		
UNIT - II	**TWO - DIMENSIONAL RANDOM VARIABLES**	**12**
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Central limit theorem (for independent and identically distributed random variables).		
UNIT - III	**TESTING OF HYPOTHESIS**	**12**
Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) – Goodness of fit.		
UNIT - IV	**DESIGN OF EXPERIMENTS**	**12**
One way and Two way classifications - Completely randomized design – Randomized block design –Latin square design		
UNIT - V	**STATISTICAL QUALITY CONTROL**	**12**
Control charts for measurements (and R charts) – Control charts for attributes (p, c and np charts) –Tolerance limits - Acceptance sampling.		
	Total:	**60 PERIODS**

Text Books:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2017.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th IndianEdition, 2017.

Reference Books:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 9th Edition, 2017.
2. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic
3. Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2017.
4. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 4th Edition, Elsevier, 2009.
5. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2008.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineersand Scientists", Pearson Education, Asia, 9th Edition, 2012.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	3	2	1	0	0	0	0	1	1	2	2
CO2	3	3	2	2	2	1	0	0	0	0	1	1	2	1
CO3	3	3	2	3	3	2	1	0	0	0	2	2	2	2
CO4	3	3	2	3	2	2	1	0	0	0	1	2	1	2
CO5	3	3	3	3	2	2	1	0	0	0	2	1	2	1

CH1401	Chemistry for Chemical Engineers	L	T	P	C
		3	0	0	3

Objectives

The course is aimed to

- ✓ To provide the knowledge of basic chemistry to understand the fundamental principles of chemical engineering.
- ✓ To familiarize the basic terms of reaction engineering.
- ✓ To understand the basic concepts of reaction components and systems.

Course Outcomes (CO)

CO1	Understand the basic principles of chemistry applicable to chemical engineering.
CO2	Understand the basics of organic compounds
CO3	Familiarize the basic reaction concepts.
CO4	Familiarize the basic terms of reaction engineering.
CO5	Understand electrochemistry.

UNIT - I **9**

Preparation, Physical & Chemical properties and Uses of Pyrrole, Furan, Furfural, Tetrahydro Furan, Thiophene, Indole, Pyridine, Quinoline and Isoquinoline. Synthesis of Antimalarial drugs – isopentaquine and chloroquine Synthesis of Antibacterial drugs – Sulphaniliamide, Sulphapyridine, Sulphathiazole and Phenacetin.

UNIT - II **9**

Carbohydrates – classification. Monosaccharides- reaction of Glucose and fructose, open chain and cyclic structures of glucose and fructose, mutarotation, epimerzation, KillianiFisher synthesis, Ruff degradation, conversion of aldoses to ketoses and Ketoses to aldoses. Disaccharides – properties and structure of sucrose. Polysaccharides – properties and structure of starch and cellulose

UNIT - III **9**

Elimination Reaction – E1,E2 elimination – Bredt's rule – Zartsev's rule – Condensation reaction – Benzoin Condensation – Aldol Condensation and Claisen Condensation – Preparation and synthetic uses of acetoacetic and malonic esters – Molecular rearrangement – Hofmann rearrangement – Schmidt rearrangement – Beckmann rearrangement.

UNIT - IV **9**

Electrolytic conductance – Specific, Equivalent and Molar conductance – Kohlrauch's law and its applications. Electro potential, Electro chemical cell – EMF of a cell and its measurements – Reference electrodes – Hydrogen , calomel and glass electrodes. The Nernst equation and applications – Concentrations cell. Conductometry – Cell constant – Conductometric titrations – Potentiometry – Principle of acid – base – and oxidation, reduction titrations.

UNIT - V **STATISTICAL QUALITY CONTROL** **9**

Rate of reaction – Rate constants – Order and molecularity of reaction – First, second, third and zero order reactions – Method of determining order of reactions – Differential and integral rate expressions – Rate measurement method – Volumetry – Spectrophotometry. Complex reactions – Reverse reactions – Parallel or side reactions, chain reactions, consecutive reactions and explosive reaction. Effect of temperature and solvent on reaction rate. Theories of reaction rates – Activated complex theory of Bi-molecular reactions, the lindemann theory of unimolecular reactions.

Total: 45 PERIODS

Text Books:

1. Advance organic Chemistry – B.S. Bahl and Arun Bahl
2. Text book of organic chemistry – P.L.Soni
3. Principles of Physical Chemistry - B. R. Puri, L.R. Sharma, M.S. Pathania

Reference Books:

1. R.P.Singh, Handbook of Chemistry, 3rd Edition, 2015, Arihant Publications
2. Jain & Jain, Engineering Chemistry, 16th Edition, 2015, , Dhanpat Rai Pulishing Compnay

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	2	3	2	1	0	0	0	0	1	1	2	2
CO2	3	3	2	2	2	1	0	0	0	0	1	1	2	1
CO3	3	3	2	3	3	2	1	0	0	0	2	2	2	2
CO4	3	3	2	3	2	2	1	0	0	0	1	2	1	2
CO5	3	3	3	3	2	2	1	0	0	0	2	1	2	1

CH1402	**Computer applications in Chemical Engineering**	**L**	**T**	**P**	**C**
		3	0	2	4

Objectives

- ✓ Students will be equipped with the software applications and the numerical solutions of chemical engineering problems.

Course Outcomes (CO)

CO1	Map ER model to Relational model to perform database design effectively
CO2	Write queries using normalization criteria and optimize queries
CO3	Design the Query Processor and Transaction Processor
CO4	Learn different database concepts like distributed databases, spatial databases and mobile databases.
CO5	Apply security concepts to databases, review cloud databases, streaming and graph databases.

UNIT - I **9 + 6**

Review on Programming languages- Basic, Application in Density, molecular weight, mole and percentage compositions, Empirical and Molecular formula calculations, Heat of mixing, Gas laws, Vapor pressure, Chemical Kinetics calculations.

Lab Component

- Calculation of average molecular weight of given gas mixture.

- Find out Empirical and molecular weight using MS Excel

UNIT - II		9 + 6

Application in data processing, Statistical analysis of data, Regression. Analysis of variance, Interpolation, Graphical representations of various Chemical Engineering problem both in laboratory exercise and core subjects such as Mechanical operation, Reaction Engineering, Distillation etc.

Lab Component

- Regression Analysis using spread sheet
- Find out the number of theoretical plates using spread sheet

UNIT - III		9 + 6

Design and developments of simple databases on Chemical and Physical properties of substances. Retrieval and Database in report, query and other formats, Interfacing with other software. Preparation of Material and energy Balances preparation of plant layout.

Lab Component

- Material and energy balance using spread sheet
- Find out the physical and Chemical properties using spread sheet

UNIT - IV		9 + 6

Problem solving techniques – Program – Program development cycle – Algorithm design – Flowchart - Pseudo code. Introduction to C – C tokens – data types – Operators and expressions – I/O functions

Lab Component

- Solve quadratic equation for different sets of inputs.
- Use of spreadsheet to create Charts(XY, Bar, Pie) and apply the formulae wherever necessary C Programming (Flowcharts and algorithms are essential for the programming exercises)

UNIT - V	STATISTICAL QUALITY CONTROL	9 + 6

Decision making statements – branching and looping – arrays – multidimensional arrays – Functions – Recursion – Passing array to functions Storage classes – Strings – String library functions

Lab Component

- Matrix operations- Addition - Transpose – Multiplication
- Greatest of three numbers using conditional operator and if statement

PRACTICALS: 30 PERIODS	THEORY: 45 PERIODS	TOTAL : 75 PERIODS

Text Books:

1. Hanna, O.T. Scandell, O.C. Computational Methods in Chemical Engineering, Prentice Hall, 1995.
2. R.K. Taxali, T.K. dBase IV made simple, Tata McGraw-Hill 1991. 80

Reference Books:

1. Jerry, O., Breneman, G.L. Spreadsheet Chemistry, Prentice Hall, Englewood Cliffs, 1991.
2. Myers, A.L. Seider W.D. Introduction to Chemical engineering and Computer Calculations.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	3	2	1	1	-	-	2	2	2	2	3
CO2	3	3	3	3	2	1	1	-	-	2	2	2	2	3
CO3	3	3	3	3	2	1	1	-	-	2	2	2	2	3
CO4	3	3	3	3	2	1	1	-	-	2	2	2	2	3
CO5	3	3	3	3	2	1	1	-	-	2	2	2	2	3

CH1403	**Mechanical operations**	**L**	**T**	**P**	**C**
		3	0	0	3

Objectives

- ✓ To impact knowledge in the field of particle size reduction and deals with the detail construction and working of equipment's used for mechanical operations.

Course Outcomes (CO)

CO1	To gain engineering knowledge on particle size, shape and its characteristics including various methods of screen analysis, equipment's, and its effectiveness.
CO2	To educate the students about various laws of crushing and suitable design equipment's.
CO3	To score engineering knowledge on settling characteristics, its types and design of continuous thickeners using batch sedimentation.
CO4	To be conversant with types of filtrations, design of various filtration equipment's and optimum cycle of operation.
CO5	To make the students understand the importance of mixing and agitation of different mixtures, storage, and transportation of solids.

UNIT - I	**PARTICLE CHARACTERIZATION AND MEASUREMENT**	**9**

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

UNIT - II	**PARTICLE SIZE REDUCTION AND SIZE ENLARGEMENT**	**9**

Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipment's, crushers, grinders, disintegrators for coarse, intermediate, and fine grinding, power requirement, work index; Advanced size reduction techniques - Nano particle fabrication - Top down 49 approach - Bottom-up approach. Size enlargement - Importance of size enlargement, principle of granulation, briquetting, pelletisation, and flocculation. Fundamentals of particle generation.

UNIT - III	**PARTICLE SEPARATION (GAS-SOLID AND LIQUID-SOLID SYSTEM)**	**9**

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

UNIT - IV	**FILTRATION AND FILTRATION EQUIPMENTS**	**9**

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

UNIT - V	MIXING AND PARTICLE HANDLING	9

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

Total:	45 PERIODS

Text Books:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.
3. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit
4. Operations", 2nd Edn., John Wiley & Sons, 1994.
5. Hiroaki Masuda , KoHigashitani and Hideto Yoshida, Powder Technology Handbook, 3rd Edition.

Reference Books:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. II, 4th Edn., Asian Books Pvt. Ltd., India, 1998.
2. Christie J. Geankoplis, Transport processes and unit operations.
3. Sunggyu Lee, Kimberly H. Henthorn, Particle Technology and Applications.
4. Martin Rhodes, Introduction to Particle Technology, Second Edition.
5. Richard R. Klimpel, Introduction to the Principles of Size Reduction of Particles by Mechanical Means, NSF Engineering Research Center for Particle Science & Technology. University of Florida, 1997.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	3	1	1	1	1	1	1	1	1	2	2
CO2	2	2	2	3	1	1	1	1	1	1	1	1	2	3
CO3	2	2	2	3	1	1	1	1	1	1	1	1	2	3
CO4	2	2	2	3	2	1	1	1	1	1	1	1	3	3
CO5	2	2	2	3	1	1	1	1	1	1	1	1	2	3

CH1404	Chemical Process Industries	L	T	P	C
		3	0	0	3

Objectives

- ✓ To impart knowledge on various aspects of production engineering and make the student understand the practical methods of production in a chemical factory.

Course Outcomes (CO)

CO1	To gain engineering knowledge on various aspects of production engineering and the practical methods of production of sulphur, sulphuric acid and cement
CO2	To understand the practical methods of production of fertilizer products
CO3	To learn &understand the practical methods of production of pulp, paper, sugar and starch industries

CO4	To gain engineering knowledge on various aspects of production of petroleum and petro chemical industries	
CO5	To learn &understand and analyse the fuel and industrial gases	
UNIT - I	**SULFUR, SULFURIC ACID AND CEMENT**	**9**
Sulfur, Raw materials Sources, Mining and production of Sulfur – Sulfuric acid, Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.		
UNIT - II	**FERTILIZER INDUSTRY**	**9**
Major Components of Fertilizer industries – Nitrogen industries, ammonia, nitric acid, urea – Phosphorus industries - Phosphorus, Phosphoric acid, Super Phosphate – Potassium chloride, Potassium Sulphate		
UNIT - III	**PULP, PAPER, SUGAR AND STARCH INDUSTRIES**	**9**
Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products, Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugar industry – Starch – Methods of production, Starch derivations.		
UNIT - IV	**PETROLEUM AND PETRO CHEMICAL INDUSTRIES**	**9**
Petroleum – Chemical Composition, Classification of crude petroleum, Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking, Reforming Polymerization, isomerization and Alkylation – petrochemicals – methanol, chloro methanol, Acetylene and ethylene, Isopropanol, Acrylonitrile, Butadiane – Chemicals from Aromatics - Benzene, Toluene and Xylene.		
UNIT - V	**FUEL AND INDUSTRIAL GASES**	**9**
Fuel Gases – Producer gas, Water gas, Coke oven gas, Natural gas, Liquefied natural gas – Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen.		
	Total:	**45 PERIODS**

Text Books:

1. Dryden, C.E, Outlines of Chemical technology, II Ed., Affiliate East West press, 2003.
2. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, Wiley, 2001.on.

Reference Books:

1. Austin, G.T., Shreve's "Chemical Process Industries", 5th ed., McGraw-Hill, 1998.
2. Srikumar Koyikkal, "Chemical Process Technology and Simulation", PHI Learning Ltd

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	2	1	3	2	2	2	1	2	2	2	2
CO2	3	3	3	2	1	3	2	2	2	1	2	2	2	3
CO3	3	3	3	2	1	3	2	2	2	1	2	2	2	3
CO4	3	3	3	2	1	3	2	2	2	1	2	2	3	3
CO5	3	3	3	2	1	3	2	2	2	1	2	2	2	3

CH1405	**Instrumental Methods of Chemical Analysis**	**L**	**T**	**P**	**C**
		3	0	0	3

Objectives

- ✓ To know the principle and importance of various analytical instruments used for the characterization of various materials.

Course Outcomes (CO)

CO1	To Learn About Introduction of Spectrometry
CO2	To Understand concept of molecular spectroscopy
CO3	To learn about magnetic resonance spectroscopy and mass spectroscopy
CO4	To Understand separation methods
CO5	To learn about electro analysis and surface microscopy

UNIT – I	**INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS**	**9**

Electromagnetic radiation: various ranges, dual properties, various energy levels, interaction of photons with matter, absorbance & transmittance and their relationship, permitted energy levels for the electrons of an atom and simple molecules, various electronic transitions in organic and inorganic compounds effected by UV, and visible radiations, various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and visible radiations, choice of solvents, cut off wavelengths for solvents

UNIT - II	**QUALITATIVE ANALYSIS BY UV AND VISIBLE SPECTROCOPY**	**9**

Lamda max and epsilon max rules, Woodward -Fieser rules for the calculation of absorption maxima (Lamda max) for dienes and carbonyl compounds, Effects of auxochromes and effects of conjugation on the absorption maxima, Different shifts of absorption peaks (Bathochromic, hypsochromic, hypochromic), Instrumentation for UV and Visible spectrophotometers (source, optical parts, and detectors), Applications of UV and Visible spectroscopy.

UNIT - III	**QUANTITATIVE ANALYSIS BY UV AND VISIBLE SPECTROCOPY**	**9**

Beer-Lambert's law, limitations, deviations (real, chemical, instrumental), estimation of inorganic ions such as Fe, Ni and estimation of nitrite using Beer -Lambert's law, multicomponent analysis (no overlap, single way overlap and two-way overlap), photometric titration (experimental set -up and various types of titrations and their corresponding curves).

UNIT - IV	**IR SPECTROSCOPY**	**9**

Theory of IR spectroscopy, various stretching, and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (near, mid, fingerprint and far) and their usefulness, Instrumentation (only the sources and detectors used in different regions), sample preparation techniques, qualitative analysis of alkanes, alkenes, and carbonyl compounds.

UNIT - V	**CHROMATOGRAPHIC METHODS**	**9**

Classification of chromatographic methods, column, thin layer, paper, gas, High Performance Liquid Chromatographical methods (principle, mode of separation and technique).

Total:	**45 PERIODS**

Text Books:

1. Sivasankar B., "Instrumental Methods of Analysis", Oxford University Press, 2012.
2. William Kemp, Organic Spectroscopy, 3rd Edition, Palgrave publishers, 2007.

Reference Books:

1. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Instrumental Analysis, CENGAGE
2. Learning, India, 7th Edition, 2007.
3. Willard H.H, Merritt L.L, Dean J.A and Settle F.A, Instrumental method of analysis, 7th edition, Wadsworth Publishing Company, 1988.
4. Gurdeep R. Chatwal, Sharma K. Anand, Instrumental methods of Chemical Analysis, Himalaya Publishers, New Delhi, 2014
5. John R Dyer, Applications of Absorption Spectroscopy of Organic Compounds, Prenticehall of India Pvt. Ltd., 2012
6. Robert M. Silverstein, Francis X. Webstrer, David Kiemle, David L. Bryce, Spectrometric Identification of Organic Compounds, Wiley, 8th Edition, 2010.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	2	1	1	1	1	1	1	3	3	2	3
CO2	3	3	2	3	2	1	1	1	1	1	3	3	2	3
CO3	3	3	1	1	1	1	1	1	1	1	3	3	2	3
CO4	3	3	2	3	1	1	1	1	1	1	3	3	2	3
CO5	3	3	1	1	1	1	1	1	1	1	3	3	2	3

CH1407	Mechanical operations Laboratory	L	T	P	C
		0	0	3	2

Objectives

- ✓ To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

Course Outcomes (CO)

CO1	Determine the size analysis in solid- solid separation systems
CO2	Capability to select different solid - fluid separation equipments.
CO3	Evaluate the size reduction and various crushing parameters
CO4	Estimate the separation characteristics
CO5	Understand the technical methods related to unit operations in process plant

LIST OF EXPERIMENTS

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher / Pulverizer/ Hammer Mill
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving
12. Determination of specific surface area using air permeability set up

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Sieve shaker
2. Leaf filter
3. Plate and Frame Filter Press
4. Sedimentation Jar
5. Jaw Crusher

6. Ball Mill
7. Cyclone Separator
8. Roll Crusher
9. Elutriator
10. Drop Weight Crusher
11. Sieves

Total Periods:	**60 PERIODS**

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	2	2	3	1	1	1	1	1	1	1	1	2	2
CO2	2	2	2	3	1	1	1	1	1	1	1	1	2	3
CO3	2	2	2	3	1	1	1	1	1	1	1	1	2	3
CO4	2	2	2	3	2	1	1	1	1	1	1	1	3	3
CO5	2	2	2	3	1	1	1	1	1	1	1	1	2	3

HS1310	**Professional Skills Lab**	**L**	**T**	**P**	**C**
		0	0	2	1

Objectives

- ✓ Enhance the Employability and Career Skills of students
- ✓ Orient the students towards grooming as a professional
- ✓ Make them Employable Graduates
- ✓ Develop their confidence and help them attend interviews successfully.

Course Outcomes (CO)

CO1	Make effective presentations
CO2	Participate confidently in Group Discussions
CO3	Attend job interviews and be successful in them.
CO4	Develop adequate Soft Skills required for the workplace
CO5	Develop their speaking skills to enable them speak fluently in real contexts

UNIT – I	**6**

Introduction to Soft Skills- Hard skills & soft skills - employability and career Skills—Grooming as a professional with values—Making an Oral Presentation–Planning and preparing a model presentation; Organizing the presentation to suit the audience and context; Connecting with the audience during presentation; Projecting a positive image while speaking; Emphasis on effective body language-General awareness of Current Affairs.

UNIT - II	**6**

Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice—— Making a Power Point Presentation -- Structure and format; Covering elements of an effective presentation; Body language dynamics. Making an Oral Presentation–Planning and preparing a model presentation; Organizing the presentation to suit the audience and context; Connecting with the audience during presentation; Projecting a positive image while speaking; Emphasis on effective body language

UNIT - III	**6**

Introduction to Group Discussion— Participating in group discussions – understanding group dynamics - brainstorming the topic –– questioning and clarifying –GD strategies- Structure and dynamics of a GD; Techniques of effective participation in group discussion; Preparing for group discussion; Accepting others' views / ideas; Arguing against others' views or ideas, etc

UNIT - IV **6**

Basics of public speaking; Preparing for a speech; Features of a good speech; Speaking with a microphone. (Famous speeches may be played as model speeches for learning the art of public speaking). Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview –Job Interviews: purpose and process; How to prepare for an interview; Language and style to be used in an interview; Types of interview questions and how to answer them.

UNIT - V **6**

Recognizing differences between groups and teams- managing time managing stress- networking professionally- respecting social protocols understanding career management- developing a long- term career plan making career changes

Total: 30 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

One Server

30 Desktop Computers

One Hand Mike

One LCD Projector

Reference Books:

1. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015
2. E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015
3. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014
4. S. Hariharanetal. Soft Skills. MJP Publishers: Chennai, 2010
5. Interact English Lab Manual for Undergraduate Students,.Orient Balck Swan: Hyderabad, 2016.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	0	2	0	2	1	0	0	0	2	3	0	0	1	2
CO2	0	2	0	2	0	0	0	0	2	3	0	0	1	2
CO3	0	0	0	0	0	0	0	0	2	2	0	0	1	2
CO4	0	0	0	0	0	0	0	0	2	2	0	2	1	2
CO5	0	2	1	1	2	0	2	0	2	3	0	2	1	2

SEMESTER V

CH1501	Chemical Reaction Engineering I	L	T	P	C
		3	0	0	3

Objectives

The course is aimed to

- ✓ Learn reaction kinetics, types of reactors, design of reactors, understand the isothermal, nonisothermal operation of reactors and gain knowledge about non ideal reactors.

Course Outcomes (CO)

CO1	To understand the kinetics of homogenous reactions
CO2	To develop performance equation and determine the conversion for different reactors
CO3	To understand the design of reactor for multiple reactions
CO4	To understand the non-isotherm operation of the reactor
CO5	To understand the residence time distribution function and analyze the non-ideality in the reactor

UNIT – I	**KINETICS OF HOMOGENEOUS REACTIONS**	**9**

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

UNIT – II	**IDEAL REACTORS AND ITS COMBINATIONS**	**9**

Ideal reactor classification. Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, and size comparison of reactors.

UNIT – III	**DESIGN OF PARALLEL REACTIONS**	**9**

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

UNIT – IV	**TEMPERATURE EFFECTS ON REACTORS**	**9**

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

UNIT – V	**NON IDEAL REACTORS AND ITS MODELS**	**9**

The residence time distribution for chemical reactors, residence time functions and relationship between them in reactor; Models for non-ideal reactors, conversion in non-ideal reactors.

Total:	**45 PERIODS**

Text Books:

1. O. Levenspiel, Chemical Reaction Engineering , Third Edition, John Wiley 1999
2. H.S. Fogler, Elements of Chemical Reaction Engineering, Third Edition, Prentice Hall of India, 1999
3. Lanny D. Schmidth The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2005

Reference Books:

1. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press , 2014
2. G.Fronment, K.B.Bischoff Chemical Reactor Analysis and Design , John Wiley and Sons, 1979

3. J.M.Smith Chemical Engineering Kinetics, Third Edition, Mc Graw Hill New York 1981

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	2	1	3	1	1	1	1	1	1	3	2
CO2	3	3	3	2	1	3	1	1	1	1	1	1	3	2
CO3	3	3	2	2	1	3	1	1	1	1	1	1	3	2
CO4	3	3	2	2	1	1	1	1	1	1	1	1	3	2
CO5	3	3	2	1	1	1	1	1	1	1	1	1	3	2

CH1502	Heat Transfer	L	T	P	C
		3	0	0	3

Objectives

The course is aimed to

- ✓ Teach the fundamental concepts of heat transfer viz., conduction, convection, radiation, boiling and condensation and its application to the students

Course Outcomes (CO)

CO1	To familiarize the students with the fundamental concepts of Heat Transfer. provide the student with knowledge about heat transfer by conduction in solids for steady state
CO2	Students will understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows
CO3	Students will understand radiative heat transfer including blackbody radiation and Kirchoff'slaw,and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems
CO4	Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers
CO5	The course provides the student with knowledge about heat transfer with phase change (boiling and condensation) and evaporation

UNIT – I **BASIC CONCEPTS & CONDUCTIVE HEAT TRANSFER** **9**

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer – Mean temperature difference- Concept of heat conduction - Fourier's law of heat conduction – One dimensional steady state heat conduction equation for flat plate, hollow cylinder, hollow sphere – Heat conduction through a series of resistances - Analogy between flow of heat and flow of electricity - Effect of temperature on thermal conductivity- Conduction through liquids- Individual and overall heat transfer coefficients and the relationship between them - Transient heat conduction.

UNIT – II **CONVECTION** **9**

Concept of heat transfer by convection - Natural and forced convection - Application of dimensional analysis for convection - Equations for forced convection under laminar, transition and turbulent conditions - Equations for natural convection - Heat transfer from condensing vapors- Heat transfer to boiling liquids - Influence of boundary layer on heat transfer - Heat transfer to molten metals – Heat transfer in packed and fluidized beds.

UNIT – III **RADIATION** **9**

Concept of thermal radiations - Black body concept - Stefan Boltzman's law - Emissive power – Black body radiation – Emissivity - Plank's Law - Radiation between black surfaces - Gray surfaces - Radiation Shields - Radiation Applications

UNIT – IV	**HEAT EXCHANGERS**	**9**

Parallel and counter flow heat exchangers - Log mean temperature difference - Single pass and multipass heat exchangers-Plate heat exchangers-Use of correction factor charts- Heat exchangers effectiveness-Number of transfer unit - Chart for different configurations - Fouling factors and Wilson's plot - Design of various types of heat exchangers - Design of condensers.

UNIT – V	**EVAPORATION**	**9**

Types of evaporation - Single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation- Boiling Point Elevation - Effect of Liquid Head - Capacity and Economy of multiple effect evaporators - Evaporation Equipments.

	Total:	**45 PERIODS**

Text Books:

1. Holman, J. P., 'Heat Transfer ', 8th Edn., McGraw Hill, 1997.
2. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984
3. Kern, D.Q., "Process Heat Transfer ", McGraw-Hill, 1999.

Reference Books:

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

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	2	1	3	1	1	1	1	1	1	3	2
CO2	3	3	3	2	1	3	1	1	1	1	1	1	3	2
CO3	3	3	2	2	1	3	1	1	1	1	1	1	3	2
CO4	3	3	2	2	1	1	1	1	1	1	1	1	3	2
CO5	3	3	2	1	1	1	1	1	1	1	1	1	3	2

CH1503	**Mass Transfer I**	**L**	**T**	**P**	**C**
		3	0	0	3

Objectives

The course is aimed to

- ✓ Learn and determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallisers.

Course Outcomes (CO)

CO1	To understand the fundamentals, types and mechanism of mass transfer operations
CO2	To understand the theories of mass transfer and the concept of inter-phase mass transfer
CO3	To understand the basics of humidification process and its application

CO4	To understand the concept and mechanism of drying operations	
CO5	To understand the concept of crystallization process and identification of suitable crystallizer	
UNIT – I	**MOLECULAR DIFFUSION**	**9**
Introduction to mass transfer operations. Molecular diffusion in gases, liquids and solids. Diffusivity measurement and prediction; multi-component diffusion		
UNIT – II	**CONVECTIVE & INTERPHASE MASS TRANSFER**	**9**
Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stage-wise and differential contractors.		
UNIT – III	**HUMIDIFICATION & DE – HUMIDIFICATION OPERATIONS**	**9**
Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.		
UNIT – IV	**DRYING**	**9**
Drying – Equilibrium. Classification of dryers, batch drying – Mechanism and time of cross through circulation drying, theoretical estimation of drying rate and time. Continuous dryers – material and energy balance. Advance drying techniques such as freeze drying, microwave drying.		
UNIT – V	**CRYSTALLIZATION**	**9**
Crystal geometry. Equilibrium, yield and purity of products, theory of super saturation, nucleation and crystal growth, classification of crystallizers, design of batch crystallizers and continuous crystallizers.		
	Total:	**45 PERIODS**

Text Books:

1. Treybal, R. E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill,1981.
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice HallInc., NewJersey, 2003.
3. Narayanan K.V. and Lakshmikutty, B "Mass Transfer – Theory and Applications", 1st Edition, CBS Publishers & Distributors Pvt Ltd, New Delhi, 2014.

Reference Books:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition., McGraw-Hill, 2005.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, 4th Edition, Asian Books Pvt. Ltd., India, 1998.
3. Seader J.D. and Henley E.J., "Separation Process Principles", 2nd Ed., John Wiley, 2006

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	2	1	3	1	1	1	1	1	1	3	2
CO2	3	3	3	2	1	3	1	1	1	1	1	1	3	2
CO3	3	3	2	2	1	3	1	1	1	1	1	1	3	2
CO4	3	3	2	2	1	1	1	1	1	1	1	1	3	2
CO5	3	3	2	1	1	1	1	1	1	1	1	1	3	2

CH1507	Heat and Mass Transfer Laboratory	L	T	P	C
		0	0	3	2

Objectives

The course is aimed to

- ✓ Develop sound practical knowledge for students on different types of heat transfer equipments
- ✓ Develop sound practical knowledge for students on different types of mass transfer equipments

Course Outcomes (CO)

CO1	Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipments.
CO2	Estimate the heat transfer rate and heat transfer co-efficient
CO3	Determine the diffusivity practically and compare the results with the empirical correlations.
CO4	Estimate the mass transfer rate and mass transfer co-efficient
CO5	Evaluate the performance/calculate the parameters in different distillation processes

LIST OF EXPERIMENTS

1. Heat Transfer in a Double Pipe Heat Exchanger
2. Heat transfer by Forced / Natural Convection
3. Batch drying kinetics using Tray Dryer
4. Heat Transfer in Helical column
5. Heat Transfer through Packed Bed
6. Heat Transfer through bare type heat exchanger
7. Heat Transfer through finned type heat exchanger
8. Drying characteristics of Vacuum Dryer
9. Drying characteristics of Rotary dryer
10. Measurement of diffusivity
11. Surface evaporation
12. Mass transfer coefficient determination by Wetted wall column

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Double pipe Heat Exchanger
2. Tray drier
3. Helical column
4. Packed Bed
5. Bare type heat exchanger
6. Finned type heat exchanger
7. Vacuum Dryer
8. Rotary dryer
9. Diffusivity set-up
10. Surface evaporation set-up
11. Wetted wall column set-up

Total Periods:	**60 PERIODS**

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	1	1	1	2	1	2	1	2	3	2	1	2	1
CO2	1	2	3	2	1	2	1	2	1	2	1	1	2	1
CO3	2	2	1	2	1	2	1	1	1	2	1	2	1	1
CO4	1	1	1	2	1	2	1	1	2	2	1	2	1	1
CO5	1	2	1	2	3	1	2	1	1	2	1	1	2	1

CH1508	**Computational Programming Laboratory for Chemical Engineers**	**L**	**T**	**P**	**C**
		0	0	3	2

Objectives

The course is aimed to

- ✓ To give the students an understanding the fundamentals concepts in mathematics, problems solving and computer programming.

Course Outcomes (CO)

CO1	Solving chemical engineering problems using different tools available in the excel software
CO2	Solving simultaneous equation and differential equation using polymath
CO3	Simulation of simple chemical process with controller using simulink tool
CO4	Estimation of fluid property and understand the unit operation simulation using Aspen Plus
CO5	Dynamic simulation of chemical process using aspen plus

Suggested Exercises

1. Equations of state using Newton's method
2. Regression for parameter estimation using a set of data points
3. Equilibrium flash distillation (Multicomponent Ideal)
4. Batch Reactor
5. CSTR in Series Stage wise contacting equipment
6. Solving a simple flow sheet by simultaneous approach
7. Simulation of batch Distillation (binary ideal).
8. Gravity Flow Tank
9. Heat Exchanger
10. Plug Flow Reactor
11. Absorber

Specific examples in ASPEN/HYSYs/MATLAB/EXCEL

1. Solving equation of state, regression of parameters using EXCEL/MATLAB
2. Calculation of Reynolds number, friction factor and pressure drop using EXCEL/MATLAB
3. Calculation of heat transfer coefficient in a Heat Exchanger using EXCEL/MATLAB
4. Calculation of minimum Reflux ratio for binary/tertiary system in a fractionator using EXCEL/MATLAB
5. Calculation of HTU and NTU in a Absorber using EXCEL/MATLAB
6. Calculation of Antoine's coefficient using EXCEL/MATLAB
7. Estimation of settling velocity of solids in liquids using Stoke's law using EXCEL/MATLAB

8. Calculation of minimum number of stages in a distillation column using EXCEL/MATLAB
9. Solving mass and energy balance problems using EXCEL/MATLAB
10. Calculation of Power in Reciprocating compressor using EXCEL/MATLAB
11. Steady state simulation of Heat Exchanger using ASPEN PLUS/ HYSYS
12. Steady state simulation of a CSTR using ASPEN PLUS/ HYSYS
13. Steady state simulation of Flash vessel using ASPEN PLUS/ HYSYS
14. Steady state simulation of Distillation Column using ASPEN PLUS/ HYSYS
15. Steady state simulation of an Absorption column using ASPEN PLUS/ HYSYS
16. Dynamic simulation of Heat Exchanger using ASPEN PLUS/ HYSYS
17. Dynamic simulation of a CSTR using ASPEN PLUS/HYSYS
18. Dynamic simulation of Flash vessel using ASPEN PLUS/ HYSYS
19. Dynamic simulation of Distillation Column using ASPEN PLUS/ HYSYS
20. Dynamic simulation of an Absorption column using ASPEN PLUS/ HYSYS

Total Periods:	**45 PERIODS**

TEXT BOOKS:

1. Bequette. B.W, "Process Dynamics": Modelling, Analysis and Simulation," Prentice Hall (1998)
2. Himmelblau. D.M. and Bischoff. K.B, "Process Analysis and Simulation", Wiley, 1988.
3. Strang.G. ,"Introduction to Linear Algebra", Cambridge Press, 4th edition,2009.
4. William. Luyben, "Process Modelling, simulation and control for Chemical Engineers, 2nd Edn., McGraw Hill International Editions, New York, 1990
5. Chapra.S.C. and Canale.R.P. "Numerical Methods for Engineers", McGraw Hill, 2001.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	3	1	3	1	2	3	2	1	2	1
CO2	2	3	1	2	1	3	2	2	1	2	1	1	2	1
CO3	1	3	2	1	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	3	2	1	1	1	2	2	1	2	1	1
CO5	3	1	2	1	2	1	2	1	1	2	1	1	2	1

SEMESTER VI

CH1601	**Chemical Reaction Engineering II**	**L**	**T**	**P**	**C**
		3	1	0	4

Objectives

The course is aimed to

- ✓ Learn gas solid non catalytic, gas solid catalytic and fluid- fluid reaction and apply the knowledge for the reactor design.

Course Outcomes (CO)

CO1	To understand the gas solid non catalytic reaction and different models for non-catalytic reaction.

CO2	To understand catalyst, catalyst preparation, property estimation and isotherm study.	
CO3	To understand the gas solid catalytic reaction and their mechanism	
CO4	To design of catalytic reactor for gas solid reaction.	
CO5	To understand the concept of Mass Transfer and Mass transfer with reaction for fluid fluid reaction and tower design.	
UNIT – I	**FLUID SOLID NON CATALYTIC KINETICS**	**12**
Gas solid non catalytic reaction. Reaction kinetics, Shrinking Core Model and Progressive conversion model, Controlling resistances (diffusion through gas film, ash layer and chemical reaction controlling), rate controlling steps; time for Complete Conversion for Single and Mixed Sizes, design of fluid –particle reactors.		
UNIT – II	**CATALYSIS & ADSORPTION**	**12**
Catalysis and adsorption: physical properties of catalyst, surface area, void volume, solid density, volume determination, catalyst classification and preparation, catalyst promoters, catalyst inhibitors, catalyst poisons. Adsorption Isotherms Freundlich and Langumir isotherms.		
UNIT – III	**KINETICS OF CATALYTIC REACTIONS**	**12**
Gas solid catalytic reaction: steps in catalytic reaction, Single site, dual site mechanisms, Langmuir Hinshelwood, Rate controlling steps. Experimental methods for determining rate, differential , integral reactor and reactor deign		
UNIT – IV	**FLUID SOLID CATALYTIC KINETICS**	**12**
Diffusion Within Catalyst Particle, Mass and Heat Transfer Within Catalyst Pellets, Effectiveness Factor, Thiele Modulus, Effectiveness factor for non-isothermal condition.		
UNIT – V	**FLUID -FLUID KINETICS**	**12**
Fluid-Fluid reaction. Kinetics and design of Fluid-Fluid Reactions. Rate equation, Kinetic regimes for absorption combined with chemical reaction. Various cases of mass transfer with chemical reaction , Factors to select the contactor, Tower Reactor Design		
	Total:	**45 PERIODS**

Text Books:

1. J.M.Smith Chemical Engineering Kinetics, Third Edition, Mc Graw Hill New York 1981
2. O. Levenspiel, Chemical Reaction Engineering , Third Edition, John Wiley 1999
3. H.S. Fogler, Elements of Chemical Reaction Engineering, Third Edition, Prentice Hall of India, 1999

Reference Books:

1. Lanny D. Schmidt The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2005
2. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press , 2014
3. G.F. Froment, K.B.Bischoff Chemical Reactor Analysis and Design , John Wiley and Sons, 1979

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	1	1	1	2	1	2	1	2	3	2	1	2	1
CO2	1	2	3	2	1	2	1	2	1	2	1	1	2	1
CO3	2	2	1	2	1	2	1	1	1	2	1	2	1	1
CO4	1	1	1	2	1	2	1	1	2	2	1	2	1	1
CO5	1	2	1	2	3	1	2	1	1	2	1	1	2	1

CH1602	Mass Transfer II	L	T	P	C
		3	0	2	4

Objectives

The course is aimed to

- ✓ Impart knowledge on how certain substances undergo the change in composition, change in phases and exhibit their properties according to the changed environment. Also, to design absorber and stripper, distillation column, extraction and leaching equipment and adsorber.

Course Outcomes (CO)

CO1	To understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process
CO2	To identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower.
CO3	To apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process.
CO4	To describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation.
CO5	To understand the concept of adsorption techniques, various isotherms and ion exchange process

UNIT – I	ABSORPTION	9 + 6

Absorption factor, Equipments in gas liquid operations, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; Absorption with chemical reaction.

Lab Component

- To study the Packed bed Absorber

UNIT – II	DISTILLATION	9 + 6

Vapour liquid equilibria - Raoult's law, Ideal and non-ideal systems, Principle of distillation - flash distillation, differential distillation, steam distillation, Azeotropic and extractive distillation, Number of ideal stages by Mc.Cabe - Thiele method, Introduction to Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio.

Lab Component

- To study the Simple, Steam and Packed distillation column

UNIT – III	LIQUID LIQUID EXTRACTION	9 + 6

Equipments used in Liquid - liquid extraction – differential contact equipment-spray, packed and mechanically agitated contactors, Pulsed extractors, centrifugal extractors-Supercritical extraction, Selection of solvent, stage wise contact – partially soluble and insoluble, cross current and counter current extraction.

Lab Component

- To study the Liquid-Liquid extraction and RDC Extractor

UNIT – IV	LEACHING	9 + 6

Single stage leaching, Solid-liquid equilibria- leaching equipment for batch and continuous operations, calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), multi stage continuous cross current and countercurrent leaching, stage calculations, stage efficiency.

Lab Component

- Experimental studies of Single stage leaching

UNIT – V	ADSORPTION, ION EXCHANGE, MEMBRANE SEPARATION PROCESSES	9 + 6

Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration, membrane distillation, recent development.

Lab Component

- Adsorption studies using Silica gel

Total: **75 PERIODS**

Text Books:

1. Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill, 1981.
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice HallInc., New Jersey, 2003.
3. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.

Reference Books:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw-Hill, 2005.
2. Seader J.D. and Henley E.J., "Separation Process Principles", 2nd Ed., John Wiley, 2006.
3. King,C.J.,"SeparationProcesses",2ndEdn.,TataMcGraw-Hill1980

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	1	1	1	2	1	2	1	2	3	2	1	2	1
CO2	1	2	3	2	1	2	1	2	1	2	1	1	2	1
CO3	2	2	1	2	1	2	1	1	1	2	1	2	1	1
CO4	1	1	1	2	1	2	1	1	2	2	1	2	1	1
CO5	1	2	1	2	3	1	2	1	1	2	1	1	2	1

CH1603	**Chemical Engineering Thermodynamics**	**L**	**T**	**P**	**C**
		3	0	0	3

Objectives

The course is aimed to

- ✓ Understand the phase Behavior of fluids under different PVT conditions and apply them for practical purposes. The course will render a comprehensive understanding of theory and application of solution thermodynamics.

Course Outcomes (CO)

CO1	To understand the systematic development of new class of properties to describe real mixtures
CO2	To develop the idea of chemical potential to derive the idea of phase equilibria
CO3	To understand the concept of equilibrium between combination of two co existing phases other than liquid and vapour
CO4	To understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.
CO5	To analyze the ideal and actual vapor-compression refrigeration cycle and Evaluate the performance of innovative vapor compression refrigeration systems

UNIT – I	**SOLUTION THERMODYNAMICS**	**9**

Thermodynamic formulation , Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures, pure species and liquids.

UNIT – II	**PHASE EQUILIBRIA**	**9**

Phase equilibrium in ideal solution, excess Gibbs free energy models, Henry's law, fugacity, Phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

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

Vapor-Liquid Equilibrium at low, moderate and high pressures; bubble and dew point calculation, thermodynamic consistency test of VLE data

UNIT – IV	**CHEMICAL REACTION EQUILIBRIA**	**9**

Chemical Reaction Equilibrium of single and multiple reactions, Standard Gibbs free change, equilibrium constant-effect of temperature; homogeneous gas and liquid phase reactions.

UNIT – V	**REFRIGERATION**	**9**

Principles of refrigeration, methods of producing refrigeration, liquefaction process, coefficient of performance, Evaluation and performance of vapor compression and gas refrigeration cycles.

Total: 45 PERIODS

Text Books:

1. Smith J.M., Van Ness, H.C., &Abbot M.C," Introduction to Chemical Engineering thermodynamics", McGraw Hill VII Edition 2004
2. Kyle B.G.," Chemical and Process Thermodynamics", Pearson International third Edition 1999.
3. Rao Y.V.C.," Chemical Engineering Thermodynamics" Universities Press,2005

Reference Books:

1. Sandler,S.I.,"Chemical and Engineering Thermodynamics", II Edition,Wiley,1989.
2. Narayanan K.V"A Text Book of Chemical Engineering Thermodynamics"Prentice Hall of India Pvt.Ltd.2001

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	1	1	1	2	1	2	1	2	3	2	1	2	1
CO2	1	2	3	2	1	2	1	2	1	2	1	1	2	1
CO3	2	2	1	2	1	2	1	1	1	2	1	2	1	1
CO4	1	1	1	2	1	2	1	1	2	2	1	2	1	1
CO5	1	2	1	2	3	1	2	1	1	2	1	1	2	1

CH1604	**Process Dynamics and Control**	**L**	**T**	**P**	**C**
		3	0	0	3

Objectives

The course is aimed to

- ✓ Determine possible control objectives, input variables (manipulated variables and disturbances), model the dynamic behavior of a process, design PID controllers, frequency response and analyze stability of closed loop and open loop systems.

Course Outcomes (CO)		
CO1	To understand the need to develop mathematical description of a chemical process as a prerequisite to process design and to control the process.	
CO2	To develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms	
CO3	To convert a process and instrumentation diagram to a control block diagram	
CO4	To understand Frequency response of control systems and tune the PID controllers	
CO5	To appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.	
UNIT – I	**INTRODUCTION**	**9**
Introduction to Chemical Process Control, Mathematical description of chemical processes, Formulating Process Models, Laplace Transforms, Properties of Laplace Transforms, Solution of ODE using Laplace Transforms, Standard input forcing functions, State – Space representation, transform domain models, Impulse response models, Inter relationship between process model forms		
UNIT – II	**FIRST ORDER AND HIGHER ORDER SYSTEMS**	**9**
Open-loop systems, 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, FOPDT Model, Skogestaad's rule for FOPDT and SOPDT, Lead- Lag systems		
UNIT – III	**CLOSED LOOP CONTROL SYSTEM**	**9**
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, principles of pneumatic and electronic controllers, control valves, transient response of closed-loop control systems and their stability, Root locus diagram.		
UNIT – IV	**FREQUENCY RESPONSE**	**9**
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings, Nyquist Stability Criterion		
UNIT – V	**ADVANCED CONTROL SYSTEMS**	**9**
Introduction to advanced control systems, cascade control, feed forward control, Controllers for Inverse response Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.		
	Total:	**45 PERIODS**

Text Books:

1. Stephanopoulos, G. (1984). Chemical process control (Vol. 2). New Jersey: Prentice hall.
2. Ogunnaike, B. A., & Ray, W. H. (1994). Process dynamics, modeling, and control (Vol. 1). New York: Oxford University Press.
3. Coughanowr, D. R., & Leblanc, S. E. (2008). Introductory concepts. Process Systems Analysis and Control, 3rd Ed, 1-6.

Reference Books:

1. Seborg, D. E., Mellichamp, D. A., Edgar, T. F., & Doyle III, F. J. (2010). Process dynamics and control. John Wiley & Sons.
2. Bequette, B. W. (2003). Process control: modeling, design, and simulation. Prentice Hall Professional.
3. Riggs, J. B., & Karim, M. N. (2006). Chemical and Bio-process Control: James B. Riggs, M. Nazmul Karim. Prentice Hall.

4. Luyben, W. L., Tyréus, B. D., &Luyben, M. L. (1998). Plantwide process control (Vol. 43). New York: McGraw-Hill

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	1	1	1	2	1	2	1	2	3	2	1	2	1
CO2	1	2	3	2	1	2	1	2	1	2	1	1	2	1
CO3	2	2	1	2	1	2	1	1	1	2	1	2	1	1
CO4	1	1	1	2	1	2	1	1	2	2	1	2	1	1
CO5	1	2	1	2	3	1	2	1	1	2	1	1	2	1

CH1605	**Process Economics and Industrial Management**	**L**	**T**	**P**	**C**
		3	0	0	3

Objectives

The course is aimed to

- ✓ Understand the various concepts of economics, process development, design consideration and cost estimation in chemical industry..

Course Outcomes (CO)

C313.1	To understand the concept of economics in a process plant, time value of money and cost indices
C313.2	Able to integrate knowledge about financial statements, Depreciation and Accounting
C313.3	Able develop economic balance for chemical engineering equipment's and determine the optimum cost for operation
C313.4	To understand the basics of principles of management, types of organization and MIS
C313.5	To understand the theory behind Work measurement technique, Production planning and elements of production control

UNIT – I	**INTEREST AND PLANT COST**	**9**

Economics-Engineering economics-Financial efficiency, human factors, capital, accounting. Time value of money – Interest, present worth, annuities, Depreciation-methods, capital investment, estimation of capital cost, elements of cost, break even analysis (BEA)

UNIT – II	**PROFITABILITY AND FINANCIAL RATIOS**	**9**

Profitability - methods to estimate profitability, Alternative investments, Balance sheet-Preparation, Income statement (Profit and loss account) and financial ratio analysis.

UNIT – III	**ECONOMIC BALANCE IN EQUIPMENTS**	**9**

Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipment, plate and frame filter press.

UNIT – IV	**PRINCIPLES OF MANAGEMENT**	**9**

Principles of management, planning and organizing, staffing, process of directing-communication and types of communication, coordinating and controlling, Types of organizations, Management information systems (MIS).

UNIT – V	**PRODUCTION PLANNING CONTROL**	**9**

Work measurement techniques, motion study(Work sampling)-procedure and application , time study procedure-performance rating-types of performance rating- learning curve, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory and control, role of control charts in quality control.

Total: 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

Reference Books:

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

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	1	1	1	2	1	2	1	2	3	2	1	2	1
CO2	1	2	3	2	1	2	1	2	1	2	1	1	2	1
CO3	2	2	1	2	1	2	1	1	1	2	1	2	1	1
CO4	1	1	1	2	1	2	1	1	2	2	1	2	1	1
CO5	1	2	1	2	3	1	2	1	1	2	1	1	2	1

CH1607	**Professional Ethical Practice**	**L**	**T**	**P**	**C**
		0	0	0	1

Objectives

- ✓ The course should cover the following topics by way of Seminars, Expert Lecturers and Assignments.

Course Outcomes (CO)

CO1	Distinguish between ethical and non ethical situations.
CO2	Practice moral judgment in conditions of dilemma.
CO3	Relate the code of ethics to social experimentation
CO4	Develop concepts based on moral issues and enquiry
CO5	Resolve moral responsibilities in complications.

1. Engineering Ethics – Moral Issues, Ethical theories and their uses
2. Engineering as Experimentation – Code of Ethics
3. Engineer's Responsibilty for Safety
4. Responsibilities in Rights
5. Global issues of engineering ethics

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

CH1608	**Chemical Reaction Engineering Laboratory**	**L**	**T**	**P**	**C**
		0	0	3	2

Objectives

The course is aimed to

- ✓ Develop sound practical knowledge for students on different types of reactors.

Course Outcomes (CO)

CO1	Determine the rate constant experimentally in a batch reactor.
CO2	Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)
CO3	Study of temperature dependence of rate constant.
CO4	Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.
CO5	Determine the conversion of reactor arranged in series.

LIST OF EXPERIMENTS

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug flow reactor
3. Kinetic studies in a CSTR
4. Kinetic studies in a Packed bed reactor
5. Kinetic studies in a PFR followed by a CSTR
6. RTD studies in a PFR
7. RTD studies in a Packed bed reactor
8. RTD studies in a CSTR
9. Studies on micellar catalysis
10. Study of temperature dependence of rate constant using CSTR.
11. Kinetic studies in Sono chemical reactor
12. Studies on Cascade CSTR
13. Kinetics of photochemical reaction
14. Demonstration of heterogeneous catalytic reaction
15. Demonstration of gas-liquid reaction
16. Kinetics study in Adiabatic reactor
17. Determination of Activation Energy of a reaction
18. Kinetic study in semi batch reactor

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Batch reactor
2. Plug flow reactor
3. Continuous Stirred Tank Reactor
4. Sono chemical reactor
5. Photo chemical reactor
6. Packed bed reactor

Total Periods:	**60 PERIODS**

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

SEMESTER VII

CH1701	**Transport Phenomena**	**L**	**T**	**P**	**C**
		3	0	0	3

Objectives

- ✓ Describe mass, momentum and energy transport at molecular, microscopic and macroscopic level to determine velocity, temperature and concentration profiles

Course Outcomes (CO)

CO1	To enable the students to understand different types of fluids, rheological models, conservation laws, theories of transport properties of gases and liquids.
CO2	To enable the students to acquire knowledge in the field General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids
CO3	To enable the students to acquire knowledge in the field of equations of change and their applications
CO4	To enable the students to acquire knowledge in the field General method of shell balance approach to Mass transfer problems
CO5	To enable the students to acquire knowledge in the field turbulents phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow

UNIT - I	**MOMENTUM TRANSPORT**	**9**

Viscosity, temperature and pressure effect on viscosity of gases and liquids, Newton's law, mechanism of momentum transport, shell momentum balance method, Shear stress and velocity distributions in falling film, circular tube, annulus, slit.

UNIT - II	**ENERGY TRANSPORT**	**9**

Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanism of energy transport, shell energy balance method, Energy flux and temperature distribution in solids and laminar flow with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, fins

UNIT - III	**MASS TRANSPORT**	**9**

Diffusivity, temperature and pressure effect on diffusivity, Fick's law, mechanism of mass transport, shell mass balance method, Mass flux and concentration distribution in solids and in laminar flow: stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst

UNIT - IV	**EQUATION OF CHANGE AND THEIR APPLICATIONS**	**9**

Momentum: Equations of continuity, motion and mechanical energy (Isothermal), Energy: Equation of energy (non-isothermal). Mass: Equations of change (multi-component), equations of continuity for each species, equation of energy (multi-component). Solutions of momentum, heat and mass transfer problems discussed under shell balance by applications of equation of change, dimensional analysis of equations of change.

UNIT - V	**TRANSPORT IN TURBULENT FLOWS AND ANALOGIES**	**9**

Comparison of laminar and turbulent flows, time-smoothed equations of change, empirical expressions. Comparison of laminar and turbulent hydrodynamics, thermal and concentration boundary layer and their thicknesses. Development and applications of analogies between momentum, heat and mass transfer.

Total:	**45 PERIODS**

Text Books:

1. Bird, R. B., Stewart, W. E. and Lighfoot, E. W., "Transport Phenomena", 2nd Edn., John Wiley, 2002
2. Brodkey, R. S., and Hershey, H. C., "Transport Phenomena", McGraw-Hill, 1988

Reference Books:

1. Welty, J. R., Wilson, R. W., and Wicks, C. W., "Fundamentals of Momentum Heat and Mass Transfer", 3rd Edition. John Wiley, New York, 1984.
2. Slattery, J. S., "Advanced Transport Phenomena", Cambridge University Press, London, 1999.
3. C. J. Geankopolis, "Transport Processes in Chemical Operations", 3rd Edn., Prentice Hall of India, New Delhi, 1996.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2	1	1	2	1	1	1	1	1	2	1	1
CO2	3	3	3	3	3	3	2	1	1	1	2	3	2	2
CO3	3	3	3	3	3	3	2	1	2	1	2	3	2	3
CO4	3	3	3	3	3	3	2	1	2	1	2	3	2	3
CO5	3	3	3	3	3	3	2	1	2	1	2	3	2	3

CH1702	**Chemical Process Equipment Design (Integrated Lab)**	**L**	**T**	**P**	**C**
		3	0	2	5

Objectives

- ✓ Students learn to do in detail process and mechanical design and engineering drawing of different chemical engineering equipment.

Course Outcomes (CO)

CO1	Apply the skill in thermal design of heat transfer equipment like shell and tube, double pipe heat exchangers and evaporators, and assessing thermal efficiency of the above equipment in practice	
CO2	Demonstrate the skills in basic design and drawing of different dryers, cooling towers and cyclone separators.	
CO3	Apply the concepts involved in phase separation and design of distillation, Extraction and absorption columns.	
CO4	Demonstrate the skills in mechanical design of process equipment, design considerations of pressure vessels and its auxiliary devices design the layout of process industries	
CO5	To study the Plant Layout, Pipe Lines and Pipe Layouts, Schematics and Presentation Materials of Construction	
UNIT - I		**9+6**
Heat Exchangers, Condensers, Evaporators **Lab Component** • Drawing considerations of Heat Exchangers		
UNIT - II		**9+6**
Cooling Tower, Dryers **Lab Component** • Drawing considerations of cooling towers		
UNIT - III		**9+6**
Absorption column, Distillation Column, Extraction Column, Adsorption column **Lab Component** • Drawing considerations of Distillation Column and Adsorption column		
UNIT - IV		**9+6**
Packed bed Reactors, Pressure Vessel, Storage Vessel **Lab Component** • Drawing consideration of vessels subjected to internal pressure, and external pressure • Drawing considerations of bolt, nut and screws, welded and riveted joints, flanged joints, nozzles and reinforcements		
UNIT - V		**9+6**
Design of Plant Layout, Pipe Lines and Pipe Layouts, Schematics and Presentation Materials of Construction and Selection of process equipment **Lab Component** • Drawing consideration of Plant Layout, Pipe Lines and Pipe Layouts		
	Total:	**75 PERIODS**

Text Books:

1. M.V.Joshi and V.V. Mahajan, "Process Equipment Design", MacMillan India Ltd.
2. S.D.Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000

Reference Books:

1. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
2. R.H. Perry, "Chemical Engineers' Handbook", McGraw-Hill.
3. W.L.McCabe, J.C.Smith and Harriet, "Unit Operation of Chemical Engineering", McGraw-Hill.
4. Robert Treybal, "Mass Transfer Operations", McGraw-Hill. 66
5. J.M. Coulson and J.Richardson, "Chemical Engineering", vol. 6, Asian Books Printers Ltd.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

CH1703	Safety and Hazard analysis	L	T	P	C
		3	0	0	3

Objectives

To enable the students to

- ✓ Become a skilled person in hazopard hazarel analysis and finding out the root cause of an accident.
- ✓ Gain knowledge in devising safety policy and procedures to be adopted to implement total safety in a plant

Course Outcomes (CO)

CO1	To understand the need and importance of Industrial safety
CO2	To understand the causes and effects of chemical hazards
CO3	To understand how industries affect the environment
CO4	To familiarise with hazard analysis and assessment procedures
CO5	To understand the concept of Disaster management

UNIT - I **INTRODUCTION TO SAFETY PROGRAMMES** **9**

Safety in industries; need for development; importance safety consciousness in Indian chemical industry; social environmental setup; tolerance limit of the society; psychological attitude towards safety programmes. Elements of safety programme; effective realization; economic and social benefits; effective communication training at various levels of production and operation.

UNIT - II **PLANT SAFETY** **9**

Chemical process industries; potential hazards; chemical and physical job safety analysis; high pressure; high temperature operation; dangerous and toxic chemicals; highly radioactive materials; safe handling and operation of materials and machineries; planning and layout.

UNIT - III **SAFETY PERFORMANCE** **9**

Appraisal; effective steps to implement safety procedures; periodic inspection and study of plant layout and constant maintenance; periodic advice and checking to follow safety procedures; proper selection and replacement of handling equipments; personal protective equipments.

UNIT - IV **ACCIDENTS** **9**

Industrial accidents – accident costs – identification of accident spots; remedial measures; identification and analysis of causes of injury to men and machines – accident prevention – accident proneness – vocational guidance, fault free analysis. Fire prevention and fire protection.

UNIT - V **HEALTH HAZARDS AND LEGAL ASPECTS** **9**

Health hazards – occupational – industrial health hazards – health standards, and rules – safe working environments – parliamentary legislations – factories act – labour welfare act – ESI Act – Workmen Compensation Act .Role of Government, safety organizations, management and trade unions in promoting industrial safety.

Total: 45 PERIODS

Text Books:

1. Ridley Safety at Work, VII Edition, Butterworth Heinman 2007.
2. William Handley, Industrial Safety Hand Book McGraw-Hill Book Company 2nd Edition, 1977.
3. Fawatt, H.H. and Wood, W.S.Safety and Accident Prevention in Chemical Operation, Interscience, 1965

Reference Books:

1. Heinrich, H.W. Dan Peterson, P.E. and Nester Rood. Industrial Accident Prevention, McGraw-Hill Book Co., 1980
2. Blake, R.P., Industrial Safety, Prentice Hall Inc., New Jersy – 3rd Edn. 1963.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

CH1707	**Mini Project**	**L**	**T**	**P**	**C**
		0	0	3	2

Objectives

- ✓ The objective of the mini project is to make use of the knowledge gained by the student at early stages of the degree course.

Course Outcomes (CO)

CO1	Demonstrate a sound technical knowledge of their selected project topic.
CO2	Undertake problem identification, formulation and solution.
CO3	Design engineering solutions to complex problems utilising a systems approach.
CO4	Conduct an engineering project.
CO5	Demonstrate the knowledge, skills and attitudes of a professional engineer.

Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry.

Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, outside the department, in industries/Research labs for which proportional weightage will be given in the final assessment.

Total Periods: 60 PERIODS

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

CH1708	PROCESS CONTROL AND DYNAMICS LABORATORY	L	T	P	C
		0	0	3	2

Objectives

The course is aimed to

- ✓ Gain the hands-on training about the control systems

Course Outcomes (CO)

CO1	Able to determine the response of a first order and second order system for various input
CO2	Able to determine the response of an interacting and non- interacting system for various input
CO3	Understand the difference between an open loop and closed loop system
CO4	Understand the concept of three classical controller P, PI, PID controller
CO5	Understand the concept of stability and tuning of a system

LIST OF EXPERIMENTS

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a level system
6. Open loop study on a flow system
7. Open loop study on a thermal system
8. Closed loop study on a level system
9. Closed loop study on a flow system
10. Closed loop study on a thermal system
11. Tuning of a level system
12. Tuning of a flow system
13. Tuning of a thermal system
14. Flow co-efficient of control valves
13. Characteristics of different types of control valves

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Thermometer and Thermo well setup
2. U tube manometer (mercury and water) setup
3. Non- interacting System
4. Interacting System
5. Closed loop Level system
6. Closed loop flow system
7. Closed loop thermal system
8. Control valve setup

Total Periods:	**60 PERIODS**

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

CH1709	**Internship**	**L**	**T**	**P**	**C**
		0	0	0	1

Objectives

- ✓ Explore career alternatives prior to graduation.

Course Outcomes (CO)

CO1	Integrate theory and practice.
CO2	Develop work habits and attitudes necessary for job success.
CO3	Build a record of work experience.
CO4	Acquire employment contacts leading directly to a full-time job following graduation from college.
CO5	Develop communication, interpersonal and other critical skills in the job interview process.

Students shall undergo training in R&D institutions / Academics / Industries for a minimum period of 15 days. At the end of internship students must submit a report for internal evaluation.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

CH1807	Project Work	L	T	P	C
		0	0	0	1

Objectives

- ✓ The objective of the project is to make use of the knowledge gained by the student at various
- ✓ stages of the degree course.

Course Outcomes (CO)

CO1	Demonstrate a sound technical knowledge of their selected project topic.
CO2	Undertake problem identification, formulation and solution.
CO3	Design engineering solutions to complex problems utilising a systems approach.
CO4	Conduct an engineering project.
CO5	Demonstrate the knowledge, skills and attitudes of a professional engineer.

Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry.
Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, outside the department, in industries/Research labs for which proportional weightage will
be given in the final assessment.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

PROFESSIONAL ELECTIVE I

CH1509	CHEMICAL WORKS ORGANIZATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed to

- To Introduce the labour welfare act, plant location and layout
- To introduce the multi dimensional facts of organizational behaviour.
- Effectiveness of the individual dimensions, the group dimensions and its dynamics

Course Outcomes (CO)

CO1	To assess their own entrepreneurial and enterprising potential
CO2	To develop an understanding of the general role of Small Business Enterprises
CO3	To gain knowledge on material and scientific management
CO4	Know the difference between entrepreneurial and managerial type jobs
CO5	Understanding of individual personalities and interpersonal skills needed for effective communications

UNIT – I **9**

Industrial Relations – Introduction. Significance & conditions for good industrial relations Causes of poor industrial relations & suggestions to improve it. Labour disputes in India. Industrial disputes act-1947 (only Salient Points). Types of industrial disputes – strikes – lockouts. Regulation of strikes & Lockouts.

UNIT – II **9**

Business organization - Various forms of private, ownerships, comparison and choice. Industrial Organizations - Plant location - Factors influencing plant location - split and coupled locations- size of industrial units. Plant layout - Choice of equipment various types of layout - guarding of machineries - illumination, heating and ventilation.

UNIT – III **9**

Material management - Organization - Production Planning, purchase, store - inventory control, sales and marketing. Scientific management - Rationalization - time and motion study analysis. Time management.

UNIT – IV **9**

Personality predispositions – personality and personality types, Maddi's models of personality. Perpectual process – development of perpectual skills. Motivation and work performance. Reinforcement theory – Relationship between motivation and performance.

UNIT – V **9**

Dynamics of communication – The communication process, structure of communication, Transactional Analysis, The five common communication networks in an organization. Group Dynamics – Synergy through groups, Group behaviour, group effectiveness, stages of group development. Properties and Characteristics of Highly effective groups

Total Periods: 45

Text Books:

1. Sukla,M.C., Business Organization and Management, 2010.
2. Uma sekaran – "Organisational Behaviour – Text and Cases" 2004, Tata McGraw Hill New Delhi.

Reference Books:

1. Tripathi – "Personnel Management & Industrial Relations" 2013, Sultan Chand and Sons New Delhi.
2. K.Aswathappa, Organization behavior - Texts and Cases, 1997Himalaya Publishing House.
3. Industrial disputes act-1947
4. Chakraborty S K- Managerial Development & Appraisal –Macmillan India
5. Strauss & Sayles – Personnel Management

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1

CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1510	**MEMBRANE SCIENCE AND ENGINEERING**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To make students understand the various types of Membrane compositions. To familiarize the students of various Membrane configuration Units.
- To provide knowledge about the various Membrane separations techniques.
- To illustrate the various membrane synthesis techniques and its applications

Course Outcomes (CO)

CO1	To Familiarize main membrane processes, principles, separation mechanisms, and applications
CO2	To Appreciate the selection criteria for different membrane processes
CO3	To Describe the principle of the most common membrane applications
CO4	To Gain knowledge on different modules
CO5	To Understand the application of membrane in various fields.

UNIT – I **9**

Synthetic Membranes - configuration, morphology, principles of permeation and separation, membrane materials.

UNIT – II **9**

Processing: Phase-inversion process, anisotropic membranes, isotropic porous membranes. Polymer blends and alloys, dynamic membranes, liquid membranes, bio mimetic membranes ion exchange membranes, electro dialysis, bipolar membranes, mosaic membranes.

UNIT – III **9**

Separation processes: Electro dialysis, micro filtration, ultra filtration, reverse osmosis, hemodialysis, hem filtration.

UNIT – IV **9**

Membrane systems: Plate and frame, spiral-wound Unit, hollow fiber Units.

UNIT – V **9**

Membrane Applications: Wastewater treatment, bio separation, biomedical.

Total Periods: 45

Text Books:

1. R.B. Kesting., Synthetic Polymeric Membranes, Second Edn., 1985, Wiley-Interscience, New York.
2. Enrico Drioli, Lidietta Giorno, Enrica Fontananova Comprehensive Membrane Science and Engineering, 2013, Elsevier, II Edn.

Reference Books:

1. Mulder, J Basic Principles of Membrane Technology, 1996, Springer.
2. Richard W. Baker, Membrane technology and applications, II Edn., 2004 Wiley Publication.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1511	**POLYMER TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed to

- To enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers.

Course Outcomes (CO)

CO1	To understand the fundamental concepts of macromolecules
CO2	To understand the addition polymerization
CO3	To understand the condensation polymerization
CO4	To analyse the polymer property relations and their application
CO5	To understand the transition polymers and its properties

UNIT – I	**INTRODUCTION**	**9**

History of Macromolecules – structure of natural products like cellulose, rubber,proteins – concepts of macro molecules – Staudinger's theory of macromolecules – difference between simple organic molecules and macromolecules.

UNIT – II	**ADDITION POLYMERIZATION**	**9**

Chemistry of Olefins and Dienes – double bonds – Chemistry of free radicals – monomers – functionality – Polymerization: Initiation – types of initiation – free radical polymerization – cationic polymerization – anionic polymerization – coordination polymerization – industrial polymerization – bulk, emulsion, suspension and solution polymerization techniques – Kinetics – Copolymerization concepts.

UNIT – III	**CONDENSATION POLYMERIZATION**	**9**

Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity – polycondensation – kinetics of polycondensation- Carother's equation – Linear polymers by polycondensation – Interfacial polymerization – crosslinked polymers by condensation – gel point.

UNIT – IV	**MOLECULAR WEIGHTS OF POLYMERS**	**9**

Difference in molecular weights between simple molecules and polymers – number average and weight average molecular weights – Degree of polymerization and molecular weight – molecular weight distribution – Polydispersity – molecular weight determination. Different methods – Gel Permeation Chromatography – Osmometry, Light Scattering.

UNIT – V	**TRANSITIONS IN POLYMERS**	**9**

First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures – crystallinity in polymers – effect of crystallization – in polymers – factors affecting crystallization crystal nucleation and growth – relationship between Tg and Tm – Relationship between properties and crystalline structure.

Total Periods:	**45**

Text Books:

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

Reference Books:

1. Joel,R.F; Polymer Science and Technology, Eastern Economy Edition, 1999.
2. Rodriguez, F., Cohen.C., Oberic.K and Arches, L.A., Principles of Polymer Systems, 5th edition, Taylor an

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1512	**FUNDAMENTALS OF THERMODYNAMICS**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed to

- understand and appreciate thermodynamics as applied to various Chemical Engineering Processes.
- introduce the behavior of components in a mixture or solution.
- impart fundamental concepts of solution thermodynamics involving ideal and non-ideal systems.

Course Outcomes (CO)

CO1	Outline the terminology associated with engineering thermodynamics, apply the concepts of heat, work and energy conversion to calculate heat and work quantities for industrial processes and predict the properties of ideal and real mixtures besed on thermodynamic principles
CO2	Apply the basic concepts of first and second laws of themodynamics for the design and analyze of the open and closed system in chemical process plants
CO3	Predict the changes in the properties of real fluids undergoing changes in process plant eqipments.
CO4	Use empirical correlations and experimental date to evaluate thermodynamic quantities that relate to the vapour - liquid or liquid-liquid equilibria of ideal and non-ideal chemical mixtutes.
CO5	Determine equilibrium constants, standard enthalpy, Gibbs free Energy and equilidrium compositions for single and multiple reaction systems.

UNIT – I	**BASIC CONCEPTS AND LAWS OF THERMODYNAMICS**	**9**
Terminologies of thermodynamics, categorization of systems and processes, Laws of Thermodynamics. Reversible and Irreversible process. PVT behaviour gases. Equation of state. Entropy change in reversible and irreversible process, Internal energy and entropy as a function of temperature and pressure		
UNIT – II	**THERMODYNAMIC PROPERTIES**	**9**
Thermodynamics relations, Maxwell relations. Fugacity and fugacity coefficients. Estimation of thermodynamic properties. Types of thermodynamic diagrams.		
UNIT – III	**PHASE EQUILIBRIA AND VAPOUR LIQUID EQUILIBRIA**	**9**
Phase equilibria - Activity and activity coefficients. Gibbs-Duhem equations. Van laar, Margules equation. Consistency test. Prediction of VLE.		
UNIT – IV	**CHEMICAL REACTION EQUILIBRIA**	**9**
Criteria of equilibrium. Standard free energy change and equilibrium constants. Effect of temperature. Evaluation of equilibrium constants		
UNIT – V	**APPLICATION OF LAWS OF THERMODYNAMICS**	**9**
Compression and expansion of fluids. Theory of multistage compression. Refrigeration principles and applications		
	Total Periods:	**45**

Text Books:

1. Smith J.M., Van Ness H.C., Abbott M.M., Introduction to Chemical Engineering Thermodynamics, Seventh Edition, Tata McGraw Hill International Student Edition, 2007

Reference Books:

1. Dodge, B.F., Chemical Engineering Thermodynamics, McGraw Hill International Student Edition, 1960.
2. Sandler, S.I., Chemical and Engineering Thermodynamics, Second Edition, John WileyInternational Student Edition, 1989. LTPC 22 0 3 38
3. Rao .Y.V.C., Chemical Engineering Thermodynamics, United press (India) ltd.1997.
4. Narayanan K.V., A Text Book of Chemical Engineering Thermodynamics, Prentice- Hall ofIndia Private Limited, New Delhi,2001.
5. Merle Potter , Craig Somerton., Schaum's outline of Thermodynamics for Engineers, Second Edition, McGraw Hill ,2009
6. Hendrick.C.Vanness, Michael M.Abbott., Schaum's outline of Thermodynamics with Chemical Applications, McGraw Hill Professional, 1989.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

PROFESSIONAL ELECTIVE II

CH1609	**INDUSTRIAL AIR POLLUTION**	**L**	**T**	**P**	**C**
		3	1	0	4

OBJECTIVE

The course is aimed to

- To enable the students to learn about Air Pollution, effects of air pollution, Global effects, Sampling of pollutants, Meteorology and air pollution, Atmospheric stability, Plume rise and dispersion and Prediction of air quality.

Course Outcomes (CO)

CO1	To understand Laws and Regulation of air act
CO2	To identify the suitable gaseous pollutants and handling technique.
CO3	To study the particulate matter removal technique.
CO4	To study the types of equipment to remove pollutant.
CO5	To understand the concept of adsorption techniques, various control equipments

UNIT – I	**INTRODUCTION**	**9**

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

UNIT – II	**AIR POLLUTION GASES**	**9**

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

UNIT – III	**PARTICULATE AIR POLLUTION**	**9**

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

UNIT – IV	**HYBRID SYSTEM**	**9**

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

UNIT – V	**AIR POLLUTION CONTROL EQUIPMENT**	**9**

Introduction – Installation, Equipments – Cost Model.

Total Periods: 45

Text Books:

1. Air Pollution Control Equipment Louis Theodore, Burley Intuscence 2008.
2. Air Pollution Control CD Cooper and FC.Alley Wairland Press III Edition 2002.
3. Air Pollution Control Engg, Noel de nevey – Mcgrew Hill.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1610	INDUSTRIAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed to

- To introduce the measurement techniques of force, torque and speed. To introduce the measurement techniques of acceleration, Vibration and density

Course Outcomes (CO)

CO1	analyze repeatability, precision and accuracy of the instruments
CO2	understand the measurement techniques for pressure
CO3	understand the measurement techniques for temperature
CO4	understand the measurement techniques for flow and Level
CO5	understand the measurement techniques for composition

UNIT – I		**9**

Characteristics of Measurement System -Elements of instruments, static and dynamic characteristics, basic concepts and qualities of measurement, basic concepts of response of first order type instruments, mercury in glass thermometer

UNIT – II		**9**

Pressure measurement: Pressure, Methods of pressure measurement, Manometers, Elastic pressure transducers, Measurement of vacuum, Force-balance pressure gauges, Electrical pressure transducers, Pressure switches, Calibration of pressure measuring instruments, Maintenance and repair of pressure measuring instruments, Troubleshooting

UNIT – III		**9**

Temperature measurement: Temperature, Temperature scales, Methods of temperature measurement, Expansion temperature, Filled-system thermometers, Electrical temperature instruments. Pyrometers: Radiation and optical

UNIT – IV		**9**

Flow Measurement: Methods of flow measurement, Inferential flow measurement, Quantity flowmeters, Mass flowmeters, Calibration of flowmeters, Selection of flowmeters. Level measurement: Methods of liquid level measurement, Direct methods, level measurement in pressure vessels, measurement of interface level, level of dry materials. Instruments for Analysis - recording instruments, indicating and signaling instruments, instrumentation diagram.

UNIT – V		**9**

Methods of composition analysis: Spectroscopic analysis, Absorption spectroscopy, Emission spectroscopy, Mass spectroscopy

	Total Periods:	**45**

Text Books:

1. D. P. Eckman, Industrial Instrumentation, Wiley Eastern Ltd.,2004
2. J. P. Bentley, Principles of Measurement Systems, Longman
3. G. C. Barney, Intelligent Instrumentation, PHI Pvt Ltd.

Reference Books:

1. D. Patranabis, Principles of Industrial Instrumentation, 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 1999.
2. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, 1st Edition, Tata McGraw-Hill Education Private Limited, 2009.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1611	**ELECTROCHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed to

- Students will gain knowledge about electrochemical process and its application

Course Outcomes (CO)

CO1	To understand the basics of electrochemistry
CO2	To understand the Mass transfer in electrochemical systems
CO3	To understand the corrosion control measures
CO4	To understand the basics of principles of electro refining
CO5	To understand the theory behind different type of electrochemical reactors

UNIT – I		**9**

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

UNIT – II		**9**

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

UNIT – III		**9**

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

UNIT – IV		**9**

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

UNIT – V		**9**

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

Total Periods:	**45**

Text Books:

1. Picket, " Electrochemical Engineering ", Prentice Hall. 1977.
2. Newman, J. S., " Electrochemical systems ", Prentice Hall, 1973.

Reference Books:

1. 1. Barak, M. and Stevenge, U. K., " Electrochemical Power Sources - Primary and Secondary Batteries" 1980
2. 2. Mantell, C., " Electrochemical Engineering ", McGraw Hill, 1972.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1612	**PROCESS PLANT UTILITIES**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To enable the students to understand the process plant utilities and optimization techniques to optimize various parameters in chemical industries.

Course Outcomes (CO)

CO1	To understand the Chemical Softening and Demineralization
CO2	To understand the problems based on Steam, Types of Steam Generator
CO3	To understand the Monochlorodifluro Methane, Chlorofluro Carbons and Brins
CO4	To understand the Air – Water Vapors and use of Humidity Chart and its calculation
CO5	To understand the Natural Gas, Liquid Petroleum Fuels, Coal and Coke

UNIT – I	**IMPORTANT OF UTILITIES**	**9**

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

UNIT – II	**STEAM AND STEAM GENERATION**	**9**

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

UNIT – III	REFRIGERATION	9

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

UNIT – IV	COMPRESSED AIR	9

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

UNIT – V	FUEL AND WASTE DISPOSAL	9

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

Total Periods:	45

Text Books:

1. Eckenfelder, W. W, Jr. "Industrial Water Pollution Control" McGraw-Hill: New York, 1966.
2. P. L. Ballaney, "Thermal Engineering", Khanna Publisher New Delhi, 1986.
3. Perry R. H. Green D. W. "Perry's chemical Engineer's Handbook", McGraw Hill, New York, 2007.

Reference Books:

1. P. N. Ananthanarayan, "Basic Refrigeration & Air conditioning", Tata McGraw Hill, New Delhi, 2007.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

PROFESSIONAL ELECTIVE III

CH1710	MODERN SEPARATION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed to

- Students will gain knowledge about recent separation methods

Course Outcomes (CO)

CO1	To understand the basics of separation process
CO2	To understand membrane separations
CO3	To understand the separation by adsorption
CO4	To understand the inorganic separations
CO5	To understand the other pervaporation and permeation techniques

UNIT – I	BASICS OF SEPARATION PROCESS	9

Review of Conventional Processes, Recent advances in 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 fiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, CeramicHybrid process and Biological 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 – IV	INORGANIC SEPARATIONS	9
Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.		

UNIT – V	OTHER 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 Periods:	45

Reference Books:

1. King, C. J., "Separation Processes", Tata McGraw Hill, 1982.
2. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987.
3. Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar, 1992

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1711	WASTE WATER TREATMENT	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed

- To focus on the wastewater transport system and the theory and design technique for the wastewater treatment process.

Course Outcomes (CO)

CO1	To understand the Regulations – Health and Environment Concerns in waste water.
CO2	To understand the process analysis and selection
CO3	To understand the chemical unit process in water treatment
CO4	To understand the principle of biological treatment.
CO5	To understand the filtration, Membrane and ion exchanger

UNIT – I	WASTE WATER TREATMENT AN OVERVIEW	9
Terminology – Regulations – Health and Environment Concerns in waste water management – Constituents in waste water inorganic – Organic and metallic constituents.		

UNIT – II	PROCESS ANALYSIS AND SELECTION	9
Components of waste water flows – Analysis of Data – Reactors used in waste water treatment – Mass Balance Analysis – Modelling of ideal and non ideal flow in Reactors – Process Selection.		

UNIT – III	CHEMICAL UNIT PROCESSES	9
Role of unit processes in waste water treatment chemical coagulation – Chemical precipitation for improved plant performance chemical oxidation – Neutralization – Chemical Storage		

UNIT – IV	BIOLOGICAL TREATMENT	9
Overview of biological Treatment – Microbial metabolism – Bacterial growth and energatus – Aerobic biological oxidation – Anaerobic fermentation and oxidation – Trickling filters – Rotating biological contractors – Combined aerobic processes – Activated sludge film packing.		

UNIT – V	ADVANCED WASTE WATER TREATMENT	9
Technologies used in advanced treatment – Classification of technologies Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process.		

												Total Periods:	**45**	

Text Books:

1. Waste water Engineering Treatment and Reuse: Mc Graw Hill, G. Tchobanoglous, FI Biston, 2002.
2. Industrial Waste Water Management Treatment and Disposal by Waste Water Mc Graw Hill III Edition 2008.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1712	**FLUIDIZATION ENGINEERING**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To enable the students to learn the design aspects of fluidized beds.

Course Outcomes (CO)

CO1	To understand the fundamental concepts of Fluidization
CO2	To understand the Minimum fluidization conditions
CO3	To understand the Bed expansion in liquid – Solid and gas – Solid fluidizations
CO4	To understand the Heat and mass transfer in fluidized bed systems
CO5	To understand the Single stage and multistage fluidization

UNIT – I	**BASICS OF FLUIDIZATION**	**9**

Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozneykarman – On set of fluidization – Properties of fluidized beds – Development of fluidization from fixed bed.

UNIT – II	**FLUIDIZED BED TYPES**	**9**

Minimum fluidization conditions – Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

UNIT – III	**DESIGN ASPECTS**	**9**

Channeling – Bed expansion in liquid – Solid and gas – Solid fluidizations. Design aspects of fluidized bed systems.

UNIT – IV	**HEAT AND MASS TRANSFER IN FLUIDIZED BEDS**	**9**

Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

UNIT – V	**OTHER TYPES OF FLUIDIZATION**	**9**

Single stage and multistage fluidization – Collection of fines – Use of cyclones.

												Total Periods:	**45**	

Text Books:

1. Levenspiel, "Fluidization Engineering", 2nd Edition, Butterworth – Heinmann, 1991.
2. Robert H. Perry and Don W. Green, "Perry's Chemical Engineer's Hand Book", 7th Edition, Mc Graw Hill – International, 1997.

Reference Books:

1. Rowe and Davidson, "Fluidization", Academic Press ,1971.
2. Leva, M., "Fluidization", McGraw Hill Book Co, 1959.
3. Wen-Ching Yang., "Handbook of Fluidization and Fluid-Particle Systems", Marcel Dekker Inc, 2003.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1713	**DISTILLATION**	**L**	**T**	**P**	**C**
		3	1	0	4

OBJECTIVE

The course is aimed

- To provide the basic knowledge on Principles of Distillation Process and Industrial Application.
- To familiarize the students the functioning of different types of Distillation Processes
- To illustrate the concepts of various types of Distillation Processes and Design

Course Outcomes (CO)

CO1	Understanding of the Basic Principles of Distillation Process
CO2	Distinguish between Different types of Distillation Processes.
CO3	Understanding of Industrial application of Distillation Process.
CO4	Understanding the different types of Distillation Processes
CO5	And the concepts of various types of Distillation Processes and Design

UNIT – I **9**

Gibbs phase rule, phase equilibrium, ideal and non-ideal gas mixtures, Raoult's law, nonideal liquid - liquid mixtures; phase diagrams, effect of pressure on phase equilibria; Vapor Liquid Equilibria: Ideal and non-ideal binary and multi-component systems - Correlation and prediction –consistency tests; VLE of complex system-true boiling point curves-ASTM distillation, equilibrium flash vaporization curves

UNIT – II **9**

Equilibrium and simple distillation: flash vaporization of binary and multi-component systems, differential vaporization and condensation; steam distillation; fractionation of binary systems- analytical and graphical methods of determination of number of equilibrium stages.

UNIT – III **9**

Ternary systems and multi-component systems- Sorel method, Lewis-Matheson method, Thiele-Geddes method, short cut methods, graphical evaluation of number of stages for ternary systems. Complex system fractionation: Pseudo-component design method, fraction with side streams.

UNIT – IV **9**

Azeotropic distillation and extractive distillation: separation of homogeneous azeoptropes, separation of heterogeneous azeotropes, selection of addition agents-design of azeotropic distillation process, design of extractive distillation process; Reactive Distillation and Case studies.

UNIT – V **9**

Design methods: fractionation devices, bubble cap, sieve and other types of trays-plate and column hydraulics and efficiency- plate fractionation column design methods, packed column design

Total Periods: 45

Text Books:

1. Van Winkle,M., Distillation, 2nd ed. 1967, McGraw Hill publications.
2. Doherty, M.F and Malone, M.F., Conceptual Design of Distillation systems, 2006, McGraw Hill International Edn

Reference Books:

1. Holland, Multi-component Distillation. First Edn., 1963
2 Treybal,R.E.,Mass Transfer Operation, 3rd Edn., 1981, McGraw Hill
3 McCabe,W.L., Smith,J.C. and P.Harriot, Unit Operations in Chemical Engineering, VIIth Edn., 2005, McGraw Hill.
4 Sherwood,T.K.,Pigford,R.L and Cr.Wilke., Mass Transfer, McGraw Hill

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1

CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

PROFESSIONAL ELECTIVE IV

CH1714	**PIPING AND INSTRUMENTATION**	**L**	**T**	**P**	**C**
		3	1	0	4

OBJECTIVE

The course is aimed

- To impart knowledge on piping technology and instrumentation on pipelines.

Course Outcomes (CO)

CO1	To understand the introduction, applications. Piping
CO2	To understand the Pipe sizing based on velocity and pressure drop
CO3	To understand the Different types of stresses and its impact on piping
CO4	To understand the support based on requirement and its calculation
CO5	To understand the and piping & instrumentation diagram

UNIT – I	**FUNDAMENTALS OF PIPING ENGINEERING**	**9**

Definitions, Piping Components their introduction, applications. Piping MOC, Budget Codes and Standards, Fabrication and Installations of piping.

UNIT – II	**PIPE HYDRAULICS AND SIZING**	**9**

Pipe sizing based on velocity and pressure drop consideration cost, least annual cost approach, pipe drawing basics, development of piping general arrangement drawing, dimensions and drawing of piping.

UNIT – III	**PLOT PLAN**	**9**

Development of plot plan for different types of fluid storage, equipment layout, process piping layout, utility piping layout. Stress analysis -Different types of stresses and its impact on piping, methods of calculation, dynamic analysis, and flexibility analysis.

UNIT – IV	**PIPING SUPPORT**	**9**

Different types of support based on requirement and its calculation.

UNIT – V	**INSTRUMENTATION**	**9**

Final Control Elements; measuring devices, instrumentation symbols introduction to process flow diagram (PFD) and piping & instrumentation diagram (P&ID)

Total Periods:	**45**

Text Books:

1. Piping Handbook, 6 th edition, M.L. Nayyar, P.E., Mc Graw-Hill, Inc
2. Piping Design Handbook edited by Johan J McKetta, CRC Press, 1992.
3. Luyben, W. L.," Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill, 1990.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1715	FOOD TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed

- To enable the students to learn to design processing equipments for Food Industries.

Course Outcomes (CO)

CO1	To understand the general aspects of food industry
CO2	To understand the food quality and standards
CO3	To understand the basics process and its application
CO4	To understand the concept and mechanism of preservative methods
CO5	To understand the concept of utilization of food products

UNIT – I	AN OVERVIEW	9

General aspects of food industry; world food needs and Indian situation.

UNIT – II	FOOD CONSTITUENTS, QUALITY AND DERIVATIVE FACTORS	9

Constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their control

UNIT – III	GENERAL ENGINEERING ASPECTS AND PROCESSING METHODS	9

Preliminary processing methods; conversion and preservation operations.

UNIT – IV	FOOD PRESERVATION METHODS	9

Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurization; fermentation and pickling; packing methods.

UNIT – V	PRODUCTION AND UTILISATION OF FOOD PRODUCTS	9

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

Total Periods: 45

Text Books:

1. Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, The AVI publishing Co., West port 1967.
2. Potter N.N., Food Science, The AVI publishing Co., Westport, 1963.

Reference Books:

1. Heldman D.R., Food Process Engineering, The AVI publishing co., 1975. 2. Charm S.E., The Fundamentals of Foods Engineering, The AVI Publishing Co., Westport, 1963.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1716	BIOCHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed

- This course mainly discusses the role of enzymes and microbes in biotechnology sectors.

Course Outcomes (CO)

CO1	To understand the development and scope of biochemical engineering
CO2	To understand the modulation and regulation of enzyme activity
CO3	To understand the models for cellular growth unstructured, structured and cybernetic models
CO4	To understand the determination of oxygen transfer rates, power requirements
CO5	To understand the disruption-mechanical and non-mechanical methods

UNIT – I	**INTRODUCTION**	**9**

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

UNIT – II	**KINETICS OF ENZYME ACTION**	**9**

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

UNIT – III	**KINETICS OF MICROBIAL GROWTH**	**9**

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

UNIT – IV	**TRANSPORT PHENOMENA**	**9**

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

UNIT – V	**DOWN STREAM PROCESSING**	**9**

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

Total Periods:	**45**

Text Books:

1. Biochemical engineering fundamentals by J.E.Bailey and D.F.Ollis, 2nd ed, 1986, McGraw Hill.
2. Bioprocess Engineering by Michael L. Shuler and FikretKargi, 2nd edition, Pearson education.

Reference Books:

1. Biochemical engineering by James M.Lee – Prentice-Hall-1992.
2. Bioprocess engineering principles, Pauline M. Doran, Academic Press.
3. Biochemical Engineering, H.W. Blanch and D.S. Clark, Marcel Dekker, 1997.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

GE1003	**PROFESSIONAL ETHICS**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To create awareness on professional ethics and human values
- To create awareness on engineering ethics providing basic knowledge about engineering ethics, variety of moral issues, inquiry and virtues.
- To provide basic familiarity about engineers as responsible experimenters and codes of ethics
- To inculcate knowledge and exposure on safety, risk and rights of an employee
- To have an adequate knowledge about global issues in multi-national companies

Course Outcomes (CO)

CO1	Define the dimensions or senses of engineering ethics and describe the various theories of moral development.
CO2	Describe the similarities and contrast of engineering experiments Vs scientific experiments and to define the code of ethics of various professional societies.

CO3	Understand significance of safety and risk assessment when developing engineering products.
CO4	Understand the social responsibilities and intellectual property rights of engineers.
CO5	Understand the process of how a multinational company works and to describe about the role of engineers in computer ethics, environment ethics, and weapons development

UNIT – I	**HUMAN VALUES**	**9**

Morals, values and Ethics; Integrity; Work ethics; Service learning; Civic virtue; Respect for others; Living peacefully, Caring, Sharing, Honesty, Courage, Valuing time, Cooperation, Commitment, Empathy, Self-confidence, Character; Spirituality; Introduction to Yoga and meditation for professional excellence and stress management.

UNIT – II	**ENGINEERING ETHICS**	**9**

Senses of 'Engineering Ethics' – Variety of moral issues, Types of inquiry, 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.

UNIT – III	**ENGINEERING AS SOCIAL EXPERIMENTATION**	**9**

Engineering as Experimentation – Engineers as responsible Experimenters; Codes of Ethics; Balanced Outlook on Law.

UNIT – IV	**SAFETY, RESPONSIBILITIES AND RIGHTS**	**9**

Safety and Risk – Assessment of Safety and Risk, Risk Benefit Analysis and Reducing Risk; Respect for Authority; Collective Bargaining; Confidentiality; Conflicts of Interest; Occupational Crime; Professional Rights; Employee Rights; Intellectual Property Rights (IPR), Discrimination.

UNIT – V	**GLOBAL ISSUES**	**9**

Multinational Corporations; Environmental Ethics; Computer Ethics; Weapons Development; Engineers as Managers – Consulting Engineers, Engineers as Expert Witnesses and Advisors; Moral Leadership; Code of Conduct; Corporate Social Responsibility.

Total Periods: 45

Text Books

1.Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2.Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

Reference Books:

1.Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2.Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2012.
3.John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 8th edition,2017.
4.Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
5.Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd, New Delhi, 2013.
6.World Community Service Centre, "Value Education", Vethathiri publications, Erode, 2011.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	3	2	2	3	2	3	2	2	3	2	1	1
CO2	1	2	3	2	2	3	2	3	2	2	3	2	1	1
CO3	1	2	3	2	2	3	2	3	2	2	3	2	1	1
CO4	1	2	3	2	2	3	2	3	2	2	3	2	1	1
CO5	1	2	3	2	2	3	2	3	2	2	3	2	1	1

PROFESSIONAL ELECTIVE V

CH1808	OPTIMIZATION OF CHEMICAL PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed

- Students will gain knowledge about process modelling and optimization

Course Outcomes (CO)

CO1	To understand the applications of optimization in chemical engineering
CO2	To understand the conditions for optimum; region elimination methods

CO3	To understand the search methods; indirect search methods
CO4	To understand the dynamic and integer programming
CO5	To understand the equipment design, resource allocation and inventory control.

UNIT – I	**INTRODUCTION**	**9**

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

UNIT – II	**SINGLE VARIABLE OPTIMIZATION**	**9**

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

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

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

UNIT – IV	**OTHER OPTIMIZATION METHODS**	**9**

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

UNIT – V	**APPLICATIONS OF OPTIMIZATION**	**9**

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

Total Periods:	**45**

Text Books:

1. Rao, S. S., Engineering Optimization - Theory and Practice, Third Edition, John Wiley & Sons, New York, 1996.
2. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes ", McGraw-Hill Book Co., New York, 2003.
3. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimisation ", John Wiley, New York, 1980

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1809	**FERMENTATION ENGINEERING**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To enable the students to understand the role of fermentation microorganisms and (bio) chemical activities and conversions that take place during fermentations, and their impact on quality.

Course Outcomes (CO)

CO1	To understand the Microbial Enzymes – Microbial metabolites
CO2	To understand the Flow measurement and control
CO3	To understand the Different centrifuge cell description
CO4	To understand the chemical and biological – Aerobic process – Anaerobic treatment
CO5	To understand the Air sterilization – Heating and cooling – Recovery costs..

UNIT – I	**INTRODUCTION TO FERMENTATION PROCESSES**	**9**

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

UNIT – II	**INSTRUMENTATION AND CONTROL**	**9**
Measurement of process variables – Temperature and its control – Flow measurement and control – Gases and Liquids – Pressure measurement and control – Cenline analysis – Control System – 93 Combination of Control Systems – Computer application in termentation technology.		
UNIT – III	**RECOVERY AND PURIFICATION OF FERMENTATIONPRODUCTS**	**9**
Removal of Microbial cells – Foam Separation – Precipitation Filtration – Different Filtration process – Centifugation – Different centrifuge cell description – Different methods – Solvent recovery – Superfluid extraction – Chromatography – Membrane processes – Drying – Crystallization – Whole growth processing.		
UNIT – IV	**EFFLUENT TREATMENT**	**9**
Strength of fermentation effluent – Treatment and disposal – Treatment Processes – Physical, chemical and biological – Aerobic process – Anareobic treatment.		
UNIT – V	**FERMENTATION ECONOMICS**	**9**
Introduction – Isolation of micro organisms of industrial interest – Strain improvement – Market potential – Plant and equipment – Media – Air sterilization – Heating and cooling – Recovery costs.		
	Total Periods:	**45**

Text Books:

1. Principles of fermentation Technology P.Stanbury Buttuworth Hanman – 1999.
2. Fermentation and Biochemical Engineering Handbook – C.C Haber. William Andrew II Edition 2007.
3. Bioprocess Engineering Hydersen B.K Nancy A.delaK.L.Nelsen Wiley Interscience,1994.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1810	**NUCLEAR ENGINEERING**	**L**	**T**	**P**	**C**
		3	1	0	4

OBJECTIVE

The course is aimed

- To gain some fundamental knowledge about nuclear physics, nuclear reactor, nuclear fuels, reactors and safe disposal of nuclear wastes.

Course Outcomes (CO)

CO1	Ability to understand nuclear reaction process
CO2	Able to gain knowledge on nuclear fuels.
CO3	Gaining knowledge in nuclear fuel reprocessing technology
CO4	Understanding of nuclear power plants
CO5	Acquiring knowledge in safety and disposal of nuclear fuels

UNIT – I	**Nuclear physics**	**9**
Nuclear model of an atom-Equivalence of mass and energy-binding- radio activity-half lifeneutron interactions-cross sections.		
UNIT – II	**Nuclear reactor**	**9**
Nuclear reactors: types of fast breeding reactors.Design and construction of fast breedi ng reactors-heat transfer techniques in nuclear reactors- reactor shielding. Fusion reactors.		
UNIT – III	**Nuclear reactions and reaction materials**	**9**
Mechanism of nuclear fission and fusion- radio activity- chain reactions-critical mass and composition-nuclear fuel cycles and its characteristics-uranium production and purification. Zirconium, thorium, beryllium.		
UNIT – IV	**Properties of irradiated fuel - separation of reactor products**	**9**
Uses of stable isotopes and methods of isotope separation principles of isotope separation - Separation of isotopes of light elements - separation of isotopes of heavy elements.		

UNIT – V	Safety and disposal	9
Nuclear plant safety-safety systems-changes and consequences of accident-criteriafor safetynuclear waste-types of waste and its disposal-radiation hazards and their preventionweapons proliferation.		
	Total Periods:	**45**

Text Books:

1. Thomas J.Cannoly, "Fundamentals of Nuclear Engineering" 1978, John Wiley.
2. Collier J.G., and Hewitt G.F, "Introduction to Nuclear power", 1987, Hemisphere publishing, New York.

REFERENCES:

1. Wakil M.M.El., "Power Plant Technology" 1984, Mc Graw

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1811	ENERGY TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed to

- Students will gain knowledge about different energy sources

Course Outcomes (CO)

CO1	To understand the general classification of energy
CO2	To understand the Thermal, hydel and nuclear reactors
CO3	To understand the solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation
CO4	To understand the hydrolysis & hydrogenation, solvolysis, biocrude
CO5	To understand the Energy management importance, duties and responsibilities.

UNIT – I	ENERGY	9
Introduction to energy – Global energy scene – Indian energy scene - Units of energy, conversion factors, general classification of energy, energy crisis, energy alternatives.		
UNIT – II	**CONVENTIONAL ENERGY**	**9**
Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.		
UNIT – III	**NON-CONVENTIONAL ENERGY**	**9**
Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.		
UNIT – IV	**BIOMASS ENERGY**	**9**
Biomass origin - Resources – Biomass estimation. Thermochemical conversion – Biological conversion, Chemical conversion – Hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification.		
UNIT – V	**ENERGY CONSERVATION**	**9**
Energy conservation - Act; Energy management importance, duties and responsibilities; Energy audit – Types methodology, reports, instruments. Benchmalcing and energy performance, material and energy balance, thermal energy management.		
	Total Periods:	**45**

Text Books:

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

4. Energy Management, Paul W.O'Callaghan McGraw – Hill, 1993

Reference Books:

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Enery - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.
4. Handbook of Energy Audit by 7th edition Albert Thumann, P.E., C.E.M & William J Younger 100 C.E.M, Faiment Press 2008

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

PROFESSIONAL ELECTIVE VI

CH1812	FERTILIZER TECHNOLOGY	L	T	P	C
		3	1	0	4

OBJECTIVE

The course is aimed

- Students will gain knowledge about petroleum refining process and production of petrochemical products

Course Outcomes (CO)

CO1	To understand the Synthetic fertilizers
CO2	To understand the Nitrogenous Fertilizers
CO3	To understand Toyo-Koatsu total recycle process
CO4	To understand the Potassium Fertilizers
CO5	To understand the Miscellaneous Fertilizer and Bio Fertilizers

UNIT – I **9**

Introduction to Chemical Fertilizers: Chemical inorganic Fertilizers and Organic manures. Types of fertilizers: Mixed, complex and Granulated, plant nutrients.

UNIT – II **9**

Processes for Raw Materials: Processes for manufacture of ammonia, nitric acid, phosphoric acid and sulphuric acid.

UNIT – III **9**

Nitrogenous and Potassium Fertilizers: Processes for urea and di-ammonium phosphate. Recovery of Potassium salts, processes for ammonium chloride and ammonium sulphate.

UNIT – IV **9**

Complex Fertilizers: Processes for nitro - phosphates and complex NPK fertilizers liquid fertilizers

UNIT – V **9**

Phosphatic Fertilizers and Indian Fertilizer Industry: Single and Triple Superphosphate, biofertilizer. Fertilizer Industry in India

Total Periods: 45

Reference Books:

1. Strelzoff, "Technology and Manufacture of Ammonia", 2nd Edn., Wiley, 1981.
2. L. J. Carpentire, "New Developments in Phosphate Fertilizer Technology", Elsevier, 1971.
3. "Handbook on Fertilizer Technology", Fertilizer Association of India, Near JNU, New Delhi 1992.
4. V. Slack, "Phosphoric Acid", 2nd Edn., Marcell Dekkar , 1968

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2

CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1813	**PULP AND PAPER TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- Gaining Knowledge of pulp & paper industry, mill Operations, products, process variables, equipment, and terminology.
- Increasing knowledge of how the Pulp &Paper processes affect product properties, in order to improve product quality and troubleshoot variations in quality.

Course Outcomes (CO)

CO1	Understand the basic concepts of pulp and paper technology to produce paper
CO2	Apply reactions and unit operations steps to manufacture pulp.
CO3	Understand the operation of equipments employed in pulp and paper industry
CO4	Apply waste disposal techniques in pulp and paper industry.
CO5	Perform various chemical tests to monitor quality of raw material, output quality and influent/effluent of pulp and paper industry

UNIT – I	**INTRODUCTION**	**9**
Introduction to pulp and paper technology – Wood haves dry – Wood as a raw material.		
UNIT – II	**WOODYARD OPERATION**	**9**
Woodyard operation - Mechanical pulping – Chemical pulping – Secondary fibre pulp processing.		
UNIT – III	**PAPER MACHINE**	**9**
Paper Machine wet and addition paper machine dry and operation – Paper machine - Wet and operation		
UNIT – IV	**PAPER AND PAPERBOARD**	**9**
Paper and paperboard frames and products – Surface treatments – Finishing operation– End uses.		
UNIT – V	**PROPERTIES AND TESTING OF PULP AND PAPER**	**9**
Properties and Testing of pulp and paper Process control – Quality assurance – Water and air pollution control.		
	Total Periods:	**45**

1. Monica ER Monica, Goran Gellerstcdt Gunnar Hennksson De Gneyter, Pulp and paper chemistry and Technology, 2009.
2. Rao, M.Gopal, Sitting, Marshall, Dryden's outlines of Chemical Technology, 3rd Edition, Affilated East-West Press Pvt. Ltd.

Reference Books:

1. Biermann, Christopher J Handbook of Pulping and Papermaking,.,ISBN-13: 978- 0120973620
2. -Metcalf & Eddy, Wastewater Engineering, Treatment, Dispose and Reuse, Inc. IV EDN, 2002.
3. Austin, George T., Shreves' Chemical Process Industries, 5th Edition, McGraw-Hill Education India Pvt. Ltd - New Delhi.
4. Bhatia, S.C. Environmental Pollution and Control in Chemical Process Industries Second Edition 2011.
5. Trivedi, R.K., Pollution Management in Industries, Environmental Publication, Karad, India

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1814	MIXING THEORY AND PRACTICE	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed

- To teach the students about the importance of mixing in chemical process industries.
- To teach the students about the heat and mass transfer coefficient and its reaction.
- To provide basic knowledge about the Non Newtonian Liquids.

Course Outcomes (CO)

CO1	Understand the Basics of Chemical Process Industries.
CO2	Able to select the equipment for mixing
CO3	Able to design the equipment for mixing
CO4	Understand heat and mass transfer aspects in mixing
CO5	Understand mixing in non Newtonian liquids

UNIT – I **9**

Examples of processes signifying importance of mixing - Goodness of mixing: Qualification - Significance of dimensionless groups - dimensional analysis - power number correlation - Expressions for NRe, NFr, NWe, NPr from their definitions as ratios applied to resisting forces - analogy between drag coefficient and power number

UNIT – II **9**

Effect of mixing on chemical reactions - introduction -batch reactor and CSTR comparison - Residence time distribution - mixing concepts and models - RTD functions J(8) and J'(8) - Average residence time from RTD - RTD from response measurements - Interpretation of response data by mixing models - Imperfect mixing in Stirred tanks - transient analysis of chemical reactors in series.

UNIT – III **9**

Heat transfer promotion by mixing - mixing and overall heat transfer coefficient - Heat transfer correlation for helical coils and jacketed vessels - transient analysis of heat transfer - isothermal heating or cooling medium - non isothermal cooling medium - external heat exchanger - isothermal/non isothermal heating/cooling medium - Design calculation for heat transfer in mixing vessels - Stirred tank scale-up heat transfer consideration - Scale up of batch and other reactors.

UNIT – IV **9**

Mixing and mass transfer - introduction - Liquid liquid extraction - equipments - batch - continuous differential - Triangular representation of concentration - phase equilibrium diagram - Material balance for stage wise contact - counter current continuous and differential contact - problems - Interfacial phenomena - drop size distribution - coalescence - breakage - emulsion - surfactant - Mass transfer coefficient - two film concept - mass transfer modeling - Correlation for mass transfer coefficient - stage efficiency.

UNIT – V **9**

Non-Newtonian liquids mixing - introduction, pseudoplastic, dilatant, Bingham plastic liquid, - thixotropic and rheopectic liquids - shear rate - shear stress behaviour - apparent viscosity - Power curve for non-Newtonian liquids - Viscometry - shear in stirred tanks - Shear in stirred tanks related to shear in pipes, apparent viscosity in pipe-line flow and stirred tanks - discussion of experimental work literature - Reynolds number modification - Practical application of Non-Newtonian mixing.

Total Periods: **45**

Text Books:

1. Holland and Chapman, Liquid Mixing and processing in Stirred Tanks, Reinhold Publishing Co-operation, 1966, New York and London.
2. Uhl and Gray, Mixing theory and practice, Vol.1 and II, 1967, Academic Press, New York and London.

Reference Books:

1. Shinji Nagata, Mixing Principles and Applications, 1975, Holted Press , Tokyo

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

CH1815	PETROLEUM REFINING AND PETROCHEMICALS	L	T	P	C
		3	1	0	4

OBJECTIVE

The course is aimed

- Students will gain knowledge about petroleum refining process and production of petrochemical products

Course Outcomes (CO)

CO1	To understand the Testing of Petroleum Products
CO2	To understand the Cracking, Thermal Cracking
CO3	To understand the Removal of Sulphur Compounds
CO4	To understand the Catalytic Reforming of Petroleum Feed Stocks
CO5	To understand the Production of Petrochemicals

UNIT – I **9**

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

UNIT – II **9**

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

UNIT – III **9**

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

UNIT – IV **9**

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

UNIT – V **9**

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

Total Periods: 45

Text Books:

1. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edn., McGraw Hill, New York, 1985.
2. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edn., Oxford and IBH Publishing Company, New Delhi, 1990.
3. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edn., Khanna Publishers, New Delhi, 1987.
4. Wiseman. P., Petrochemicals, UMIST Series in Science and Technology.
5. H. Steiner, Introduction to petrochemicals Industry', Pergamon, 1961.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	3	1	2	1	2	1	3	2	1	3	1	1
CO2	3	3	1	3	2	1	3	2	1	3	2	1	2	1
CO3	3	1	3	3	1	1	3	2	1	1	1	1	1	2
CO4	1	3	3	2	2	1	2	1	3	3	1	2	1	1
CO5	2	1	3	3	2	1	2	3	1	2	3	3	1	2

OPEN ELECTIVE I

OCE103	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed

- To impart knowledge on Environmental management and Environmental Impact Assessment.

Course Outcomes (CO)

CO1	carry out scoping and screening of developmental projects for environmental and social assessments
CO2	explain different methodologies for environmental impact prediction and assessment
CO3	plan environmental impact assessments and environmental management plans
CO4	evaluate environmental impact assessment reports
CO5	To understand the Membrane Applications.

UNIT – I	INTRODUCTION	9

Impact of development projects–EIA Notifications-Urbanization–Meaning– Activities involved– Effects on environment-Environmental Impact Assessment(EIA)-Environmental Impact Statement(EIS) –

UNIT – II	METHODOLOGIES	9

Methods of EIA–Checklists–Matrices–Networks–Cost-benefit analysis–Analysis of alternatives – Uncertainty in EIA

UNIT – III	PREDICTION ANDASSESSMENT	9

Assessment of Impact on land, water, air, social & cultural activities and on flora& Fauna- Mathematical models-Public participation–SIA Judgment authorities-Rapid EIA

UNIT – IV	ENVIRONMENTAL MANAGEMENT PLAN	9

Plan for mitigation of adverse impact on environment–Options for mitigation of impact on water, air, land and on flora& fauna- Addressing the issues related to the Project Affected People.

UNIT – V	CASESTUDIES	9

EIA for infrastructure projects–Dams–Highways–Multi-storey Buildings–Water Supply and Drainage Projects–Waste water treatment plants, STP

Total Periods: 45

Text Books:

1. Canter,R.L.,"Environmental Impact Assessment", McGraw-Hill Inc.,New Delhi,1996.
2. Richard K. Morgan., "Environmental Impact Assessment" Kluwer Academic Publications, London, 2002

Reference Books:

1. John G. Rauand David C Hooten (Ed).,"Environmental Impact Analysis Handbook", McGraw-Hill BookCompany,1990.
2. "Environmental Assessment Sourcebook",Vol.I,II&III. The World Bank, Washington, D.C., 1991.
3. Judith Petts,"Handbook of Environmental Impact Assessment Vol.I&II", Blackwell Science, 1999.

Course Outcomes	Program Outcomes	Program Specific Outcomes

	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OCS101	**INTRODUCTION TO C PROGRAMMING**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To express algorithms and draw flowcharts in a language independent manner.
- To teach how to write modular, efficient and readable C programs
- To impart knowledge in creating and using Arrays of the C data types.
- To describe the techniques for creating program modules in C using functions and recursive functions.

Course Outcomes (CO)

CO1	Write, compile and debug programs in C language.
CO2	Use different data types in a computer program.
CO3	Design programs involving decision structures, loops, arrays and functions
CO4	Identify the difference between call by value and call by reference
CO5	Use pointers to understand the dynamics of memory, Create and perform different file operations

UNIT – I **9**

Introduction to the C Language – Algorithm, Pseudo code, Flow chart, Background, C Programs, Identifiers, Data Types, Variables, Constants, Input / Output, Operators(Arithmetic, relational, logical, bitwise etc.), Expressions, Precedence and Associatively, Expression Evaluation, Type conversions.

UNIT – II **9**

Statements- Selection Statements(making decisions) – if and switch statements, Repetition statements (loops)- while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to, Simple C Program examples

UNIT – III **9**

Functions- Introduction to Structured Programming, Functions- basics, user defined functions, inter function communication (call by value, call by reference), Standard functions. Storage classes-auto,

UNIT – IV **9**

Arrays– Basic concepts, one-dimensional arrays, two – dimensional arrays, multidimensional arrays, C programming examples Pointers – Introduction (Basic Concepts), pointers to pointers, compatibility, Pointer Applications, Arrays and Pointers, Pointer Arithmetic, memory allocation functions, array of pointers, pointers to void, pointers to functions, command –line arguments, Introduction to structures and unions.

UNIT – V **9**

Strings – Concepts, C Strings, String Input / Output functions, string manipulation functions, string /data conversion. Input and Output – Concept of a file, streams, text files and binary files, Differences between text and binary files, State of a file, Opening and Closing files, file input / output functions (standard library input / output functions for files), file status functions (error handling),Positioning functions.

Total Periods: 45

Text Books:

1. Computer Science: A Structured Programming Approach Using C, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
2. The C Programming Language by Brian Kernighan and Dennis Ritchie 2nd edition

Reference Books:

1. Let Us C Yashavant kanetkar BPB.
2. Absolute beginner's guide to C, Greg M. Perry, Edition 2, Publisher: Sams Pub., 1994.
3. Computer Programming and Data Structures by E Balagurusamy, Tata McGraw Hill.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OEE105	**SOLAR ENERGY UTILIZATION**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To learn the fundamental concepts of solar energy and radiation collecting instruments
- To study about approaches for the storage of solar energy along with solar energy collectors

Course Outcomes (CO)

CO1	To understand the History of solar energy utilization - Solar radiation and modeling
CO2	To understand the Types – Nuclear waste
CO3	To understand the Materials for flat plate collector and their properties
CO4	To understand the solar pond - solar thermal power generation
CO5	To understand the Thermal Storage - Electrical Storage

UNIT – I	**SOLAR RADIATION**	**9**

History of solar energy utilization - Solar radiation and modeling - Empirical equations for predicting the availability of solar radiation – Measurement of global, direct and diffuse radiation – Radiation computations on inclined surfaces – Angstrom's turbidity - Solar chart - Standard radiation scale.

UNIT – II	**SOLAR RADIATION MEASUREMENT AND ESTIMATION**	**9**

Measurement of solar radiation - Solar energy measuring instruments – Pyranometer – Pyrheliometer – Sunshine recorder - Estimation of average solar radiation - Ratio of beam and total radiation on tilted surface of that on horizontal surface.

UNIT – III	**SOLAR COLLECTORS**	**9**

Flat plate collector - Materials for flat plate collector and their properties - Thermal Analysis of Flat- plate Collector and Useful Heat Gained by the fluid - fin efficiency - collector efficiency factor - Heat Removal Factor - Focusing collectors - Types and applications of focusing collectors

UNIT – IV	**SOLAR ENERGY APPLICATIONS**	**9**

Introduction and principle of operation of solar cooker - solar air heater - solar water heater - solar distillation - solar pond - solar thermal power generation – Greenhouse - Solar PV system.

UNIT – V	**STORAGE OF SOLAR ENERGY**	**9**

Types of Energy Storage - Thermal Storage - Electrical Storage - Chemical Storage - hydro-storage

Total Periods: 45

Reference Books:

1. Rai, G.D., Solar Energy Utilization, Khanna Publishers, N. Delhi, 2010.
2. Sukhatme S.P., Solar Energy, Tata McGraw Hills P Co.,3rd Edition, 2008.
3. Jean Smith Jensen, Applied solar energy research: a directory of world activities and bibliography of significant literature, Volume2, Association for Applied Solar Energy, Stanford Research Institute, 2009.
4. Duffie, J.A., an
5. Jui Sheng Hsieh, Solar Energy Engineering, Prentice- Hall, 2007.
6. Garg, H.P.,Treatise on Solar Energy, John Willey & Sons, 2006.
7. 7. Anna Mani, S Rangarajan: Handbook of Solar Radiation Data for India, Allied Publishers, 2006.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OBT101	**INDUSTRIAL BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To motivate students to excel in research and to practice the technologies in the field of Industrial biotechnology. To provide students with a solid understanding of Biotechnology fundamentals and applications required to solve real life problems. To provide students with an academic environment that is aware of professional excellence and leadership through interaction with professional bodies

Course Outcomes (CO)

CO1	Design, perform experiments, analyze and interpret data for investigating complex problems in Biotechnology, Engineering and related fields.
CO2	Decide and apply appropriate tools and techniques in biotechnological manipulation.
CO3	Justify societal, health, safety and legal issues
CO4	Understand his responsibilities in biotechnological engineering practices

CO5	Understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.

UNIT – I	**OVERVIEW OF THE CELL**	**9**

Cell, structure and properties, prokaryotic and eukaryotic cells, structural organization and function of intracellular organelles; Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes and Chloroplast.

UNIT – II	**MICROBIAL GROWTH: PURE CULTURE TECHNIQUES**	**9**

Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. The definition of growth, mathematical expression of growth, Growth curve, availability of oxygen, culture collection and maintenance of cultures.

Media formulation: principles of microbial nutrition, formulation of culture medium, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents. Importance of pH.

UNIT – III	**MANAGEMENT OF WASTE**	**9**

Management of Contaminated land, lake sediments and Solid Waste, Anaerobic digestion, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting

UNIT – IV	Bioremediation	**9**

Definition, constraints and priorities of Bioremediation, Types of bioremediation, In-situ and Ex-situ bioremediation techniques, Factors affecting bioremediation. Bioremediation of Hydrocarbons. Lignocellulosic Compounds.

UNIT – V	**BIOENERGY & BIOMINING**	**9**

Bio energy: Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass. Biomining: Bioleaching, monitoring of pollutants, microbially enhanced oil recovery, microbial fuel cells.

Total Periods:	**45**

Text Books:

1. Molecular Biology of cell, Alberts. B et al. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
2. AVN Swamy, Industrial Pollution Control Engineering, 2006, Galgotia Publication,

Reference Books:

1. Environmental Biotechnology - Allan Stagg.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OBT102	**HAZARDOUS WASTE MANAGEMENT**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- Understand the type, nature and treatment of hazardous wastes.

Course Outcomes (CO)	
CO1	To understand Hazardous Solid Waste
CO2	To introduce students to basic concepts of planning and management of hazardous waste management.
CO3	The content involves importance of necessity of hazardous waste management
CO4	To understand Physico-Chemical Treatment: Incineration
CO5	To understand the Hazard analysis.

UNIT – I	INTRODUCTION	9

Hazardous waste definition- Regulatory aspects of Hazardous Waste Management in India – Sources, characterization, categories - Analysis of hazardous waste -Physical and biological routes of transport of hazardous substances

UNIT – II	HAZARDOUS WASTES MANAGEMENT	9

Handling, collection, storage and transport- TSDF concept -Hazardous waste treatment technologies-Physical, chemical and thermal treatment of hazardous waste–Solidification- Chemical fixation–Encapsulation-Pyrolysis and Incineration–Biological Treatment of Hazardous Waste, Hazardous waste landfills-Site selections-design and operation-HW reduction- Recycling and reuse–Hazardous Site remediation – onsite and offsite Techniques

UNIT – III	BIOMEDICAL WASTE MANAGEMENT	9

Biomedical waste–Definition– Regulatory aspects of Biomedical Waste. Sources–Classification– Waste Handling and Collection–Segregation and labeling- Treatment – autoclaving, Incineration, Chemical Disinfection - ,disposal. Infection control Practices.

UNIT – IV	RADIOACTIVE WASTE MANAGEMENT	9

Radioactive waste: Definition–Measurement of Radiation -Sources-Effects -Low level and high level radioactive wastes-Transuranic Waste-and their management–Uranium Mine and Tailings, Characterization – Treatment and Control - Radiation standard by ICRP and AERB.

UNIT – V	E-WASTE MANAGEMENT	9

Regulatory aspects of E-l Waste management, Waste characteristics- Generation–- Collection - Material Composition-Transport– Treatment and disposal. Recycling and Recovery – intergraded e-waste management

Total Periods:	45

Text Books:

1. Hazardous waste management CharlesA.Wentz.Second edition 1995.McGraw Hill nternational.
2. Hazardous waste management Michael D. La Gerga, PhilipL Buckingham, Jeffrey C. Evans, Second edition 2010.Waveland Press.
3. Criteria for hazardous waste landfills–CPCBguidelines2000

Reference Books:

1. Basic Hazardous waste management, "William C.Blackman.Jr", Third Edition, 2001, Lewis Publishers ,
2. Integrated solidwaste management George Techobanoglous, Hilary Theisen & Sammuel A.Vigil.
3. Criteria for hazardous waste landfills–CPCB guidelines 2000..
4. Standard handbook of Hazardous waste treatment and disposal by Harry M. Freeman, McGraw Hill 1997.
5. Management of Solid waste in developing countries by Frank Flint off, WH Original publication.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1

CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OEE106	**ENERGY CONSERVATION AND MANAGEMENT**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- Understand and analyse the energy data of industries

Course Outcomes (CO)

CO1	the students can able to analyse the energy data of industries
CO2	To understand the energy pricing, energy
CO3	Can carry out energy accounting and balancing
CO4	Conduct energy audit and suggest methodologies for energy savings and Utilize the available resources in optimal ways
CO5	Can suggest methodologies for energy savings

UNIT – I	**INTRODUCTION**	**9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing

UNIT – II	**ELECTRICAL SYSTEMS**	**9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT – III	**THERMAL SYSTEMS**	**9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT – IV	**ENERGY CONSERVATION IN MAJOR UTILITIES**	**9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

UNIT – V	**ECONOMICS**	**9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

Total Periods: 45

Text Books:

1. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004.

Reference Books:

1. Witte L.C., Schmidt P.S., Brown D.R, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford,1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Murphy. W.R. and G. Mc KAY "Energy Management" Butterworths, London 1987.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OPEN ELECTIVE II

OBT103	FUEL CELL CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed

- To create awareness about alternate clean fuel available.
- To familiarize the students with the concepts and chemistry of fuel cell

Course Outcomes (CO)

CO1	Students will be aware of alternate energy sources and its importance of it.
CO2	To understand the process analysis and selection
CO3	To understand the chemical unit process in water treatment
CO4	To understand the principle of biological treatment.
CO5	To understand the filtration, Membrane and ion exchanger

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.

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 Periods:	**45**

Text Books:

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.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OEE102	**RENEWABLE ENERGY SOURCES**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To explain concept of various forms of renewable energy
- To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications and to analysis the environmental and cost economics of using renewable energy sources compared to fossil fuels.

Course Outcomes (CO)

CO1	Understanding of commercial energy and renewable energy sources
CO2	Knowledge in working principle of various energy systems
CO3	Capability to do basic design of renewable energy systems
CO4	Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers
CO5	The course provides the student with knowledge about heat transfer with phase change (boiling and condensation) and evaporation

UNIT – I	**INTRODUCTION TO ENERGY**	**9**

Indian Energy Scenario – Types & Forms of Energy - Primary / Secondary Energy Sources – Energy Conservation – Need – EC Act 2003 : Salient Features – Energy Intensive Industries – Barriers -Roles & Responsibility of Energy Managers – Energy Auditing : Preliminary & Detailed - Benchmarking .

UNIT – II	**SOLAR ENERGY**	**9**

Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

UNIT – III	**WIND ENERGY**	**9**

Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy – Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept.

UNIT – IV	**BIO-ENERGY**	**9**

Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction – biochemical conversion - anaerobic digestion - types of biogas Plants - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

UNIT – V	**OTHER TYPES OF ENERGY**	**9**

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plants - ocean wave energy conversion - tidal energy conversion – small hydro – geothermal energy - geothermal power plants – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.– Energy scenario in India – Growth of energy sector and its planning in India.

	Total Periods:	**45**

Text Books:

1. Sukhatme, S.P., J.K.Nayak, Solar Energy, III Edn. 2008,Tata McGraw Hill,.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources,1986, EFN Spon Ltd..

Reference Books:

1. Kishore VVN, Renewable Energy Engineering and Technology, 2012, Teri Press, New Delhi
2. Peter Gevorkian, Sustainable Energy Systems Engineering, 2007, McGraw Hill
3. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, 1996, Oxford University Press, U.K, 3. Yogi Goswami, Kreith, F and Kreider, J. F., Principles of Solar Engineering, 2000, McGraw-Hill, II Edn.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OME102	**DESIGN OF EXPERIMENTS**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- To demonstrate knowledge and understanding of Taguchi's approach
- To demonstrate knowledge and understanding of Classical Design of Experiments (DOE) To develop skills to design and conduct experiments using DOE and Taguchi's approach
- To develop competency for analysing the data to determine the optimal process parameters that optimize the process.

Course Outcomes (CO)

CO1	To understand the fundamental principles of Classical Design of Experiments

CO2	To apply DOE for process understanding and optimisation
CO3	To apply Taguchi based approach to evaluate quality
CO4	To describe the Taguchi's approach to experimental design for process performance robustness
CO5	To understand the Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm

UNIT – I	**FUNDAMENTALS OF EXPERIMENTAL DESIGNS**	**9**

Hypothesis testing – single mean, two means, dependant/ correlated samples – confidence intervals, Experimentation – need, Conventional test strategies, Analysis of variance, F-test, terminology, basic principles of design, steps in experimentation – choice of sample size – Normal and half normal probability plot – simple linear and multiple linear regression, testing using Analysis of variance.

UNIT – II	**SINGLE FACTOR EXPERIMENTS**	**9**

Completely Randomized Design- effect of coding the observations- model adequacy checking - estimation of model parameters, residuals analysis- treatment comparison methods- Duncan's multiple range test, Newman-Keuel's test, Fisher's LSD test, Tukey's test- testing using contrasts- Randomized Block Design – Latin Square Design- Graeco Latin Square Design – Applications.

UNIT – III	**FACTORIAL DESIGNS**	**9**

Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model - Rule for sum of squares and Expected Mean Squares- 2K Design with two and three factors- Yate's Algorithm-fitting regression model- Randomized Block Factorial Design - Practical applications.

UNIT – IV	**SPECIAL EXPERIMENTAL DESIGNS**	**9**

Blocking and Confounding in 2K Designs- blocking in replicated design- 2K Factorial Design in two blocks- Complete and partial confounding- Confounding 2K Design in four blocks- Two level Fractional Factorial Designs- one-half fraction of 2K Design, design resolution, Construction of one-half fraction with highest design resolution, one-quarter fraction of 2K Design- introduction to response surface methods, central composite design

UNIT – V	**TAGUCHI METHODS**	**9**

Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments- Response Graph Method, ANOVA- attribute data analysis- Robust design- noise factors, Signal to noise ratios, Inner/outer OA design- case studies

Total Periods:	**45**

Text Books:

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley & sons, 2012
2. Krishnaiah K, and Shahabudeen P, Applied Design of Experiments and Taguchi Methods, PHI, India, 201

Reference Books:

1. 1.Krishnaiah K, and Shahabudeen P, "Applied Design of Experiments and Taguchi Methods", PHI, India, 2011.
2. Phillip J. Ross, "Taguchi Techniques for Quality Engineering", Tata McGraw-Hill, India, 2005.
3. Box, G. E., Hunter,W.G., Hunter, J.S., Hunter,W.G., "Statistics for Experimenters: Design, Innovation, and Discovery", 2nd Edition, Wiley, 2005.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OBT104	**BIOSENSORS**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

The course is aimed

- understand protein based biosensors and their enzyme reactivity, stability and their application

Course Outcomes (CO)

CO1	The students will able to understand protein based biosensors and their enzyme reactivity, stability and their application in protein based nano crystalline thin film processing
CO2	The students will able to describe DNA based biosensors to study the presence of heavy metals in the food products
CO3	The students will able to understand fluorescence, UV-Vis and electrochemical applications of biosensors
CO4	The students will able to study about the fabrication of biosensors and its application as nanochip analyzer
CO5	To understand the Future direction in biosensor research

UNIT – I	**PROTEIN BASED BIOSENSORS**	**9**

Nano structure for enzyme stabilization - Single enzyme nano particles - Nanotubes microporus silica - Protein based nanocrystalline Diamond thin film for processing

UNIT – II	**DNA BASED BIOSENSOR**	**9**

Heavy metal complexing with DNA and its determination water and food samples - DNA zymo biosensors

UNIT – III	**ELECTRO CHEMICAL APPLICATION**	**9**

Detection in biosensors - Flurorescence - Absorption - Electrochemical. Integration of various techniques - Fibre optic biosensors

UNIT – IV	**FABRICATION OF BIOSENSORS**	**9**

Techniques used for microfabrication - Microfabrication of electrodes - On chip analysis

UNIT – V	**BIOSENSORS IN RESEARCH**	**9**

Future direction in biosensor research - Designed protein pores-as components of biosensors - Molecular design -Bionanotechnology for cellular biosensing - Biosensors for drug discovery - Nanoscale biosensors

Total Periods: 45

Text Books:

1. Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004

Reference Books:

1. Nanomaterials for Biosensors, Cs. Kumar, Willey - VCH, 2007
2. Smart Biosensor Technology, G.K. Knoff, A.S. Bassi, CRC Press, 2006.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OME106	TESTING OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed

- To understand the various destructive and non destructive testing methods of materials and its industrial applications

Course Outcomes (CO)

CO1	Ability to use the different technique and know its applications and limitations
CO2	Identify suitable testing technique to inspect industrial component
CO3	To understand the Visual inspection, Liquid penetrant test
CO4	To understand the Differential scanning calorimetry
CO5	To understand the Thermomechanical and Dynamic mechanical analysis

UNIT – I INTRODUCTION TO MATERIALS TESTING **9**

Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing.

UNIT – II MECHANICAL TESTING **9**

Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT – III NON DESTRUCTIVE TESTING **9**

Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT – IV MATERIAL CHARACTERIZATION TESTING **9**

Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.

UNIT – V OTHER TESTING **9**

Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo- mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.

Total Periods: 45

Text Books:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Cullity, B. D., "Elements of X-ray diffraction", 3rd Edition, Addison-Wesley Company Inc., New York, 2000.
3. P. Field Foster, "The Mechanical Testing of Metals and Alloys" 7th Edition, Cousens Press, 2007.

Reference Books:

1. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.
2. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA.
3. Brandon D.G., "Modern Techniques in Metallography", Von Nostrand Inc. NJ, USA, 1986.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

OBT105	INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE

The course is aimed to

- Understand the principles of processing, manufacturing and characterization of nanomaterials and nanostructures.

Course Outcomes (CO)

CO1	Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology
CO2	Understand the different classes of nanomaterials.
CO3	Identify the CVD, MOCVD
CO4	Outline the applications of nanotechnology and
CO5	develop an ability to critically evaluate the promise of a nanotechnology device.

UNIT – I	BASICS OF NANOTECHNOLOGY	9

Introduction - Time and length scale in structures -Definition of a nanosystem -Dimensionality and size dependent phenomena -Surface to volume ratio -Fraction of surface atoms - Surface energy and surface stress-surface defects-Effect of nanoscale on various properties - Structural,thermal, mechanical,magnetic, optical and electronic properties.

UNIT – II	DIFFERENT CLASSES OF NANOMATERIALS	9

Classification based on dimensionality-Quantum Dots,Wells and Wires- Carbon based nano materials (buckyballs, nanotubes, graphene)- Metal based nanomaterials (nanogold, nanosilver and metal oxides) - Nanocomposites-Nanopolymers - Nano ceramics -Biological nanomaterials.

UNIT – III	**SYNTHESIS OF NANOMATERIALS**	**9**

Chemical Methods:Metal Nanocrystals by Reduction -Sol - gel processing -Solvothermal Synthesis-Photochemical Synthesis - Chemical Vapor Deposition(CVD) - Metal Oxide - Chemical Vapor Deposition (MOCVD).Physical Methods:Ball Milling - Electrodeposition - Spray Pyrolysis - DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE).

UNIT – IV	**CHARACTERIZATION OF NANOSTRUCTURES**	**9**

Introduction, structural characterization, X-ray diffraction (XRD-Powder/Single crystal), Small angle X-ray scattering (SAXS), Scanning Electron Microscopy (SEM) - Energy Dispersive X-ray analysis (EDAX)-Transmission Electron Microscope (TEM) - Scanning Tunneling Microscope (STM)-Atomic Force Microscopy (AFM), UV-vis spectroscopy (liquid and solid state) - Raman Spectroscopy -X-ray Photoelectron Spectroscopy (XPS) - Auger Electron spectroscopy (AES).

UNIT – V	**APPLICATIONS**	**9**

Solar energy conversion and catalysis - Molecular electronics and printed electronics -Nanoelectronics -Polymers with a special architecture - Liquid crystalline systems - Applications in displays and other devices - Nanomaterials for data storage -Photonics, Plasmonics- Chemical and biosensors -Nanomedicine and Nanobiotechnology

Total Periods:	**45**

Text Books:

1. Nano Technology: Basic Science and Emerging Technologies, Mick Wilson, Kamali Kannargare., Geoff Smith Overseas Press (2005)
2. A Textbook of Nanoscience and Nanotechnology,Pradeep T., Tata McGrawHill Education Pvt. Ltd., 2012.
3. Nanostructured Materials and Nanotechnology,Hari Singh Nalwa,Academic Press, 2002.
4. Introduction to Nanotechnology, Charles P.Poole, FrankJ.Owens, Wiley Interscience (2003)
5. Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, Baldev Raj, B BRath, James Murday, Springer Science & Business Media, 2013.

Reference Books:

1. Nanotechnology: A gentle introduction to the next Big idea, Mark A.Ratner, Daniel Ratner, Mark Ratne, Prentice Hall P7R:1st Edition (2002)
2. Fundamental properties of nanostructed materials Ed D. Fioran, G.Sberveglier, World Scientific 1994
3. Nanoscience: Nanotechnologies and Nanophysics, Dupas C., Houdy P., Lahmani M., Springer-Verlag Berlin Heidelberg, 2007

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1	2	1	2	2	1	2	1	2	3	2	1	2	1
CO2	1	1	2	2	1	2	1	2	1	2	1	1	2	1
CO3	1	3	2	2	1	2	1	1	1	2	1	2	1	1
CO4	2	2	1	2	1	2	1	1	2	2	1	2	1	1
CO5	3	1	2	1	3	1	2	1	1	2	1	1	2	1

AUDIT COURSES

AD1001	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Teach history and philosophy of Indian Constitution.
- Describe the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- Summarize powers and functions of Indian government.
- Explain emergency rule.
- Explain structure and functions of local administration

COURSE OUTCOMES	
Upon completion of the course, the students will be	
CO1	Able to understand history and philosophy of Indian Constitution.
CO2	Able to understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
CO3	Able to understand powers and functions of Indian government.
CO4	Able to understand emergency rule.
CO5	Able to understand structure and functions of local administration.

UNIT I:	**INTRODUCTION**	**9**

History of Making of the Indian Constitution-Drafting Committee- (Composition & Working) -Philosophy of the Indian Constitution-Preamble-Salient Features

UNIT II:	**CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES**	**9**

Fundamental Rights-Right to Equality-Right to Freedom-Right against Exploitation Right to Freedom of Religion-Cultural and Educational Rights-Right to Constitutional Remedies Directive Principles of State Policy-Fundamental Duties

UNIT III:	**ORGANS OF GOVERNANCE**	**9**

Parliament-Composition-Qualifications and Disqualifications-Powers and Functions-Executive President-Governor-Council of Ministers-Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions

UNIT IV:	**EMERGENCY PROVISIONS**	**9**

Emergency Provisions - National Emergency, President Rule, Financial Emergency

UNIT V:	**LOCAL ADMINISTRATION**	**9**

District's Administration head- Role and Importance-Municipalities- Introduction- Mayor and role of Elected Representative-CEO of Municipal Corporation-Pachayati raj- Introduction- PRI- Zila Pachayat-Elected officials and their roles- CEO ZilaPachayat- Position and role-Block levelOrganizational Hierarchy (Different departments)-Village level- Role of Elected and Appointed officials-Importance of grass root democracy

TOTAL PERIODS: 45

TEXT BOOKS:

1. Basu D D, Introduction to the Constitution of India, Lexis Nexis, 2015.
2. Busi S N, Ambedkar B R framing of Indian Constitution, 1st Edition, 2015.
3. Jain M P, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. The Constitution of India (Bare Act), Government Publication,1950

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO4	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO5	-	-	-	-	-	-	-	-	1	-	-	1	-	-

AD1002	VALUE EDUCATION	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Develop knowledge of self-development
- Explain the importance of Human values
- Develop the overall personality through value education
- Overcome the self destructive habits with value education
- Interpret social empowerment with value education

COURSE OUTCOMES

Upon completion of the course, the students will be

CO1	Gain knowledge of self-development
CO2	Learn the importance of Human values
CO3	Develop the overall personality through value education
CO4	Overcome the self destructive habits with value education
CO5	Interpret social empowerment with value education

UNIT I:	INTRODUCTION TO VALUE EDUCATION	9

Values and self-development –Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non- moral valuation, Standards and principles, Value judgments

UNIT II:	IMPORTANCE OF VALUES	9

Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness. Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline

UNIT III:	INFLUENCE OF VALUE EDUCATION	9

Personality and Behaviour development - Soul and Scientific attitude. Positive Thinking, Integrityand discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship Happiness Vs suffering,love for truth.

UNIT IV:	REINCARNATION THROUGH VALUE EDUCATION	9

Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation

UNIT V:	VALUE EDUCATION IN SOCIAL EMPOWERMENT	9

Equality, Non violence, Humility, Role of Women, All religions and same message,Mind your Mind, Self-control, Honesty, Studying effectively

TOTAL PERIODS: 45

REFERENCE:

Chakroborty , S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press ,New Delhi

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	-	-	-	-	-	-	1	1	-	-	-	1	-	-
CO2	-	-	-	-	-	-	1	1	1	-	-	1	-	-
CO3	-	-	-	-	-	-	1	1	1	-	-	1	-	-
CO4	-	-	-	-	-	-	1	1	-	-	-	1	-	-
CO5	-	-	-	-	-	-	1	1	-	-	-	1	-	-

AD1003	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Understand the methodology of pedagogy.
- Compare pedagogical practices used by teachers in formal and informal classrooms in developing countries.
- Infer how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
- Illustrate the factors necessary for professional development.
- Identify the Research gaps in pedagogy.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

CO1	Understand the methodology of pedagogy
CO2	Understand Pedagogical practices used by teachers in formal and informal classrooms in developing countries.
CO3	Find how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
CO4	Know the factors necessary for professional development.
CO5	Identify the Research gaps in pedagogy.

UNIT I:	**INTRODUCTION AND METHODOLOGY**		**9**
Aims and rationale, Policy background, Conceptual framework and terminology - Theories oflearning, Curriculum, Teacher education - Conceptual framework, Research questions - Overviewof methodology and Searching.			
UNIT II:	**THEMATIC OVERVIEW**		**9**
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.			
UNIT III:	**EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES**		**9**
Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.			
UNIT IV:	**PROFESSIONAL DEVELOPMENT**		**9**
Professional development: alignment with classroom practices and follow up support - Peersupport - Support from the head teacher and the community - Curriculum and assessment – Barriers to learning: limited resources and large class sizes			
UNIT V:	**RESEARCH GAPS AND FUTURE DIRECTIONS**		**9**
Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment -Dissemination and research impact.			
		TOTAL PERIODS:	**45**

REFERENCES:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	1	-	-

AD1004	STRESS MANAGEMENT BY YOGA	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Develop healthy mind in a healthy body thus improving social health also improve efficiency
- Invent Do's and Don't's in life through Yam
- Categorize Do's and Don't's in life through Niyam
- Develop a healthy mind and body through Yog Asans
- Invent breathing techniques through Pranayam

COURSE OUTCOMES	
Upon completion of the course, the students will be able to	
CO1	Develop healthy mind in a healthy body thus improving social health also improve efficiency
CO2	Learn Do's and Don't's in life through Yam
CO3	Learn Do's and Don't's in life through Niyam
CO4	Develop a healthy mind and body through Yog Asans
CO5	Learn breathing techniques through Pranayam

UNIT I:	**INTRODUCTION TO YOGA**	**9**
Definitions of Eight parts of yog.(Ashtanga)		
UNIT II:	**YAM**	**9**
Do`s and Don't's in life.Shaucha, santosh, tapa, swadhyay, ishwarpranidhan		
UNIT III:	**NIYAM**	**9**
Do`s and Don't's in life. Ahinsa, satya, astheya, bramhacharya and aparigraha		
UNIT IV:	**ASAN**	**9**
Various yog poses and their benefits for mind & body		
UNIT V:	**PRANAYAM**	**9**
Regularization of breathing techniques and its effects-Types of pranayam		
		TOTAL PERIODS: 45

REFERENCES:

1. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
2. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	-	-	-	-	-	-	1	1	-	-	-	1	-	-
CO2	-	-	-	-	-	-	1	1	-	-	-	1	-	-
CO3	-	-	-	-	-	-	1	1	-	-	-	1	-	-
CO4	-	-	-	-	-	-	1	1	-	-	-	1	-	-
CO5	-	-	-	-	-	-	1	1	-	-	-	1	-	-

AD1005	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Develop basic personality skills holistically
- Develop deep personality skills holistically to achieve happy goals
- Rewrite the responsibilities
- Reframe a person with stable mind

COURSE OUTCOMES

Upon completion of the course, the students will be

CO1	To develop basic personality skills holistically
CO2	To develop deep personality skills holistically to achieve happy goals
CO3	To rewrite the responsibilities
CO4	To reframe a person with stable mind, pleasing personality and determination
CO5	To awaken wisdom in students

UNIT I:	**NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY - I**	**9**

Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue)

UNIT II:	**NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY - II**	**9**

Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT III:	**ORGANS OF GOVERNANCE**	**9**

Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48

UNIT IV:	**EMERGENCY PROVISIONS**	**9**

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter12 -Verses 13, 14, 15, 16,17, 18

UNIT V:	**LOCAL ADMINISTRATION**	**9**

Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 –Verses 37,38,63

TOTAL PERIODS:45

REFERENCES:

1. Gopinath,Rashtriya Sanskrit Sansthanam P, Bhartrihari's ThreeSatakam , Niti-sringarvairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram,Publication Department, Kolkata,2016.

Course Outcomes	Program Outcomes												Program Specific Outcomes	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO4	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO5	-	-	-	-	-	-	-	-	1	-	-	1	-	-

AD1007	ESSENCE OF INDIAN KNOWLEDGE TRADITION	L	T	P	C
		2	0	0	0

OBJECTIVES:

The course will introduce the students to

- Get a knowledge about Indian Culture
- Know Indian Languages and Literature religion and philosophy and the fine arts in India
- Explore the Science and Scientists of Ancient, Medieval and Modern India
- Understand education systems in India

COURSE OUTCOMES

Upon completion of the course, the students will be able to	
CO1	Understand philosophy of Indian culture.
CO2	Distinguish the Indian languages and literature.
CO3	Learn the philosophy of ancient, medieval and modern India.
CO4	Acquire the information about the fine arts in India.
CO5	Know the contribution of scientists of different eras.
CO6	Understand education systems in India

UNIT I:	**INTRODUCTION TO CULTURE**	**9**
Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India		
UNIT II:	**INDIAN LANGUAGES AND LITERATURE**	**9**
Indian Languages and Literature – I: Languages and Literature of South India, – Indian Languagesand Literature – II: Northern Indian Languages & Literature		
UNIT III:	**RELIGION AND PHILOSOPHY**	**9**
Major religions practiced in India and Understanding their Philosophy – religious movements in Modern India (Selected movements only)		
UNIT IV:	**FINE ARTS IN INDIA (ART, TECHNOLOGY& ENGINEERING)**	**9**
Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in India, development of science in ancient, medieval and modern India		
UNIT V:	**EDUCATION SYSTEM IN INDIA**	**9**
Education in ancient, medieval and modern India, aims of education, subjects, languages, Scienceand Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India		

TOTAL PERIODS: 45

REFERENCES:

1. Kapil Kapoor, "Text and Interpretation: The India Tradition",ISBN: 81246033375, 2005
2. "Science in Samskrit", Samskrita Bharti Publisher, ISBN 13: 978-8187276333, 2007
3. NCERT, "Position paper on Arts, Music, Dance and Theatre", ISBN 81-7450 494-X, 200
4. Narain, "Examinations in ancient India", Arya Book Depot, 1993
5. Satya Prakash, "Founders of Sciences in Ancient India", Vijay Kumar Publisher, 1989
6. M. Hiriyanna, "Essentials of Indian Philosophy", Motilal Banarsidass Publishers, ISBN 13: 978-8120810990, 2014

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO4	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO5	-	-	-	-	-	-	-	-	1	-	-	1	-	-

AD1008	**SANGA TAMIL LITERATURE APPRECIATION**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

OBJECTIVES:

The main learning objective of this course is to make the students an appreciation for:

1. Introduction to Sanga Tamil Literature.
2. 'Agathinai' and'Purathinai' in SangaTamil Literature.
3. 'Attruppadai' in SangaTamil Literature.
4. 'Puranaanuru' in SangaTamil Literature.
5. 'Pathitrupaththu' in SangaTamil Literature.

COURSE OUTCOMES
Upon completion of the course, the students will be able to

CO1	Appreciate and apply the messages in Sanga Tamil Literature in their life.
CO2	Differentiate ‘Agathinai’ and ‘Purathinai’in their personal and societal life.
CO3	Appreciate and apply the messages in‘ Attruppadai’ in their personal and societal life.
CO4	Appreciate and apply the messages in‘ Puranaanuru’ in their personal and societal life.
CO5	Appreciate and apply the messages in‘ Pathitrupaththu’ in their personal and societal life.

UNIT I:	**SANGA TAMIL LITERATURE – AN INTRODUCTION**	**9**

Introduction to Tamil Sangam–History of Tamil Three Sangams–Introduction to Tamil Sangam Literature–Special Branches in Tamil Sangam Literature- Tamil Sangam Literature’s Grammar Tamil Sangam Literature’s parables.

UNIT II:	**‘AGATHINAI’AND‘PURATHINAI’**	**9**

Tholkappiyar’s Meaningful Verses–Three literature materials–Agathinai’s message- History of Culture from Agathinai–Purathinai–Classification–Mesaage to Society from Purathinai.

UNIT III:	**‘ATTRUPPADAI’.**	**9**

AttruppadaiLiterature–Attruppadaiin‘Puranaanuru’-Attruppadaiin‘Pathitrupaththu’-Attruppadaiin ‘Paththupaattu’.

UNIT IV:	**‘PURANAANURU’**	**9**

Puranaanuru on Good Administration, Ruler and Subjects–Emotion & its Effect in Puranaanuru.

UNIT V:	**‘PATHITRUPATHTHU’**	**9**

Pathitrupaththuin‘Ettuthogai’–Pathitrupaththu’sParables–Tamildynasty:Valor, Administration, Charity in Pathitrupaththu- Mesaage to Society from Pathitrupaththu.

TOTAL PERIODS: 45

REFERENCES:

1. Sivaraja Pillai, The Chronology oftheEarlyTamils,SagwanPress,2018.
2. HankHeifetz andGeorgeL. Hart, The Purananuru,Penguin Books,2002.
3. Kamil Zvelebil, The Smile of Murugan: OnTamil Literature of South India, Brill Academic Pub,1997.
4. GeorgeL. Hart, Poetsof theTamil Anthologies: AncientPoemsofLove andWar, Princeton University Press,2015.
5. XavierS.Thani Nayagam, Landscape and poetry:a study of nature in classical Tamil poetry,Asia Pub.House, 1967.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	-	-	-	-	-	-	-	-	-	1	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	1	-	1	-	-
CO3	-	-	-	-	-	-	-	-	-	1	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	1	-	1	-	-
CO5	-	-	-	-	-	-	-	-	-	1	-	1	-	-