ADHIYAMAAN COLLEGE OF ENGINEERING

[An Autonomous Institution Affiliated to Anna University, Chennai]
[Accredited by NAAC]
Dr.M.G.R. NAGAR, HOSUR, KRISHNAGIRI(DT)-635130, TAMILNADU, INDIA

REGULATIONS 2018
CHOICE BASED CREDIT SYSTEM

B.TECH – CHEMICAL ENGINEERING

Vision:

To develop competent, proactive and creative chemical engineers to meet the global standards and expectations of engineering education.

Mission:

M1 To provide a congenial environment and a rigorous teaching-learning process that train students to excel in fundamental sciences, chemical and allied engineering fields

M2 To offer a program to inculcate good engineering design with creative thinking and leadership qualities contributing globally for technological and economical advancements.

M3 To foster principles of sustainability that promotes environmental friendly technologies with ethical values and noble ideas for the benefit of society.

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

- The graduates of the program will have sound knowledge in Mathematical, Scientific and Engineering concepts necessary to formulate, analyze, design and solve Engineering problems and to prepare them for higher learning, research and industry.
- The graduates of the program will possess innovative skills to asses and apply the rapid changes in technology and to engage in research leading to novel solutions for human, social and global competency.
- The graduates of the program will acquire knowledge and grab opportunities to work as teams on multidisciplinary environment, communicate ideas effectively with diverse audiences, leadership qualities with ethical values and engage in life-long learning.

2. PROGRAMME OUTCOMES (POS)

	Graduate Attribute	Programme Outcomes (POs)
PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**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.
PO3	**Design/development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**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 provide valid conclusions.
PO5	**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
PO6	**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.
PO7	**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.
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**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.
PO11	**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.
PO12	**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 technologicalchange.

3. PROGRAMME SPECIFIC OUTCOMES (PSOS)

By the completion of Chemical Engineering Programme the student will have following Program-specific outcomes.

1 Graduates will apply knowledge in physics, chemistry and biology in the field of transfer processes for effective separation and purification of petrochemicals, pharmaceuticals and health care products.
2 Graduates will automate and control processes by applying mathematics, process control, instrumentation, simulation and process modelling
3 Equip Chemical Engineering graduates with integrity and ethical values so that they become responsible Engineers.

4. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES

Program Educational Objectives (PEOs)	Program Outcomes(POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I	√	√	√	√	√		√				√		√	√	
II		√	√	√	√	√	√	√	√	√		√	√		√
III						√	√	√	√	√	√	√			√

5. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Year-1	Semester-1	Technical English	3	2	-	-	2	-	-	1	-	-	-	2	2	2	1
		Engineering Mathematics-I	3	3	-	-	-	-	-	-	2	2	-	2	2	1	1
		Engineering Physics	3	2	-	-	3	-	2	-	-	-	-	2	2	2	1
		Engineering Chemistry	3	2	-	3	-	-	-	-	-	-	-	-	-	-	-
		Engineering Graphics	3	3	-	-	-	-	-	-	-	-	2	-	2	2	1
		Basic Civil And Mechanical Engineering	3	2	-	-	2	-	1	-	-	-	-	2	2	2	1
		Engineering Chemistry Laboratory	3	3	-	3	2	1	-	-	2	1	-	-	2	3	1
		Engineering Practice Laboratory	1	-	1	2	1	-	-	1	1	-	1	1	1	-	2
	Semester-2	Communicative English	-	2	2	2	2	-	-	-	-	-	-	-	2	2	1
		Engineering Mathematics-II	2	2	2	2	2	2	-	-	-	-	1	1	2	2	1
		Environmental Science And Engineering	-	2	1	-	-	2	2	-	2	2	-	2	3	2	1
		Engineering Mechanics	1	2	1	1	1	-	-	-	-	-	-	2	1	-	1
		Problem Solving And Python Programming	3	3	2	-	2	-	-	-	-	2	-	2	-	2	1
		Chemistry For Technologists	3	2	1	-	2	-	-	-	2	-	-	-	2	2	1
		Engineering Physics Laboratory	3	2	-	3	-	-	-	-	-	-	-	-	-	-	-
		Problem Solving And Python Programming Laboratory	3	3	2	-	2	-	-	-	-	2	-	2	-	2	-
Year -2	este	Engineering Mathematics – III	3	3	2	3	2	1	-	-	-	-	1	-	3	3	-
		Organic Chemistry	3	-	2	2	3	-	1	-	-	-	-	-	3	-	-

		Chemical Process Calculations	3	3	3	3	2	2	-	-	-	-	2	2	2	3	-
		Instrumentation Methods and Analysis	3	3	3	2	2	2	3	-	-	-	-	-	3	3	-
		Principles of Electrical and Electronics Engineering	3	3	2	3	2	3	-	-	-	-	-	-	2	3	-
		Organic Chemistry Laboratory	3	-	2	2	3	-	1	-	-	-	-	-	3	-	-
		Technical Analysis Laboratory	3	2	2	2	1	2	-	-	-	2	2	-	3	3	-
		Electrical Engineering Laboratory	3	3	2	3	2	2	-	-	-	-	-	-	2	3	-
		Elective															
	Semester 4	Numerical Methods	3	3	3	3	3	-	-	-	-	-	-	-	3	3	-
		Physical Chemistry	3	2	3	3	2	2	3	_	_	_	_	_	3	2	_
		Chemical Process Industries	3	3	3	2	2	3	2	-	-	1	1	-	3	3	-
		Chemical Engineering Fluid Mechanics	3	3	3	3	3	3	2	-	-	-	1	-	3	3	-
		Mechanical Operations	3	3	2	3	3	3	2				1		3	3	3
		Fluid Mechanics Laboratory	3	3	3	3	3	3	2	-	-	-	1	-	3	3	-
		Physical Chemistry Laboratory	2	2	3	2	2	1	2	-	-	-	-	-	3	1	-
		Mechanical Operations Laboratory	3	3	3	2	2	1	-	-	-	-	-	-	3	3	-
		Elective															
Year-3	**Semester-5**	Probability and Statistics	3	2	3	2	2	1	-	-	-	-	-	2	2	-	2
		Chemical Engineering Thermodynamics	2	2	3	2	-	1	2	1	1	2	-	2	3	1	2
		Heat Transfer	2	2	2	2	2	1	2	1	2	2	2	1	2	2	1
		Mass transfer – I	2	3	2	2	2	2	2	2	2	2	3	2	2	2	2
		Heat Transfer Laboratory	3	3	3	3	2	3	1		2	1	1	3	2		1
		Chemical Engineering Computational Laboratory	2	3	3	3	3	1	2	1	2	-	2	2	3	3	3
		Employability Skills Lab	-	-	-	-	-	-	-	-	-	2	2	2	-	-	1
		Elective-1															
		Elective-2															
	Semester-6	Mass Transfer – II	2	2	2	2	2	1	-	1	-	-	-	2	3	2	2
		Chemical Reaction Engineering-I	2	2	2	2	1	1	2	1	1	2	-	1	2	-	1
		Process Dynamics and Control	3	3	3	3	2	1	1	2	1	1	-	1	1	2	2
		Chemical Process Plant Safety	2	2	2	1	1	2	2	3	2	1	1	2	1	-	3
		Process Control Laboratory	3	3	3	3	3	-	-	1	-	-	1	2	3	3	3
		Mass Transfer Laboratory	3	3	3	3	3	-	-	1	-	-	1	2	3	3	3
		Chemical Process Equipment Design & Drawing Lab –I	3	3	2	2	-	1	1	2	2	1.5	-	-	-	-	2
		Elective-1															
		Elective-2															
Year-4	**Semester-7**	Chemical Reaction Engineering – II	3	3	3	3	-	-	-	-	-	-	-	-	3	-	-
		Chemical Engineering Plant Design and Economics	2	2	2	2	-	2	1	2	2	3	3	2	-	-	2
		Transport Phenomena	3	2	3	-	-	-	-	-	-	-	-	-	3	2	-
		Chemical Engineering Modeling and Simulation	2	2	2	2	2	-	-	-	-	-	-	-	2	3	-
		Chemical Reaction Engineering Lab	2	2	2	2	2	-	-	-	-	-	-	-	2	3	-
		Chemical Process Equipment Design & Drawing Lab – II	2	2	-	1	1	2	2	2	1	2	-	2	-	-	1

		Chemical Engineering Simulation Laboratory	2	2	-	1	1	2	2	2	1	2	-	2	-	-	1
		Elective-1															
		Elective-2															
	Semester-8	Total Quality Management	-	-	-	3	-	3	3	2	-	1	2	3	-	-	2
		Project Work – Viva voce	3	3	3	3	3	2	2	1	3	2	2	3	3	3	3
		Elective-1															
		Elective-2															

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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CHOICE BASED CREDIT SYSTEM (CBCS)

B.TECH – CHEMICAL ENGINEERING

CURRICULA AND SYLLABI FOR SEMESTERS I TO VIII

SEMESTER I

S. NO.	CODE NO.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	118ENT01	Technical English	HS	2	0	0	2	2
2.	118MAT02	Engineering Mathematics-I	BS	3	0	0	3	3
3.	118PHT03	Engineering Physics	BS	2	0	0	2	2
4.	118CYT04	Engineering Chemistry	BS	3	0	0	3	3
5.	118EGT05	Engineering Graphics	ES	2	0	4	4	4
6.	118ESE0X	ELECTIVE (GROUP1)	ES	3	0	0	3	3
PRACTICALS								
7.	118CYP07	Engineering Chemistry Laboratory	BS	0	0	2	1	1
8.	118EPP08	Engineering Practice Laboratory	ES	0	0	2	1	1
			TOTAL	15	0	8	19	19

SEMESTER -II

S. NO.	CODE NO.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	218ENT01	Communicative English	HS	2	0	2	3	3
2.	218MAT02	Engineering Mathematics-II	BS	3	1	0	4	4
3.	218GET03	Environmental Science and Engineering	HS	2	0	0	2	2
4.	218EMT04	Engineering Mechanics	ES	3	0	0	3	3
5.	218PPT05	Problem Solving and Python Programming	ES	3	0	0	3	3
6.	218BSE0X	ELECTIVE (GROUP2)	BS	2	0	0	2	2
PRACTICALS								
7.	218PHP07	Engineering Physics Laboratory	BS	2	0	0	1	1
8.	218PPP08	Problem Solving and Python Programming Laboratory	ES	0	0	2	1	1
			TOTAL	15	1	6	19	19

SEMESTER – III

S. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	318MAT01	Engineering Mathematics – III	BS	3	4	0	4	4
2.	318CHT02	Organic Chemistry	BS	3	3	0	3	3
3.	318CHT03	Chemical Process Calculations	PC	3	3	0	3	3
4.	318CHT04	Instrumentation Methods And Analysis	PC	3	3	0	3	3
5.	318EET05	Principles of Electrical and Electronics Engineering	ES	3	3	0	3	3
6.		**Professional Elective – I**	PE	3	3	0	3	3
7.	**X18ECT01**	**Gender, Culture And Development**	MC	1	0	0	0	0
PRACTICALS								
8.	318CHP07	Organic Chemistry Laboratory	BS	0	1	2	1	1
9.	318CHP08	Technical Analysis Laboratory	PC	0	1	2	1	1
10.	318CHP09	Electrical Engineering Laboratory	ES	0	1	2	1	1
			TOTAL	**18**	**3**	**06**	**22**	**22**

SEMESTER – IV

S. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	418NMT01	Numerical Methods	BS	3	0	0	3	3
2.	418CHT02	Physical Chemistry	BS	3	0	0	3	3
3.	418CHT03	Chemical Process Industries	PC	3	0	0	3	3
4.	418CHT04	Chemical Engineering Fluid Mechanics	PC	3	2	0	4	4
5.	418CHT05	Mechanical Operations	PC	3	0	0	3	3
6.		**Professional Elective – II**	PE	3	0	0	3	3
7.	X18MC01	**Indian Constitution**	MC	1	0	0	1	0
PRACTICALS								
8.	418CHP07	Fluid Mechanics Laboratory	PC	0	0	2	1	1
9.	418CHP08	Physical Chemistry Laboratory	PC	0	0	2	1	1
10.	418CHP09	Mechanical Operations Laboratory	PC	0	0	2	1	1
			TOTAL	**18**	**2**	**06**	**22**	**22**

SEMESTER –V

S. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	518PST01	Probability and Statistics	BS	3	0	0	3	3
2.	518CHT02	Chemical Engineering Thermodynamics	PC	3	0	0	3	3
3.	518CHT03	Heat Transfer	PC	3	0	0	3	3
4.	518CHT04	Mass Transfer-I	PC	3	0	0	3	3
5.		Professional Elective - III	PE	3	0	0	3	3
6.		Open Elective – I	OE	3	0	0	3	3
PRACTICALS								
7.	518CHP07	Heat Transfer Laboratory	PC	0	0	4	1	1
8.	518CHP08	Chemical Engineering Computation Laboratory	PC	0	0	4	1	1
9.	518CHP09	Employability skills Laboratory	EEC	0	0	4	1	1
			TOTAL	18	0	12	21	21

SEMESTER –VI

S. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	618CHT01	Mass Transfer – II	PC	3	0	0	3	3
2.	618CHT02	Chemical Reaction Engineering-I	PC	3	0	0	3	3
3.	618CHT03	Process Dynamics and Control	PC	3	0	0	3	3
4.	618CHT04	Chemical Process Plant Safety	PC	3	0	0	3	3
5.		Professional Elective - IV	PE	3	0	0	3	3
6.		Open Elective – II	OE	3	0	0	3	3
PRACTICALS								
7.	618CHP07	Process Control Lab	PC	0	0	4	1	1
8.	618CHP08	Mass Transfer Laboratory	PC	0	0	4	1	1
9.	618CHP09	Chemical Process Equipment Design and Drawing Laboratory - I	PC	0	0	4	1	1
			TOTAL	18	0	12	21	21

SEMESTER –VII

S. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	718CHT01	Chemical Reaction Engineering - II	PC	3	0	0	3	3
2.	718CHT02	Chemical Engineering Plant Design and Economics	PC	3	0	0	3	3
3.	718CHT03	Transport Phenomena	PC	3	0	0	3	3
4.	718CHT04	Chemical Engineering Modelling and Simulation	PC	3	0	0	3	3
5.		**Professional Elective - V**	PE	3	0	0	3	3
6.		**Professional Elective - VI**	PE	3	0	0	3	3
PRACTICALS								
7.	718CHP07	Chemical Reaction Engineering Laboratory	PC	0	0	2	1	1
8.	718CHP08	Chemical Process Equipment Design & Drawing Laboratory -II	PC	0	0	2	1	1
9.	718CHP09	Chemical Engineering Simulation Laboratory	PC	0	0	2	1	1
			TOTAL	**18**	**0**	**6**	**21**	**21**

SEMESTER-VIII

S. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	818CHT01	Total Quality Management	HS	3	0	0	3	3
2.		**Professional Elective - VII**	PE	3	0	0	3	3
3.		**Professional Elective - VIII**	PE	3	0	0	3	3
4.	818CHP04	Project Work & Viva Voce	EEC	0	0	18	9	9
			TOTAL	**09**	**0**	**18**	**18**	**18**

TOTAL NO. OF CREDITS: 163

B.TECH. CHEMICAL ENGINEERING

ELECTIVE (GROUP1)

S. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			
				L	T	P	C
1	118ESE01	Basic Civil and Mechanical Engineering	ES	3	0	0	3
2	118ESE02	Basic Civil Electrical and Electronics Engineering	ES	3	0	0	3
3	118ESE03	Basic Mechanical Electrical and Electronics Engineering	ES	3	0	0	3
4	118ESE04	Elements of Mechanical Engineering	ES	3	0	0	3

ELECTIVE (GROUP2)

S. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			
				L	T	P	C
1	218BSE01	Material Science	BS	2	0	0	2
2	218BSE02	Quantum Mechanics for Engineers	BS	2	0	0	2
3	218BSE03	Chemistry for Technologists	BS	2	0	0	2
4	218BSE04	Energy Storage Devices and Fuel Cells	BS	2	0	0	2

B.TECH. CHEMICAL ENGINEERING

PROFESSIONAL ELECTIVES [PE]

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			Credit
			Lecture	Tutorial	Practical	
1	318CHE01	Analytical Chemistry	3	0	0	3
2	318CHE02	Process Organic Synthesis	3	0	0	3
3	318CHE03	Green Chemistry and Engineering	3	0	0	3
4	318CHE04	Materials Technology	3	0	0	3
5	318CHE05	Solid Mechanics for Technologists	3	0	0	3
6	318CHE06	Composite Materials	3	0	0	3
7	418CHE01	Polymer Science and Technology	3	0	0	3
8	418CHE02	Sugar Technology	3	0	0	3
9	418CHE03	Renewable Energy Technologies	3	0	0	3
10	418CHE04	Plastics Engineering	3	0	0	3
11	418CHE05	Heat Power Engineering	3	0	0	3
12	418CHE06	Fuel and Combustion Technologies	3	0	0	3
13	518CHE01	Process Instrumentation	3	0	0	3
14	518CHE02	Fuel cell Technology	3	0	0	3
15	518CHE03	Introduction to Colloidal Science and Interfacial Engineering	3	0	0	3
16	518CHE04	Oil and Natural Gas Engineering	3	0	0	3
17	518CHE05	Fluidization Engineering	3	0	0	3
18	618CHE01	Energy Conservation and Management in Process Industries	3	0	0	3
19	618CHE02	Industrial Management	3	0	0	3
20	618CHE03	Pulp and Paper Technology	3	0	0	3
21	618CHE04	Electrochemical Engineering	3	0	0	3
22	618CHE05	Disaster mitigation and Management	3	0	0	3
23	618CHE06	Food Science and Technology	3	0	0	3
24	718CHE01	Mathematical Methods for Chemical Engineers	3	0	0	3
25	718CHE02	Biochemical Engineering	3	0	0	3
26	718CHE03	Modern Separation Techniques	3	0	0	3
27	718CHE04	Process Automation	3	0	0	3
28	718CHE05	Solid waste Management	3	0	0	3

29	718CHE06	Programming Using MATLAB	3	0	0	3
30	718CHE07	Optimization of Chemical processes	3	0	0	3
31	718CHE08	Industrial waste water Treatment	3	0	0	3
32	718CHE09	Catalyst Science and Technology	3	0	0	3
33	718CHE10	Fundamentals of Nanotechnology	3	0	0	3
34	718CHE11	Computational Fluid Dynamics	3	0	0	3
35	718CHE12	Piping Engineering	3	0	0	3
36	818CHE01	Fermentation Technology	3	0	0	3
37	818CHE02	Petroleum Refinery Engineering	3	0	0	3
38	818CHE03	Chemical Process flow sheeting	3	0	0	3
39	818CHE04	Entrepreneurship Development	3	0	0	3
40	818CHE05	Air Pollution Control and Design of Equipment	3	0	0	3
41	818CHE06	Drugs and Pharmaceutical Technology	3	0	0	3
42	818CHE07	Heterogeneous Catalysis	3	0	0	3
43	818CHE08	Bioreactor Design	3	0	0	3
44	818CHE09	Supply Chain Management	3	0	0	3
45	818CHE10	Corrosion Engineering	3	0	0	3
46	818CHE11	Mixing Technology	3	0	0	3
47	818CHE12	Professional Ethics and Human Values	3	0	0	3

HUMANITIES AND SOCIAL SCIENCES [HS]

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			Credit
			Lecture	Tutorial	Practical	
1	118ENT01	Technical English	2	0	0	2
2	218ENT01	Communicative English	2	0	2	3
3	218GET03	Environmental Science and Engineering	2	0	0	2
4	818CHT01	Total Quality Management	3	0	0	3
TOTAL CREDITS						**10**

BASIC SCIENCES [BS]

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			Credit
			Lecture	Tutorial	Practical	
1	118MAT02	Engineering Mathematics-I	3	0	0	3
2	118PHT03	Engineering Physics	2	0	0	2
3	118CYT04	Engineering Chemistry	3	0	0	3
4	118CYP07	Engineering Chemistry Laboratory	0	0	2	1
5	218MAT02	Engineering Mathematics-II	3	1	0	4
6	218BSE0X	ELECTIVE (GROUP2)	2	0	0	2
7	218PHP07	Engineering Physics Laboratory	2	0	0	1
8	318MAT01	Engineering Mathematics – III	3	4	0	4
9	318CHT02	Organic Chemistry	3	3	0	3
10	318CHP07	Organic Chemistry Laboratory	0	1	2	1
11	418NMT01	Numerical Methods	3	0	0	3
12	418CHT02	Physical Chemistry	3	0	0	3
13	518PST01	Probability and Statistics	3	0	0	3
					TOTAL CREDITS	**33**

ENGINEERING SCIENCES [ES]

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			Credit
			Lecture	Tutorial	Practical	
1	118EGT05	Engineering Graphics	2	0	4	4
2	118ESE0X	ELECTIVE (GROUP1)	3	0	0	3
3	118EPP08	Engineering Practice Laboratory	0	0	2	1
4	218EMT04	Engineering Mechanics	3	0	0	3
5	218PPT05	Problem Solving and Python Programming	3	0	0	3
6	218PPP08	Problem Solving and Python Programming Laboratory	0	0	2	1
7	318EET05	Principles of Electrical and Electronics Engineering	3	0	0	3
8	318CHP09	Electrical Engineering Laboratory	0	1	2	1
					TOTAL CREDITS	**19**

PROFESSIONAL CORE COURSE [PC]

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			Credit
			Lecture	Tutorial	Practical	
1	318CHT03	Chemical Process Calculations	3	3	0	3
2	318CHT04	Instrumentation Methods And Analysis	3	3	0	3
3	318CHP08	Technical Analysis Laboratory	0	1	2	1
4	418CHT03	Chemical Process Industries	3	0	0	3
5	418CHT04	Chemical Engineering Fluid Mechanics	3	2	0	4
6	418CHT05	Mechanical Operations	3	0	0	3
7	418CHP07	Fluid Mechanics Laboratory	0	0	2	1
8	418CHP08	Physical Chemistry Laboratory	0	0	2	1
9	418CHP09	Mechanical Operations Laboratory	0	0	2	1
10	518CHT02	Chemical Engineering Thermodynamics	3	0	0	3
11	518CHT03	Heat Transfer	3	0	0	3
12	518CHT04	Mass Transfer-I	3	0	0	3

13	518CHP07	Heat Transfer Laboratory	0	0	4	1
14	518CHP08	Chemical Engineering Computation Laboratory	0	0	4	1
15	618CHT01	Mass Transfer – II	3	0	0	3
16	618CHT02	Chemical Reaction Engineering-I	3	0	0	3
17	618CHT03	Process Dynamics and Control	3	0	0	3
18	618CHT04	Chemical Process Plant Safety	3	0	0	3
19	618CHP07	Process Control Lab	0	0	4	1
20	618CHP08	Mass Transfer Laboratory	0	0	4	1
21	618CHP09	Chemical Process Equipment Design and Drawing Laboratory - I	0	0	4	1
22	718CHT01	Chemical Reaction Engineering – II	3	0	0	3
23	718CHT02	Chemical Engineering Plant Design and Economics	3	0	0	3
24	718CHT03	Transport Phenomena	3	0	0	3
25	718CHT04	Chemical Engineering Modelling and Simulation	3	0	0	3
26	718CHP07	Chemical Reaction Engineering Laboratory	0	0	2	1
27	718CHP08	Chemical Process Equipment Design & Drawing Laboratory -II	0	0	2	1
28	718CHP09	Chemical Engineering Simulation Laboratory	0	0	2	1
					TOTAL CREDITS	**61**

EMPLOYABILITY ENHANCEMENT COURSES [EEC]

S. NO	**COURSE CODE**	**COURSE TITLE**	**PERIODS PER WEEK**			Credit
			Lecture	Tutorial	Practical	
1	518CHP09	Employability skills Laboratory	0	0	4	1
2	818CHP04	Project Work & Viva Voce	0	0	18	9
					TOTAL CREDITS	**10**

OPEN ELECTIVES [OE]

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			Credit
			Lecture	Tutorial	Practical	
1		Open Elective -I	3	0	0	3
2		Open Elective -II	3	0	0	3
					TOTAL CREDITS	**6**

MANDATORY COURSE [MC]

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			Credit
			Lecture	Tutorial	Practical	
1	418MC01	Indian Constitution	1	0	0	0
2	X18ECT01	Gender, Culture , Development	3	0	0	0

SUMMARY

	SEMESTER								Credits Total
	I	II	III	IV	V	VI	VII	VIII	
Humanities and Social Sciences **[HS]**	**2**	**5**						**3**	**10**
Basic Sciences **[BS]**	**9**	**7**	**8**	**6**	**3**				**33**
Engineering Sciences **[ES]**	**8**	**7**	**4**						**19**
Professional Core **[PC]**			**7**	**13**	**11**	**15**	**15**		**61**
Professional Electives **[PE]**			**3**	**3**	**3**	**3**	**6**	**6**	**24**
Open Electives **[OE]**					**3**	**3**			**6**
Employability Enhancement Courses **[EEC]**					**1**			**9**	**10**
Total	**19**	**19**	**22**	**22**	**21**	**21**	**21**	**18**	**163**

SEMESTER I

118ENT01 **TECHNICAL ENGLISH** **L T P C**
2 0 0 2

COURSE OBJECTIVES

- 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

UNIT – I **09**

Listening - Ink talks and gap exercises - Speaking – Asking for and giving directions - Reading – short technical texts from journals and newspapers - Writing - definitions – instructions – checklists – recommendations - Vocabulary Development - technical vocabulary - Language Development – parts of speech – articles – word formation

UNIT – II **09**

Listening - longer technical talks - Speaking – process description - Reading – longer technical texts – Writing – graphical representation - Vocabulary Development - vocabulary used in formal letters/emails and reports - Language Development – tenses - voices - numerical adjectives – question tags

UNIT – III **09**

Listening - listening to classroom lectures - Speaking – introduction to technical presentations - Reading – longer texts both general and technical and practice in speed reading – Writing – process description using sequence words and sentences - Vocabulary Development - Misspelled words – one-word substitution - Language Development - embedded sentences – singular and plural nouns - compound nouns - editing

UNIT – IV **09**

Listening - Listening to documentaries and making notes - Speaking – mechanics of presentations - Reading – reading comprehension – Writing - email etiquettes - job application – cover letter –Résumé preparation - essay writing - Vocabulary Development – synonyms and antonyms –paraphrasing - Language Development – modals – conditionals.

UNIT – V **09**

Listening - TED talks - Speaking – brainstorming and debate – Reading – reading and understanding technical articles – Writing – reports - minutes of a meeting - Vocabulary

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Read technical texts and write area- specific texts effortlessly
CO2 Listen and comprehend lectures and talks in their area of specialization successfully
CO3 Speak appropriately and effectively in varied formal and informal contexts
CO4 Understand the basic grammatical structures and its applications
CO5 Write reports and winning job applications

TEXT BOOKS:

1. Board of editors. Fluency in English A Course book for Engineering and Technology. Orient Blackswan, Hyderabad: 2016
2. Sudharshana. N. P and Saveetha. C. English for Technical Communication. Cambridge University Press: New Delhi, 2016
3. Uttham Kumar. N. Technical English I (with work book). Sahana Publications, Coimbatore, 2016

REFERENCES:

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Read technical texts and write area- specific texts effortlessly	3	2										2	2		
CO2	Listen and comprehend lectures and talks in their area of specialization successfully	3	2			2			1				2	2		1
CO3	Speak appropriately and effectively in varied formal and informal contexts	3	2			2							2	2	2	1
CO4	Understand the basic grammatical structures and its applications	3	2			2							2		2	1
CO5	Write reports and winning job applications	3	2						1				2		2	

118MAT02 **ENGINEERING MATHEMATICS-I** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the eigen value problems
- To solve differential equations of certain types, including systems of differential equations that they might encounter in the same or higher semesters
- To understand the concepts of curvatures, evolutes and envelopes and to study the maxima and minima of any function
- To learn the partial derivatives and apply the same to find maxima and minima
- To solve certain linear differential equations using the Laplace transform technique which has applications in control theory and circuit theory

UNIT – I **09**

Eigenvalues and eigenvectors of a real symmetric matrix –Properties – Cayley - Hamilton theorem (Statement only) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT – II **09**

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes – Evolutes as envelope of normals

UNIT – III **09**

Partial derivatives – Euler's theorem for homogenous functions – Total derivatives – Jacobians – Taylor's expansion– Maxima and Minima – Method of Lagrangian multipliers

UNIT – IV **09**

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients-Applications to Engineering problems-Electric Circuits, Simple Harmonic Motions and bending of beams

UNIT – V **09**

Laplace transforms – Conditions for existence –Basic properties (without proof) – Laplace Transform of elementary functions, derivatives and integrals, unit step function and impulse functions, periodic functions. Definition of Inverse Laplace transform – Convolution theorem (Statement and applications only) – Initial and final value theorems (Statement and applications only) – Solution of linear ordinary differential equations of second order with constant coefficients using Laplace transform techniques

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Develop the knowledge of basic linear algebraic concepts
CO2 Determine the solutions of ordinary differential equations by various methods which have an application in their core subjects
CO3 Acquire the basic knowledge of ordinary differential calculus
CO4 Compute maxima and minima of a function
CO5 Apply Laplace transform techniques to solve ordinary differential equations which have an application in many engineering fields

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 10th edition New Delhi 2016
2. Grewal. B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, Delhi, 2014

REFERENCES:

1. T.Veerarajan, "Engineering Mathematics " Tata McGraw-Hill Publishing company, New Delhi, 2014
2. Kandasamy.P, Thilagavathy,K., &Gunavathi.K., "Engineering Mathematics for first year "., S.Chand & Company Ltd., New Delhi,2014
3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010
4. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Develop the knowledge of basic linear algebraic concepts	3	3							2	2		2	2		1
CO2	Determine the solutions of ordinary differential equations by various methods which have an application in their core subjects	3	3							2	2		2	2	1	
CO3	Acquire the basic knowledge of ordinary differential calculus	3	3							2	2		2	2		1
CO4	Compute maxima and minima of a function	3	3							2	2		2	2	1	
CO5	Apply Laplace transform techniques to solve ordinary differential equations which have an application in many engineering fields	3	3							2	2		2	2	1	

118PHT03 **ENGINEERING PHYSICS** **L T P C**
2 0 0 2

COURSE OBJECTIVES

- To understand the concept of properties of matter
- To understand the properties of sound and principles of quantization of energy
- To understand the properties of coherent light and its importance

UNIT – I **09**

Elasticity – Stress – Strain diagram – Factors affecting elasticity – Twisting couple on a wire – Torsion pendulum – Young's modulus – cantilever – Uniform and Non uniform bending (theory and experiment)– Viscosity-Poiseuille's method for Coefficient of Viscosity (Qualitative).

UNIT – II **09**

Classification of sound, loudness, intensity – Decibel – Weber Fechner Law – Reverberation and Reverberation time – derivation of Sabine's formula for Reverberation time (Growth and Decay)– Absorption coefficient and its determination.

Introduction of Ultrasonics – Production – magnetostriction effect – magnetostriction generator – piezoelectric effect – piezoelectric generator – Detection of ultrasonic waves, properties – Cavitation – Applications – Depth of sea – Non Destructive Testing.

UNIT – III **09**

Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh-jeans' Law from Planck's theory – Compton Effect-derivation- Matter waves – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box – Degeneracy and Non-degeneracy

UNIT – IV **09**

Introduction – Principle of Spontaneous emission and stimulated emission – Population inversion – pumping – Einstein's A and B coefficients – derivation – Types of lasers – He-Ne, CO_2, Nd-YAG, Semiconductor lasers – homojunction – Applications of Laser.

UNIT – V **09**

Interference – Air wedge (theory & experiment) – Polarization- Methods of polarizing light-Theory of plane circularly and elliptically polarized light.

Principle and propagation of light in optical fibers – Numerical aperture and Acceptance angle – Types of optical fibers (material, refractive index, and mode) – Fiber optical communication system (Block diagram) – Fiber optic sensors – Temperature & Displacement sensors (Qualitative).

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 To understand properties of solids with different types of moduli and to gain knowledge about absorption coefficients of solids and different surfaces.
CO2 To understand basic concepts of high frequency sound waves and its applications
CO3 To understand basic concepts of quantum mechanical behavior of wave and particle along with applications
CO4 To understand the concepts of production of laser and its behavior with diffraction principle of interference
CO5 To apply the concept of polarization phenomenon and thereby its applications in fiber optic communication

TEXT BOOKS:

1. R.K. Gaur and S.C. Gupta, 'Engineering Physics' Dhanpat Rai Publications, New Delhi (2003)
2. Jayaprakash R.N, 'Engineering Physics - I', Dhanam Publications, Chennai, (2007)

REFERENCES:

1. R. Murugeshan , Kiruthiga Sivaprasath , Modern Physics S. Chand publications 2016,New Delhi
2. A. Ghatak Optics The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020
3. Dr.M.N.Avadhanulu,Introduction to Lasers: theory and applications S.Chand publications 2012,New Delhi

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	To understand properties of solids with different types of moduli and to gain knowledge about absorption coefficients of solids and different surfaces	3	2										2	2		1
CO2	To understand basic concepts of high frequency sound waves and its applications	3	2			3							2	2		
CO3	To understand basic concepts of quantum mechanical behavior of wave and particle along with applications	3	2			3							2	2	2	
CO4	To understand the concepts of production of laser and its behavior with diffraction principle of interference	3	2			3							2		2	
CO5	To apply the concept of polarization phenomenon and thereby its applications in fiber optic communication	3	2			3		2					2		2	1

118CYT04 **ENGINEERING CHEMISTRY** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques
- To recall the terminologies of electrochemistry and explain the function of batteries and fuel cells with its electrochemical reactions
- To understand the fundamentals of corrosion, its types and polymers with its applications
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels

UNIT – I **09**

Hardness of water - types - expression of hardness - units - estimation of hardness of water by EDTA - numerical problems -Alkalinity-types of alkalinity-determination of alkaninity-boiler troubles (scale and sludge) - treatment of boiler feed water - Internal treatment (carbonate, colloidal, phosphate and calgon conditioning) external treatment Ion exchange process, zeolite process - desalination of brackish water - Reverse Osmosis

UNIT – II **09**

Electrochemical cell-single electrode potential-standard electrode potential-electrochemical series and its significance-EMF of a cell- Nernst equation -Electrodes-Reference electrodes-hydrogen, calomel, quinhydrone and glass electrodes. Determination of pH of a solution using a glass electrode. Batteries - primary and secondary cells, dry cell, alkaline, lead acid storage cell, Ni-Cd battery and lithium nano battery. Clean energy fuel cells - H_2-O_2 fuel cell

UNIT – III **09**

Corrosion: definition - types of corrosion: chemical and electrochemical corrosion – Pilling Bedworth ratio - types of oxide layer (stable, unstable, volatile, porous) - hydrogen evolution and oxygen absorption mechanism for electrochemical corrosion - mechanism for rusting of iron. Types of electrochemical corrosion: Galvanic corrosion - differential aeration corrosion (pitting, waterline and pipeline). Galvanic series - applications. Factors influencing corrosion: nature of metal and environment. Corrosion control methods: sacrificial anode method - impressed current Cathodic protection method - electroplating - electroless plating

UNIT – IV **09**

Monomers - polymers - polymerization - functionality – degree of polymerization - classification of polymers based on source and applications - Molecular weight determination. Types of polymerization: addition, condensation and copolymerization - mechanism of free radical polymerization. Preparation, properties and applications of PE, PVC, Teflon, terylene, Nylon and Bakelite. Rubber-drawbacks of natural rubber-Vulcanization-Compounding of plastics - injection and blow moulding methods

UNIT – V **09**

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - 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 (ORSAT Method)

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Attribute the internal and external treatment methods for the removal of hardness in water for domestic and industrial applications
- CO2 Construct an electrochemical cell and Identify the components and processes in batteries and infer the selection criteria for commercial battery systems with respect to different applications
- CO3 Utilize electrochemical data to formulate an electrochemical half-cell and cell reactions for corrosion control processes
- CO4 Differentiate the polymers used in day to day life based on its source, properties and applications
- CO5 Analyse the three types of fuels based on calorific value for selected application

TEXT BOOKS:

1. S. S. Dara and S. S. Umare, “A Textbook of Engineering Chemistry”, S. Chand & Company LTD, New Delhi, 2015
2. P. C. Jain and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India PVT, LTD, New Delhi, 2013

REFERENCES:

1. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, “Engineering Chemistry”, Cengage Learning India PVT, LTD, Delhi, 2015
3. Shikha Agarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, 2015

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Attribute the internal and external treatment methods for the removal of hardness in water for domestic and industrial applications	3	2													
CO2	Construct an electrochemical cell and Identify the components and processes in batteries and infer the selection criteria for commercial battery systems with respect to different applications	3	2		2											
CO3	Utilize electrochemical data to formulate an electrochemical half-cell and cell reactions for corrosion control processes	3	2		3											
CO4	Differentiate the polymers used in daytodaylife based on its source, properties and applications	3	2		3											
CO5	Analyse the three types of fuels based on calorific value for selected application	2	3		3											

118EGT05 **ENGINEERING GRAPHICS**
(Common to all Non-Circuit Branches)

L	T	P	C
2	0	4	4

COURSE OBJECTIVES

- To understand the graphical skills for drawing the object and the principle of free-hand sketching techniques
- To understand the principle of orthographic projection of points, lines and plane surfaces
- To study the principle of simple solids
- To understand the principle of section and development of solids
- To understand the principle of Isometric and Perspective projections.

UNIT – I **09**

Curves used in engineering practices:

Conics – Construction of ellipse, Parabola and hyperbola by Eccentricity method – Construction of cycloid – Construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Free hand sketching:

Representation of Three Dimensional objects – General principles of orthographic projection – Need for importance of multiple views and their placement – First angle projection – layout views – Developing visualization skills through free hand sketching of multiple views from pictorial views of objects

UNIT – II **09**

Projection of points and straight lines located in the first quadrant – Determination of true lengths and true inclinations – Projection of polygonal surface and circular lamina inclined to both reference planes

UNIT – III **09**

Projection of simple solids like prisms, pyramids, cylinders and cones when the axis is inclined to one reference plane by change of position method

UNIT – IV **09**

Sectioning of simple solids like prisms, pyramids, cylinders and cones in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other – Obtaining true shape of section.

Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders and cones – Development of lateral surfaces of solids with cylindrical cutouts, perpendicular to the axis

UNIT – V **09**

Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones.

Perspective projection of prisms, pyramids and cylinders by visual ray method.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Recognize the conventions and apply dimensioning concepts while drafting simple objects

CO2 Draw the orthographic projection of points, line, and plane surfaces

CO3 Draw the orthographic projection of simple solids

CO4 Draw the section of solid drawings and development of surfaces of the given objects

CO5 Apply the concepts of isometric and perspective projection in engineering practice.

TEXT BOOKS:

1. Ranganath G, Channankaiah and Halesh Koti, “Engineering Graphics”, Second Edition, Sahana Publishers, 2015
2. Bhatt. N.D., “Engineering Drawing” Charotar Publishing House, 53th Edition, 2014

REFERENCES:

1. Dhananjay A.Jolhe, “Engineering Drawing with an introduction to AutoCAD” Tata McGraw Hill Publishing Company Limited, 2017
2. Gopalakrishnana. K. R, “Engineering Drawing” (Vol. I & II), Subhas Publications, 2014.
3. Basant Agarwal and C.M.Agarwal, “Engineering Drawing”, Tata McGraw Hill, 2013
4. Natrajan K. V, “A Text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2012.
5. M.B.Shaw and B.C.Rana, “Engineering Drawing”, Pearson Education India, 2011.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Recognize the conventions and apply dimensioning concepts while drafting simple objects	3	2											3		2
CO2	Draw the orthographic projection of points, line, and plane surfaces	3	3									1			2	1
CO3	Draw the orthographic projection of simple solids	3	3									2		1		
CO4	Draw the section of solid drawings and development of surfaces of the given objects	3	3											3	2	1
CO5	Apply the concepts of isometric and perspective projection in engineering practice	3														

118ESE01 BASIC CIVIL AND MECHANICAL ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES

- To gain the knowledge on civil works like masonry, roofing, flooring and plastering.
- To gain the knowledge on stress, strain of various building and foundations.
- The students should familiar with foundry, welding and forging processes.
- The students should familiar working principle of IC engines and its types.
- To gain the knowledge about various energy recourses and refrigeration air condition systems

A – CIVIL ENGINEERING

UNIT – I SURVEYING AND CIVIL ENGINEERING MATERIALS **09**

Surveying: Objects, types, classification, principles, measurements of distances, angles, leveling, determination of areas, illustrative examples. Civil Engineering Materials: Bricks, stones, sand, cement, concrete, steel sections.

UNIT – II BUILDING COMPONENTS AND STRUCTURES **09**

Foundations: Types, Bearing capacity, Requirement of good foundations. Superstructure: Brick masonry, stone masonry, beams, columns, lintels, roofing, flooring, plastering, Mechanics, Internal and external forces, Stress, Strain, Elasticity, Types of Bridges and Dams, Basics of Interior Design and Landscaping

B – MECHANICAL ENGINEERING

UNIT – III FOUNDRY WELDING AND FORGING **09**

Foundry: Introduction - Patterns –materials. Types of pattern and pattern allowances. Molding sand, types and properties, Molding procedure. Welding: Definition and Classification, Gas welding, Oxy Acetylene welding, Types of flames, advantages and disadvantages of gas welding. Resistance welding - Classification, Spot welding and Seam welding. Soldering, Definition and Classification. Brazing – Definition and Classification. Forging: Types of Forging, Differences between Hot working and Cold working processes

UNIT – IV I C ENGINES& BOILERS **09**

Internal combustion engines, Working principle of Petrol and Diesel Engines, Four stroke and Two stroke cycles, Comparison of four stroke and two stroke engines, Boilers: Introduction of boilers, classification, Lancashire boiler, Babcock and Wilcox boiler, list of boiler mountings and accessories and applications (no sketches).

UNIT – V SOURCE OF ENERGY&REFRIGERATION **09**

Sources of energy: Introduction, conventional and non-conventional sources of energy, examples, solar energy, hydro power plant. Introduction to refrigeration and air-conditioning, COP, properties of refrigerants and types of refrigerants, working principle of vapour compression & vapour absorption refrigeration system, Layout of typical domestic refrigerator, Window and Split type room Air conditioner

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 The usage of surveying and properties of construction materials.

CO2 The stress strain of various building and material such as substructure, road transport and bridge.

CO3 The concept of manufacturing methods encountered in engineering practice such as foundry, welding and forging processes.

CO4 The working of internal combustion engines and its types.

CO5 The concept of energy conservation in practical, power plant refrigeration air condition and its types.

TEXT BOOKS:

1. Ranganath G and Channankaiah, “Basic Engineering Civil & Mechanical”, S.S.Publishers, 2014.
2. Shanmugam G and Palanichamy M S, “Basic Civil and Mechanical Engineering”, Tata McGraw Hill Publishing Co., New Delhi, 3rd Edition, 2012.

REFERENCES:

1. Venugopal.K and PrabhuRaja.V, “Basic Mechanical Engineering”, Anuradha Publishers, Kumbakonam, 2015.
2. Ramamrutham. S, “Basic Civil Engineering”, Dhanpat Rai Publishing Co. (P) Ltd, 3rd Edition reprint, 2013.
3. Shanmugasundaram. S and Mylsamy. K, “Basics of Civil and Mechanical Engineering”, Cenage Learning India Pvt.Ltd, NewDelhi, 2012.
4. Khanna O.P, Foundry Technology, Dhanpat Rai Publishing Co. (P) Ltd, 2011.
5. Shanmugam G., “Basic Mechanical Engineering”, Tata McGraw Hill Publishing Co., New Delhi, 2010.
6. Gopalakrishna K R, “Elements of Mechanical Engineering”, Subhas Publications, Bangalore, 2008.
7. Shantha Kumar S R J, “Basic Mechanical Engineering”, Hi-Tech Publications, Mayiladuthurai, 2001.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	The usage of surveying and properties of construction materials	3											2		3	2
CO2	The stress strain of various building and material such as substructure, road transport and bridge	3	2			2		1						3		
CO3	The concept of manufacturing methods encountered in engineering practice such as foundry, welding and forging processes	3	2										2	3	2	1
CO4	The working of internal combustion engines and its types	3	2			2		1					2	2	1	
CO5	The concept of energy conservation in practical, power plant refrigeration air condition and its types	3											2	1		1

118CYP07	ENGINEERING CHEMISTRY LABORATORY (Common to all Non-Circuit Branches)	L T P C
		0 0 2 1

COURSE OBJECTIVES

- Students will be conversant with the estimation of various compounds using volumetric and instrumental analysis

LIST OF EXPERIMENTS

1. Estimation of Total hardness by EDTA
2. Determination of percentage of calcium in Lime Stone by EDTA
3. Estimation of chloride in water sample
4. Estimation of alkalinity of Water sample
5. Determination of DO in Water (Winkler's Method)
6. Determination of Rate of Corrosion of the given steel specimen by weight loss method (Without inhibitor)
7. Determination of Rate of Corrosion of the given steel specimen by weight loss method (With inhibitor)
8. Conduct metric titration (Simple acid base)
9. Conduct metric titration (Mixture of weak and strong acids)
10. Conduct metric titration using $BaCl_2$vs Na_2 SO_4
11. Potentiometric Titration (Fe^{2+} / $KMnO_4$ or $K_2Cr_2O_7$)
12. PH titration (acid & base)
13. Determination of water of crystallization of a crystalline salt -Copper sulphate
14. Preparation of Bio-Diesel by Trans etherification method.

A minimum of TEN experiments shall be offered.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Carry out the volumetric experiments and improve the analytical skills

CO2 Understand the maintenance and usage of analytical instruments and thereby develop their skills in the field of engineering

CO3 Understand the principle and handling of electrochemical instruments and Spectrophotometer

CO4 Apply their knowledge for protection of different metals from corrosion by using different inhibitors

REFERENCES

1. Arthur I. Vogel's, "Quantitative Inorganic Analysis including Elementary Instrumental Analysis", ELBS, Group, 7th Edition, 2000
2. Dr. K .Sivakumar, "Engineering Chemistry lab manual", S.S publishers, 2016

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Carry out the volumetric experiments and improve the analytical skills	3	3		3	2	1			2	1			2	1	
CO2	Understand the maintenance and usage of analytical instruments and thereby develop their skills in the field of engineering	3	2		3	2				2	1			2	1	
CO3	Understand the principle and handling of electrochemical instruments and Spectrophotometer	3	3		3					2	1			2	1	
CO4	Apply their knowledge for protection of different metals from corrosion by using different inhibitors	3	2												2	1

118EPP08	ENGINEERING PRACTICE LABORATORY (Common to all Non-Circuit Branches)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

- To get the knowledge on welding techniques and its types
- To do the fitting operation on a given material. (Specimen)
- To carry out sheet metal operation
- To know the principle involved in plumbing work.
- To do the carpentry work on a given work piece

LIST OF EXPERIMENTS

WELDING:

Study of Electric Arc welding and Gas welding tools and equipment's.

Preparation of Arc welding and Gas welding models:

i) Butt joint ii) Lap joint iii) T - joint.

FITTING:

Study of fitting tools and operations.

Preparation of fitting models: i) V-fitting ii) Square fitting

SHEET METAL WORK:

Study of sheet metal tools and operations

Preparation of sheet metal models: i) Rectangular Tray ii) Funnel

PLUMBING WORKS:

Study of pipeline joints and house hold fittings.

Preparation of plumbing models: Basic pipe connections with PVC and GI pipe fittings.

CARPENTRY:

Study of wooden joints and tools used in roofs, doors, windows, furniture.

Preparation of carpentry models:

i) Lap joint ii) Dovetail joint iii) T-Joint

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Prepare simple Lap, Butt and T- joints using arc welding equipments

CO2 Prepare the rectangular trays and funnels by conducting sheet metal operation

CO3 Prepare the pipe connections and identify the various components used in plumbing.

CO4 Prepare simple wooden joints using wood working tools

CO5 Demonstrate basic electrical, electronic and computer components based on their physical parameters and dimensions

TEXTBOOK

1. Ranganath. G & Channankaiah, "Engineering Practices Laboratory Manual", S.S. Publishers, 2014
2. Jeyapoovan.T & Gowri S "Engineering Practice Lab Manual", Vikas publishing house pvt.ltd, 2016

REFERENCES

1. Kannaiah.P & Narayana.K.L, "Manual on Workshop Practice", Scitech Publications, 2015.
2. Ramesh BabuV, "Engineering Practices Laboratory Manual", VRB Publishers Private Limited, Chennai, Revised Edition, 2014
3. Peter Norton, "Introduction to Computers", 7th Edition, Mc Graw Hill, 2010
4. Bawa. H.S, "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2009
5. David Anfinson and Ken Quamme, "IT Essentials PC Hardware and Software Companion Guide", CISCO Press, Pearson Education, Third Edition, 2008.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Prepare simple Lap, Butt and T- joints using arc welding equipment	1		2	2	1			1	1		1	1	1		2
CO2	Prepare the rectangular trays and funnels by conducting sheet metal operation	2		2	2	1				1		1	1	1		2
CO3	Prepare the pipe connections and identify the various components used in plumbing.	1		1	2	1				1		1	1	1		2
CO4	Prepare simple wooden joints using wood working tools	1		1	2	1				1		1	1	1		2
CO5	Demonstrate basic electrical, electronic and computer components based on their physical parameters and dimensions	1		1	1	2				1		1	1	1		2

SEMESTER II

218ENT01 **COMMUNICATIVE ENGLISH (Common to all Branches)** **L T P C**

2 0 2 3

COURSE OBJECTIVES

- 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 develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop grammar and vocabulary of a general kind by developing their reading skills

UNIT – I **09**

Listening - conversation - Speaking – introducing oneself - exchanging personal information - Reading – comprehension - Writing - paragraph - Vocabulary Development - synonyms and antonyms - Language Development – consonants & vowels - phonetic transcription.

UNIT – II **09**

Listening - telephonic conversation - Speaking – sharing information of a personal kind – greeting - taking leave - Reading – short stories – The Gift of the Magi, A Service of Love and The Last Leaf by O. Henry – Writing – developing hints - Vocabulary Development – everyday vocabulary - Language Development – British and American English - infinitive and gerund

UNIT – III **09**

Listening – class memory quiz - Speaking – impromptu - Reading – magazines – Writing – agenda - proposals - Vocabulary Development - important words used in speaking and writing - Language Development – types of sentences - information and emphasis

UNIT – IV **09**

Listening – interviews of famous persons - Speaking – story narration - Reading – case study – Writing – invitation letter - quotation letter - Vocabulary Development – listening and reading vocabulary - Language Development – cause and effect – purpose and function.

UNIT – V **09**

Listening - a scene from a film - Speaking - role play - Reading – jigsaw – Writing – essay writing - Vocabulary Development- business vocabulary - Language Development - degrees of comparison – real English phrases

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Comprehend conversations and talks delivered in English.

CO2 Participate effectively in formal and informal conversations; introduce themselves and their friends and express opinions in English

CO3 Read short stories, magazines, novels and other printed texts of a general kind.

CO4 Write short paragraphs, essays, letters and develop hints in English

TEXT BOOKS:

1. Board of Editors. Using English A Coursebook for Undergarduate Engineers and Technologists. Orient BlackSwan Limited, Hyderabad: 2015
2. Richards, C. Jack. Interchange Students' Book-2, New Delhi: CUP, 2015
3. Uttham Kumar, N. Communicative English (with work book). Sahana Publications, Coimbatore, 2019

REFERENCES:

1. Bailey, Stephen. Academic Writing: A Practical Guide for Students. New York: Rutledge, 2011
2. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011
3. Dutt P. Kiranmai and Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013
4. Means, L. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning, USA: 2007
5. Redston, Chris & Gillies Cunningham. Face2Face (Pre-intermediate Student's Book & Workbook). Cambridge University Press, New Delhi: 2005

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Comprehend conversations and talks delivered in English		1		2	2								2		
CO2	Participate effectively in formal and informal conversations; introduce themselves and their friends and express opinions in English			2	2	2									2	1
CO3	Read short stories, magazines, novels and other printed texts of a general kind			2	3	2									2	1
CO4	Write short paragraphs, essays, letters and develop hints in English		2	1		3								1		

218MAT02 **ENGINEERING MATHEMATICS-II**
(Common to all Branches)

L	T	P	C
3	1	0	4

COURSE OBJECTIVES

- To understand double and triple integration concepts and apply to study vector calculus comprising of surface and volume integrals along with the classical theorems involving them.
- To learn analytic functions and their properties and also conformal mappings with few standard examples those have direct applications
- To grasp the basics of complex integration and application to contour integration which is important for evaluation of certain integrals encountered in engineering problems
- To introduce the concept of improper integrals through Beta and Gamma functions.

UNIT – I **09**

Definite and indefinite integrals - Substitution rule – Techniques of integration –Integration by parts – Trigonometric integrals - Trigonometric substitutions - Integration of rational functions by partial fractions – Integration irrational functions

UNIT – II **09**

Double integration – Cartesian and polar co-ordinates – Change of order of integration – Change of variables between Cartesian and polar coordinates –Triple integration in Cartesian co-ordinates – Area as double integral – Volume as triple integral

UNIT – III **09**

Gradient Divergence and Curl – Directional derivative – Irrotational and solenoidal, vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (Statement and applications only) – Simple applications involving cubes and rectangular parallelopipeds

UNIT – IV **09**

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy- Riemann equation and Sufficient conditions (Statement and applications only) – Harmonic and orthogonal properties of analytic function (Statement and applications only) – Harmonic conjugate – Construction of analytic functions – Conformal mapping: w= z+c, cz, 1/z, and bilinear transformation

UNIT – V **09**

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor and Laurent expansions – Singular points –Residues – Residue theorem – Application of residue theorem to evaluate real integrals – Unit circle and semi-circular contour (excluding poles on boundaries).

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Determine the area and volume in 2-dimension and 3-dimension respectively using multiple integrals and also extending the concept to vector fields

CO2 Learn the basic concepts of analytic functions and transformations of complex functions

CO3 Master the integration in complex domain.

CO4 Understand the use of improper integrals' applications in the core subject

CO5 Evaluate the integrals using complex integration

TEXT BOOKS:

1. Grewal. B.S., "Higher Engineering Mathematics", 43th Edition, Khanna Publications, Delhi, 2015

REFERENCES:

1. James Stewart, "Stewart Calculus", 8th edition,2015, ISBN: 9781285741550/1285741552
2. Erwin Kreyszig, "Advanced Engineering Mathematics", tenth edition, Wiley India, 2011
3. P.Kandasamy, K.Thilagavathy, K.Gunavathy, "Engineering Mathematics for first year", S.Chand & Company Ltd., 9th Edition, New Delhi, 2014
4. V.Prameelakaladharan and G.Balaji, "Engineering Mathematics - II",1st Edition, Amrutha marketing, Chennai, 2017.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Determine the area and volume in 2-dimension and 3-dimension respectively using multiple integrals and also extending the concept to vector fields	3	1		2	2								2		
CO2	Learn the basic concepts of analytic functions and transformations of complex functions			2	2	2									2	1
CO3	Master the integration in complex domain			2	3	2									2	
CO4	Understand the use of improper integrals' applications in the core subject	3	2	1		3								1		
CO5	Evaluate the integrals using complex integration	1		2			2					1	1		2	

218GET03 **ENVIRONMENTAL SCIENCE AND ENGINEERING (Common to all Branches)** **L T P C**

2 0 0 2

COURSE OBJECTIVES

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems
- To study the interrelationship between living organism and environment
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value
- To study the dynamic processes and understand the features of the earth's interior and surface.

UNIT – I **09**

Definition, scope and importance of environment – need for public awareness - Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use 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 – II **09**

Concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers –energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – 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 wildlife, man-wildlife conflicts – endangered and endemic species of India –conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes.

UNIT – III **09**

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 solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT – IV **09**

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 – environment production 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- Public awareness

UNIT – V **09**

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course
- CO2 Public awareness of environmental is at infant stage
- CO3 Ignorance and incomplete knowledge has led to misconceptions
- CO4 Development and improvement in std. of living has led to serious environmental disasters

TEXT BOOKS:

1. Benny Joseph, Environmental Science and Engineering ', Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science ', 2nd edition, Pearson Education, 2004.
3. Dr. G. Ranganath, Environmental Science and Engineering, Sahana Publishers, 2018 edition

REFERENCES:

1. Dharmendra S. Sengar, Environmental law ', Prentice hall of India PVT LTD, New Delhi, 2007

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course		2				2	3		2						
CO2	Public awareness of environmental is at infant stage						2				2			3	2	1
CO3	Ignorance and incomplete knowledge has led to misconceptions							2						2		
CO4	Development and improvement in std. of living has led to serious environmental disasters			1				2					2		2	1

218EMT04 **ENGINEERING MECHANICS**
(Common to all Non-Circuit Branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the vectorial and scalar representation of forces and moments.
- To understand the static equilibrium of particles and rigid bodies both in two dimensions.
- To understand the concepts of centroids and moment of inertia of composite sections.
- To understand the principle of work and energy.
- To enable the students to comprehend the effect of friction on equilibrium.

UNIT – I **09**

Introduction-Units and Dimensions-Laws of mechanics - Lame's theorem, Parallelogram and Triangular law of forces, Polygon force, Resolution and Composition of forces, Equilibrium of a particle-Forces in space - Equilibrium of a particle in space-Equivalent systems of forces-Principle of transmissibility-Single equivalent force.

UNIT – II **09**

Free body diagram-Types of supports and their reactions-Requirements of stable equilibrium-Moments and Couples, Moment of a force about a point and about an axis-Vectorial representation of couples-Varignon's theorem-Equilibrium of Rigid bodies in two dimensions- Equilibrium of Rigid bodies in three dimensions – Examples.

UNIT – III **09**

Determination of Areas and Volumes-First moment of area and the centroid of sections - rectangle, circle, triangle from integration - T section, I section, Angle section, Hollow section by using standard formula, Second and product moments of plane area - Rectangle, triangle, circle from integration-T section, I section, Angle section, Hollow section by using standard formula, Parallel axis theorem and perpendicular axis theorem

UNIT – IV **09**

Displacement, Velocity and Acceleration, their relationship, Relative motion- Rectilinear motion-Curvilinear motion, Newton's law-Work Energy Equation of particles-Impulse and Momentum-Impact of elastic bodies

UNIT – V **09**

Frictional force - Laws of Coloumb friction - Simple contact friction - Rolling resistance - Belt friction - Ladder friction - wedge friction

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Explain the differential principle applies to solve engineering problems dealing with force, displacement, velocity and acceleration
- CO2 Find solution for problems related to equilibrium of particles.
- CO3 Solve the Moment of inertia for different 2-D plane figures
- CO4 Analyze the forces in any structures
- CO5 Solve rigid body subjected to frictional forces

TEXT BOOKS:

1. Ramamrutham S, “Engineering Mechanics (S.I Units)”, Dhanpat Rai Publications, 10th Edition, Reprint 2015
2. Dr. Gujral I S, “Engineering Mechanics”, Lakmi Publications, Second Edition, 2011

REFERENCES:

1. Bhavikatti S, “Engineering Mechanics”, New Age International Publisher, 4th Edition, 2014.
2. Khurmi R S, “Engineering Mechanics”, S Chand Publisher, 20th Edition, 2012.
3. Dr. Bansal R K and Sanjay Bansal, “Engineering Mechanics”, Lakshmi Publication, 7th Edition, 2011.
4. Rajput R K, “Engineering Mechanics”, Dhanpat Rai Publications, 3rd Edition, 2005.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Explain the differential principle applies to solve engineering problems dealing with force, displacement, velocity and acceleration		2											1		1
CO2	Find solution for problems related to equilibrium of particles	1	1											2		
CO3	Solve the Moment of inertia for different 2-D plane figures	1	2			1							1	1		1
CO4	Analyze the forces in any structures	1	2	1	1	1							2	1		1
CO5	Solve rigid body subjected to frictional forces	1	2	1										1		1

218PPT05 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C

3 0 0 3

COURSE OBJECTIVES

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures -- lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT – I ALGORITHMIC PROBLEM SOLVING **09**

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). 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 DATA, EXPRESSIONS, STATEMENTS **09**

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT – III CONTROL FLOW, FUNCTIONS **09**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT – IV LISTS, TUPLES, DICTIONARIES **09**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT – V FILES, MODULES, PACKAGES **09**

Files and exception: text files, reading and writing files, format operator; command line arguments, date and time, errors and exceptions, handling exceptions, debugging, modules, packages; Illustrative programs: word count, copy file

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Develop algorithmic solutions to simple computational problems

CO2 Read, write, execute by hand simple Python programs.

CO3 Structure simple Python programs for solving problems.

CO4 Decompose a Python program into functions.

CO5 Represent compound data using Python lists, tuples, dictionaries and read and write data from/to files in Python Programs

TEXT BOOKS:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, ¯An Introduction to Python - Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES:

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 to Computer Science using Python 3”, Second edition, Pragmatic Programmers, LLC, 2013.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Develop algorithmic solutions to simple computational problems		3			2					2		2			
CO2	Read, write, execute by hand simple Python programs			2							2		2			1
CO3	Structure simple Python programs for solving problems			2							2		2		2	
CO4	Decompose a Python program into functions	3	3	2		2					2		2			1
CO5	Represent compound data using Python lists, tuples, dictionaries			2							2		2		2	

218BSE03 **CHEMISTRY FOR TECHNOLOGISTS** **L T P C**
2 0 0 2

COURSE OBJECTIVES

- To get ample knowledge about gaseous properties.
- To acquire knowledge about the properties of solutions.
- To apply the basic concepts of thermodynamics for engineering stream
- To understand the mechanistic pathway of chemical reactions.
- To impart an adequate knowledge about dyes and drugs

UNIT – I **09**

Measurable properties of gases, Gas Laws-Boyles law, Charle's law, Graham's law of diffusion, Avogadro's law, Dalton's law of partial pressure, Absolute scale of temperature, Ideal gas equation. Postulates of Kinetic theory of gases-average-root mean square and most probable velocities-real gases-deviation from ideal behaviour-Compressibility factor-Vander walls equation.
Properties of Liquids-Vapour Pressure-Viscosity-surface tension and effect of temperature on various properties.

UNIT – II **09**

Different methods for expressing concentration of solution - molality, molarity, mole fraction, percentage (by volume and mass both), vapour pressure of solutions and Raoult's Law - Ideal and non-ideal solutions, vapour pressure - composition, plots for ideal and non-ideal solutions; Colligative properties- Determination of molecular mass using colligative properties; Abnormal value of molar mass, van't Hoff factor and its significance

UNIT – III **09**

Terminologies- System, Surroundings-First law of Thermodynamics-Internal energy and enthalpy of System-Second law of Thermodynamics-entropy of a system-entropy change for an ideal gas-entropy change accompanying change of Phase-Gibbs Helmholtz equation-Clausius –clapeyron equation-Applications-Maxwell relation-Chemical potential; Gibbs-Duhem equation – variation of chemical potential with temperature and pressure.

UNIT – IV **09**

Introduction-kinetics, equilibria and energetics of reaction-nucleophilic substitution-addition-elimination-electrophilic substitution in aromatic systems. Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes, nitrenes ylides and enamines

UNIT – V **09**

Classification and properties of drugs. Penicillin sulpha drugs, mode of action, synthesis of sulphanilamide, chloroquine and chloramphenicol. Colour and constitution, chromogen and chromophore. Classification of dyes based on structure and mode of dyeing. Synthesis of dyes. Malachite green, methyl orange, Congo red, phenolphthalein

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply gas laws in various real life situations.
CO2 Able to explain the characteristic properties and behaviour of solutions
CO3 Apply the basic concepts of thermodynamics for engineering stream.
CO4 Familiar in reaction pathways
CO5 Able to understand the chemistry behind dyes and drugs

TEXT BOOKS:

1. Jerry March Organic Reaction Mechanism John Weily Ed, 5 2002.
2. P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, 2013

REFERENCES:

1. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015
2. Puri BR, Sharma LR, Patha nia S, "Principles of Physical Chemistry", 42nd Edition, 2008, Vishal Publishing Co., Jalandhar
3. Morrison RT, Boyd RN, Bhattacharjee SK, "Organic Chemistry", 7Th Edition, Pearson India, 2011.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply gas laws in various real life situations	3	2											1		
CO2	Able to explain the characteristic properties and behaviour of solutions	3	3	1		2				2				2	2	
CO3	Apply the basic concepts of thermodynamics for engineering stream	3	2											2	2	1
CO4	Familiar in reaction pathways	3	2											2	2	
CO5	Able to understand the chemistry behind dyes and drugs	3	1												2	1

218PHP07 **ENGINEERING PHYSICS LABORATORY (Common to all Non-Circuit Branches)** **L T P C**

0 0 2 1

COURSE OBJECTIVES

- To understand the practical concepts of Interference and diffraction
- To understand the concept of velocities of sound in different liquids
- To get better knowledge of modulus of elasticity.
- To understand the concepts of thermal conductivity
- To understand the concepts of viscosities of liquid

LIST OF EXPERIMENTS

1. (a) Determination of laser parameters – Wavelength.
   (b) Particle size determination using Diode Laser.
2. Determination of thickness of a thin wire-Air wedge method.
3. Determination of velocity of sound and compressibility of liquid- Ultrasonic interferometer.
4. Determination of wavelength of mercury spectrum-Spectrometer grating.
5. Determination of thermal conductivity of a bad conductor-Lee's disc method.
6. Determination of Young's modulus of the material –Non uniform bending.
7. Determination of viscosity of liquid – Poiseuille's method.
8. Spectrometer- Dispersive power of prism.
9. Determination of Young's modulus of the material - Uniform bending.
10. Tensional pendulum- Determination of Rigidity modulus.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understanding the moduli of elasticity by determining Young's modulus and Rigidity modulus of a beam and cylinder respectively

CO2 Understanding the phenomenon of diffraction, dispersion and interference of light using optical component

CO3 Acquiring knowledge of viscosity by determining coefficient of viscosity of a liquid and measuring the parameters of ultrasound propagating through a liquid

CO4 Understanding the phenomenon of heat transfer through conductors and bad conductors by determining thermal conductivity

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understanding the moduli of elasticity by determining Young's modulus and Rigidity modulus of a beam and cylinder respectively	3	2													
CO2	Understanding the phenomenon of diffraction, dispersion and interference of light using optical component	3	2		2											
CO3	Acquiring knowledge of viscosity by determining coefficient of viscosity of a liquid and measuring the parameters of ultrasound propagating through a liquid	3	2		3											
CO4	Understanding the phenomenon of heat transfer through conductors and bad conductors by determining thermal conductivity	2	1													

218PPP08 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C

0 0 4 2

COURSE 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, dictionaries.
- Read and write data from/to files in Python.

LIST OF EXPERIMENTS

1. To Implement python scripts using Variables and operators
2. To Demonstrate Operator precedence to evaluate an expression
3. Display grade of a student using elif statement
4. Implement Floyd triangle using for loop
5. Checks the given number is prime or not using while loop
6. Compute the GCD of Numbers using functions
7. Finding factorial of a given number using recursive function.
8. Takes a list of words and returns the length of longest one using strings
9. To perform linear and binary search using strings
10. To implement list as arrays (multiply 2 matrices)
11. To demonstrate use of list & related functions
12. To demonstrate use of tuple, set& related functions
13. To demonstrate use of Dictionary& related functions
14. Finding most frequent words in a text read from a file
15. Programs that take command line arguments (word count)

PLATFORM NEEDED

Python 3 interpreter for Windows/Linux

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Write, test, and debug simple Python programs.
CO2 Implement Python programs with conditionals and loops.
CO3 Develop Python programs step-wise by defining functions and calling them.
CO4 Use Python lists, tuples, dictionaries for representing compound data.
CO5 Read and write data from/to files in Python.

Course Articulation Matrix:

Cos	Course outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Write, test, and debug simple Python programs		3			2					2		2			
CO2	Implement Python programs with conditionals and loops			2							2		2		2	
CO3	Develop Python programs step-wise by defining functions and calling them			2							2		2		2	
CO4	Use Python lists, tuples, dictionaries for representing compound data	3	3	2		2					2		2			
CO5	Read and write data from/to files in Python			2							2		2			

SEMESTER III

318MAT01 ENGINEERING MATHEMATICS – III

L	T	P	C
3	1	0	4

COURSE OBJECTIVES

- To learn various methods to solve the partial differential equations.
- To introduce Fourier series analysis, this plays a vital role in many applications in engineering.
- To understand the boundary value problems and to obtain the solution using partial differential equations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To develop z-transform techniques which analyze the discrete time signals

UNIT – I PARTIAL DIFFERENTIAL EQUATIONS 12

Solutions of first order partial differential equations-Standard types-Singular solutions-Lagrange's Linear equation-Method of grouping and Method of multipliers-Solution of homogeneous and non-homogenous linear equations of second and higher order with constant coefficients

UNIT – II FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Change of scale - Odd and even functions – Half-range Sine and Cosine series – Parseval's identity applications – Harmonic Analysis

UNIT – III BOUNDARY VALUE PROBLEMS 12

Classification of Partial Differential Equations – Method of separation of Variables – Solutions of one dimensional wave equations and One-dimensional heat equations –Applications using Fourier series solutions in Cartesian coordinates - Steady state solution of two-dimensional heat equation

UNIT – IV FOURIER TRANSFORM `12

Fourier integral theorem – Fourier transform pair - Sine and Cosine transforms – Properties – Fourier Transform of simple functions – Convolution theorem (statement and applicationsonly) – Parseval's identity (statement and applicationsonly)

UNIT – V Z – TRANSFORM 12

Z-Transform - Elementary properties and applications – Initial and final value theorems(Statement and applications only) -Inverse Z-Transform –Partial fractions method, Residue theoremmethod and Convolution theorem (statement and applicationsonly) - Solution of difference equations by applyingZ-transforms

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Know the methods to solve partial differential equations occurring in various physical and engineering problems

CO2 Describe an oscillating function which appear in a variety of physical problems by Fourier series helps them to understand its basic nature deeply

CO3 Acquire the knowledge to construct partial differential equations with initial and boundary conditions for various physical and engineering real time problems and obtaining solution using Fourier series methods

CO4 Understand the effect of Fourier transform techniques and their applications

CO5 Gain the concept of analysis of linear discrete system using Z-transform approach

TEXT BOOKS:

1. .S.Grewal, "Higher Engineering Mathematics", Khanna Publications, 43rd edition, 2015

REFERENCES:

1. Andrews L.C and Shivamoggi. B.K., “Integral Transforms for Engineers”, SPIE Press Book, 1999
2. Wylie C R and Barrett L C, “Advanced Engineering Mathematics”, 6th Edition, McGraw-Hill Co., New Delhi, 1995
3. Erwin Kreyszig, “Advanced Engineering Mathematics”, 10th Edition Wiley India, 2016
4. V.Prameelakaladharan and G.Balaji ,“Engineering Mathematics-III”, Amrutha marketing, Chennai,2016
5. T.Veerarajan,”Engineering Mathematics-III”, Tata McGraw-Hill Publishing company, New Delhi,2015
6. P.Kandasamy, K.Thilagavathy, K.Gunavathy, “ Engineering Mathematics-III”, S.ChandPublishers,2015

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Know the methods to solve partial differential equations occurring in various physical and engineering problems	3	3	2		2									3	
CO2	Describe an oscillating function which appear in a variety of physical problems by Fourier series helps them to understand its basic nature deeply	3	3	2		2									3	
CO3	Acquire the knowledge to construct partial differential equations with initial and boundary conditions for various physical and engineering real time problems and obtaining solution using Fourier series methods	3	3	2	3	2	1					1		3	3	
CO4	Understand the effect of Fourier transform techniques and their applications	3	3	3	3	2	1					1			3	
CO5	Gain the concept of analysis of linear discrete system using Z-transform approach	3	3	3	3	2	1					1			3	

318CHT02 **ORGANIC CHEMISTRY** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the basic nomenclature in reaction mechanism and organic synthetic methodology.
- To study the type of components in which organic reactions take place and also to know the preparation of the essential organic compounds

UNIT – I ORGANIC REACTION MECHANISM **09**

Electrophilic reactions-Friedel crafts reaction, Riemer Tiemenn reaction, Beckmann rearrangements; nucleophilic reactions-aldol condensation, perkin reaction, benzoin condensation; free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide; allylic halogenation -using N-Bromo Succinamide (NBS), thermal halogenation of alkene CH_3-CH = CH_2

UNIT – II SOLVENTS AND REAGENTS **09**

Synthesis, properties and uses of Dimethyl-formamide (DMF), Dimethyl sulfoxide (DMSO), Tetrahydrofuran (THF), Diethyl ether, Dichloromethane and Carbon tetrachloride.

Reagents of Synthetic Importance: oxidizing agents – $KMnO_4$, $K_2Cr_2O_7$, Lead tetra acetate, Osmium Tetroxide. Reducing agents - $LiAlH_4$, Na/liquid ammonia, DCC, Aluminium isopropoxide

UNIT – III HETEROCYCLIC COMPOUNDS **09**

Preparation, Physical, Chemical properties and uses of Pyrrole, Furan, Furfural, Tetrahydrofuran, Thiophene, Indole, Pyridine, Quinoline and Isoquinoline

UNIT – IV AMINO ACIDS AND PROTEINS **09**

Classification, preparation (Strecker, Skraup, Gabriel phthalimide) and properties of Amino acids. Composition and classification of proteins. Structure of proteins –tests for proteins –general properties and relations of proteins –hydrolysis of proteins

UNIT – V CARBOHYDRATES **09**

Carbohydrates – classification. Monosaccharides- reaction of Glucose and fructose, open chain and cyclic structures of glucose and fructose, mutarotation, epimerzation, Killiani- Fisher 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

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understanding organic reactions mechanism and rearrangements

CO2 Learn and understand synthetic utilityof solvents and reagents

CO3 Learn the synthetic and biological importance of heterocycles

CO4 Learn the basics chemistry principles behind amino acids and proteins

CO5 Understand chemistry of carbohydrates

TEXT BOOKS:

1. Tiwari K.S. Vishnoi N.K. and Marhotra S.N., A text book of Organic Chemistry, II Edition , Vikas Publishing House Pvt.Ltd., (1998), New Delhi
2. P.L.Soni, A text book of Organic Chemistry, Sultan and Chand Publishers, (2001),New Delhi
3. Arun Bhal and B.S. Bhal, “A text book of Organic chemistry”, S.Chand & Co., New Delhi, 2008

REFERENCES:

1. R.T. Morrison and R.N. Boyd “Organic Chemistry” VI Edition Prentice Hall Inc (2004)USA
2. I.L. Finar, “Organic chemistry (Vol.1)”, 6th Edition, Pearson Education, New Delhi, 2006
3. I.L. Finar, “Organic Chemistry (Vol.2)”, 5th edition, Pearson Education, New Delhi, 2006

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understanding organic reactions mechanism and rearrangements	3		2	2	3		1						3		
CO2	Learn and understand synthetic utilityof solvents and reagents	3		2	2	3		1						3		
CO3	Learn the synthetic and biological importance of heterocycles	3		2	2	3		1				1		3		
CO4	Learn the basics chemistry principles behind amino acids and proteins	3		2	2	3		1				1		3		
CO5	Understand chemistry of carbohydrates	3		2	2	3		1				1		3		

318CHT03 **CHEMICAL PROCESS CALCULATIONS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To become familiar with different systems of units and conversions, different ways of expression of composition and behaviour of ideal gases.
- To understand the concepts and behaviour of vapour gas mixtures and principles of stoichiometry.
- To understand the concept of material balance and techniques to solve the problems involving simple unit operations.
- To apply material balance concepts to problems involving reactions.
- To understand the concept of energy balance and its application to simple problems

UNIT – I UNITS, DIMENSIONS AND BASIC CALCULATIONS **09**

Basic Chemical Calculations: Fundamentals and derived units. Conversion of units. Dimensional consistency of equations. Dimensionless groups and constants. Conversion of equations. Concept of mole, mole fraction etc. Compositions of mixtures of solids and liquids and gases. Density and Specific gravity; Concept of molarity, molality, normality and ppm.

UNIT – II BEHAVIOUR OF IDEAL GASES AND VAPOUR-GAS CONCEPTS **09**

Behaviour of Ideal Gases: Applications of the Ideal gas law – Gaseous mixtures – Dalton's law and Amagat's Law

Vapour-Gas Concepts: Ideal gas law calculations, Vapour pressure concepts and calculations different systems. Problems using semi-log and log-log graphs.

Psychrometry: Humidity related terms, humidity chart, and humidification & dehumidification operations: Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity; Wet bulb Temperature and Dew point calculations

UNIT – III MATERIAL BALANCE **09**

General material balance equation: Steady and unsteady state: Block Diagrams-Process Flow Sheet-Material Balances-Different Models: Linear, Matrix, Graphical;

Application of material balance to unit operations: Mixing Tank, Dissolution, Drying, Evaporation, Distillation, Absorption, Extraction, Crystallisation; Recycle and bypass;

Material balance with reaction: Principles of stoichiometry, Concept of limiting and excess reactants and inerts, fractional and percentage conversion, fractional yield and percentage yield, Selectivity related Problems.

UNIT – IV ENERGY BALANCE **09**

Thermophysics and Thermochemistry Principles: Heat Capacity, Enthalpy, Heat of Formation, Heat of Reaction, Heat of Combustion and Calorific Value. Heat of Solution, Heat of Mixing, Heat of Crystallization. Sensible and latent heat calculations

Application of General Steady State Energy Balance equation: Determination of ΔH_R at standard and elevated temperature. Theoretical, flame and adiabatic flame temperature calculations.

Energy balance of simple unit operations viz. double pipe heat exchanger, evaporator

UNIT – V FUELS AND COMBUSTION **09**

Fuels and Combustion: Types of Fuels: Solid, Liquid & Gas; Ultimate and Proximate analysis of fuels, Calculations involving burning of solid, liquid and gaseous fuels, excess air, Air – fuel ratio calculations. Orsat analysis;

Numerical Problems on sulphur & sulphur burning compounds, Recycle, Bypass and Purge calculations

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Clear idea of various types of unit systems and they will be able to convert units from one form of the unit to other and able to find the equations for fitting data.
CO2 Develop strategy for solving problems involving gases, vapours etc.
CO3 Adopt the tools learned from the course to solve numerical problems which contain one or more unit operations.
CO4 Ability to solve material balance problems involving reactions.
CO5 Develop mathematical relations for both mass and energy balances for different processes

TEXT BOOKS:

1. Bhatt.B.I and Thakore.S.B., "Stoichiometry", Fifth Edition, McGraw-Hill Education (India) Private Limited, 2017.
2. Narayanan, K. V. and Lakshmikutty, B, "Stoichiometry and Process Calculations" 1st Edition, Prentice Hall of India, 2013.

REFERENCES:

1. Venkataramani, V and Anantharaman, N. "Process Calculations",2 nd Edition, Prentice Hall of India, 2011.
2. O.A. Hougen, K. M. Watson, and R. A. Ragatz, "Chemical Process Principles. Part I. Material and Energy Balances", 1st e-book Edition, CBS Publishers, 2018.
3. David M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", Eighth Edition, PearsonIndia, 2015.
4. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", 4thEdition., John Wiley & Sons, New York, 2018.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Clear idea of various types of unit systems and they will be able to convert units from one form of the unit to other and able to find the equations for fitting data.	3	3	3	3	2	2					2	2	2	3	
CO2	Develop strategy for solving problems involving gases, vapours etc.	3	3	3	3	2	2					2	2	2	3	
CO3	Adopt the tools learned from the course to solve numerical problems which contain one or more unit operations.	3	3	3	3	2	2					2	2	2	3	
CO4	Ability to solve material balance problems involving reactions.	3	3	3	3	2	2					2	2	2	3	
CO5	Develop mathematical relations for both mass and energy balances for different processes	3	3	3	3	3	3					2	2	2	3	

318CHT04 INSTRUMENTATION METHODS AND ANALYSIS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To recognize the importance of electromagnetic spectrum
- To Extrapolate Beer-Lambert law to quantitative analysis
- To compare IR and Raman spectroscopy
- To imbibe the chromatography based separation techniques

UNIT – I INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS **09**

Electromagnetic radiation-Electromagnetic spectrum Errors, Precision and Accuracy: Definitions, Significant figures, Types of errors, Methodsof expressing accuracy and precision, mean, median, mode, standard deviation.

Definition &Types of spectroscopy, Absorption spectrum, Emission spectra, Wave length and Wave number, Electromagnetic radiation, Visible spectrum, Stokes's shift, Hypochromicity, transmittance

UNIT – II UV-VIS SPECTROPHOTOMETRY AND COLORIMETRY **09**

Theory, Deviations from Beer's Law. Colorimetry-Instrumentation (Line diagram alone) and application, estimation of inorganic ions such as Fe,Ni.

Ultra violetspectroscopy - Theory, instrumentation and application - Quantum description,Instrumentation, Chemical shift, applications and limitations.Different shifts of absorption peaks (Bathochromic, hypsochromic, hypochromic)

UNIT – III IR SPECTROCOPY AND THERMAL ANALYSIS **09**

Theory of IR spectroscopy, various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (near, mid, finger print and far), Instrumentation (sources and detectors).Difference between Raman spectra and IR spectra.

Thermal methods – TGA, DTA,Thermometrictitrations and their applications.

UNIT – IV SEPARATION METHODS **09**

TLC: Stationary phase, mobile phase, sample application, development techniques – evaluation and documentation, advantages and disadvantages of TLC.

Gas Chromatography: Principle, carrier gas, stationery phase, instrumentation, sample injection, column detectors (TCD, FID, ECD), effect of temperature on retention.

HPLC: Principle, instrumentation, column, sample injection, detectors (absorbance, refractive index, electrochemical), mobile phase selection, ion pair chromatography.

UNIT – V FLAME SPECTROSCOPYAND XRD **09**

Principle and Instrumentation for Flame Spectrometric Methods, FlameEmission Spectrometry, Atomic Absorption Spectrometry, InterferenceAssociated with Flame and Furnaces, Applications, Comparison of FESand AAS.

XRD-Principle, Braggs equation, Laue photographic method and Powder method, Applications of XRD

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understanding the basics of electromagnetic spectrum.
CO2 Learning analysis using UV-Visible spectroscopy
CO3 Learning analysis through IR spectroscopy
CO4 Understanding various separation techniques.
CO5 Learning analysis using Flame spectroscopy and XRD

TEXT BOOKS:

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

REFERENCES:

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understanding the basics of electromagnetic spectrum.	3	3	3	2	2	2	3						3	3	
CO2	Learning analysis using UV-Visible spectroscopy	3	3	3	2	2	2	3						3	3	
CO3	Learning analysis through IR spectroscopy	3	3	3	2	2	2	3						3	3	
CO4	Understanding various separation techniques	3	3	3	2	2	2	3						3	3	
CO5	Learning analysis using Flame spectroscopy and XRD	3	3	3	2	2	2	3						3	3	

318EET05 PRINCIPLES OF ELECTRICAL AND ELECTRONICS ENGINEERING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the basic concepts of magnetic circuits, AC & DC circuits.
- To explain the working principle, construction, applications of DC & ACmachines and measuring instruments.
- To gain knowledge about the electronic devices and applications.
- To understand the basic concepts of communication engineering

UNIT – I FUNDAMENTALS OF DC CIRCUITS **09**

Introduction to DC and AC circuits, Active and passive two terminal elements, Ohms law, Voltage-Current relations for resistor, inductor, capacitor , Kirchhoff's laws, Mesh analysis, Nodal analysis, Ideal sources –equivalent resistor, current division, voltage division - Faraday's laws, and induced emfs.

UNIT – II AC FUNDAMENTALS **09**

Introduction to DC and AC circuits, Active and passive two terminal elements, Ohms law, Voltage-Current relations for resistor, inductor, capacitor , Kirchhoff's laws, Mesh analysis, Nodal analysis, Ideal sources –equivalent resistor, current division, voltage division - Faraday's laws, and induced emfs.

UNIT – III ELECTRICAL MACHINES **09**

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, basic principles of single phase and three phase induction Motor

UNIT – IV SEMICONDUCTOR DEVICES AND APPLICATIONS **`09**

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Bipolar Junction Transistor – CB, CE, CC Configurations. Half wave and Full wave Rectifiers – SCR characteristics

UNIT – V ELECTRICAL DRIVES **09**

Speed control of DC series and shunt motors – Armature and field control, single phase controlled rectifiers – applications Speed control of three phase induction motor – Voltage control, voltage / frequency control– single phase inverters– applications

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Acquired good understanding of basics of DC electrical circuits
CO2 Acquired good understanding of basics of AC fundamentals
CO3 Capable of understanding the construction, working principle of electrical machines
CO4 Gained knowledge on construction and characteristics of various semiconductor devices
CO5 Learnt about the steady state behavior of electrical drive

TEXT BOOKS:

1. Dash.S. S, Subramani.C, Vijayakumar.K, “Basic Electrical Engineering”, Firstedition,Vijay Nicole Imprints Pvt.Ltd,2013
2. V.N. Mittle “Basic Electrical Engineering”, TMH Edition, New Delhi, 1990
3. R.S. Sedha, “Applied Electronics” S. Chand & Co., 2006

REFERENCES:

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, “Basic Electrical, Electronics and Computer Engineering”, TMH, Second Edition, (2006)
2. Nagsarkar T K and Sophia M S, “Basics of Electrical Engineering”, Oxford press (2005)
3. Mehta V K, “Principles of Electronics”, S.Chand& Company Ltd, (1994)
4. MahmoodNahvi and Joseph A. Edminister, “Electric Circuits”, Schaum’ Outline Series, McGraw Hill, (2002)
5. Premkumar N, “Basic Electrical Engineering”, Anuradha Publishers, (2003)

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Acquired good understanding of basics of DC electrical circuits	3	3	2	2	1	1							1	3	
CO2	Acquired good understanding of basics of AC fundamentals	3	3	2	3	2	3							1	3	
CO3	Capable of understanding the construction, working principle of electrical machines	3	3	2	3	2	3							3	3	
CO4	Gained knowledge on construction and characteristics of various semiconductor devices	3	3	2	3	2	3							3	3	
CO5	Learnt about the steady state behavior of electrical drive	3	3	2	2	1	1							1	3	

318CHP07 **ORGANIC CHEMISTRY LABORATORY** **L T P C**
0 0 2 1

COURSE OBJECTIVES

- To learn basic principles involved in analysis and synthesis of different organic derivative

LIST OF EXPERIMENTS

1. Quantitative analysis of organic compounds – Identification of aliphatic/aromatic, saturated/unsaturatedcompounds.
2. Identification and characterization of various functional groups by their characteristic reactions:

a) alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester, g) primary, secondary and tertiary amines and h) nitro compounds.

3. Analysis of an unknown organic compound and preparation of suitable solidderivatives (Benzoic acid from Benzaldehyde, hydrolysis of ester and meta- dinitrobenzene from nitrobenzene).
4. Analysis of carbohydrates.
5. Analysis ofproteins.
6. Methodology of filtration andrecrystallization.
7. Introduction to organic synthetic procedures:
   i. Acetylation – Preparation of acetanilide fromaniline.
   ii. Hydrolysis – Preparation of salycilic acid from methylsalyciliate.
   iii. Substitution – Conversion of acetone toiodoform.
   iv. Nitration – Preparation of m-dinitrobenzene fromnitrobenzene.
   v. Oxidation – Preparation of benzoic acid from benzaldehyde/ benzylalcohol

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 The student is able to identify what distinguishes a strong and weak nucleophile and recall the rules of reactions.

CO2 The student shows their mastery of nomenclature since ethyl bromide is not drawn out

CO3 The student analyses a list of compounds and determines their reactivity.

REFERENCES

1. Vogels's Text Book of Practical Organic Chemistry, Fifth Edition, Longman Singapore Publishers Pte. Ltd., Singapore, 2001.

Course Articulation Matrix:

os	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	The student is able to identify what distinguishes a strong and weak nucleophile and recall the rules of reactions.	3		2	2	3		1						3		
CO2	The student shows their mastery of nomenclature since ethyl bromide is not drawn out	3		2	2	3		1						3		
CO3	The student analyses a list of compounds and determines their reactivity.	3		2	2	3		1						3		

318CHP08 **TECHNICAL ANALYSIS LABORATORY** **L T P C**
0 0 2 1

COURSE OBJECTIVES

- To learn basic principles involved in estimation and characterization of industrially important materials.

LIST OF EXPERIMENTS

1. Determination of Redwood / Say bolt numbers, kinematic viscosity and viscosity index of Lubricating oils.
2. Determination of flash point, fire point, cloud and pour point of oils.
3. Determination of acid value and iodine value of oils.
4. Determination of COD of water samples.
5. Cement Analysis (a) Estimation of silica content (b) Estimation of mixed oxide content (c) Estimation of calcium oxide content (d) Estimation of calcium oxide by rapid method.
6. Coal Analysis (a) Estimation of sulphur present in coal (b) Ultimate analysis of coal (c) Proximate analysis of coal.
7. Soap Analysis (a) Estimation of total fatty acid (b) Estimation of percentage alkali content.
8. Flue gas analysis by Orsat's apparatus.
9. Estimation of phenol.
10. Determination of calorific value using bomb calorimeter.
11. Determination of nitrite in water.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Familiarization with equipment like viscometers, flash and fire point apparatus, etc.

CO2 Familiarization of methods for determining COD.

CO3 Familiarization of a few simple synthetic techniques for soap.

REFERENCES

1. Environmental pollution analysis, S.M. Khopkar, New age international.2011
2. Manual of environmental analysis, N.C Aery, Ane books.2010
3. Text book of quantitative chemical analysis, J.Mendham, Pearson education2008

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Familiarization with equipment like viscometers, flash and fire point apparatus, etc.	3	2	1	2	1					2	2		3	3	
CO2	Familiarization of methods for determining COD.	3	3	3	2	2	1				2	2		3	3	
CO3	Familiarization of a few simple synthetic techniques for soap.	3	2	3	2	1	2							2	3	

318CHP09 **ELECTRICAL ENGINEERING LABORATORY** **L T P C**
0 0 2 1

COURSE OBJECTIVES

- To gain knowledge on characteristics of Electrical machines and Electronic Devices

LIST OF EXPERIMENTS

1. Ohm's law and kirchoff's laws
2. Diode characteristics
3. Open circuit characteristics of a dc shunt generators
4. Load characteristics of a dc shunt generators
5. Load test of D.C. shunt motor
6. Load test on single phase induction motor
7. Equivalent circuit of a transformer
8. Swinburn's test
9. Load test on 3- phase squirrel cage induction motor
10. Load test on 1 -phase transformer
11. Characteristics of half and full wave rectifiers

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Analyze the characteristics of DC generators
CO2 Analyze and test different DC motors
CO3 Test and analyze the different AC motors & transformers

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Analyze the characteristics of DC generators	3	3	2	2	1	1							1	3	
CO2	Analyze and test different DC motors	3	3	2	3	2	3							1	3	
CO3	Test and analyze the different AC motors & transformers	3	3	2	3	2	3							3	3	

SEMESTER IV

418NMT01	NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

- This course gives a complete procedure for solving numerically different kinds of problems occurring in engineering and technology
- The students would be acquired with the basic concepts of numerical methods and their applications

UNIT – I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 12

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gaussian elimination - Gauss-Jordon methods- Iterative methods of Gauss Jacobi and Gauss-Seidel - matrix Inversion of by Gauss Jordon method – Eigen values of a matrix by Power method

UNIT – II INTERPOLATION AND APPROXIMATION 12

Interpolation with equal intervals - Newton's forward and backward difference formulae - Interpolation with unequal intervals - Lagrange interpolation – Newton's divided difference interpolation - Cubic splines

UNIT – III NUMERICAL DIFFERENTIATION AND INTEGRATION 12

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

UNIT – IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 12

Single step method - 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 Adam's – Bash forth predictor and corrector methods for solving first order equations

UNIT – V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

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: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Apply numerical methods such as direct and iterative methods to solve algebraic or transcendental equations and system of equations
- CO2 Use the concept of interpolation and apply to real life situations.
- CO3 Appreciate numerical solutions for differential and integral calculus as a handy tool to solve problems.
- CO4 Implement numerical algorithms to find solutions for intial value problems for ordinary differential equations.
- CO5 Demonstrate algorithms using finite differences to obtain solutions to boundary value problems

TEXT BOOKS:

1. Kandasamy, P., Thilagavathy, K and Gunavathy, K., "Numerical Methods", S.Chand Co. Ltd., New Delhi, 2003
2. Sankara Rao, K. "Numerical methods for Scientists and Engineers' 3rd Edition Prentice Hall of India Pvt.Ltd., New Delhi, 2007

REFERENCES:

1. Grewal, B.S and Grewal, J.S., " Numerical Methods in Engineering and Science', 6th Edition, Khanna Publishers, New Delhi, 2004
2. Gerald, C.F, and Wheatley, P.O, "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2006
3. Chapra, S. C and Canale, R.P. "Numerical Methods for Engineers", 5th Edition, Tata McGraw – Hill, New Delhi, 2007

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply numerical methods such as direct and iterative methods to solve algebraic or transcendental equations and system of equations	3	3	3	3	2								3	3	
CO2	Use the concept of interpolation and apply to real life situations.	3	2	3	3	3								3	3	
CO3	Appreciate numerical solutions for differential and integral calculus as a handy tool to solve problems.	3	3	3	2	3								3	2	
CO4	Implement numerical algorithms to find solutions for intial value problems for ordinary differential equations.	3	2	3	3	3								3	3	
CO5	Demonstrate algorithms using finite differences to obtain solutions to boundary value problems	3	3	3	2	3								3	2	

418CHT02 **PHYSICAL CHEMISTRY** **L T P C**
3 1 0 4

COURSE OBJECTIVES

- To acquire knowledge in the field of electro and thermo chemistry
- To acquire knowledge in solubility behavior, chemical reaction kinetics
- To acquire knowledge in distribution and colloidal chemistry towards different applications

UNIT – I THERMOCHEMISTRY **09**

Units of Energy changes - Heat of Reaction or Enthalpy of a Reaction - Exothermic and Endothermic Reactions – Thermo chemical Equations - Heat of Combustion - Heat of Solution - Heat of Neutralisation - Energy Changes during Transitions or Phase changes - Hess's Law of Constant Heat Summation - Applications of Hess's Law -Bond Energy- Measurement of the Heat of Reaction

UNIT – II DISTRIBUTION LAW **09**

Nernst's Distribution Law-Thermodynamics of solutions-Thermo dynamical derivation of distribution law-Calculation of Partition coefficient- Determination of Equilibrium Constant from Partition Coefficient – Extraction with a Solvent - Multiple Extraction- Applications of Distribution Law

UNIT – III COLLOIDS AND COLLIGATIVE PROPERTIES **09**

Types of colloidal systems – classification of colloids – lyophilic and lyophobic sols – kinetic- optical and electrical properties of colloids – theory of electrical double layer – protective colloids- gold number – emulsions – gels- application of colloids. Colligative properties – definition –thermodynamic aspect of lowering of vapour pressure – elevation of boiling point – depression of freezing point – osmotic pressure

UNIT – IV ELECTROCHEMISTRY **09**

Faraday's law of electrolysis- specific- molar and equivalent conductances and their variation with dilution- transport number- Kohlrausch's law-applications of Kohlrausch's law-conductance measurements-applications. Theory of strong electrolytes-Arrhenius theory, limitations- Debye-Huckel theory of strong electrolytes- Onsager equation (no derivation)- solubility product and its applications-pH scale and buffer action

UNIT – V KINETICS AND CATALYSIS **09**

Rate of a reaction-Order of a reaction – Examples and rate equations for Zero order, First order, Second order and Third order reactions –Molecularity of a reaction – Unimolecular and Bimolecular reactions – Half life period- Kinetics of parallel and opposing reactions – Activation energy – Arrhenius equation –Collision theory of reaction rates – Theory of absolute reaction rates – Michalis Menton kinetics of enzyme catalyzed reactions

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the thermo chemical reactions and applications of it
CO2 Understand Distribution law and can determine Equilibrium Constant from Partition Coefficient
CO3 Understand types, classification and applications of colloids
CO4 Understand the applications of electrochemistry
CO5 Determine the kinetics of all types of reaction

TEXT BOOKS:

1. Kund and Jain, Physical Chemistry, S. Chand and Company, New Delhi (2014)
2. Puri B.H. Sharma L.R. and M.S. Prathama, "Principles of Physical Chemisry", S. Chand and Company, New Delhi (2010)
3. B.S.Bahl, ArunBahl and G.D.Tuli, "Essentials of Physical Chemistry", S.Chand and Company, New Delhi (2011)

REFERENCES:

1. Gordon M. Barrow, Physical Chemistry, Sixth Edition, Tata McGraw Hill (2005)
2. Peter Atkins & Julio de Paula, Atkins' Physical Chemistry, 7th Edition, Oxford university press (2011)

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the thermo chemical reactions and applications of it	2	2	3	3	2	1	3						3	2	
CO2	Understand Distribution law and can determine Equilibrium Constant from Partition Coefficient	3	2	3	3	2	1	3						3	2	
CO3	Understand types, classification and applications of colloids	2	3	3	3	2	1	3						3	2	
CO4	Understand types, classification and applications of colloids	2	3	3	2	2	1	2						3	2	
CO5	Determine the kinetics of all types of reaction	3	2	3	3	2	2	3						3	2	

418CHT03 **CHEMICAL PROCESS INDUSTRIES** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To study the basic concepts of process industries and various methodology used in process industries.
- To know the process methodology regarding chlorine and sulphur.
- To study the basic ideas of fertilizer and nitrogen and phosphorous industries.
- To know the process methodology regarding paper, pulp and oil industry.
- To study the process methodology regarding rubber and fiber industry

UNIT – I INTRODUCTION & INORGANIC CHEMICAL INDUSTRIES 09

The role of a chemical engineers in process industries, Introduction to common devices used in manufacturing processes, block diagrams, flow charts and standard symbols used for devices, unit operations, unit process, process utilities and economics.

Manufacture of Soda ash, sodium bicarbonate, sodium chloride, caustic soda, Bleaching powder.

UNIT – II ACID AND FERTILIZER INDUSTRIES 09

Sulphuric acid, Hydrochloric acid, Phosphoric acid, Ammonia and Nitric acid

Plant nutrients, growth elements and regulators. Manufacture of ammonium sulphate, ammonium nitrate, ammonium phosphate, potassium chloride, potassium sulphate, single, triple super phosphate and Urea.

UNIT – III PULP AND PAPER, SUGAR INDUSTRIES 09

Manufacture of pulp – different processes of pulping – Manufacture of paper and Boards.

Raw and refined sugar, by products of sugar industries, Starch and starch derivatives.

UNIT – IV OIL & DYE INDUSTRIES 09

Vegetable oils and animal fats, their nature, analysis and extraction methods, hydrogenation of oils, soaps, synthetic detergents.

Manufacture of dye- Azo Dyes, anthraquinone dye, vat dyes, pigments and explosives – TNT, RDX & HMX.

UNIT – V RUBBER AND POLYMERS, SYNTHETIC FIBRE AND FILM INDUSTRIES 09

Monomers – Thermosetting and Thermoplastic materials, Natural rubber; Synthetic rubber such as SBR, NBR, CR - Fundamental methods of processing of synthetic rubbers. Natural and synthetic fibers – properties of - Poly amides – manufacture of Nylon 6. 6. Polyesters Fibers – manufacturer of- Viscose Rayon production manufacture of films - PVC, Polyesters – polyethylene

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Acquire knowledge about basics of various aspects of process industries and understands the methods of production of different chemicals.

CO2 Get fundamental knowledge about plant and equipment design

CO3 Apply knowledge about sulphur, nitrogen and fertilizer industry.

CO4 Acquire knowledge about the Manufacturing and processing of paper and pulp, Sugar, by products of sugar and starch and oil, fat products.

CO5 Get skilled in monomers, types of polymers, properties and applications of Resins, types of rubbers. Know the properties and manufacture of Natural and synthetic fibers and films.

TEXT BOOKS:

1. Austin, G.T.,Shreve's Chemical Process Industries, Fifth Edition, McGraw-Hill International Book Co, Singapore, 1984.
2. Dryden, C.E., Outlines of Chemicals Technology, Edited and Revised by Gopala Rao, M. and M.Sittig, Third Edition, Affiliated East-West press, 1997.

REFERENCES:

1. Shukla and G.N. Pandey "Text book on Chemical Technology", Vikas publishing company,1997
2. Kirk and Othmer,"Encyclopedia of Chemical Technology", Fifth Edition, Wiley, 2007.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Acquire knowledge about basics of various aspects of process industries and understands the methods of production of different chemicals	3	3	3	2	2	3	2			1	1		3	3	
CO2	Get fundamental knowledge about plant and equipment design	3	3	3	2	2	3	2			1	1		3	3	
CO3	Apply knowledge about sulphur, nitrogen and fertilizer industry.	3	3	3	2	2	3	2			1	1		3	3	
CO4	Acquire knowledge about the Manufacturing and processing of paper and pulp, Sugar, byproducts of sugar and starch and oil, fat products.	3	3	3	2	2	3	2			1	1		3	3	
CO5	Get skilled in monomers, types of polymers, properties and applications of Resins, types of rubbers. Know the properties and manufacture of Natural and synthetic fibers and films.	3	3	3	2	2	3	2			1	1		3	3	

418CHT04 CHEMICAL ENGINEERING FLUID MECHANICS L T P C
2 2 0 3

COURSE OBJECTIVES

- To impart to the student knowledge on fluid properties,
- To impart to the student knowledge on fluid statics, dynamic characteristics for flow through pipes and porous medium,
- To impart to the student knowledge on flow measurement and fluid machineries

UNIT – I DIMENSIONAL ANALYSIS AND FLUID STATICS 09

Unit system - laws of dimensional homogeneity – the principle of dimensional homogeneity – the PI – theorem – relationship between dimensional analysis and similitude – use of dimensional analysis for scale up studies - hydrostatic pressure distributions- laws of buoyancy, Pressure drop measurements, types of manometers, decanters – gravity and centrifugal

UNIT – II FLUID FLOW PHENOMENA 09

Nature of fluids - Physical properties of fluids – Compressible and incompressible fluids - Types of fluids-Newtonian and Non Newtonian fluids- types of flow – laminar and turbulent, concept of boundary layer. Basic equation of fluid flow – equations of continuity and momentum – energy equations – Bernoulli's equations with and without friction

UNIT – III INCOMPRESSIBLE FLOW IN PIPES AND CHANNELS 09

Reynolds number regimes- internal versus viscous flow – laminar flow in pipes and annular pipe – Newtonian fluids – Hagen Poiseuelle's equation - laminar flow of non – Newtonian fluids – turbulent flow in pipes and channels head losses in fittings and valves

UNIT – IV FLOW THROUGH PACKED AND FLUIDIZED BEDS 09

Flow past immersed bodies – skin and form drag – drag coefficients – fluid flow through packed bed – Ergun's equation –mechanics of particle motion – terminal velocity – gravity and centrifugal settling-settling regimes-hindered settling.

Fluidization – types of fluidization – conditions of fluidization – minimum fluidization velocity

UNIT – V METERING AND TRANSPORTATION OF FLUIDS 09

Metering of fluids – orifice meter – Venturi meter- Pitot tube – Rotameter – weirs – notches – principle and application of Doppler effect and flow measurement – Valves – types of Valves- fluid moving machinery – centrifugal pumps – pump characteristics – positive displacement, reciprocating and rotatory pumps – air lift and diaphragm pumps – fans – blowers – compressors – steam jet ejector – selector and specifications

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Students can get the knowledge about the unit and dimensions and also about the role of pressure in the fluid flow and pressure measurement.

CO2 Students can get the knowledge about the types of fluid flow and also on the discharge measurement by using different equipment at different conditions.

CO3 Students would have knowledge on Fluid properties, their characteristics while static and during flow through ducts, pipes and porous medium.

CO4 Students get the idea about different types of forces, losses and their effects in the fluid flow

CO5 Students get the knowledge about several machineries used to transport the fluid and their performance

TEXT BOOKS:

1. McCabe, W.L, Smith J.C and Harriot .P., "Unit Operations in Chemical Engineering", Mc-Graw-Hill, 7th Edition, McGraw-Hill International Edition, 2005.
2. White, F.M., "Fluid Mechanics", 8th Edition, McGraw-Hill Inc., 2016.

REFERENCES:

Noel de Nevers, “Fluid Mechanics for Chemical Engineers”, Second Edition, McGraw-Hill,
1. McGraw-Hill International Edition, 2005.
2. Coulson J.M. and Richardson J.E.., Chemical Engineering, Vol. 1 (3rd Edition) Pergamon Press
3. YunusCengel and John Cimbala “Fluid Mechanics”, McGraw-Hill Inc., 2014.
4. Munson, Okiishi, Huebsch, Rothmaye,“Fluid Mechanics”, Wiley Inc. 2015
5. Shames, I.H., “Mechanics of Fluids”, Third Edition, McGraw-Hill Inc., 1992.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Students can get the knowledge about the unit and dimensions and also about the role of pressure in the fluid flow and pressure measurement.	3	3	3	3	3	3	2				1		3	3	
CO2	Students can get the knowledge about the types of fluid flow and also on the discharge measurement by using different equipment at different conditions.	3	3	3	3	3	3	2				1		3	3	
CO3	Students would have knowledge on Fluid properties, their characteristics while static and during flow through ducts, pipes and porous medium.	3	3	3	3	3	3	2				1		3	3	
CO4	Students get the idea about different types of forces, losses and their effects in the fluid flow	3	3	3	3	3	3	2				1		3	3	
CO5	Students get the knowledge about several machineries used to transport the fluid and their performance	3	3	3	3	3	3	2				1		3	3	

418CHT05 **MECHANICAL OPERATIONS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To study the principles of size reduction using various equipments
- To know the techniques of separating solids based on size by different methods
- To study the various aspects of mixing and agitation of solids and liquids and concept of filtration

UNIT – I PARTICLE TECHNOLOGY **09**

Particle Technology - Characteristics of solid particles – screen analysis, Differential and cumulative mean diameters for mixture of particles, properties of particulate masses. Agglomeration and aggregation of particles - Handling and transport of solids, storage equipment for mechanical conveyors and elevators, pneumatic transport. Communition – principles of communition laws and energy requirements. Size reduction - Description and working of crushing and grinding equipment – jaw, Gyratory and Roll crusher, Hammer mill, Rod mill and Ball mill, Ultra-fine grinders. Cutting machines – Open and closed circuit grinding

UNIT – II SIZE SEPARATION **09**

Size Separation: Industrial screening equipment - Grizzlies, Tromels and gyratory. Capacity and effectiveness of screen. Flotation, Frothing and dispersing agents' magnetic separation, electrostatic precipitators.

Classifiers, jigging. Sorting classifiers – Heavy medium and differential settling methods. Principle and working of cyclones and hydro cyclones.

UNIT – III SEDIMENTATION **09**

Sedimentation: Flocculation – Batch sedimentation – Thickeners – Thickener design – Kynch Theory, Principles of centrifugal sedimentation – Centrifugal classifiers and decanters – tubular, disc, bowl and scroll centrifuges

UNIT – IV FILTRATION **09**

Filtration – equations for batch filtration. Description of plate and frame filter presses, shell and leaf filters. Rotary vacuum drum filters. Membrane filtration, Centrifugal filters. Filter aids, Theory of constant rate and centrifugal filtration.

UNIT – V MIXING AND AGITATION **09**

Mixing and Agitation: Agitation of liquids – Agitation equipment – Circulation velocities and power consumption in agitated vessels. Equipment for blending and mixing of liquids – Suspension of solid particles. Critical speed – Dispersion of gas in liquids. Gas holdup and power requirement. Dispersion of liquids in liquids. Equipment for mixing of solids and pastes – Mixers for dry powders – mixing index.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Decide the usage of equipment for industrial application with respect to size reduction.
CO2 Decide the necessary equipment to screen different particles.
CO3 Apply the knowledge of different blends and mixing techniques to liquids and solids.
CO4 Students will be able to understand the concept of filtration techniques.
CO5 Apply the usage of various filtration equipments and thickeners.

TEXT BOOKS:

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Seventh Edition, 2005.
2. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Seventh Edition, 2005.
3. G.G.Brown, "Unit Operations", CBS publishers, 2005.

REFERENCES:

1. Coulson, J.M and Richardson, J.F., "Chemical Engineering", Volume 2, Fourth Edition, Butterworth-Heineman, 2004.
2. Badger, Walter L. and Banchero, Julius T., "Introduction to Chemical Engineering", Tata McGraw Hill Publishers, New Delhi, 1998.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Decide the usage of equipment for industrial application with respect to size reduction.	3	3	3	3	2	3	2				1		3	3	3
CO2	Decide the necessary equipment to screen different particles.	3	3	3	3	3	3	2				1		3	3	3
CO3	Apply the knowledge of different blends and mixing techniques to liquids and solids.	3	3	3	3	2	3	2				1		3	3	3
CO4	Students will be able to understand the concept of filtration techniques.	3	3	3	2	3	3	2				1		3	3	3
CO5	Apply the usage of various filtration equipments and thickeners.	3	3	2	3	3	3	2				1		3	3	3

418CHP07 **FLUID MECHANICS LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES

- To determine experimentally the flow characteristics of fluids and also to determine the efficiency of the flow measuring devices and fluid transport machineries.
- To gain practical knowledge on the measurement of Fluid Flow and their characteristics at different operating conditions.

LIST OF EXPERIMENTS

1. Determination of Venturi coefficient
2. Determination of Orifice coefficient
3. Pressure drop studies in packed column
4. Pressure drop studies in Fluidized bed
5. Development of Characteristic curves of Single stage centrifugal pump
6. Development of Characteristic curves of Multi stage centrifugal pump
7. Development of Characteristic curves of Submersible pump
8. Development of Characteristic curves of Reciprocating pump
9. Determination of coefficient of Rectangular notch
10. Determination of coefficient of Triangular notch
11. Determination of coefficient of Vertical (Open) orifice
12. Determination of friction factor in flow through straight pipe
13. Evaluation of head loss coefficients in pipe fittings
14. Calibration of Variable area meter

LIST OF EXPERIMENTS

1. Orifice Meter with U tube manometer
2. Venturi meter with U tube Manometer
3. V-notch and Rectangular Notch weirs
4. Straight pipes with U tube Manometers
5. Packed column with U tube manometer
6. Fluidized column with U tube manometer
7. Flow loops for pipes, fittings and valves with U tube manometer
8. Vertical orifice setup
9. Single stage centrifugal pump setup
10. Multi stage centrifugal pump setup
11. Submersible pump setup
12. Reciprocating pump setup
13. Rotameter

*Minimum 10 experiments shall be offered

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Conduct experiments for fluid flow in circular pipes, orifice and venture meters.
CO2 Estimate the coefficient of rectangular and triangular notches.
CO3 Estimate head loss in pipe fittings.
CO4 Estimate coefficient of discharge for flow through open and closed channels, show relationship between Reynolds number and friction factor
CO5 Perform characteristic studies of submersible and centrifugal pump

TEXT BOOKS

1. McCabe, W.L, Smith J.C and Harriot .P, “Unit Operations in Chemical Engineering”, Mc-Graw-Hill, 7th Edition, McGraw-Hill International Edition, 2005.
2. White, F.M., “Fluid Mechanics”, 8th Edition, McGraw-Hill Inc., 2016.

REFERNCES

1. Noel de Nevers, “Fluid Mechanics for Chemical Engineers”, Second Edition, McGraw-Hill, McGraw-Hill International Edition, 2005.
2. Coulson J.M. and Richardson J.E.., Chemical Engineering, Vol. 1 (3rd Edition) Pergamon Press.
3. Yunus Cengel and John Cimbala “Fluid Mechanics”, McGraw-Hill Inc., 2014.
4. Munson, Okiishi, Huebsch, Rothmaye, “Fluid Mechanics”, Wiley Inc. 2015
5. Shames, I.H., “Mechanics of Fluids”, Third Edition, McGraw-Hill Inc., 1992.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Conduct experiments for fluid flow in circular pipes, orifice and venture meters.	3	3	3	3	3	3	2				1		3	3	
CO2	Estimate the coefficient of rectangular and triangular notches.	3	3	3	3	3	3	2				1		3	3	
CO3	Estimate head loss in pipe fittings.	3	3	3	3	3	3	2				1		3	3	
CO4	Estimate coefficient of discharge for flow through open and closed channels, show relationship between Reynolds number and friction factor	3	3	3	3	3	3	2				1		3	3	
CO5	Perform characteristic studies of submersible and centrifugal pump	3	3	3	3	3	3	2				1		3	3	

418CHP08 **PHYSICAL CHEMISTRY LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES

- To estimate the amount and determine the various physico- chemical properties of different chemical compounds and mixtures
- To improve the practical knowledge on the properties and characteristics of solvents and mixtures

LIST OF EXPERIMENTS

1. Determination of velocity constant of hydrolysis of ethyl acetate in alkaline medium
2. Determination of Transition Temperature (TT) of a hydrated salt by Thermometric method
3. Determination of surface tension of liquid using Stalagmometer
4. Determination of molecular weight of solute by Beckmann's method
5. Determination of molecular weight of solute by Rast's method
6. Determination of coefficient of viscosity using Ostwald viscometer
7. Determination of Critical Solution Temperature (CST) of Phenol-water system
8. Determination of rate constant of hydrolysis of ethyl acetate in acidic medium
9. Determination of surfactant's Critical Micelle Concentration (CMC) of sodium salt by conductivity method
10. Estimation of glucose using Polarimeter
11. Determination of partition co-efficient of benzoic acid between two immiscible solvents
12. Determination of molecular weight of a polymer by viscosity method

LIST OF EQUIPMENTS

1. Beckmann's apparatus
2. Thermometers (0 to 110°F)
3. Ostwald Viscometer
4. Drop Pipette
5. Polarimeter
6. Melting point apparatus
7. Transition Temperature apparatus

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the principles, properties and characteristics of solvents and mixtures
CO2 Determine the molecular weight of solute using different methods
CO3 Determine the Critical Micelle Concentration (CMC) of a metal salt
CO4 Apply the kinetics to hydrolysis of ester
CO5 Determine the molecular weight of a polymer

REFERENCES

1. Vogel, A. L.,A text book of Quantitative inorganic Analysis, ELBS, London, 2009
2. Alexander Findley,Physical Chemistry experiments, McGraw-Hill, Fourth Edition, 2015
3. Shoemaker D.P. and Gardad, C.W., Experiments in Physical Chemistry, McGraw Hill, London, 2015

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the principles, properties and characteristics of solvents and mixtures	2	2	3	3	2	1	2						3	1	
CO2	Determine the molecular weight of solute using different methods	2	2	3	2	2								3	1	
CO3	Determine the Critical Micelle Concentration (CMC) of a metal salt	2	2	3	2	2	1							3	1	
CO4	Apply the kinetics to hydrolysis of ester	3	2	3	2	3								3	1	
CO5	Determine the molecular weight of a polymer	3	2	3	2	3	1							3	1	

418CHP09 **MECHANICAL OPERATIONS LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES

- To impart practical knowledge and have an experience on various mechanical operations involving size reduction and size separation

LIST OF EXPERIMENTS

1. Study of crushing strength (Work Index) of solid materials using jaw crusher
2. Study of crushing strength (Work Index) of solid materials using rod mill
3. Study of crushing strength (Work Index) of solid materials using drop weight crusher
4. Study of crushing strength (Work Index and Critical Speed) of solid materials using ball mill
5. Determining the average size of particles (cumulative and differential method) using Tyler Sieves
6. Study of characterization of filtration using the Plate and frame filter press.
7. Study of characterization of filtration using leaf filter
8. Study of separation efficiency (fine particles) using cyclone separator
9. Determining the minimum thickener area (Kynch Theory) by batch sedimentation method
10. Study of separation of fine particles using screens and determination of effectiveness factor
11. Determining the percentage purity of the given sample of mixture of sand and $CaCO_3$ by froth flotation

LIST OF EQUIPMENTS

1. Jaw crusher
2. Rod Mill
3. Ball mill
4. Tyler sieving
5. Filter press
6. Leaf filter
7. Cyclone separator
8. 2 liter and one liter Glass Jars, Stop Clock
9. Screens of various mesh sizes
10. Drop weight crusher
11. Froth-Floatation
12. Baum Jig

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Determine work index, average particle size through experiments by crushers, ball mill, rod mill and conducting size analysis by various size sieves.

CO2 Design size separation equipments such as cyclone separator, pressure and vacuum filters

CO3 Determine thickener area from batch sedimentation experiment

TEXTBOOK

1. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Seventh Edition, 2005.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Determine work index, average particle size through experiments by crushers, ball mill, rod mill and conducting size analysis by various size sieves.	3	3	3	2	2	1							3	3	
CO2	Design size separation equipments such as cyclone separator, pressure and vacuum filters	3	3	3	2	2	1							3	3	
CO3	Determine thickener area from batch sedimentation experiment	3	3	3	2	2	1							3	3	

SEMESTER V

518PST01 PROBABILITY AND STATISTICS L T P C
3 0 0 3

COURSE OBJECTIVES

- To impart the knowledge of basic probabilistic theory.
- To learn one dimensional discrete and continuous probability distributions occurring in natural phenomena.
- To extend the probability theory to two dimensional random variables and to study the statistical measures.
- To introduce the notion of sampling distributions and have acquired knowledge of statistical techniques useful in making rational decision in management problems.
- To expose to statistical methods designed to contribute to the process of making scientific judgments in the face of uncertainty and variation.

UNIT – I PROBABILITY AND RANDOM VARIABLE 12

Axioms of probability - Conditional probability - Total probability – Baye's theorem- Random variable - Probability mass function - Probability density function - Properties - Moments - Moment generating functions and their properties.

UNIT – II PROBABILITY DISTRIBUTIONS 12

Binomial, Poisson, Geometric, Uniform, Exponential, and Normal distributions and their properties - Functions of a random variable-simple applications.

UNIT – III TWO-DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and Conditional distributions – Covariance – Correlation and Linear regression – Central limit theorem (Statement and applications only for independent and identically distributed random variables).

UNIT – IV TESTING OF HYPOTHESIS 12

Sampling distributions - Tests for single mean, Proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances – Chi-square test for goodness of fit – Independence of attributes.

UNIT – V DESIGN OF EXPERIMENTS 12

Analysis of variance – Completely Randomized Design (CRD) -one way classification – Randomized Block Design (RBD) -two way classification - Latin Square Design (LSD) – Factorial Designs- 2^2 Factorial designs- Control charts for measurements - $\bar{X}$ chart, R-chart, *p* - chart and *np* – chart.

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Imbibing the knowledge of basic probability improves the quality of interpretation and decision making in real time problems of uncertainty.

CO2 Understanding the real time application of probability distributions.

CO3 Learning the concept of two dimensional random variables helps to understand and analyse the Statistical measures which describe an outcome of a random experiment.

CO4 Drawing inference & decision making through hypothesis testing.

CO5 Acquainting the knowledge of analysis of variance and control limits.

TEXT BOOKS:

1. Miller and Freund., "Probability and Statistics for Engineers", Pearson Education, Asia, 7th edition, 2012.

REFERENCES:

1. Spiegel, M.R, Schiller,J and Alu Srinivasan, R, "Schaum's Outlines Probability and Statistics", Tata McGraw-Hill Publishing Company Ltd. New Delhi , 2010.
2. Gupta.S.C., & Kapoor,V.K., "Fundamentals of mathematical statistics", 11th edition, Sultan Chand & Sons publishers, New Delhi, 2013.
3. Ibe, O.C.,"Fundamentals of Applied Probability and Random Processes", Elsevier, U.P., 1st Indian Reprint, 2007.
4. Veerarajan.T., "Probability, Statistics and Random Processes", Tata McGraw-Hill publishing company Limited, New Delhi, 2014.
5. Kandasamy.P,Thilagavathy,K.,&Gunavathi.K., "Probability, Statistics and Queueing Theory"., S.Chand & Company Ltd., New Delhi, 2014.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Imbibing the knowledge of basic probability improves the quality of interpretation and decision making in real time problems of uncertainty.	3	1	2	3	1								2		
CO2	Understanding the real time application of probability distributions.	3	3	3		2	1							2		2
CO3	Learning the concept of two dimensional random variables helps to understand and analyse the Statistical measures which describe an outcome of a random experiment.	2	2	2	2	3								2		2
CO4	Drawing inference & decision making through hypothesis testing.	3	3	3	2	3							2	3		3
CO5	Acquainting the knowledge of analysis of variance and control limits.	3	2	3	1	2								3		2

518CHT02 CHEMICAL ENGINEERING THERMODYNAMICS L T P C
3 0 0 3

COURSE OBJECTIVES

- The Students will be well versed with the behavior of fluids under PVT conditions and also apply them for practical purpose. Main advantage will be to deal with power production and refrigeration processes. The study further provides a comprehensive exposition to theory and application of solution thermodynamics.

UNIT – I BASIC CONCEPTS AND LAWS OF THERMODYNAMICS 12

Terminologies of thermodynamics, categorization of systems and processes, Laws of Thermodynamics. Reversible and Irreversible process. Entropy change in reversible and irreversible process, Internal energy and entropy as a function of Temperature and pressure.

UNIT – II THERMODYNAMIC PROPERTIES 12

PVT behavior gases. Equation of state. Thermodynamics relations, Maxwell relations. Fugacity and fugacity coefficients. Estimation of thermodynamic properties.

UNIT – III PHASE EQUILLIBRIA AND VAPOUR LIQUID EQUILLIBRIA 12

Phase equillibria - Activity and activity coefficients. Gibbs-Duhem equations. Van Laar equation, Margules equation, Consistency test, Prediction of VLE.

UNIT – IV CHEMICAL REACTION EQUILLIBRIA 12

Criteria of equilibrium. Standard free energy change and equilibrium constants. Effect of temperature. Evaluation of equilibrium constants.

UNIT – V APPLICATION OF LAWS OF THERMODYNAMICS 12

Compression and expansion of fluids. Theory of multistage compression. Refrigeration principles and applications.

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

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 based on thermodynamic principles.

CO2 Apply the basic concepts of first and second laws of thermodynamics for the design and analyze of the open and closed system in chemical process plants.

CO3 Predict the changes in the properties of real fluids undergoing changes in process plant equipment.

CO4 Use empirical correlations and experimental data to evaluate thermodynamic quantities that relate to the vapour-liquid or liquid-liquid equillibria of ideal and non-ideal chemical mixtures.

CO5 Determine equilibrium constants, standard enthalpy, Gibbs free energy and equilibrium compositions for single and multiple reaction systems.

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.
2. Narayanan K.V “A Text Book of Chemical Engineering Thermodynamics” Prentice Hall of India Pvt. Ltd. 2011.

REFERENCES:

1. Dodge, B.F., Chemical Engineering Thermodynamics, McGraw Hill International Student Edition, 1960.
2. Sandler, S.I., Chemical and Engineering Thermodynamics, Second Edition, John Wiley International Student Edition, 1989.
3. Rao .Y.V.C., Chemical Engineering Thermodynamics, united press (India) ltd.1997.
4. Merle Potter, Craig Somerton., Schaum’s outline of Thermodynamics for Engineers, Second Edition, McGraw Hill, 2009.
5. Hendrick.C.Vanness, Michael M.Abbott., Schaum’s outline of Thermodynamics with Chemical Applications, McGraw Hill Professional, 1989.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
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 based on thermodynamic principles.	3	2	2									2	3		1
CO2	Apply the basic concepts of first and second laws of thermodynamics for the design and analyze of the open and closed system in chemical process plants.	3	3	3	2		1	2	1				1		1	
CO3	Predict the changes in the properties of real fluids undergoing changes in process plant equipment.	2	2	3	1				1				2			2
CO4	Use empirical correlations and experimental data to evaluate thermodynamic quantities that relate to the vapour-liquid or liquid-liquid equillibria of ideal and non-ideal chemical mixtures.	1	2	2	1		2				2		2	2		1
CO5	Determine equilibrium constants, standard enthalpy, Gibbs free energy and equilibrium compositions for single and multiple reaction systems.	2	2	3	2		1	1	2	1			1	3		2

518CHT03 **HEAT TRANSFER** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To provide an overall view of different modes of heat transfer applicable to process industries
- To learn the path of heat transfer when different phases are involved.
- To impart the concept and functioning of different heat exchangers.

UNIT – I CONDUCTION **12**

Modes of heat transfer- basic laws of heat transfer – Fourier's law of heat conduction. One dimensional steady state heat conduction-Flat plate, hollow cylinder, hollow spheres and their composite structures. Heat transfer from extended surfaces and applications; Critical insulation thickness\radius. Introduction to transient heat conduction

UNIT – II CONVECTION **12**

Natural and forced convection- Application of dimensional analysis for convection and dimensionless numbers. Natural and forced convection through vertical and horizontal plates and tubes

UNIT – III RADIATIONS **12**

Nature of thermal radiations- Concept of grey and black bodies. Laws of radiations- Stefan's Boltzmann law, Kirchhoff's law and Planck's law. Radiation exchange between surfaces –plates and , cylinders. Radiation shield and its applications.

UNIT – IV HEAT TRANSFER WITH PHASE CHANGE **12**

Introduction to boiling and condensation- Condenser- vertical and horizontal.Evaporators- Types and application. Methods of feed In multiple effect evaporator. Calculation of steam consumption, steam economy and heat transfer area in single effect evaporator.

UNIT – V HEAT EXCHANGERS **12**

Types of Heat exchangers-LMTD –use of correction temperature factors-Fouling Heat transfer area for shall and tube and double pipe heat exchanger. Heat exchanger Effectiveness and NTU .Wilson plot applications. Compact heat exchanger –applications

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Distinguish different modes of heat transfer
CO2 Find the rate of heat transfer with and without change of phase
CO3 Evaluate film coefficients in convection under different situations (forced, natural convection, Boiling and Condensation Heat)
CO4 Decide the type of evaporator required for a specific purpose
CO5 Analyze the concepts of heat exchangers

TEXT BOOKS:

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Seventh Edition, 2005.
2. BinayK.Dutta "Heat Transfer Principles and Applications", Prentice Hall of India, 2001
3. Holman, J.P., " Heat Transfer", Mcgraw Hill Education, Tenth Edition, 2009

REFERENCES:

1. Coulson, J.M., Richardson, J.F., "Chemical Engineering", Volume 2, Sixth Edition, Butterworth, 2001.
2. Kern, D.Q., "Process Heat Transfer", McGraw-Hill - Revised Edition – 1999

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Distinguish different modes of heat transfer		1	2	1	1		1					2	1	2	
CO2	Find the rate of heat transfer with and without change of phase	1	1	1		2	1		1		1			3		1
CO3	Evaluate film coefficients in convection under different situations (forced, natural convection, Boiling and Condensation Heat)	1	2	3	2	2	1	2	1		1	2	1	3	2	1
CO4	Decide the type of evaporator required for a specific purpose	3	2		3	3	2	2	2	3	3	2	1	3	1	1
CO5	Analyze the concepts of heat exchangers	2	2	2	1	1		1	1	1			1	1	1	1

518CHT04 **MASS TRANSFER – I** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the mass diffusion .fundamentals in gas, Liquid and solid mediums.
- To understand the interphase mass transfer and transfer coefficient concepts.
- To Understand the mass transfer operations and design calculations in humidification, drying and crystallization operations

PREREQUISITE

Fundamentals of process calculations, fluid flow and heat flow

UNIT – I DIFFUSION **12**

Molecular and eddy diffusion in gases and liquids, steady state diffusion under stagnant and laminar flow conditions Diffusivity measurement and prediction, multicomponent diffusion, diffusion in solids and its applications

UNIT – II MASS TRANSFER COEFFICIENTS **12**

Concept of mass transfer coefficients, mass transfer under laminar and turbulent flow past solids, boundary layers, mass transfer at fluids surfaces correlation of mass transfer coefficients, theories of mass transfer and their applications, interphase mass transfer and over all mass transfer coefficients in binary systems; application to gas-liquid and liquid-liquid systems

UNIT – III HUMIDIFICATION AND AIR CONDITIONING **12**

Basic concepts, psychrometric chart construction, Humidification and dehumidification operations, design calculations, cooling tower principle, operation, types and design calculations.

UNIT – IV DRYING **12**

Theory and mechanism of drying, drying characteristics of materials, batch and continuous drying, drying equipment, design and performance of various drying equipments, Vacuum Drying.

UNIT – V CRYSTALLIZATION **12**

Nuclei formation and crystal growth, theory of crystallization, growth coefficients and the factors affecting the crystallization, batch and continuous industrial crystallizers, design principles.

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Write rate equations for mass transfer operations
CO2 Apply the diffusion principles in mass transfer calculations
CO3 Apply the concepts of inter phase mass transfer in gas- liquid, liquid-liquid and solid – liquid mass transfer operations
CO4 Design Cooling towers, dryers and crystallizers
CO5 Acquire knowledge about crystal formation and industrial crystallizers.

TEXT BOOKS:

1. Treybal, R.E., “Mass Transfer Operations”, McGraw-Hill Kogakusha, 1980.
2. Anantharaman, N., Begum, K. M. MeeraSheriffa, Mass Transfer : Theory And Practice, PHI Learning, 2011.
3. Binay K.Dutta “Principles of Mass Transfer and Separation Processes”, Prentice Hall India, 2007.
4. Narayanan KV ,”Mass Transfer Theory and applications”, CBSPublishers & Distributors, 2014.

REFERENCES:

1. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Seventh Edition, 2005.
2. Coulson, J.M., Richardson, J.F., “Chemical Engineering”, Volume 2, Sixth Edition, Butterworth, 2001.
3. Foust, A.S.Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., “Principles of Unit Operations”, Second Edition, Wiley, 1980.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Write rate equations for mass transfer operations	1		2	1									1		
CO2	Apply the diffusion principles in mass transfer calculations	1	2	1	1		1	1	1	1	1		1	1		
CO3	Apply the concepts of inter phase mass transfer in gas- liquid, liquid-liquid and solid – liquid mass transfer operations	2	3	3	3	2	2	1	2	1			2	2	1	1
CO4	Design Cooling towers, dryers and crystallizers	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	Acquire knowledge about crystal formation and industrial crystallizers.	2	2	1	2	2	1	1	1					1		

518CHP07 **HEAT TRANSFER LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES

- To determine the heat transfer coefficient in different equipments.
- To have a wide knowledge on the conductive, convective and radiation type of heat transfer under different operative conditions.

LIST OF EXPERIMENTS

1. Determination of the natural convective heat transfer coefficient for a vertical tube
2. Determination of forced convective heat transfer coefficient for air flowing through a pipe
3. Determination of thermal conductivity of a Lagged material
4. Determination of Emissivity of a grey surface
5. Determination of thermal conductivity of a metal rod
6. Determination of heat transfer coefficient of Pin-Fin Apparatus (Natural and Forced Convection).
7. Determination of thermal conductivity of an insulating powder
8. Determination of Stefan Boltzmann Constant
9. Determination of overall heat transfer coefficient in double pipe heat exchanger
10. Determination of overall heat transfer coefficient in horizontal condenser
11. Boiling heat transfer experiment.
12. Single effect evaporator.

LIST OF EQUIPMENTS

1. Natural Convection Experimental Setup
2. Forced Convection Experimental Setup
3. Heat Transfer Through Lagged Pipe Setup
4. Emissivity Experiment Setup
5. Thermal Conductivity of a Metal Rod Setup
6. Pin-Fin Apparatus
7. Insulating Powder Experiment Setup
8. Stefan Boltzmann Constant Apparatus
9. Double Pipe Heat Exchanger Setup
10. Horizontal Condenser Setup

Minimum 10 experiments shall be offered

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Determine the thermal conductivity for various conductors and Stefan Boltzmann constants through experiments.

CO2 Use experimental data to evaluate heat transfer co-efficient and evaluate performance of different types of equipment including heat exchangers, condensers.

CO3 Use experimental data to evaluate heat transfer co-efficient and evaluate performance of different types of equipment including heat exchangers, condensers.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Determine the thermal conductivity for various conductors and Stefan Boltzmann constants through experiments.	3	3	3	3	3	1	1	1	1	1			3		1
CO2	Use experimental data to evaluate heat transfer co-efficient and evaluate performance of different types of equipment including heat exchangers, condensers.	3	3	3	1	2			1		1	1		2		1
CO3	Use experimental data to evaluate heat transfer co-efficient and evaluate performance of different types of equipment including heat exchangers, condensers.	3	3	3	3	2	3	1		2	1	1	3	2		1

518CHP08 CHEMICAL ENGINEERING COMPUTATIONAL LABORATORY L T P C

0 0 4 2

COURSE OBJECTIVES

- To give the students in understanding the fundamental concepts in mathematics, problems solving and computer programming.
- To implement numerical techniques developed in the course to problems of engineering interest.
- To implement various numerical methods to solve the equations related to chemical engineering.

LIST OF EXPERIMENTS

Numerical Oriented Computation using C / C++/MATLAB and Excel Programming

1. The Solution of Non linear equation, f(x) = 0
    a. Fixed – Point Iteration
    b. Bisection Method
    c. Regular falsi method
    d. Newton Rapson Iteration
    e. SecantMethod
    f. Newton – Rapson Method in two dimension.
2. The Solution of Linear Systems **AX** = **B**
    a. Back substitution
    b. Upper Triangularization followed by back substitution
    c. **PA** = **LU** Factorization with Pivoting
    d. Jacobi Iteration
    e. Gauss Seidal Iteration
3. Interpolation and polynomial approximation
    a. Evaluation of a Taylor's series
    b. Lagrange Approximation
4. Curve Fitting
    a. Least Square Line
    b. Non-Linear curve Fitting
5. Numerical Differentiation
    a. Differentiation using Limits
    b. Differentiation using Extrapolation
    c. Differentiation based on N + 1 Nodes
6. Numerical Integration
    a. Compositie Trapezoidal Rule
    b. Composite Simpson Rule
7. Numerical Optimization
    a. Golden Search for minimum
8. Solution of differential equation
    a. Euler's Method
    b. R.K. Method
    c. Predictor – Corrector Method
9. Solution of Partial Differential Equation
    a. Finite – Difference Solution for the Wave Equation
    b. Forward – Difference method for the Heat Equation
    c. Crank – Nicholson Method.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Equipped with the software applications and the numerical solutions of chemical engineering problems.

CO2 Solve the various numerical problems using these tools and commercial packages.

CO3 Optimize the various factors using the computational techniques

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Equipped with the software applications and the numerical solutions of chemical engineering problems.	2	3	3	3	3	2	2	1	2				2	2	
CO2	Solve the various numerical problems using these tools and commercial packages.	3	3	3	3	3	1		1	2			2	3	3	3
CO3	Optimize the various factors using the computational techniques	2	3	3	3	3	1	1	1	2		2	1	3	3	3

518CHP09 **EMPLOYABILITY SKILLS LAB** **L T P C**
0 0 4 2

COURSE OBJECTIVES

- To equip students of engineering and technology with effective speaking and listening skills in English.
- To help them enrich their soft skills and interpersonal skills, which will make the transition from college to workplace smoother and help them excel in their career.
- To enhance the performance of the students in the recruitment processes, self enhancement and launching start ups.

LAB REQUIREMENTS:

1. Teacher console and systems for students.
2. English Language Lab Software
3. Career Lab Software

UNIT – I **09**

Listening Audios and answering MCQs - Watching video clips on famous speeches, motivational videos, documentaries and answering MCQs - Listening Comprehension and TED talks.

UNIT – II **09**

Prepared talk – Extempore - story knitting - Picture Talk – Brainstorming – Debates - Group Discussions - Elevator Speech - Mock HR Interviews - Story Narration – Miming - Short Skits

UNIT – III **09**

Reading Comprehension - Verbal Analogy - Classification - Alphabet Test - Logical Sequence of Words - Statement & Conclusions - Statement & Courses of Action - Situation Reaction Test - Theme Detection - Deriving Conclusions from Passages.

UNIT – IV **09**

Business Letters - Email Writing (hints development) - Essay Writing - Paragraph Writing - Paraphrasing.

UNIT – V **09**

Vocabulary Test (GRE, TOEFL, TOEIC & CAT Exam words) - Confused Pair of words - Contronyms - One Word Substitution - Sequencing of Sentences – Sentence correction.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Comprehend the various strategies of listening and its significance.

CO2 Articulate their views clearly and concisely with self-confidence and persuasiveness.

CO3 Understand the prevailing practices of testing in the recruitment process by the corporate and the institutional selection processes.

CO4 Communicate the corporate and social requirements in an impressive written mode.

CO5 Enhance their verbal skills in the screening tests competently both for recruitment and pursuing higher studies as well.

TEXT BOOKS:

1. Agarwal R. S., A Modern Approach to Verbal and Non-verbal Reasoning, Chand & Co., New Delhi, 2012.

REFERENCES:

1. Lingua: Essays for TOEFL/IELTS, Dreamtech Press, New Delhi, 2016.
2. Lily Mangalam, Global English Comprehension, Allied Publishers Pvt. Ltd., New Delhi, 2014
3. Sharon Weiner Green and Ira K. Wolf, Barron's GRE, Glagotia Publications Pvt. Ltd., 18th Edition, New Delhi, 2011.
4. Mohamed Elias, R. Gupta's IELTS/TOEFL Essays, Ramesh Publishing House, 6th Edition, New Delhi, 2016.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Comprehend the various strategies of listening and its significance.										3		3			
CO2	Articulate their views clearly and concisely with self-confidence and persuasiveness.										2		3			
CO3	Understand the prevailing practices of testing in the recruitment process by the corporate and the institutional selection processes.										3		2			
CO4	Communicate the corporate and social requirements in an impressive written mode.										2	2	2			1
CO5	Enhance their verbal skills in the screening tests competently both for recruitment and pursuing higher studies as well.										2		2			1

618CHT01	MASS TRANSFER – II	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To discuss the fundamental concepts of mass transfer operations and principles
- To provide students with the theoretical or analytical background to understand mass transfer operations.
- To understand the basic concepts regarding extraction and leaching.

UNIT – I ABSORPTION 09

Equilibrium and operating line concept in absorption calculations; selection of solvent for absorption, types of contactors, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of HETP, NTU, HTU and overall volumetric mass transfer coefficients; multi component absorption; absorption with chemical reaction

UNIT – II DISTILLATION -I 09

Vapour-liquid equilibria, Raoult's law, positive and negative deviations from ideality, flash distillation, steam distillation and differential distillation for binary mixtures, Continuous rectification - binary systems, multistage tray towers – method of McCabe and Thiele, enriching section, stripping section, feed introduction, total reflux, minimum and optimum reflux ratios, types of condensers, tray efficiencies

UNIT – III DISTILLATION -II 09

Theory of Ponchon-Savarit method: enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios; (No numerical problems)

Continuous contact distillation, packed tower design calculations; extractive and azeotropic distillation, comparison of azeotropic and extractive distillation, low pressure distillation. Introduction to multi component distillation

UNIT – IV LIQUID-LIQUID EXTRACTION 09

Equilibrium in ternary systems; solvent selection, equilibrium stage wise contact calculations for batch and continuous extractors, differential contact extraction equipment – spray, packed and mechanically agitated extractors; pulsed extractors, centrifugal extractors; selection of extractors

UNIT – V SOLID-LIQUID EXTRACTION (LEACHING), MEMBRANE SEPARATION PROCESS AND ADSORPTION 09

Solid-liquid equilibria; leaching equipment-batch and continuous types; calculation of number of stages

Principle of Ion exchange techniques and applications; Solid and liquid membranes; Concept of Osmosis; Reverse osmosis; Dialysis and Electro dialysis; Microfiltration; Ultra filtration. Theories of adsorption of gases and liquids; industrial adsorbents, adsorption equipment for batch and continuous operations; principles of ion-exchange

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply mass transfer and separation principles in several unit operations like absorption, distillation

CO2 Determine the number of theoretical stages in a stage-wise mass transfer processes

CO3 Calculate height requirements of continuous separation columns.

CO4 Apply mass transfer and separation principles in several unit operations like liquid-liquid extraction, leaching and adsorption

CO5 Understand the principle of ion exchange.

TEXT BOOKS:

1. Treybal, R.E., “Mass Transfer Operations”, McGraw-Hill, Kogakusha, 1980
2. Binay. K.Dutta,”Principles of Mass Transfer and separation processes, Prentice Hall of India,2007
3. Anantharaman, N., Begum, K. M. MeeraSheriffa, “Mass Transfer: Theory and Practice”, Prentice hall of India, 2011.

REFERENCES:

1. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Seventh Edition, 2005
2. Roman Zarfyki and AndrzejChacuk, “Absorption Fundamentals and Applications", Pergamon Press,1993
3. Philip C Wankat, “Equilibrium Stage Separations”, Prentice Hall,1993

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Apply mass transfer and separation principles in several unit operations like absorption, distillation	2	2	2	2	2			1				2	3	2	
CO2	Determine the number of theoretical stages in a stage-wise mass transfer processes	3	3	3	3		1		1					3	2	
CO3	Calculate height requirements of continuous separation columns.	2	2	2	2	2			1					3	2	
CO4	Apply mass transfer and separation principles in several unit operations like liquid-liquid extraction, leaching and adsorption	3	3	3	3				1				2	3	3	2
CO5	Understand the principle of ion exchange.	1	1	1	1									1	1	

618CHT02	CHEMICAL REACTION ENGINEERING-I	L T P C 3 1 0 4

COURSE OBJECTIVES

- To understand the basic concepts of kinetics, types of reactors, non- ideality in reactors.
- To study the various types of reactors used to carry out single and multiple reactions.
- To gain knowledge on the selection of right type of reactor for the required reaction

UNIT – I KINETICS OF HOMOGENEOUS REACTIONS 12

Introduction, Chemical kinetics and Thermodynamics/Equilibrium, single and multiple reactions, Rate constant and rate of reaction, Factors affecting rate of reaction, Molecularity and order of reaction, elementary and non-elementary reactions, rate equations, temperature dependence of rate, Arrhenius, Collision and activated complex theories, kinetic models for non-elementary reactions

UNIT – II INTERPRETATION OF BATCH REACTOR DATA 12

constant volume batch reactor, Analysis of total pressure data obtained in a constant-volume system, Integral method of analysis of data, Differential method of analysis, fractional life method, varying volume batch reactor

UNIT – III DESIGN OF IDEAL REACTORS SINGLE HOMOGENEOUS REACTORS 12

The general mole balance equation for a reactor, design equations for Ideal batch reactor, ideal steady mixed flow reactor and steady state ideal plug flow reactor. Size comparison of single reactors, optimum reactor size problems

Multiple Reactor Systems: Plug flow reactors in series and/or in parallel-equal sized mixed flow reactors in series-mixed flow reactors of different sizes in series – finding the conversion in a given system – determining the best system for a given conversion – reactors of different types in series-recycle reactor – autocatalytic reactions

UNIT – IV MULTIPLE REACTIONS 12

Introduction to multiple reactions - Design for parallel reactions- optimum yield, conversion, and selectivity-qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size

Quantitative discussion about product distribution, quantitative treatment in a plug flow or batch reactor, quantitative treatment in a mixed flow reactor, irreversible series-parallel reactions-two step irreversible series-parallel reactions

UNIT – V BASICS OF NON IDEAL FLOW 12

Introduction to non-ideal flow, concept of micro and macro mixing, residence time distribution functions, C, E and F curves, calculation of mean residence time from E and F curves, interpretation of the response data using the "Dispersion" and "Tanks-in-series" models (for first order reactions)

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply the basic principles of reaction kinetics, understand the effect of temperature on the rate of reaction

CO2 Learn and analyze batch reactor data

CO3 Design of single and multiple ideal flow reactors for homogeneous reactions.

CO4 Learn about multiple reactions and analyze the thermal characteristics of reactors and its usage in design procedure.

CO5 Acquire basic knowledge on non-ideal flow reactors

TEXT BOOKS:

1. Octave Levenspiel, “Chemical Reaction Engineering”, 3rd ed., John Wiley & Sons, 2001.
2. Fogler H.S., “Elements of Chemical Reaction Engineering”, 4th ed., PHI, 2005

REFERENCES:

1. J.M.Smith, “Chemical Engineering Kinetics”, 3 rd ed., McGraw-Hill Education India Pvt. Ltd, 2014.
2. Lanny D. Schmidt, “The Engineering of Chemical Reactions”, 2nd Edition, Oxford University Press, 2007

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply the basic principles of reaction kinetics, understand the effect of temperature on the rate of reaction	2	2	2	2					1	2		1			1
CO2	Learn and analyze batch reactor data	1	1	1	1		1		1					1		
CO3	Design of single and multiple ideal flow reactors for homogeneous reactions.	3	3	3	3	1	2	2	1	2			1	2		2
CO4	Learn about multiple reactions and analyze the thermal characteristics of reactors and its usage in design procedure.	1	1	1	1			1								1
CO5	Acquire basic knowledge on non-ideal flow reactors	1	1	1	1		1			1						1

618CHT03 **PROCESS DYNAMICS AND CONTROL** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To introduce control equipments used to control the production process of a chemical factory and to introduce the control mechanism thro' automation and computers
- To gain knowledge in designing a control system and identifying the alternative control configuration for a given process plant or entire plant
- To become familiar with the control mechanism before attempting to tackle process control problems

UNIT – I INTRODUCTION **09**

Incentives for chemical process control, Design elements of a control system, classification of chemical process variables, physical elements (hardware) constituting a control system.
Development of a Mathematical model- Why do we need mathematical modeling for process control – state variables and state equations – additional elements of the mathematical models – concept of dead time – modeling of mixing process – the input – output model – Degrees of Freedom

UNIT – II LOOP CONTROL SYSTEMS **09**

Analysis of the dynamic behavior of chemical processes – linearization of systems with one variable – examples – Laplace transforms – development of Transfer function and the Input/ Output models – poles and zeros of a transfer function – Qualitative analysis of the response of a system – dynamics of first order systems and dynamics of second order systems – Interacting and Non – Interacting systems.

UNIT – III CONTROLLERS & ADVANCED CONTROL TECHNIQUE **09**

Introduction to feedback control – concept of feedback control – types of feedback controllers – transfer function of feedback controllers; Dynamic behavior of feedback controlled processes: Block diagram and the closed loop response – Effect of P, PI, PID controllers on closed loop process.
Advance controlled techniques: Feed forward controller – ratio control – cascade control – selective control – split range control – adaptive control – Introduction to control – characterization.

UNIT – IV STABILITY ANALYSIS AND CONTROLLER TUNING **09**

Stability Analysis of Feedback systems: Routh – Hurwitz Criterion for Stability, Root locus analysis; Design of feedback controllers: Simple performance criteria, Time – Integral performance criteria – selection of the type of feedback controller – Process reaction Curve technique for controller tuning - Ziegler – Nichols Tuning Technique.

UNIT – V FREQUENCY RESPONSE ANALYSIS **09**

Frequency response analysis – response of a first order system to a Sinusoidal input – Frequency Frequency response analysis – response of a first order system to a Sinusoidal input – Frequency response characteristics – Frequency response of a different processes and controllers – Bode Diagram – Nyquist Plots; Design of feedback controllers using frequency response analysis – Bode stability Criterion – Gain and Phase Margins

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the prerequisites of control strategies.
CO2 Design of process control systems
CO3 Suggest the suitable controllers for different chemical process
CO4 Analyze stability and apply different tuning techniques
CO5 Design control systems using frequency response analysis

TEXT BOOKS:

1. Coughanowr and Koppel, "Process Systems Analysis and Control", McGraw-Hill, New York, 2013
2. George Stephanopolous, "Chemical Process Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2008.
3. William L.Luyben/Michael L.Luyben, Essentials of Process Control, McGraw - Hill Companies, Inc., 1997.

REFERENCES:

1. Thomas, E.Marlin, Process Control, 2nd Edn, McGraw-Hills International 2nd Ed., 2000.
2. Peter Harriott, Process control, Tata McGraw-Hill Publishing Co., Reprint 2004.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the prerequisites of control strategies.	2	2	2	2									1	1	1
CO2	Design of process control systems	3	3	3	3	3	1	1		1				1	3	3
CO3	Suggest the suitable controllers for different chemical process	3	3	3	3	1			1	1	1		1	1	2	2
CO4	Analyze stability and apply different tuning techniques	2	2	2	2	2			2					1	2	1
CO5	Design control systems using frequency response analysis	3	3	3	3	3	1	1	1				1	1	3	

618CHT04 CHEMICAL PROCESS PLANT SAFETY L T P C
3 0 0 3

COURSE OBJECTIVES

- To provide effective knowledge about process plant layout and various safety programmes
- To know about the importance of industrial safety, safety performances and importance of prevention of accidents
- To provide knowledge about Health hazards and legal aspects regarding safety

UNIT – I INTRODUCTION TO SAFETY PROGRAMMES 09

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 TOXICOLOGY – INDUSTRIAL HYGIENE 09

Toxicology: entry, elimination and effects of toxicants on organisms, toxicological studies, dose versus response, relative toxicity and threshold limit values. Color codes of chemicals, first aid.
Industrial hygiene: laws and regulations, OSHA, EPA, DHS and material safety data sheets. Identification, evaluation and control of industrial hygiene. Mock drill.

UNIT – III FIRES AND EXPLOSIONS 09

The fire triangle, distinction between fires and explosion, definitions, flammability characteristics of liquids and vapors. Limiting oxygen concentration and inerting, flammability diagram, ignition energy, auto ignition, auto oxidation, adiabatic compression, ignition sources, sprays and mist explosions.
Prevention of fires and explosions: inerting static electricity, explosion proof equipment and instruments, ventilation and sprinkler systems.

UNIT – IV CHEMICAL REACTIVITY, HAZARDS 09

Chemical Reactivity**:** Identification, characterization and control of reactive chemical hazards.
Reliefs: Concepts, definitions. Location, types and characteristics. Relief systems.
Hazards identification: process hazard check list, hazard survey, hazards and operability studies(HAZOP), safety reviews

UNIT – V RISK ASSESSMENT, SAFETY PROCEDURES AND DESIGN 09

Risk assessment: review of probability theory, event tree analysis, fault tree analysis, quantitative risk analysis(QRA), layers of protection analysis (LOPA)Safety Procedures and Designs: Process safety hierarchy and strategies, managing safety operating procedure, permit procedures, safety reviews and accident investigation.
Designs of process safety, fires and explosions run away reactions and handling dust

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Impart knowledge on safety management process in chemical process industries.
CO2 Understand the effects of toxicants and safety policies and procedures.
CO3 Identify the sources and consequences of fire and explosion
CO4 Analyze the hazard and can identify the root cause of an accident**.**
CO5 Understand the concept of failure probabilities, and frequency of accident scenarios.

TEXT BOOKS:

1. Ridley, Safety at Work, Seventh 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.
4. Daniel A. Crowl, Joseph F. Louvar; "Chemical Process Safety Fundamentals with Applications"; Third Edition, Prentice Hall International Series,2011.

REFERENCES:

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 Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Impart knowledge on safety management process in chemical process industries.	1			1		2	2	3	1		1		1		2
CO2	Understand the effects of toxicants and safety policies and procedures.	1			1		2	3	3	1		1		1		3
CO3	Identify the sources and consequences of fire and explosion	1			1	1	2	2	3	1		1		1		2
CO4	Analyze the hazard and can identify the root cause of an accident.	2	2	2	2	1	2	2	3	3	1		2			3
CO5	Understand the concept of failure probabilities, and frequency of accident scenarios.	2	2	2	2	1	2	2	3	3	1	1	2			3

618CHP07	PROCESS CONTROL LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

- To determine experimentally the methods of controlling the processes including measurements using process simulation techniques.
- To gain knowledge on the development and use of right type of control dynamics for process control under different operative conditions.

LIST OF EXPERIMENTS

1. Evaluation of time constant of Thermometer
2. Study of two tank Interacting system
3. Study of two tank Non-Interacting system
4. Simulation of First order system
5. Simulation of Second order system
6. Optimum Controller tuning by closed loop method
7. Optimum Controller tuning by open loop method
8. Simulation of P,PI,PID controller
9. Evaluation of parameters of second order system by simulation
10. Control valve characteristics with and without positioned
11. Modeling of second order over damped system
12. Simulation of nonlinear system

LIST OF EQUIPMENTS

1. Control valve characteristics setup
2. Time constant of Thermometer setup
3. Interacting, Non-Interacting setup
4. 10 Computers with MATLAB

Minimum 10 experiments shall be offered

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understands the importance of dynamics of process in controller design

CO2 Able to design of controller and evaluation of its performance

CO3 Able to use MATLAB Simu-link software in dynamic study of processes, and design of controllers

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understands the importance of dynamics of process in controller design	3	3	3	3	3			1			1		3	3	3
CO2	Able to design of controller and evaluation of its performance	3	3	3	3	3			1			1	2	3	3	3
CO3	Able to use MATLAB Simu-link software in dynamic study of processes, and design of controllers	3	3	3	3	3			1			1	1	3	3	3

618CHP08 **MASS TRANSFER LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES

- To acquire basic knowledge on the different mass transfer operations
- To carry out experiments and to find certain parameters like diffusivity, mass transfer coefficient, efficiency of a process
- To gain knowledge on the different distillation operations

LIST OF EXPERIMENTS

1. To verify the Raleigh's equation using the simple distillation experiment for the methanol-water system
2. To find the Thermal efficiency, Vaporization efficiency and Theoretical steam distillation temperature using steam distillation experiment
3. To determine the mass transfer coefficient for the given system using the experimental setup
4. To determine the Height Equivalent to Theoretical Plate (HETP) of the given packed column for the distillation of methanol-water system under total reflux condition
5. To determine the diffusivity (coefficient of diffusion) of acetone in air at a known constant temperature
6. To carry out three stage cross current extraction operation for the separation of Benzoic acid from a Toluene
7. To carry out three stage cross current leaching operation for the separation of Na_2CO_3 from sand-Na_2Co_3 mixture using water as the solvent at room temperature Vapor liquid equilibrium
8. To study the drying characteristics of a wet material.
9. To study the equilibrium moisture content of the given material under vacuum in tray drier.
10. To plot T-x-y diagram for a given system using VLE Setup.
11. To determine the rate of adsorption of oxalic acid on charcoal.

LIST OF EQUIPMENTS

1. Simple distillation setup
2. Steam distillation setup
3. Wetted wall column setup
4. Packed column distillation setup
5. Diffusivity measurement setup
6. Liquid-liquid extraction setup
7. Leaching setup
8. Rotary dryer
9. Vacuum tray dryer
10. Vapor liquid column setup
11. Adsorption set up

Minimum 10 experiments shall be offered

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply the basic principles of mass transfer operations
CO2 Perform experiments and to Determine diffusivity, mass transfer rate, drying rate, efficiency in leaching / extraction and mass transfer coefficient of a given system using fundamental principles
CO3 Choose a mass transfer operation for separation of a mixture into pure components

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply the basic principles of mass transfer operations	3	3	3	3	3			1			1		3	3	3
CO2	Perform experiments and to Determine diffusivity, mass transfer rate, drying rate, efficiency in leaching / extraction and mass transfer coefficient of a given system using fundamental principles	3	3	3	3	3			1			1	2	3	3	3
CO3	Choose a mass transfer operation for separation of a mixture into pure components	3	3	3	3	3			1			1	1	3	3	3

618CHP09 CHEMICAL PROCESS EQUIPMENT DESIGN & DRAWING LAB – I L T P C

0 0 2 1

COURSE OBJECTIVES

- To integrate the various courses such as Chemistry, Engineering mechanism, Engineering Graphics, unit operation, Mechanics of solids Materials Technology for a comprehension approach to the design of the process equipments
- To develop skill to design and install process equipments used widely in a chemical industry

All Tables/ Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.

LIST OF EXPERIMENTS

1. Design and drawing considerations of bolt, nut and screws, welded and riveted joints, flanged joints, nozzles and reinforcements. Pipe fittings
2. Design and Drawing of storage tanks
3. Design and Drawing of Pressure vessels
4. Design and Drawing of Packed-bed Reaction vessels
5. Design and Drawing of Cyclone Separator
6. Design and Drawing of agitated vessel

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Students understands design and drawing considerations of process equipment
CO2 Students will be able to perform required calculations for the process equipment design
CO3 Students will be able to design and draw process equipments

TEXT BOOKS:

1. Khurmi, **.** R. S and Gupta, J. K., "Machine Design" Eurasia Publishing House, 2005.
2. V.V. Mahajani, "Joshi's Process Equipment Design", 5th Ed., Trinity Press, 2014.
3. L.E. Brownell and E. Young, "Process equipment design" John Wiley, New York, 2009

REFERENCES:

1. Dawande, S.D.,"Process Design of Equipments", Central Techno Publications, Nagpur, 2000.
2. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
3. Perry, R.H. "Chemical Engineers' Handbook", McGraw-Hill, 8th Ed 2007.
4. McCabeW.L., Smith J.Cand Harriot, P. "Unit Operation of Chemical Engineering", McGraw-Hill, 2001.
5. Robert Treybal, "Mass Transfer Operations", McGraw-Hill.1980
6. J.M. Coulson J. F. Richardson, R.K. Sinnott "Chemical Engineering Design Vol. 6, 3rd Ed., Butter worth – Heinemann, 1999.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Students understands design and drawing considerations of process equipment	2							2							1
CO2	Students will be able to perform required calculations for the process equipment design	3	3	2			1	1	2	2	2					2
CO3	Students will be able to design and draw process equipments	3	3	2	2		1	1	3	2	1					2

SEMESTER VII

718CHT01	CHEMICAL REACTION ENGINEERING – II	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To impart knowledge on non-isothermal effects in reactor design, different regimes in heterogeneous non catalytic reactions, properties of catalysts, catalyst preparation and mechanism of catalytic reactions and diffusion effects in porous catalysts.

UNIT – I TEMPERATURE AND PRESSURE EFFECTS 09

Energy balance equations for batch, PFR and CSTR under non-isothermal conditions, Equilibrium conversion under adiabatic conditions, Design of the homogeneous reactors under adiabatic conditions and optimum temperature progression

UNIT – II FLUID-SOLID NON-CATALYTIC REACTIONS 09

Fluid-Solid Non-Catalytic Reactions-shrinking core model, determination of the rate controlling step, conversion in reactors with constant fluid composition, conversion in reactors with variable fluid composition - fixed bed reactor, moving bed reactor

UNIT – III FLUID-FLUID NON-CATALYTIC REACTIONS 09

Fluid-Fluid Non-Catalytic Reactions- models for transfer at gas-liquid interface, enhancement factor, Hatta number, Derivation of overall rate equation for first order irreversible reaction and instantaneous reaction, design of packed bed reactors for gas-liquid non-catalytic reactions (simple cases).

UNIT – IV CATALYSIS & SOLID CATALYSTS 09

Catalysis**:** catalysts, classification of catalysts, catalyst properties, steps in catalyst reaction, adsorption and desorption isotherms (singe site and dual site mechanism), synthesizing a rate law, mechanism and rate limiting step

Solid Catalysts**:** Determination of surface area, void volume, solid density, pore volume distribution, Mercury – penetration method, catalyst preparation, promoters, inhibitors, catalyst deactivation

UNIT – V REACTION AND DIFFUSION IN POROUS CATALYSTS & HETEROGENEOUS CATALYTIC REACTORS 09

Reaction And Diffusion In Porous Catalysts - effectiveness factor, Thiele modulus, non-isothermal effectiveness factor, Global rate equations, estimation of diffusion – and reaction limited regions (Weisz – Prater criterion for internal diffusion and Mears' Criterion for external diffusion).

Heterogeneous Catalytic Reactors - Fixed bed reactors, fluidized bed reactors, slurry reactors, Trickle bed reactors, design aspects with some simple examples

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Evaluate the temperature and pressure effects in ideal reactors
- CO2 Able to understand the nature of fluid – solid non catalytic reactions and selection of reactors.
- CO3 Able to understand the nature of gas – liquid non catalytic reactions and design of reactors.
- CO4 Acquire knowledge on the catalysis preparation process, and mechanism.
- CO5 Acquire knowledge on the pore diffusion in catalyst, and operation of heterogeneous catalytic reactors

TEXT BOOKS:

1. Smith, J.M., "Chemical Engineering Kinetics", 3rd edition, McGraw-Hill Education India Pvt. Ltd, 2014.
2. Levenspiel. O; "Chemical Reaction Engineering", 3rd Edition, Wiley India Pvt Ltd, 2010.

REFERENCES:

1. Fogler. H.S., "Elements of Chemical Reaction Engineering "6th Edition, Prentice Hall of India Pvt. Ltd., 2015

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Evaluate the temperature and pressure effects in ideal reactors	3	3	2	2									3		
CO2	Able to understand the nature of fluid – solid non catalytic reactions and selection of reactors.	3	3	2	3									3		
CO3	Able to understand the nature of gas – liquid non catalytic reactions and design of reactors.	3	3	3	3									3		
CO4	Acquire knowledge on the catalysis preparation process, and mechanism.	3	3	3	3									3		
CO5	Acquire knowledge on the pore diffusion in catalyst, and operation of heterogeneous catalytic reactors	3		3	3									3		

718CHT02 CHEMICAL ENGINEERING PLANT DESIGN AND ECONOMICS L T P C

3 0 0 3

COURSE OBJECTIVES

- The course is aimed at training the students to perform economic evaluation of chemical processes and chemical projects & gain familiarity of the professional conventions and formats for representing engineering results.

UNIT – I **09**

Introduction to Process Design: Introduction – Process design development, design confederations, Cost and asset accounting, Cash flow for industrial operations, Factors effecting investment, Production cost

Plant Design: Design basis, process selection – selection of equipment, specification and design of equipment's, material of construction, plant location, plant layout and installation, safety, startup, shutdown and operating guidelines

UNIT – II **09**

Process industries – Capital and interests, economics and process engineering, value of money, equations for economic studies, equivalence. The bond, capital recovery, depreciation, interest in depreciation capital

UNIT – III **09**

Cost indices, equipment cost, the William's six-tenths factor, service facilities, capital requirements for complete plants, total and process investment, the balance sheet, sources of capital, Variable cost, fixed cost, use of cost data, profits and earnings economic production charts

UNIT – IV **09**

Annual cost method, present worth method, equivalent alternatives, rate of return method, pay out lime method, effect of source of capital, replacement of existing facilities

UNIT – V **09**

Profitability & Optimum Design: Profitability, Alternative investments and replacements, Profitability standards, discounted cash flow, Capitalized cost payout period, Alternative investments, Optimum design, Design strategy, Optimum condition, and Optimum production rates fluid dynamics.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Calculate various costs involved in a process industry and Compute break even period for rate of return. Calculate the taxes by different methods.

CO2 Estimate profitability of a company, how to work with balance sheets, understand relationship between demand & supply.

CO3 Acquire the concept of management and also personnel management, labour management relations.

CO4 Acquire the concept of Annual cost method and replacement of existing facilities.

CO5 Acquire knowledge about Profitability & Optimum Design.

TEXT BOOKS:

1. Plant Design and Economics for Chemical Engineering; by M.S.Peters and K.D.Timmerhaus, Mc Graw Hill, 4th Ed.,1991.
2. Schweyer.H.E." Process Engineering Economics "-McGraw-Hill, (ISE) 1995.

REFERENCES:

1. Chemical Process Engineering - Design & Economics by Harry Silla
2. Perry, Robert H. and Green, Don W. (1984). Perry's Chemical Engineers' Handbook (6th Edition ed.). McGraw-Hill. ISBN 0-07-049479-7

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Calculate various costs involved in a process industry and Compute break even period for rate of return. Calculate the taxes by different methods.	2	2				2	1		2		3	2			2
CO2	Estimate profitability of a company, how to work with balance sheets, understand relationship between demand & supply.	2	2	2								3				2
CO3	Acquire the concept of management and also personnel management, labour management relations.						1		2	2	3	3				2
CO4	Acquire the concept of Annual cost method and replacement of existing facilities.	2		2	2							3				2
CO5	Acquire knowledge about Profitability & Optimum Design.	2		2	2							3				2

718CHT03	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Different types of Fluids, their flow characteristics and different mathematical models are analyzed and applied to actual situations. This subject helps the students to understand the mechanism of fluids in motion under different conditions.

PREREQUISITE

Basic knowledge of momentum, heat and mass transfer is required. Basics of numerical solutions of ODE and PDE are necessary.

UNIT – I MOMENTUM TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) 09

Newton's law of viscosity: Newtonian and non-Newtonian fluids; rheological models; 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 in pipes for flow of Newtonian fluids in planes, slits and annulus

UNIT – II HEAT AND MASS TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) 09

Fourier's law of heat conduction; Definitions of concentrations, velocities, and mass fluxes, Fick's law of diffusion. Heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical; forced and free convection; mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection

UNIT – III EQUATIONS OF CHANGE AND THEIR APPLICATIONS 09

Conservation laws and equations of change; Development of equations of continuity motion and energy in single multi components systems in rectangular co-ordinates and the forms in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change, scale factors; applications in scale-up

UNIT – IV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 09

Turbulent phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface

UNIT – V ANALOGIES BETWEEN TRANSPORT PROCESSES 09

Importance of analogy; development and applications of analogies between momentum heat and mass transfer; Reynolds, Prandtl, Von Karman and Colburn analogies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Able to develop mathematical models of momentum, heat and mass transport to determine respective fluxes and velocity, temperature and concentration distribution.

CO2 Able to apply equations of change to determine the velocity, temperature and concentration profile of complex transport processes.

CO3 Able to understand the turbulence and boundary layer concept and analogy between transport processes

CO4 Able to apply in Transport in Turbulent and Boundary Layer Flow.

CO5 Able to understand Analogies between Transport Processes.

TEXT BOOKS:

1. R.B. Bird, W.E. Stewart and E.W. Lighfoot, "Transport Phenomena", John Wiley, 1978.

2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena", McGraw-Hill International Edn. 1988.

REFERENCES:

1. L.S.Sissom, and D.R.Pitts, “Elements of Transport Phenomena”, McGraw-Hill, New York, 1972
2. R.W.Fahien, “Elementary Transport Phenomena”, McGraw-Hill, New York, 1983.
3. J.R. Welty, R.W. Wilson, and C.W.Wicks, “Fundamentals of Momentum Heat and Mass Transfer”, 2nd Edn. John Wiley, New York, 1973.
4. B.M.Suryavanshi and L.R..Dongre, “Transport Phenomena”, NiraliPrakashan ,First Edison

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Able to develop mathematical models of momentum, heat and mass transport to determine respective fluxes and velocity, temperature and concentration distribution.	3	2	2										3		
CO2	Able to apply equations of change to determine the velocity, temperature and concentration profile of complex transport processes.	3	2	3	2									3	2	
CO3	Able to understand the turbulence and boundary layer concept and analogy between transport processes	3	2	3										3	2	
CO4	Able to apply in Transport in Turbulent and Boundary Layer Flow.	3	2	3										3	2	
CO5	Able to understand Analogies between Transport Processes.	3	2	3										3	2	

718CHT04 CHEMICAL ENGINEERING MODELING AND SIMULATION L T P C

3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on modeling of various equipments and their simulation

UNIT – I BASIC MODELING 09

Introduction to modeling; uses of mathematical models; scope of coverage; principles of formation; review on algebraic, ordinary and partial differential equations- solutions of the above equations; linearization; probabilization models; development of models by experiment and statics; regression and correlation analysis.

UNIT – II MATRIX MODELS 09

Elementary matrix concepts; simple array models; multi-component distillation; dynamic simulation of distillation column; solution techniques for matrix differential equations; matrix formation of distributed parameter system; flow pattern in stirred tanks; design of mixers.

UNIT – III LUMPED PARAMETER MODEL 09

Introduction to lumped parameter system; mathematical description of multiphase transfer process; non isothermal reactors etc.; Axial dispersion in packed beds; reactor design from response curves; reactor effectiveness factor; computer aided modeling of reaction networks.

UNIT – IV DISTRIBUTED PARAMETER MODEL 09

Formation and solution of one-dimensional unsteady state problem in heat transfer and F systems; multidimensional problems; application in heat and mass transfer equipments.

UNIT – V OPTIMIZATION AND SIMULATIONS 09

Introduction; application; analytical and numerical techniques for multivariable problems; techniques for constrained optimization; simulation; introduction; discrete event and continuous simulation; dynamic simulation of reactors, distillation columns, absorbers, evaporators and crystallizers; simulation in process control.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics

CO2 Formulate the mathematical models of stirred tank heaters, heat exchangers, evaporators, reactors and distillation column.

CO3 Analyze the simulation principles of steady state processes

CO4 Apply in heat transfer and mass transfer equipments.

CO5 Optimize analytical and numerical techniques for multivariable problem

TEXT BOOKS:

1. Ramirez, W.; “Computational Methods in Process Simulation”, Butterworths Publishers, New York, 1989.
2. Edgar, T.F.; Himmelblau, D.M.; “Optimisation of Chemical Processes”, McGraw-Hill Book Co., New York, 1989, Wiley inter science, New York, 1972.

REFERENCES:

1. Luyben, W.L., “Process Modelling Simulation and Control”, McGraw-Hill Book Co., 1973.
2. Myers, A.L., Seider, W.D.; “Introduction to Chemical Engineering and Computer Calculations”, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1976.
3. Chemical Engineering Refresher Series on “Process Dynamics”, McGraw-Hill Publications, 1983.
4. Mickley, H.S.; Sherwood, T.S.; Reed C.E.; “Applied Mathematics for Chemical Engineers”, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1989

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics	2	2	1	1	2								2	3	
CO2	Formulate the mathematical models of stirred tank heaters, heat exchangers, evaporators, reactors and distillation column.	3	3	3	2	2								2	3	
CO3	Analyze the simulation principles of steady state processes	2	2	2	2									2	3	
CO4	Apply in heat transfer and mass transfer equipments.	2	2	2	2									2	3	
CO5	Optimize analytical and numerical techniques for multivariable problem	2	2	3	2	2								2	3	

718CHP07 CHEMICAL REACTION ENGINEERING LABORATORY L T P C
0 0 2 1

COURSE OBJECTIVES

- To determine experimentally the kinetics and rate constants of reactions in different types of reactors
- To evaluate the parameters (order, rate constant)and mode of a reactor (Plug flow, mixed flow) for optimum performance
- To provides a practical knowledge to students about the different chemical reactors used in chemical engineering industries

PREREQUESTIE

Chemical Reaction Engineering – I

LIST OF EXPERIMENTS

1. To study the kinetics of liquid phase reaction in a batch reactor – Equimolar feed.
2. To study the kinetics of liquid phase reaction in a batch reactor – Non-Equimolar feed.
3. Kinetic studies in Plug Flow Reactor- Coiled tube.
4. Kinetic studies in Plug Flow Reactor- Straight tube.
5. Kinetic studies in Continuous Stirred Tank Reactor.
6. To study residence time distribution (RTD) in a PFR- coiled tube.
7. To study residence time distribution (RTD) in a Continuous Stirred Tank Reactor.
8. Kinetics studies in cascade Continuous Stirred Tank Reactor setup.
9. To determine the activation energy and frequency factor for the exothermic reaction between sodium thiosulphate and hydrogen peroxide adiabatically.
10. Kinetic studies in Packed Bed Reactor.
11. Kinetic study of a Semibatch Reactor

LIST OF EQUIPMENTS

1. Batch Reactor Setup (2 No's)
2. PFR Setup -Straight
3. PFR Setup - Coiled
4. CSTR Setup
5. RTD in PFR Setup
6. RTD in CSTR Setup
7. CSTR's in Series Setup
8. Packed Bed Reactor Setup
9. Activation energy Setup

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Able to find rate constant in different types of reactors

CO2 Able to carry out kinetic studies in different reactors and to calculate conversion, rate constant.

CO3 Able to analyze the performance of PFR, PBR, CSTR and RTD in reactors and kinetics studies.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Able to find rate constant in different types of reactors	2	2	1	1	2								2	3	
CO2	Able to carry out kinetic studies in different reactors and to calculate conversion, rate constant.	3	3	3	2	2								2	3	
CO3	Able to analyze the performance of PFR, PBR, CSTR and RTD in reactors and kinetics studies.	2	2	2	2									2	3	

718CHP08 **CHEMICAL PROCESS EQUIPMENT DESIGN & DRAWING LAB – II** **L T P C**

0 0 2 1

COURSE OBJECTIVES

- To acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. double pipe heat exchanger, shell and tube heat exchanger, evaporator and packet column, supports etc.).
- To understand the application of the equipment for the desired conditions.
- To enhance the skill of design and drawing of process equipment.

All Tables/ Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.

PREREQUISITE: Knowledge of Heat exchange equipment and Distillation

LIST OF EXPERIMENTS

1. Design and drawing of Double Pipe Heat Exchanger
2. Design and drawing of Shell and Tube Heat Exchanger
3. Design and drawing of Packed Absorption Column
4. Design and drawing of Plate Distillation Column
5. Design and drawing of Evaporators
6. Rotary Dryer

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Acquire knowledge of basics of process equipment design and important parameters of equipment design and drawing.

CO2 Design and draw heat exchange equipment and mass transfer equipment (e. g. Double pipe heat exchanger).

CO3 Design and draw various parts of vessels (e.g. heads)

CO4 Gain knowledge about design of Evaporators

CO5 Design rotary driers

TEXT BOOKS:

1. V.V. Mahajani, "Joshi's Process Equipment Design", 5th Ed., Trinity Press, 2014.
2. L.E. Brownell and E. Young, "Process equipment design" John Wiley, New York, 2009

REFERENCES:

1. S.D. Dawande, "Process Design of Equipments", Vol. 1&2, 6th Ed., Central Techno Publications, Nagpur, 2009.
2. Perry, Robert H. and Green, Don W. Perry's Chemical Engineers' Handbook 9th Ed. McGraw-Hill. 2018.
3. Kern D.Q., Process Heat Transfer, McGraw Hill, 2001.
4. Robert E Treybal, "Mass Transfer Operations", 3rd Ed., McGraw-Hill, 2012.
5. J.M. Coulson J. F. Richardson, R.K. Sinnott "Chemical Engineering Design Vol. 6, 3rd Ed., Butter worth – Heinemann, 1999.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Acquire knowledge of basics of process equipment design and important parameters of equipment design and drawing.	2	2	1	1	2								2	3	
CO2	Design and draw heat exchange equipment and mass transfer equipment (e. g. Double pipe heat exchanger).	3	3	3	2	2								2	3	
CO3	Design and draw various parts of vessels (e.g. heads)	2	2	2	2									2	3	
CO4	Gain knowledge about design of Evaporators	2	2	2	2									2	3	
CO5	Design rotary driers	2	2	3	2	2								2	3	

718CHP09 CHEMICAL ENGINEERING SIMULATION LABORATORY L T P C

0 0 2 1

COURSE OBJECTIVES

- To become familiar with the modern software tools and packages for the design, monitoring and control of chemical processes.
- To gain insights for solution to industrial problems such as creating steady-state and dynamic models for plant design, monitoring performance, optimization and troubleshooting.

SOFTWARE SUGGESTED: DWSIM,ASPEN ONE, ASPEN HYSYS, CHEMCAD, DESIGN-II, gPROM, UNISIM

LIST OF EXPERIMENTS

1. Flowsheet simulation and parameter optimization
2. Sensitivity analysis
3. Distillation
4. Heat exchanger design
5. Dynamic simulation of reactors
6. Process control simulation

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Use any chemical process simulation software.
CO2 Understand the importance of steady state processes from simulation principle.
CO3 Optimize the parameters in a chemical process using simulation software
CO4 Simulate a chemical engineering Transfer process.
CO5 Optimize and troubleshoot a multivariate problem.

TEXT BOOKS:

1. Pushpavanam, S. Mathematical Methods in Chemical Engineering, Prentice-Hall of India, New Delhi (2004).
2. Fausett L.V. (2007) Applied Numerical Analysis Using MATLAB, 2nd, Pearson Education
3. Chapra S.C. and Canale R.P. (2006) Numerical Methods for Engineers, 5th , McGraw Hill
4. Schefflan R. (2011), Teach Yourself the Basics of Aspen Plus, John Wiley and Sons
5. Finlayson B. A. (2006), Introduction to Chemical Engineering Computing, John Wiley and Sons

REFERENCES:

1. Luyben, W.L., “Process Modelling Simulation and Control”, McGraw-Hill Book Co., 1973.
2. Myers, A.L., Seider, W.D.; “Introduction to Chemical Engineering and Computer Calculations”, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1976.
3. Chemical Engineering Refresher Series on “Process Dynamics”, McGraw-Hill Publications, 1983
4. Mickley, H.S.; Sherwood, T.S.; Reed C.E.; “Applied Mathematics for Chemical Engineers”, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1989.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Use any chemical process simulation software.	1	1			1	1	2		1			2			1
CO2	Understand the importance of steady state processes from simulation principle.	2	2		1		1	1	2				2			1
CO3	Optimize the parameters in a chemical process using simulation software	2	2				2	2	2	1						1
CO4	Simulate a chemical engineering Transfer process.	2					2	2	2	1	2		2			1
CO5	Optimize and troubleshoot a multivariate problem.	2					2	2	1	1	2		1			

818CHT01 **TOTAL QUALITY MANAGEMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the Total Quality Management concept and principles, various tools available to achieve Total Quality Management.
- To understand the statistical approach for quality control.
- To create an awareness about ISO and QS certification process and its need for the industries.

UNIT – I INTRODUCTION **09**

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT – II TQM PRINCIPLES **09**

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

UNIT – III STATISTICAL PROCESS CONTROL (SPC) **09**

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT – IV TQM TOOLS **09**

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA

UNIT – V QUALITY SYSTEMS **09**

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand definition of quality, analysis techniques for quality costs, role of senior management and its functions.
CO2 Understand the principles of TQM
CO3 Understand the importance of seven tools of quality.
CO4 Apply benchmarking tools.
CO5 Explain importance of quality systems and need of quality systems.

TEXT BOOKS:

1. Dale H. Besterfield, Hemant Urdhwareshe, Mary Besterfield-Sacre, Carol Besterfield-Michna, Rashmi Urdhwareshe, Glen H. Besterfield, Total Quality Management, Pearson Education Asia, 3rd Edition, 2010.
2. James R.Evans& William M.Lidsay, The Management and Control of Quality, 6th Edition, South-Western (Thomson Learning), 2004.

REFERENCES:

1. Feigenbaum.A.V., Total Quality Management, McGraw Hill, 1991.
2. Oakland.J.S. Total Quality Management, Butterworth – Heinemann Ltd., Oxford,1989.
3. Narayana V and Sreenivasan, N.S., Quality Management – Concepts and Tasks, New Age International, 2007.
4. Zeiri. Total Quality Management for Engineers, Wood Head Publishers, 1991.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand definition of quality, analysis techniques for quality costs, role of senior management and its functions.				3							3	3			2
CO2	Understand the principles of TQM								2			3	3			2
CO3	Understand the importance of seven tools of quality.								2			2	3			2
CO4	Apply benchmarking tools.								2			2	3			2
CO5	Explain importance of quality systems and need of quality systems.						3	3			1	2	3			2

818CHP04	PROJECT WORK – VIVA VOCE	L	T	P	C
		0	0	18	9

COURSE OBJECTIVES

- The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course. This help to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the course

EVALUATION:

Each student is required to submit a Project report on the project assigned to him by the department. There port should be based on the information available in the literature or data obtained by the student by way of experiments conducted in the laboratory/industry.

There shall be three assessments during the semester by a review committee. The student shall make three presentations on the progress made before the committee at various stages of the Project work. The Head of the Department shall constitute the review committee. The total marks obtained in the three reviews, shall be taken in to account for continuous assessment. There will be a viva-voce examination at the end of the Project work, conducted by one internal examiner and one external examiner, the assessment marks shall be taken for end assessment.

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Analysis independently to design experiments

CO2 Simulate

CO3 Fabricate and Setup experiments

CO4 Demonstrate the application of the chemical engineering principles to particular process variables for optimization of experimental projects.

CO5 Prepare clear concise project reports with the help of graph, charts, and power point presentations

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Analysis independently to design experiments	3	3	3			1	1	1		2	2				3
CO2	Simulate	3	3	3	3		3	3			2	2	3	3		3
CO3	Fabricate and Setup experiments	2	2	3	3	3				3	2	2	3	3	3	3
CO4	Demonstrate the application of the chemical engineering principles to particular process variables for optimization of experimental projects.				2	3					2	2	2			3
CO5	Prepare clear concise project reports with the help of graph, charts, and power point presentations										3	3				3

PROFESSIONAL ELECTIVES

318CHE01 ANALYTICAL CHEMISTRY **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To provide the required knowledge about analytical chemistry and its kinetics

UNIT – I WET CHEMICAL METHODS OF ANALYSIS **09**

Volumetric analysis –neutralization, precipitation, complexometric and redox titrations- theoretical titrations curves - theory of indicators; Gravimetric analysis- volatilization and precipitation methods- homogeneous precipitation; Colorimetric analysis - principles and applications- estimation of iron and nickel.

UNIT – II SPECTRAL METHODS **09**

Molecular and atomic spectroscopy - interaction of electromagnetic radiation with matter – Beer-Lambert law - UV / Visible absorption spectroscopy- photometric titrations, IR absorption spectroscopy; Fluorescence, phosphorescence and chemiluminescence methods; Atomic spectroscopy – atomic absorption spectrometry; Emission spectroscopy - flame photometry and ICP-AES; atomic fluorescence spectroscopy; Principles, instrumentation and analytical applications of spectral methods

UNIT – III ELECTROANALYTICAL TECHNIQUES **09**

Conductometry and high frequency titrations; Potentiometry, pH meter Ion selective electrodes; Electrogravimetry and coulometry; Voltametry and polarography; ampherometric titrations and anode stripping Voltametry, principle, practice and application

UNIT – IV SEPARATION TECHNIQUES **09**

Solvent extraction and Ion exchange techniques – principles and applications; Chromatographic techniques – adsorption chromatography, thin layer chromatography, gas chromatography, high performance chromatography, size exclusion chromatography; Supercritical fluid chromatography

UNIT – V THERMAL METHODS OF ANALYSIS, SAMPLING AND EVALUATION **09**

Thermal analytical techniques – TGA, DTA, DSC – principles, instrumentation and applications; Sampling methods - Types of errors-evaluation of analytical data-statistical methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand basic wet chemical methods of analysis.

CO2 Familiarize the concept of two dimensional random variables helps to understand and analyze the statistical measures which describe an outcome of a random experiment.

CO3 Implement electro analytical techniques, separation techniques.

CO4 Understand separation techniques

CO5 Familiarize thermal methods of analysis, sampling and evaluation.

TEXT BOOKS:

1. D.A.Skoog, D.M.West, F.J. Holler and S.R.Crouch, “Fundamentals of Analytical Chemistry”, 8th Ed., - Thomson Brooks/Cole Pub. (2005).
2. J.Mendham, R.C.Denney, J.D. Barnes and M.J.K.Thomas, “ Vogel’s Text book of quantitative chemical analysis”, 6th Ed., Pearson Education (2008).

REFERENCES:

1. F.W. Fifield and D.Kealey, “ Principles and Practice of Analytical Chemistry, 1st Indian Reprint, Blackwell Pub. (2004).
2. H.H Willard, L.L Merritt, J.A Dean, and F.A Settle, “Instrumental Methods of Analysis”, 7th Ed., -CBS Pub (2004).
3. K.A. Rubison and J,F. Rubison, “ Contemporary Instrumental Analysis, Printice Hall, Inc. (2000).

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand basic wet chemical methods of analysis.	3	2	1	2	1								3	3	
CO2	Familiarize the concept of two dimensional random variables helps to understand and analyze the statistical measures which describe an outcome of a random experiment.	3	3	3	2	2	1							3	3	
CO3	Implement electro analytical techniques, separation techniques.	3	2	3	2	1	2							2	3	
CO4	Understand separation techniques	3	2	3	2	1	2	2						2	3	
CO5	Familiarize thermal methods of analysis, sampling and evaluation.	3	2	3	2	1	2	2						2	3	

318CHE02 **PROCESS ORGANIC SYNTHESIS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To explore the importance of synthesis of organic compounds by using advanced methods
- To gain knowledge in various organic and inorganic chemical reactions
- To obtain knowledge in synthesis of dyes and drugs

UNIT – I NITRATION AND AMINATION **09**

Principle of Nitration-N-Nitro compounds and Nitration esters, industrial equipment and process. Amination; methods – reduction and Ammonolysis. Catalytic reaction and manufacture of amino compounds

UNIT – II HYDROGENATION AND ALKYLATION **09**

Production and Properties of Hydrogen, Catalytic hydrogenation and Hydrogenolysis; Methanation and Fischer-Tropsch reactions. Types and Factors affecting alkylation, Industrial alkylation process

UNIT – III OXIDATION, HYDROLYSIS AND ESTERIFICATION **09**

Types of Oxidation reaction-Liquid-phase and Vapour-phase; Hydrolysis-process and equipment. Esterification of organic and inorganic acids-applications in chemical industries

UNIT – IV HALOGENATION, SULFONATION AND SULFATION **`09**

Halogenation- Chlorination reaction; Sulfonation and sulfation; Desulfonation reactions

UNIT – V DYES AND DRUG SYNTHESIS **09**

Synthesis of Dyes - Congo red. Triphenylmethane dyes -Malachite green, Para Rosaniline, Alizarin, Eosin; Drug Synthesis - Sulphanilamide, Sulphapyridine, Chloroquinine, penicillin, erythromycin

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the various unit processes in synthesis of organic compounds
CO2 Understand the application of organic compounds in various industries
CO3 Analyze chemical reactions and identify reaction schemes
CO4 Solve mechanisms for a number of important reactions used in organic synthesis
CO5 Understand the synthesis of important dyes and drugs

TEXT BOOKS:

1. Groggins P.H., “Unit Processes in Organic Synthesis”, 5th Edition (Reprint), McGraw Hill International Co., 2007
2. Austin G.T. “Shreve's Chemical Process Industries” 5th Edition (Special Reprint Edition), McGraw Hill International Co., 2005

REFERENCES:

1. Tiwari K.S. and Vishnoi N.K., "A Textbook of Organic Chemistry ", 3rd Edition, Vikas Publishing House, New Delhi, 2007
2. Graham Solomons T.W., Craig B. Fryhle and Scott A. Snyder, " Organic Chemistry ", 11th Edition, International Student Version, John Wiley & Sons Inc., New York, 2013

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the various unit processes in synthesis of organic compounds	3	3	2	2	1	2							3	2	
CO2	Understand the application of organic compounds in various industries	3	3	2	2	1	2							3	2	
CO3	Analyze chemical reactions and identify reaction schemes	3	3	3	2	2	2							3	2	
CO4	Solve mechanisms for a number of important reactions used in organic synthesis	3	2	3	3	2	1							3	2	
CO5	Understand the synthesis of important dyes and drugs	3	3	2	2	2	2							3	2	

318CHE03 **GREEN CHEMISTRY AND ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To explore the importance of green chemistry to newer synthetic methods
- To identify alternate solvents for the synthesis of fine chemicals
- To obtain knowledge in process and operation

UNIT – I INTRODUCTION-GREEN CHEMISTRY 09

Definition-Twelve Principles of Green Chemistry-Measure of Greenness-Safety and Risk Indices-Mass and Energy Indices-The Hierarchical Approach-The Sustainable Process Index

UNIT – II NEWER SYNTHETIC METHODS 09

Introduction-Use of Microwaves for Synthesis-Electro-Organic Methods-Elegant and Cost-Effective Synthetic Design-Catalysis and Green Chemistry

UNIT – III ALTERNATE SOLVENTS AND INDUSTRIAL EXAMPLES 09

Industries in Need of Support to Go Green-Safer Solvents-Green Solvents-Water as Solvent-Solvent free Conditions-Ionic Liquids-Maleic Anhydride Manufacturing Process-Surfactant Industry-Dye Industry-Tannery Industry

UNIT – IV PROCESS AND OPERATIONS `09

Industry Perception-Reactions-Reactor Designs-Micro Mixers-Unit Operations-Reactions with Separation Operations-Other New Reactor Designs-Process Integration – Solvent Recovery

UNIT – V ALTERNATE ENERGY SOURCES AND INHERENT SAFETY 09

Greenhouse Gases-Renewable Energy-Future Sources of Renewable Energy-Conflicts due to Inherently Safe Designs

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Familiarize the 12 principles of green chemistry
CO2 Familiarize with synthetic design
CO3 Understand the applications of green solvents
CO4 Understand the design concepts of various reactor design
CO5 Understand the alternate energy sources and inherent safety

TEXT BOOKS:

1. MukeshDoble and Anil Kumar Kruthiventi, Green Chemistry and Engineering, Academic Press, 2007
2. Concepción Jiménez-González, David J.C. Constable, Green Chemistry and Engineering: A Practical Design Approach" 1st Edition, John Wiley & Sons, 2011

REFERENCES:

1. Paul T. Anastas, Julie B. Zimmerman. "Innovations in Green Chemistry and Green Engineering" 1st Edition, Springer, 2013

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Familiarize the 12 principles of green chemistry	2	3	3	2	2	3	3						3	3	
CO2	Familiarize with synthetic design	3	2	3	3	2	3	3						3	2	
CO3	Understand the applications of green solvents	3	3	3	3	2	2	3						3	2	
CO4	Understand the design concepts of various reactor design	3	3	3	3	2	2	3						3	2	
CO5	Understand the alternate energy sources and inherent safety	3	3	3	3	2	2	3						3	2	

318CHE04 **MATERIAL TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To gain knowledge on the nature of materials, its properties, and the use of materials in engineering
- To acquire an understanding about metallurgy and phase equilibrium
- To understand the important aspects of the chemistry of ferrous metal and non ferrous metals
- To gain knowledge on some selected composites, adhesives, FRPs and their applications
- To gain an understanding of the properties, manufacture and the applications of building materials

UNIT – I NATURE OF MATERIALS 09

Importance of materials, Historical perspective, Selection process of engineering materials (General aspects)-Chemical and physical properties of materials-chemical structure: Micro and macro structure-corrosion resistance-chemical reactivity. Mechanical properties-stress, strain, strength, hardness, malleability, Brittleness, ductility-elasticity-plasticity-toughness, thermal stability. Types of deformation: Plastic, viscous; plastic deformation of single crystal, poly crystalline metals: slip, twinning, dislocations-visco elasticity-creep in metals, amorphous materials

UNIT – II METALLURGY 09

Extractive Metallurgy: Hydro, pyro and electro metallurgy-refining of metals. Powder Metallurgy: methods of production of metal powder-Mixing of metal powders-compaction of powders-applications. Extraction process of Iron: manufacture of pig iron-blast furnace operations-chemistry of reactions. Manufacture of cast iron-varieties of cast iron-effect of impurities. Production of steel-Bessemer process - open-hearth process-L D methods. Classification of steel-effect of impurities. Heat treatment process: annealing, hardening, tempering, normalizing and gas carburizing. Fe-Carbon phase diagram

UNIT – III NON - FERROUS METALS, ALLOYS 09

Extraction of Copper, Nickel, Lead-methods involved-properties and applications. Alloys of Cu, Ni and Pb-brasses-bronzes-nickel with Cu, Zn, Cr, Fe, Mo-super alloys. Lead alloys-Pb with Sb, Sn.-applications

UNIT – IV COMPOSITES AND ADHESIVES `09

Polymer composites-introduction-Types of composites-particle reinforced-fiber reinforced- structural composites-examples. Matrix materials, reinforcement materials-Kevlar, Polyamides, fibers, glass, carbon fibers, ceramics and metals. Techniques for producing FRP-applications

UNIT – V BUILDING MATERIALS 09

Cement-types-portlandcement-manufature-properties-uses environmentaleffectsRefractories: properties of refractories-acidic, basic and neutral-manufacture of refractories-common refractory bricks-insulating refractories. Ceramics: Classification-fabrication methods of clay, silicon carbide, alumina, silicon nitride-Properties of important engineering ceramics-applications. Abrasives: classification-applications

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the properties of materials and criteria for selecting the material
CO2 Apply the principles of metallurgy and phase equilibrium
CO3 Predict the properties, manufacture and the applications of building materials
CO4 Describethe importance of the chemistry of ferrous metal and non-ferrous metals in industries
CO5 Describe the composite materials, its importance and the different applications

TEXT BOOKS:

1. Khanna. O.P, “AText book of Material science and Metallurgy”, Dhanpat Rai Publications, 1999
2. Dara.S.S, “A text book of Engineering Chemistry”, S.Chand and company Ltd., 2003

REFERENCES:

1. Rajput.R.K., “A Text book of Material Science and Engineering”, S.K Kataria& Sons, Delhi, 2003

2. Agarwal. C.V, “Chemistry of Engineering materials”, Tata McCraws Hill,1997
3. William F.Smith, “Foundation of Materials Science and Engineering”, TataMcCraw Hill, 1998

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the properties of materials and criteria for selecting the material	3	3	3	2	2		2						3	3	
CO2	Apply the principles of metallurgy and phase equilibrium	3	3	3	2	2		2						3	3	
CO3	Predict the properties, manufacture and the applications of building materials	3	3	3	2	2		2						3	3	
CO4	Describe the importance of the chemistry of ferrous metal and non-ferrous metals in industries	3	3	3	2	2		2						3	3	
CO5	Describe the composite materials, its importance and the different applications	3	3	3	2	2		2						3	3	

318CHE05 SOLID MECHANICS FOR TECHNOLOGISTS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To gain knowledge on structural and mechanical properties of beams
- To gain knowledge on properties of columns and shafts
- To understand the concept of various theorems and derivations related to beams

UNIT – I STRESS, STRAIN AND DEFORMATION OF SOLIDS 09

Rigid bodies and deformable solids –forces on solids and supports – equilibrium and stability –strength and stiffness – tension, compression and shear stresses – Hooke's law and simple problems – compound bars –thermal stresses – elastic constants and poisson's ratio – welded joints – design

UNIT – II TRANSVERSE LOADING ON BEAMS 09

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

UNIT – III DEFLECTIONS OF BEAMS 09

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

UNIT – IV STRESSES IN BEAMS `09

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 –shear stress distribution in beams – determination of shear stress in flanged beams

UNIT – V TORSION & COLUMNS 09

Torsion of circular shafts – derivation of torsion equation – stress and deformation in circular and hollow shafts – stresses and deformation in circular and hollow shafts – stepped shafts – shafts fixed at both ends –stresses in helical springs – deflection of springs – spring constant

Axially loaded short columns –columns of unsymmetrical sections – Euler's theory of long columns – critical loads for prismatic columns with different end conditions – effect of eccentricity

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Perform calculations related to stress, strain and deformation of solids
CO2 Understand the concept of beam loadings
CO3 Design the support column, beams, pipelines, storage tanks and reaction columns
CO4 Solve all the problems related to beams, shafts and columns
CO5 Apply the principles of solid mechanics in real time problems

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. Third Edition, McGraw Hill International Editions, 1994
3. Bansal, R.K, Strength of Materials, Laxmi Publications(P) Ltd., Fourth Edition 2010

REFERENCES:

1. Rowland Richards, Jr., Principles of solid mechanics,CRC Press,United States of America, 2001

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Perform calculations related to stress, strain and deformation of solids	2	3	3	2	2	2	1						3	3	3
CO2	Understand the concept of beam loadings	2	3	3	2	2	2	1						3	3	3
CO3	Design the support column, beams, pipelines, storage tanks and reaction columns	2	3	2	2	2	2	1						3	3	3
CO4	Solve all the problems related to beams, shafts and columns	1	3	2	2	2	2	1						3	3	3
CO5	Apply the principles of solid mechanics in real time problems	1	3	2	2	2	2	1						3	3	3

318CHE06 **COMPOSITE MATERIALS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To impart the basic concepts of composite materials
- To acquire an understanding about the basic concepts of reinforcement
- To gain the knowledge about the reinforcement and matrix materials
- To acquire the knowledge about the manufacturing methods of advanced composites
- To gain the knowledge about the testing of composite materials

UNIT – I INTRODUCTION TO COMPOSITE MATERIALS 09

Introduction to composite materials – definitions and basic concepts – natural and man-made composites – classification based on structure – phase composition and layered composition; types of composite materials – plastics matrix composites – rubber matrix composites – metal matrix composites –ceramic and other brittle matrix composites characteristic features and advantages of composites materials

UNIT – II THEORY OF REINFORCEMENT 09

Basic criterion to be adopted in the selection of matrix and reinforcement – mechanics of composite materials – micromechanics and macro mechanics –mechanism of load transfer – minimum and critical fibre content – critical fibre length – law of mixture rule – unidirectional and fibrous composites – effects of fibre orientation on stiffness and strength – bidirectional and random fibre composites – concepts of unit cell-stress analysis of unit cells – toughness of fibrous composites, microscopic stress – strain curves

UNIT – III REINFORCEMENT AND MATRIX MATERIALS 09

Polymer matrix composites: Preparation of Moulding compounds and prepregs – hand lay up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding- vaccum bag moulding centrifugal casting-pultrusion-machinery, operation, advantages and disadvantages – Fibre Reinforced Thermoplastics (FRTP) preparation-brief description of coating process-melt compounding process and dry blending process-injection moulding, rotational moulding and cold forming of reinforced thermoplastics

UNIT – IV MANUFACTURE OF ADVANCED COMPOSITES `09

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 –shear stress distribution in beams – determination of shear stress in flanged beams

UNIT – V TESTING OF COMPOSITES MATERIALS 09

Brief outlines of testing of glass fiber, testing of resins – testing of products. General design considerations – design values – factor of safety – working stress approach – service ability design – warning of danger – design process –shape design & selection of materials and processing methods – application of composite of materials in various fields-chemical industries – electrical and electronic industries – aerospace, marine, and transport applications – application in buildings

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Find the properties of composite materials
CO2 Analyze the composite materials
CO3 Describe the manufacturing processes of composite materials
CO4 Describe the reinforcement concept
CO5 Describe the effect of reinforcement and matrix materials

TEXT BOOKS:

1. Hull, D and T. W. Clyne, An Introduction to Composite Materials, Cambridge University Press, Cambridge, 1996
2. Chawala K.K., Composites materials, science and Engineering, 3rd Edition, Springer, 2012
3. Lubin, G., Handbook of composites, Von Nostrand, New York, 1982

REFERENCES:

1. Mohr.J.G.et al, SPI handbook of Technology and Engineering of reinforced Plastics/Composites, 2nd Edn., Von Nostrand, New York. 1978

2. Katz.H.S. J.V. Milewski, Handbook of Fillers and Reinforcement for plastics- Von Nostrand Reinhold, New York. 1987
3. Richardson, M.O.W., Polymer Engineering Composites. Applied Science Publishers, London, 1977

Course Articulation Matrix:

Cos	Course Outocmes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Find the properties of composite materials	3	3	3	2	1	2							3	1	
CO2	Analyze the composite materials	3	1	3	2	1	2							3	2	
CO3	Describe the manufacturing processes of composite materials	1	1	3	2	1	2							3	1	
CO4	Describe the reinforcement concept	1	3	3	2	1	2							3	2	
CO5	Describe the effect of reinforcement and matrix materials	3	1	3	2	1	2							3	2	

418CHE01 POLYMER SCIENCE & TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- To Impart knowledge on various types and aspects of polymers,
- To Impart knowledge various types and aspects of Elastomers,
- To Impart knowledge various processing methods of polymers and elastomers, Various properties and application of polymers

UNIT – I POLYMER CHAINS AND THEIR CHARACTERIZATION 09

The science of large molecules - Basic concepts of polymer science. History of Macromolecular science, Molecular Forces and chemical Bonding in polymers. Polymer solutions. Criteria for polymer solubility, Conformations of Dissolved polymer chains, Thermodynamics of polymer solutions, Phase Separation in polymer solutions

UNIT – II STRUCTURE AND PROPERTIES OF BULK POLYMERS 09

Morphology and Order in Crystalline polymers - Configurations of polymer Chains, Crystal structure of polymers, Morphology of polymer Single Crystals. Rheology and the Mechanical properties of polymers - Viscous Flow, Kinetic theory of Rubber Elasticity, Visco elasticity. Polymer structure and physical properties - The crystalline melting point, the Glass Transition, Properties involving Large Deformations, properties involving small Deformations, property requirement and polymer Utilization

UNIT – III POLYMERIZATION 09

Step-Reaction (Condensation) Polymerization - Classification of polymers and polymerization Mechanisms, chemistry of stepwise polymerization, Kinetics and Statistics of Linear stepwise polymerization. Radical Chain (Addition) Polymerization - chemistry of vinyl polymerization, Laboratory Methods in Vinyl polymerization, Steady state kinetics of vinyl radical polymerization. Ionic and Coordination chain (Addition) Polymerization - chemistry of Non radical chain polymerization, Cationic polymerization, Anionic polymerization, Coordination polymerization. Copolymerization - Kinetics of copolymerization, Composition of copolymers, Chemistry of copolymerization. Polymerization Conditions and Polymer Reactions - polymerization in Homogeneous Systems, polymerization in Heterogeneous Systems, Degradation of polymers

UNIT – IV PROPERTIES OF COMMERCIAL POLYMERS 09

Hydrocarbon plastics and Elastomers - low density (branched) Polyethylene, High density (linear) Polyethylene, polypropylene, Natural Rubber and other Polyisomers, Rubbers derived from Butadiene. LTPC 30 0 3 94 Other carbon chain polymers - polystyrene and related polymers, Acrylic polymers, poly (Vinyl Esters) and Derived polymers. Heterochain Thermoplastics - Polyamides. Thermosetting Resins - Phenolic Resins, Amino Resins

UNIT – V POLYMER PROCESSING 09

Plastic Technology - Molding, Other processing Methods, Fillers, Plasticizers, and Other Additives. Fiber Technology - Textile and Fabric properties, Spinning, Fiber After Treatments. Elastomer Technology - Compounding and Elastomer properties, Vulcanization, Reinforcement

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Survey the current usage of Polymer and Compounding ingredients
- CO2 Compare the use and general properties of Polymers with traditional materials
- CO3 Recognize the different types of polymers preparation methods
- CO4 Understand the properties of polymers
- CO5 Understand the technology involved in the manufacturing processes of various types of polymers

TEXT BOOKS:

1. Billmeyer F.W., Textbook of Polymer Science, Third Edition, Wiley Interscience, 1984
2. Charles E., Carraher Jr., Seymour/carraher's polymer chemistry, Seventh Edition, Crc Press, 2012

REFERENCES:

1. Fried J.R., Polymer Science and Technology, Second Edition, Prentice Hall of India Pvt Ltd., 2003. 2. Bhatnagar M.S., A Textbook of Polymers, Vol.2, S.Chand and Company Ltd., 2012

2. Joel,R.F; Polymer Science and Technology, Eastern Economy Edition, 1999.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Survey the current usage of Polymer and Compounding ingredients	2	2	2	1	2	3							2	2	
CO2	Compare the use and general properties of Polymers with traditional materials	2	3	2	1	2	3							2	2	
CO3	Recognize the different types of polymers preparation methods	2	2	3	1	2	3							2	2	
CO4	Understand the properties of polymers	2	2	2	1	3	3							2	2	
CO5	Understand the technology involved in the manufacturing processes of various types of polymers	2	2	3	1	2	3							2	2	

418CHE02 **SUGAR TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- Acquire the basic knowledge about the sugar industry.
- To provide the clear knowledge about all the process, operations like evaporation, Filtration, crystallization, purification.
- Acquire the basic knowledge on effluent treatment and their equipments and instruments which are being used in sugar industry

UNIT – I INTRODUCTION **09**

Sugar industry in India. Chemical and Physical properties of Sucrose and reducing sugars. Source for Sucrose. Formation of sucrose plants. Non sugar compounds of sugar cane. Inorganic constituents of sugar cane juices and sugars. Processes used in the conversion of sugarcane to juice. Analytical methods used in Sugar Industry

UNIT – II PURIFICATION AND EVAPORATION **09**

Chemical technology of the purification processes. Fundamental reactions and physical chemistry aspects of clarification. Liming, sulphitation and carbonation processes. Filtration of sugar juice. Evaporation of sugar juice. Heat transfer in evaporators. Evaporation equipment and auxiliaries. Methods of obtaining steam. Chemistry of the evaporation process. Scale formation and cleaning of evaporators

UNIT – III CRYSTALLOGRAPHY OF SUCROSE **09**

Solubility of sucrose. Solubility of sucrose - nucleation in super saturated solutions - kinetics and growth of crystallization. Chemistry of crystallization. Control methods and equipment in sugar crystallization; Technology of sugar crystallization. Evaporation and circulation in vacuum pans

UNIT – IV CENTRIFUGATION **09**

Theory of the centrifugal processes. Centrifugal operation. Engineering principles of sugar centrifugals and the centrifugal process. Centrifugal equipment and auxiliaries. Production of final molasses and its utilizations. Grading of sugar

UNIT - V BYPRODUCTS AND EFFLUENT TREATMENT 09

Byproducts: Bagasse, Molasses – Uses – Distilleries, Fertilizers and power generation - Effluent treatment plant (sugar industry) – disposal of solid, liquid and gas wastes - pollution control measures

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Get knowledge about the scenario of sugar industry in India
CO2 Understand the process of sugar juice purification and evaporation processes
CO3 Understand the kinetics and applications of crystallization in sugar industry
CO4 Understand the usage of different types of centrifugation equipments
CO5 Find the usage of byproducts of sugar industry; treatment of effluent with different technologies

TEXT BOOKS:

1. Honig P., Principles of Sugar Technology, Vol.1,2 and 3, Elsevier Publishing Company, 1953
2. Van der Poel P.W., Schwartz T.K., Schiweck H.M., Sugar Technology [Beet and Cane Sugar Manufacture], Beet Sugar Development Foundation (Fort Collins, Colo.), Fourth Edition, VerlagDr Albert Bartens KG, 1998

REFERENCES:

1. J.H., Sugarcane factory Analytical control, Fifth Edition, Elsevier Publisher, London, 1968
2. Jenkins G.H., Introduction to Sugarcane technology, Elsevier Publisher, London, 1966

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Get knowledge about the scenario of sugar industry in India	2	3	2	3	2	2							3	2	
CO2	Understand the process of sugar juice purification and evaporation processes	3	3	2	3	2	2							3	3	
CO3	Understand the kinetics and applications of crystallization in sugar industry	3	3	2	3	2	2							3	3	
CO4	Understand the usage of different types of centrifugation equipments	3	3	2	3	2	2							3	3	
CO5	Find the usage of byproducts of sugar industry; treatment of effluent with different technologies	3	3	2	3	2	2							3	2	

418CHE03 RENEWABLE ENERGY TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- To impart the basic concepts of Renewable Energy Technologies.
- To gain knowledge about energy harnessing methodology for sustainable development.
- To impart the basic concept on biomass

UNIT – I INTRODUCTION TO ENERGY SOURCES 09

Energy sources and their availability- Introduction, commercial or conventional energy sources, Energy Reserves of India, Energy Scenario of India. New energy technologies

Renewable energy sources- Prospects of renewable energy sources, Impact of renewable energy generation on Environment, Scope of Renewable energy in India.

UNIT – II WIND ENERGY AND GEOTHERMAL ENERGY 09

Wind Energy: Introduction- Wind Energy Conversion- Basic components of WECS, Classification of WECS, Types of Wind Energy collectors-Horizontal Axial and Vertical Axial Machines, Energy Storage- Application of Wind Energy- Safety Systems- Environmental Aspects.

Geothermal Energy: Introduction- Nature of Geothermal fields-Geothermal sources, Advantages and disadvantages of Geothermal Energy over other energy forms, Applications of Geothermal Energy.

UNIT – III SOLAR ENERGY AND OCEAN ENERGY 09

Solar Energy: Solar Radiation: Introduction-Solar Constant; Solar Radiation measurements

Solar Energy Collectors: Flat Plate Collectors, Concentrating Collectors-Focusing and Non-Focusing type

Solar Energy Storage: Storage System- Solar Ponds- Applications of Solar Ponds.

Application of Solar Energy: Solar Water heating, Solar Water Heating, Solar Distillation, Solar Pumping, Solar Furnace, Solar Cooking.

Ocean Energy :Introduction – Methods of Ocean Thermal Electric Power Generation- Energy Utilization- Hybrid cycle, Energy from Tides- Basic principles of Tidal Power- Components of Tidal Power Plants-Operation Methods of utilization of Tidal Energy- Ocean Waves- Advantages and Disadvantages- Wave Energy- Energy Conversion Devices- Small Scale Hydroelectric plants – Turbines and Generators for small scale hydro-electric power plant

UNIT – IV ENERGY FROM BIOMASS 09

Biomass: Introduction- Composition of biomass-Source of biomass for energy generation, Biomass conversion technologies-thermo chemical conversion, wet processes and dry processes, Methods for obtaining energy from Biomass

Biogas: Biogas Generation- Classification of Biogas Plants-Types of Biogas plant. Advantages and disadvantages of fixed dome and floating drum type biogas plants - Thermal Gasification and Application, Pyrolysis, Application of biogas in Automotive Engines.

UNIT – V FUEL CELL AND MHD POWER GENERATION 09

Fuel Cells: Introduction, Principles of operation of Fuel Cell, Classification of Fuel cells, Types of fuel Cells, Advantages and Disadvantages of Fuel Cell.

MHD (Magneto Hydro Dynamic):Introduction, Principles of MHD power Generation, MHD systems-Open Cycle and Closed cycle system, Advantages and disadvantages of MHD systems, Cogeneration.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Recognize the renewable energy sources with their situation and exploration in detail.

CO2 Understand the different types of energy conversion systems in wind and geothermal energy.

CO3 Understand the various energy conversion systems for solar and ocean energy harnessing.

CO4 Familiarize multiple methods in biomass and biogas conversion and its application

CO5 Familiar with principle operation and application of energy produced from Fuel and MHD in industries.

TEXT BOOKS:

1. Rai, G.D., “Non conventional energy sources”, Khanna Publishers, 1st Edition, 2010.
2. Kothari,D.P.,Singal K.C., and RakeshRanjan, “ Renewable Energy Sources and Emerging Technologies”PHI learning Private Limited, 2nd Edition, 2011.

REFERENCES:

1. TasneemAbbasi, Abbasi, S.A., “Renewable Energy Sources their impact on global warming and pollution”, PHI learning Private Limited, 1st Edition, 2011.
2. Chetan Singh Solanki, “Renewable Energy Technologies A Practical Guide for Beginners”, PHI learning Private Limited, 1stEdition, 2009.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Recognize the renewable energy sources with their situation and exploration in detail.	2	3	2	3	2	2							3	2	
CO2	Understand the different types of energy conversion systems in wind and geothermal energy.	3	3	2	3	2	2							3	3	
CO3	Understand the various energy conversion systems for solar and ocean energy harnessing.	3	3	2	3	2	2							3	3	
CO4	Familiarize multiple methods in biomass and biogas conversion and its application	3	3	2	3	2	2							3	3	
CO5	Familiar with principle operation and application of energy produced from Fuel and MHD in industries.	3	3	2	3	2	2							3	2	

418CHE04 **PLASTICS ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To make them understand the structure property relationship of various plastics.
- To make them understand the structure property relationship and applications of engineering plastics and high performance polymers.
- To make the student to understand the design factors involved in plastic products.

UNIT – I INTRODUCTION TO PLASTICS **09**

Brief history of plastics - Advantages and disadvantages Plastics – Classification – Structure – Property relationship (effect on thermal, mechanical, optical, chemical, electrical properties)

UNIT – II PREPARATION, PROPERTIES AND APPLICATIONS OF PLASTIC MATERIALS **09**

Thermoplastics and thermosets. Manufacture of monomers - polymerization - structure - properties - processing and applications of polyethylene, cross-linked polyethylene, chlorinated polyethylene and polypropylene. Preparation, properties and applications of polytetrafluoroethylene, tetrafluoroethylene copolymers, polyvinyl fluoride and polyvinylidenefluoride.

UNIT – III ENGINEERING PLASTICS **09**

Polyamides, (nylons), modified polyamides, polyesters – PET, PBT, Polyacetals, PC and its blends – Preparation, properties & applications, LCP's

UNIT – IV HIGH TEMPERATURE PLASTICS **09**

Fluorine containing Plastics – Preparation, properties & uses of PTFE, PCTFE, PVDF, other high performance plastics like PPO, PPS, polysulphones, PEEK, Polyimides, Polybenzimidazoles, aromatic polyamides – Kevlar, Nomex – Preparation, properties & applications.

UNIT – V CONCEPT OF PLASTIC PRODUCT DESIGN **09**

Plastics for designer- Selection of Plastics - Product Design, Development and Manufacture – Checklist forms – Versatility of Design and assembly with Polymers – Property considerations in designing of Plastics parts –Mechanical properties of plastics – Creep curves of Plastics. Product design consideration–Stress strain curves.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Classify the different types of plastics and demonstrate an idea about structure property relation of different plastics and its uses.
CO2 Understand different methods of preparation of plastic materials
CO3 Understand engineering of plastics.
CO4 Understand the preparation, properties and applications of high performance plastics.
CO5 Design various plastic products.

TEXT BOOKS:

1. J.A.Brydson, Plastics Materials, 7th edition Elsevier Publication, 1999.
2. James M. Margolis " Engineering. Plastics Handbook" McGraw – Hill, 2006.
3. Joseph Gordon R. M., Industrial Design of Plastics Products, Wiley Interscience Publication 2003.

REFERENCES:

1. Engineering. Plastics, Vol.2, ASM International 1988.
2. R.J Crawford Plastics Engineering, 3 rd Edition, Elsevier publications. Pye 'Injection Moulding'

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Classify the different types of plastics and demonstrate an idea about structure property relation of different plastics and its uses.	2	1	2	3	3	1							2	2	
CO2	Understand different methods of preparation of plastic materials	2	1	2	3	3	1							2	2	
CO3	Understand engineering of plastics.	2	1	2	3	3	1							2	2	
CO4	Understand the preparation, properties and applications of high performance plastics.	2	1	2	3	3	1							2	2	
CO5	Design various plastic products.	2	1	2	3	3	1							2	2	

418CHE05 **HEAT POWER ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To make them understand the Laws of Thermodynamics
- To make them understand the concept of Boilers and Properties of Steam
- To make the student to understand the Turbines and Vacuum Systems

UNIT – I LAWS OF THERMODYNAMICS 09

Thermodynamic systems -closed, open and isolated. Property, state, path and process, quasi-static process, work, Energy. Zeroth, First and Second laws of Thermodynamics (Basic concepts only), Internal energy, Specific heat capacity and Enthalpy

UNIT – II THERMODYNAMIC CYCLES 09

Air standard Cycles: Carnot, Otto, Diesel and Combined cycle; Brayton and Rankine cycles – determination of cycle efficiency

UNIT – III BOILERS 09

Types and classification of boilers: water tube, fire tube, coal, oil and gas fired boilers; Stoker fired, pulverized and fluidized bed boilers. Mountings and accessories. Performance and efficiency calculation of boilers

UNIT – IV PROPERTIES OF STEAM 09

Properties of steam, Mollier chart, determination of dryness fraction of steam- Different types of calorimeters. Concept of Steam distribution systems. Steam traps- types and their characteristics. Energy conservation opportunities in steam systems

UNIT – V TURBINES AND VACUUM SYSTEMS 09

Steam turbines- types and principles: Reaction and impulse turbines; Application of co-generation principles in process industries. Gas turbines- principle and working. Production of Vacuum: Systems and Equipment - Vacuum Pumps, Steam Ejectors; Instrumental methods of Vacuum measurement

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Understand the conceptual laws of thermodynamics for application in thermodynamic cycles
- CO2 Analyze different thermodynamic cycles and calculate their thermal efficiencies
- CO3 Perform simple calculations of boiler efficiencies
- CO4 Identify the energy conservation opportunities in steam systems
- CO5 Perform calculations for turbine design and efficiencies

TEXT BOOKS:

1. Rajput R.K., "Thermal Engineering", 9th Edition, Laxmi Publications, 2010
2. Rudramoorthy R., "Thermal Engineering", 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2006

REFERENCES:

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the conceptual laws of thermodynamics for application in thermodynamic cycles	3	2	2	2	3	2							2	2	
CO2	Analyze different thermodynamic cycles and calculate their thermal efficiencies	3	2	2	2	3	2							2	2	
CO3	Perform simple calculations of boiler efficiencies	3	2	2	2	3	2							2	2	
CO4	Identify the energy conservation opportunities in steam systems	3	2	2	2	3	2							2	2	
CO5	Perform calculations for turbine design and efficiencies	3	2	2	2	3	2							2	2	

418CHE06 FUEL AND COMBUSTION TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES

- The subject will help the students to have knowledge on the fluid properties.
- Students are able to characteristics while static, during flow through ducts pipes and other channels.
- To acquire knowledge on several machineries used to transport the fluid and their performance are assessed

UNIT – I CHARACTERIZATION 09

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis - Proximate and Ultimate Analysis – Moisture Determination - Calorific Value - Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation – Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures

UNIT – II SOLID FUELS AND LIQUID FUELS 09

Solid Fuels: Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking of Coals - Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels – Manufactured Solid Fuels. Liquid Fuels: Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Cloud point, Pour Point & Smoke point - Octane Number, Cetane Number etc, - Alcohols - Tar Sand Oil - Liquefaction of Solid Fuels

UNIT – III GASEOUS FUELS 09

Classification - Composition & Properties - Estimation of Calorific Value – Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non -Thermal Route - Biogas - Digesters - Reactions - Viability - Economics

UNIT – IV COMBUSTION: STOICHIOMETRY & KINETICS 09

Stoichiometry - Mass Basis & Volume Basis - Excess Air Calculation - Fuel & Flue Gas Compositions - Calculations - Rapid Methods - Combustion Processes – Stationary Flame - Surface or Flameless Combustion - Submerged Combustion - Pulsating & Slow Combustion Explosive Combustion. Mechanism of Combustion - Ignition & Ignition Energy - Spontaneous Combustion - Flame Propagation - Solid, Liquid & Gaseous Fuels Combustion - Flame Temperature - Theoretical, Adiabatic & Actual - Ignition Limits - Limits of Inflammability

UNIT – V COMBUSTION EQUIPMENTS 09

Coal Burning Equipments - Types - Pulverized Coal Firing - Fluidized Bed Firing – Fixed Bed & Recycled Bed - Cyclone Firing - Spreader Stokers - Vibrating Grate Stokers - Sprinkler Stokers, Traveling Grate Stokers. Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners – Burners Classification according to Flame Structures - Factors Affecting Burners & Combustion

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand different characterization methods of fuel
CO2 Understand classification and purification methods of solid and liquid fuels
CO3 Understand classification and purification methods of gaseous fuels
CO4 Determine the kinetics and mechanism of combustion process
CO5 Design equipment for combustion process

TEXT BOOKS:

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
2. Bhatt, Vora Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 1984
3. BlokhAG,Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn,1988

REFERENCES:

1. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand different characterization methods of fuel	2	2	3	2	3	1							3	2	2
CO2	Understand classification and purification methods of solid and liquid fuels	2	2	3	2	3	1							3	2	2
CO3	Understand classification and purification methods of gaseous fuels	2	2	3	2	3	1							3	2	2
CO4	Determine the kinetics and mechanism of combustion process	2	2	3	2	3	1							3	2	2
CO5	Design equipment for combustion process	2	2	3	2	3	1							3	2	2

518CHE01 **PROCESS INSTRUMENTATION** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To give fundamental concepts about different instruments in chemical process industries
- To study the instruments used for measuring various ranges of temperature.
- To gain knowledge about instruments used to measure pressure.
- To provide exposure in various methods for measuring viscosity, density and quantity meter
- To gain knowledge on instruments that leads to safety of employee and industry.

UNIT – I TEMPERATURE MEASUREMENT 09

Elements of instruments, static and dynamic characteristics, basic concepts of response of first order type instruments, mercury in glass thermometer, bimetallic thermometer, pressure spring thermometer, static accuracy and response of thermometry

Thermo electricity: Industrial thermocouples, thermo couple wires, thermo couple wells and response of thermo couples

UNIT – II OPTICAL METHODS FOR MEASUREMENT 09

Thermal coefficient of resistance, industrial resistance, thermometer bulbs and circuits, radiation receiving elements, radiation photo electric and optical pyrometers

Composition analysis, spectroscopic analysis by absorption, emission, mass and color measurement spectrometers, gas analysis by thermal conductivity, analysis of moisture, refractometer

UNIT – III PRESSURE MEASUREMENT 09

Pressure vacuum and head: liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measuring pressure in corrosive liquids, static accuracy and response of pressure gauges

UNIT – IV MEASUREMENT OF DENSITY, LEVEL, FLOW & VISCOSITY 09

Head, density and specific gravity, direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels, measurement of interface level, density measurement, and level of dry materials

Head flow meters, area flow meters, open channel meters, viscosity meters, quantity meters, flow of dry materials, viscosity measurements

UNIT – V RECORDING AND INDICATING INSTRUMENTS 09

Recording instruments, indicating and signaling instruments, transmission of instrument readings, controls center, instrumentation diagram, process analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the working mechanism of important instruments used in process industry.
CO2 Understand the basic principle and operation of various temperature measuring Instruments.
CO3 Identify instruments used for measuring various ranges of pressure measurement.
CO4 Select suitable instruments for measurement of viscosity, density and quantity meter
CO5 Acquire sound knowledge about applications of various instruments in the required fields

TEXT BOOKS:

1. Donald P.Eckman , “Industrial instrumentation” , 1st Edition, CBS, 2004

REFERENCES:

1. Patranabis. D, “Principles of industrial instrumentation” 3rd Edition, Tata McGraw Hill, 2010
2. Gregory K. McMillan, Douglas M. Considine“Process/ Industrial Instruments And Controls Handbook”, 5th Edition, Tata McGraw Hill.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the working mechanism of important instruments used in process industry.	2	2	2	2		2	2	3		2	1	1	2	3	3
CO2	Understand the basic principle and operation of various temperature measuring Instruments.	3						2					1	1		
CO3	Identify instruments used for measuring various ranges of pressure measurement.	2	2	3	3		1	1	2	1	3		2	2	2	1
CO4	Select suitable instruments for measurement of viscosity, density and quantity meter	3	3	3	3	3	3	3	2	1	3		1	3	2	3
CO5	Acquire sound knowledge about applications of various instruments in the required fields	2	2	2	2		2	2	2	1	1		1	2	3	3

518CHE02 FUEL CELL TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- To provide the required knowledge about principles, kinetics and applications of Fuel Cell Technology

UNIT – I INTRODUCTION TO FUEL CELLS 09

Brief history of fuel cells - Operating principles- Differences between electrochemical and chemical energy conversion -Types of fuel cells (with an emphasis on PEMFC and DMFC technology) - Applications- Current state of the art -Limitations and principle research areas (addressing limitations)

UNIT – II FUEL CELL THERMODYNAMICS 09

Brief review of first and second law of thermodynamics -Application of the first and second law to fuel cells -Significance of the Gibbs free energy -Concept of chemical potential and emf-Derivation of the Nernst equation -Fuel cell efficiencies, comparison with Carnot efficiencies -Thermodynamic advantage of electrochemical energy conversion

UNIT – III SOME CONCEPTS OF ELECTROCHEMISTRY 09

Brief review of electrochemical concepts -Electrochemical cells, oxidation and reduction processes - Half cell potentials and the electrochemical series -Faraday's law, faradaic and nonfaradaic processes -Important factors involved in faradaic processes -Current and reaction rate -Polarization and overpotential-Cell resistance -Mass transport in electrochemical cells,
Important electrochemical experiments (linear sweep voltammetry, cyclic voltammetry).

UNIT – IV FUEL CELL ELECTROLYTES – THE IONOMERIC MEMBRANE 09

Different fuel cell technologies – electrolytes used -The ionomeric membrane in a PEFC -Properties (requirements) of ionomeric membranes -Mechanisms of proton transport in ionomeric membranes - Water content and transport in ionomeric membranes -Relationship between proton conductivity and membrane water content -Ionomer in the electrode layers – the membrane electrode interface.

UNIT – V FUEL CELL ELECTROCATALYSIS 09

Different fuel cell technologies – catalysts used -Hydrogen oxidation (anode) electrocatalysis in a PEFC -Effect of impurities on anode electrocatalysis in a PEFC -Oxygen reduction (cathode) electrocatalysis in a PEFC -Electro catalysts used at the anode and cathode in a PEFC – supported and unsupported catalysts -The electrode structure – importance of three phase contact -Half cell experiments to estimate catalytic activity – Voltammetry -Full cell experiments to determine cathode catalytic activity and anode polarization – Voltammetry -Arriving at an optimal electrode structure – parameters to be evaluated

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Differentiate the available fuel cells
CO2 Apply Fuel Cell Thermodynamic Principles in electrochemical energy conversion
CO3 Apply mass transport concepts in electrochemical cells
CO4 Understand Electrolytes used on fuel cells and the membranes used in fuel cells
CO5 Find the Electro - catalysts for different Fuel Cells

TEXT BOOKS:

1. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, New York (2006).
2. Bard, A. J. , L. R., Faulkner, Electrochemical Methods, Wiley, New York (2004)

REFERENCES:

1. Basu, S. (Ed) Fuel Cell Science and Technology, Springer, New York (2007)
2. Liu, H., Principles of fuel cells, Taylor & Francis, New York(2006).

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Differentiate the available fuel cells	2	2	2	2								1			1
CO2	Apply Fuel Cell Thermodynamic Principles in electrochemical energy conversion	3	3	3	3	1	2	2	1		1		1	1		1
CO3	Apply mass transport concepts in electrochemical cells	2	2	2	2		1	1	1				1			2
CO4	Understand Electrolytes used on fuel cells and the membranes used in fuel cells	1	1	1			1	1		1	1					1
CO5	Find the Electro - catalysts for different Fuel Cells	1	1				1	1	1		1		1			1

518CHE03 **INTRODUCTION TO COLLOIDAL SCIENCE AND INTERFACIAL ENGINEERING** **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To understand of basic nomenclature, concepts and tools of colloid and interface science and engineering; multi-phase nano-systems; mechanics and thermodynamics on small scales.
- To understand of differences between the surface and bulk dominated regimes and behavior and exploitation of nano-behavior.
- Appreciation of how these concepts and tools translate into a variety of applications from processes to materials.

UNIT – I SURFACE TENSION, ADHESION AND CAPILLARITY 09

Effects of confinement and finite size; Concepts of surface and interfacial energies and tensions; Apolar (van derWaals) and polar (acid-base) components of interfacial tensions.
Young-Laplace equation of capillarity; examples of equilibrium surfaces; multiplicity, etc.

UNIT – II SOLUTION KINETICS 09

Stability of equilibrium solutions; Contact angle and Young's equation; Determination of apolar (van der Waals) and acid-base components of surface/interfacial tensions.

UNIT – III MESOSCALE THERMODYNAMICS 09

Mesoscale Thermodynamics: Gibbs treatment of interfaces; concept of excess concentration; variation of interfacial tensions with surfactant concentration.
Mesoscale phenomena in soft matter and applications: Adhesion, wetting, nucleation, flotation, patterning of soft material by self - organization and other techniques.

UNIT – IV NANOSCALE THERMODYNAMICS 09

Stability of nanoparticle dispersions: DLVO and DLVO like theories and kinetics of coagulation plus general principles of diffusion in a potential field/Brownian movement.
Nanofluidics: Stability of thin (< 100 nm) films; self-organization in confined systems; meso-patterning.

UNIT – V FUNCTIONAL INTERFACES 09

Advanced and Functional Interfaces: Super hydrophobicity, functional coatings, structural colors, nano-adhesives; nanocomposites.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the basic nomenclature, concepts and tools of colloid and interface science and engineering.
CO2 Understand the basics of multi-phase nano-systems; mechanics and thermodynamics on small scales.
CO3 Establish the differences between the surface and bulk dominated regimes and behavior and exploitation of nano-behavior.
CO4 Utilize the concepts and tools translate into a variety of applications from processes to materials.
CO5 Understand the mechanism of advanced and functional interfaces in coatings in nanoadhesives

TEXT BOOKS:

1. Paul C. Hiemenz, “Principles of Colloid and Surface Chemistry”, Marcel Dekker, 2nd edition, 1986.

REFERENCES:

1. Physical Chemistry of Surfaces, Arthur W. Adamson, 5th edition, Wiley, 1990.
2. Foundations of Colloid Science, Robert J. Hunter, Clarendon, Oxford, Volume 1, 1989.
3. Colloidal Dispersions, W. B. Russel, D. A. Saville and W. R. Schowalter, Cambridge University Press, 1989.
4. Intermolecular and Surface Forces, Jacob N. Israelachvili, Academic Press, 1992.
5. Interfacial Forces in Aqueous Media, Carel J. van Oss, Marcel Dekker, 1994.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the basic nomenclature, concepts and tools of colloid and interface science and engineering.	1						2					1			1
CO2	Understand the basics of multi-phase nano-systems; mechanics and thermodynamics on small scales.	1	1	1		1										1
CO3	Establish the differences between the surface and bulk dominated regimes and behavior and exploitation of nano-behavior.	1		1			1			1	1	1				1
CO4	Utilize the concepts and tools translate into a variety of applications from processes to materials.	1	1	1	1		1						1			1
CO5	Understand the mechanism of advanced and functional interfaces in coatings in nanoadhesives	1						2					1			1

518CHE04 **OIL AND NATURAL GAS ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To know about various types and compositions of crude
- To know steps and considerations in the exploration of natural gas
- To gain knowledge in the field of storage, handling, and transportation of oil-gas systems

UNIT – I **PRODUCTION OF PETROLEUM, CRUDE- TYPES AND CHARACTERIZATION** **09**

Origin, Exploration and production of petroleum, Availability Versus Demands, Future outlook, Types of crudes, composition, characteristics, products pattern and characteristics, indigenous and imported crudes.

UNIT – II **NATURAL GAS** **09**

Development of Natural Gas- types of Natural Gas Accumulations: Conventional Natural Gas- Gas in Tight Sands- Gas in Tight Shales- Methane gas occluded in coal- Natural Gas from Geo-pressurized reservoirs.

UNIT – III **PROPERTIES OF NATURAL GAS AND CONDENSATE SYSTEMS** **09**

Composition of Natural Gas- Phase behavior- The Ideal Gas- Properties of Gaseous mixtures- Behavior of Real Gas- Compressibility of Natural Gas- Viscosity of Natural Gas- Gas formation volume factor and expansion factor- Water vapour content of Natural Gas – Two phase systems

UNIT – IV **SEPARATION, PROCESSING AND COMPRESSION OF NATURAL GAS** **09**

Gas and Liquid separation- Dehydration of Natural Gas- Types of Compressors- Reciprocating Compressors- Centrifugal Compressors- Rotary Blowers

UNIT – V **ENVIRONMENTAL ASPECTS OF GAS PROCESSING AND USE** **09**

Environmental Impacts of Natural Gas processing: Air pollutants- Emissions: Gas Flare Emissions- Methane Emissions- Water pollutions- Soil pollution- pollution prevention- Emissions from Natural Gas Use- Combustion Emissions- Acid rain formation- Smog Formation- Greenhouse gas emission- Industrial and Electrical Generation Emissions- protocols and Environment Programs- Environmental Management System

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the properties and composition of cure oil and production of natural gas

CO2 Learn the properties processing of natural gas

CO3 Assess the environmental aspects of gas processing

CO4 Acquire knowledge about compressors

CO5 Acquire knowledge about emissions and environmental management systems

TEXT BOOKS:

1. Ikoku, Chi. U “Natural Gas Production Engineering”, Krieger Publishing Company- Malabar Florida, 1992.
2. Saied Mokhatab, Poe, W. A, Speight, J. G “Handbook of Natural Gas Transmission and Processing”, Gulf Professional Publishing imprint of Elsevier, Jordan Hill- Oxford, UK, 2006.

REFERENCES:

1. Katz Donald L. and Lee Robert L., “Natural Gas Engineering”, Mc Graw – Hill Publishing Company, NY, 1990
2. Lyons William C., “Standard Handbook of Oil and Natural Gas Engineering”, Gulf Professional Publishing – an imprint of Butterworth - Heinmann, Vol. 1 & 2, 1996.
3. Nelson, W.L “Petroleum Refinery Engineering” McGraw Hill Publishing Company Limited, 1985.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the properties and composition of cure oil and production of natural gas	1	1					1	1	1				2		
CO2	Learn the properties processing of natural gas	1		1			1	1				1	1			
CO3	Assess the environmental aspects of gas processing	1	1	1	1		1	1					1	2		
CO4	Acquire knowledge about compressors	1	1	1	1				1		1			2		1
CO5	Acquire knowledge about emissions and environmental management systems	1	1	1	1		1	1	1		1	1	1	2		1

515CHE05 **FLUIDIZATION ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To study the phenomena and factors affecting the Fluidization in the fluidized beds.
- To do the pressure drop calculations in the Fluidized beds.

UNIT – I BASICS OF FLUIDIZATION 09

Pressure drop velocity relationship in packed beds. Correlations of kozeny-Carman, Leva and Ergun. Fluidization phenomena – properties of fluidized beds. Development of fluidized condition from fixed bed.

UNIT – II FLUIDIZED BED TYPES 09

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

UNIT – III DESIGN ASPECTS 09

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

UNIT – IV HEAT AND MASS TRANSFER IN FLUIDIZED BEDS 09

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

UNIT – V OTHER TYPES OF FLUIDIZATION 09

Single stage and multi stage continuous fluidization its flow of solids by gravity and collection of fine using cyclones.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the properties of Fluidized bed.
CO2 Learn different type of Fluidization processes.
CO3 Acquire knowledge on design aspects of fluidization equipment.
CO4 Acquire knowledge on heat and mass transfer in Fluidized Beds and types of fluidization.
CO5 Acquire the knowledge of single and multi-stage continuous fluidization equipment.

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, McGraw Hill – International, 1997.

REFERENCES:

1. Liang-Shih Fan, Gas-Liquid-Solid Fluidization Engineering, Butter Worths, 1989.
2. Monsoon Kwauk,Fluidization idealized and Bubbleless with Applications, Science Press, 1992.
3. Wen-Ching Yang,Handbook of Fluidization and Fluid-Particle Systems,Marcel Dekker Inc, 2003.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the properties of Fluidized bed.	1												1		
CO2	Learn different type of Fluidization processes.	1	1	1	1								1	1		1
CO3	Acquire knowledge on design aspects of fluidization equipment.	1	1	1	1	1		1	1	1	1		1	1		1
CO4	Acquire knowledge on heat and mass transfer in Fluidized Beds and types of fluidization.	1	1	1	1						1		1	1		1
CO5	Acquire the knowledge of single and multi-stage continuous fluidization equipment.	1	1	1	1			1	1	1	1	1	1	1		1

618CHE01 ENERGY CONSERVATION AND MANAGEMENT IN PROCESS INDUSTRIES **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To provide students an exposure to energy, their significance and types.
- To ensure that students begin to understand environmental aspects.
- To gain a preliminary understanding of approaches of energy conservation and management.

UNIT – I INTRODUCTION **09**

Definition and units of energy, power, Forms of energy, Conservation of energy, second law of thermodynamics, Energy flow diagram to the earth. Origin of fossil fuels, time scale of fossil fuels, Renewable Energy Resources, Role of energy in economic development and social transformation.

UNIT – II ENVIRONMENTAL IMPACT **09**

Environmental degradation due to energy production and utilization, Primary and secondary pollution, air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Pollution due to thermal power station and their control. Pollution due to nuclear power generation, radioactive waste and its disposal. Effect of hydroelectric power stations on ecology and environment. Effect of Hydro electric power stations on ecology and environment.

UNIT – III ENERGY CONSERVATION& ENERGY MANAGEMENT **09**

Energy Conservation and its Importance; Energy Strategy for the Future; The Energy Conservation Act, 2001 and its Features Definition & Objectives of Energy Management; Importance; Indian need of Energy Management; Duties and responsibilities of energy managers.

UNIT – IV ENERGY ACTION PLANNING **09**

Key elements; Force field analysis; Energy policy purpose, perspective, contents, formulation, ratification; Organizing the management: location of energy management, top management support, managerial function, accountability; Motivation of employees: Information system designing barriers, strategies; Marketing and communicating: Training and planning. Energy audit.

UNIT – V ENERGY MONITORING AND TARGETING **09**

Definition; Elements of Monitoring & Targeting System; A Rationale for Monitoring, Targeting and Reporting; Data and Information Analysis; Relating Energy Consumption and Production; CUSUM; Case Study

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Analyze differentiate the types of energy and its conservation.
CO2 Assess various environmental issues and impact.
CO3 Understand the importance of energy conservation.
CO4 Analyze energy action planning methods.
CO5 Understand the concept of energy monitoring and targeting.

TEXT BOOKS:

1. Jerrold H Kertz, Energy Conservation and Utilization, Allyn and Bacur Inc, 1976.
2. Gemand M Gramlay, Energy, Macmillion publishing Co, Newyork, 1975.

REFERENCES:

1. Krentz J. H., Energy Conservation and Utilization, Allyn and Bacur Inc., 1976.
2. Gramlay G. M., Energy, Macmillan Publishing Co., New York, 1975.
3. Rused C. K., Elements of Energy Conservation, McGraw-Hill Book Co., 1985.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Analyze differentiate the types of energy and its conservation.	2	2	1	1		1	1					1	2		1
CO2	Assess various environmental issues and impact.	1	1	1	1		1	1				1	1	1		1
CO3	Understand the importance of energy conservation.	1	1				1	1	1		1		1	1		1
CO4	Analyze energy action planning methods.	1	1			1	1	1	1	1	1	1	1	1		1
CO5	Understand the concept of energy monitoring and targeting.	1	1			1	1	1	1	1	1		1	1		1

618CHE02 **INDUSTRIAL MANAGEMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand fundamental concepts and principles of management, including the basic roles, skills and functions of management
- To be knowledgeable of historical development, theoretical aspects and practice application of managerial process
- To be familiar with interactions between the environment, technology, human resources and organizations in order to achieve high performance

UNIT – I BASICS OF MANAGEMENT **09**

Introduction, Definition of management, characteristics of management, functions of management - Planning, Organising, Staffing, Directing, Co-ordination, Controlling,Motivating, Communication, Decision Making, Principles of management – F.W.Taylor, HenryFayol, Elton Mayo, Administration and management, Nature of management, levels ofmanagement, managerial skills, managerial roles, Forms of Organization- Line , Line –staffetc. Forms of ownerships – Partnership, Proprietorship, Joint stock, Co-operative society, Govt. Sector etc, concept of Globalisation

UNIT – II STRATEGIC MANAGEMENT **09**

Military origins of strategy – Evolution - Concept and Characteristics of strategicmanagement – Defining strategy – Mintzberg's 5P's of strategy – Corporate, Business andFunctional Levels of strategy - Strategic Management Process. Preparing an EnvironmentalThreat and Opportunity Profile (ETOP) – Industry Analysis - Porter's Five Forces Model ofcompetition.BCG Matrix – GE 9 Cell Model -Balanced Scorecard, Generic CompetitiveStrategies: Low cost, Differentiation, Focus.

UNIT – III QUALITY MANAGEMENT **09**

Definition of quality, goalpost view of quality, continuous improvement definition of quality,types of quality – quality of design, conformance and performance, phases of qualitymanagement, Juran's and Demings view of quality, Quality Management Assistance Tools:Ishikawa diagram – Pareto Analysis – Pokka Yoke (Mistake Proofing).quality circles, TQM,Kaizen, Five S (5S), Six sigma Quality Management Standards (Introductory aspects only)-The ISO 9001:2000 Quality Management System Standard- The ISO 14001:2004Environmental Management System Standard- ISO 27001:2005 Information SecurityManagement System

UNIT – IV FINANCIAL & PROJECT MANAGEMENT **09**

Capital Structure, Fixed & working capital, Role of Securities and Exchange Board of India(SEBI), function of money market and capital Market, sources of finance. Introduction tocapital budgeting, Techniques of capital budgeting. Break even analysis - assumptions,importance, Cost-Benefit analysis, CVP graph, Project Management, Project networkanalysis, CPM, PERT and Project crashing and resource Leveling.

UNIT – V HUMAN RESOURCE DEVELOPMENT **09**

Strategic importance HRM; objectives of HRM; challenges to HR professionals; role,Responsibilities and competencies of HR professionals; HR department operations; HumanResource Planning - objectives and process; human resource information system. Talent acquisition; recruitment and selection strategies, career planning and management, training and development, investment in training programme; executive development

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the function of leadership and organizing culture, importance of quality control in process and planning operations

CO2 Understand the necessity of planning process and objectives, decision making processes under different conditions

CO3 Understand the nature and purpose of organization and importance of staffing selection recruitment.

CO4 Understand the function of leadership and organizing culture.

CO5 Understand importance of quality control in process and planning operations

TEXT BOOKS:

1. P. Khanna, “Industrial Engineering and Management”, Dhanpatrai publications Ltd, New Delhi.
2. L.C.Jhamb , SavitriJhamb , Industrial Management – I , Everest Publishing House

REFERENCES:

1. Dinesh Seth and Subhash C. Rastogi, “Global Management Solutions”, Cengage Learning, Second Edition, USA.
2. M.Y. Khan and P. K. Jain, “Financial Management”, Tata McGraw Hill, New Delhi
3. Ravi M. Kishore, “Project Management”, Tata McGraw Hill, New Delhi

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the function of leadership and organizing culture, importance of quality control in process and planning operations								3		2	3	3			2
CO2	Understand the necessity of planning process and objectives, decision making processes under different conditions	1					1	1	2	1	2	3	3			1
CO3	Understand the nature and purpose of organization and importance of staffing selection recruitment.								3			3	2			1
CO4	Understand the function of leadership and organizing culture.								3	2	3	3	2			1
CO5	Understand importance of quality control in process and planning operations	2	1				2	2	3	1	2	3	2			1

618CHE03 **PULP AND PAPER TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To provide the basic concepts of pulp and paper manufacturing process.
- Students will understand and acquire knowledge in pulp and paper sector.
- Students will acquire knowledge on properties and testing of pulp and paper

UNIT – I INTRODUCTION **09**

Pulp and Paper Industry Scenario in India, Chronological development of pulp and Paper technology, Introduction to Basic pulp and paper technology, properties and applications of cellulose, Wood and other sources as a Raw material. Fibrous and Non Fibrous raw materials.

UNIT – II WOOD YARD OPERATIONS AND PULPING PROCESSING **09**

Wood yard operation; cutting machines; Mechanical and thermo mechanical pulping; Chemical pulping - Sulphate and Sulphite pulping processes; Secondary fibre pulp processing; Black liquor recovery process.

UNIT – III PAPER MACHINE AND PAPER PRODUCTS **09**

Stock Preparation; Head box construction details; Fourdrinier Machine – Forming section, Press and Squeezing section, Drying section, Calendering section, Reel section, Winding section, Coating section and Super calendering section; Various types of paper products.

UNIT – IV PAPER AND PAPERBOARD **09**

Comparison of different types of pulp; Paper and paperboard frames and products ; Surface treatments; Finishing operation; End uses; Paper production by wet process from pulp; Paper storage room conditions – Humidity and temperature. Paper quality testing methods and measurements.

UNIT – V TESTING OF PULP AND WASTE TREATMENT **09**

Testing methods of pulp; Quality assurance – Pulp quality measurements; Characteristics and treatment of pulp and paper industrial waste water treatment; Air pollution analysis and control; Biotechnological approaches for lignin waste treatment. Solid waste treatment and disposal.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the scenario of Indian pulp and paper industry
CO2 Acquire knowledge of pulping processes and required raw materials.
CO3 Learn different types of processes for paper manufacturing and testing of paper
CO4 Acquire knowledge on properties and testing of pulp and paper
CO5 Acquire knowledge of various paper machine

TEXT BOOKS:

1. Smook. G. A, Hand book for Pulp and Paper Technologists,7 Edition., TAAPI Press, 1989.
2. Mc Donald. R. G and Franklin J. N., Pulp and Paper Manufacture, Vol 2. McGraw Hill, 1969
3. Biermann, Christopher.J, Handbook of Pulping and Papermaking, ISBN-13:978-0120973620

REFERENCES:

1. Gopala Rao .M and Marshall Sittig, Dryden's Outlines of Chemical Technology, 3rd Edition, East-West Press, New Delhi, 2004.
2. George. T, Austin, Shreve's Chemical Process Industries, 5th Edition, McGraw-Hill, International Editions, Singapore, 2004.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the scenario of Indian pulp and paper industry	2	1					1					1			1
CO2	Acquire knowledge of pulping processes and required raw materials.	1	1				1	1	1		1		1			1
CO3	Learn different types of processes for paper manufacturing and testing of paper	2	2				1	1	2		2		2			
CO4	Acquire knowledge on properties and testing of pulp and paper	2	2	2	2		1	1	2							
CO5	Acquire knowledge of various paper machine	2	2	2	3				2				2			1

618CHE04 **ELECTROCHEMICAL ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on basic electrochemical concepts.
- To impart knowledge on basic thermal balance.
- To acquire knowledge on basic transport properties & potential theory in electrochemical processes.

UNIT – I BASIC ELECTROCHEMICAL CONCEPTS **09**

Introduction - electrode potential - phase equilibrium, chemical and electrochemical potentials, cells with solution of uniform concentration, transport processes in junction regions, electrolyte concentration cells. The electric potential-the electrostatic potential, intermolecular forces, outer and inner potential, potentials of reference electrode, the electric potential in thermodynamics. Activity coefficients-ionic distributions in dilute solutions, electrical contribution to the free energy, measurement of activity coefficients

UNIT – II REFERENCE ELECTRODE AND ELECTRICAL DOUBLE LAYER **09**

Reference electrode-criteria of reference electrodes, hydrogen electrode, the calomel electrode and other mercury and mercurous salt electrodes, silver-silver halide electrodes. Potentials of cells with junction- the Nernst equation, types of liquid junctions, cells with liquid junction, potentials across membranes. Structure of the electric double layer- qualitative description of double layers, the Gibbs adsorption isotherm, the Lippmann equation, the diffused part of the double layer. Electrode kinetics, electro kinetic phenomena, Electro capillary phenomena.

UNIT – III INFINITELY DILUTE SOLUTIONS AND THERMAL BALANCE **09**

Infinitely dilute solutions-transport laws, conductivity, diffusional potential and transference numbers, conservation of charge, binary electrolyte, supporting electrolyte, multicomponent diffusion by elimination of the electric field. Mobilities and diffusion coefficients. Neutrality and Laplace's equation. Concentrated solutions-liquid junction potentials. Thermal effects-thermal diffusion, heat generation, conservation and transfer, Thermo galvanic cells.

UNIT – IV TRANSPORT PROPERTIES **09**

Transport properties- single and multicomponent solutions. Fluid mechanics stress in a Newtonian fluid, magnitude of electrical forces. Transport in dilute solutions, simplification for convective transport, the Graetz problem, two dimensional diffusion layer in laminar force convection, axisymmetric diffusion layers in forced convection.

UNIT – V POTENTIAL THEORY **09**

Application of potential theory- primary and secondary current distribution. Numerical solution. Effect of migration on limiting currents-Correction factors for limiting currents. Concentration variation of supporting electrolyte, limiting currents for free convection. Concentration over potential- binary electrolyte, supporting electrolyte. Currents below the limiting current

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the basic concepts involved in electrochemical processes
CO2 Learn different types of electrodes used for processes
CO3 Apply the concepts of potential theory for design of advanced electrodes
CO4 Applying the concept of transport properties
CO5 Learn different types of potential properties

TEXT BOOKS:

1. Prentice. G, Electrochemical Engineering Principles, Englewood Cliffs, Prentice Hall, NJ, 1986.

2. Thomas F. Fuller, John N. Harb, "Electrochemical Engineering", First Edition, John Wiley & Sons, Inc.Companion, 2018.

REFERENCES:

1. Newman. J, Electrochemical Systems, Englewood Cliffs, Prentice Hall, NJ, 1991.
2. Rousar. I, Micka, K and Kimla, A., Electrochemical Engineering, Vol. I & II,Elsevier, 1986.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the basic concepts involved in electrochemical processes	2	1					1					1			1
CO2	Learn different types of electrodes used for processes	1	1				1	1	1		1		1			1
CO3	Apply the concepts of potential theory for design of advanced electrodes	2	2				1	1	2		2		2			
CO4	Applying the concept of transport properties	2	2	2	2		1	1	2							
CO5	Learn different types of potential properties	2	2	2	3				2				2			1

618CHE05 DISASTER MITIGATION AND MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)

UNIT – I INTRODUCTION TO DISASTERS 09

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks - Disasters: Types of disasters - Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT – II APPROACHES TO DISASTER RISK REDUCTION (DRR) 09

Disaster Risk Reduction Strategies, Disaster Cycle, Phases of Disaster, Culture of safety- Prevention- Mitigation and preparedness community based DRR- Structural- non structural measures- Roles and responsibilities of community- Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs)- States- Centre- and other stakeholders- Institutional processes and Framework at state and Central level- State Disaster Management Authority (SDMA)- Early warning system- Advisories from appropriate agencies.

UNIT – III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 09

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT – IV DISASTERS MITIGATION 09

Disaster mitigation ,Response plan for chemical(industrial)disasters, Mitigation plan for public health in emergency, functional plan for early warning dissemination, food and nutrition, drinking water and water supply, public health and sanitation ,damages losses and needs assessment.

UNIT – V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 09

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Analyze and differentiate the types of disasters, causes and their impact on environment and society.
CO2 Assess vulnerability and various methods of risk reduction measures as well as mitigation.
CO3 Draw the hazard and vulnerability profile of India, scenarios in the Indian context.
CO4 Analyze Disaster damage assessment and mitigation.
CO5 Develop disaster management alternatives flow through case studies.

TEXT BOOKS:

1. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003.
2. Coppola, D. P. (2015). Introduction to International Disaster Management (3rd ed), Burlington, MA: Elsevier.

REFERENCES:

1. Alexander David, 2000 Introduction in 'Confronting Catastrophe', Oxford University Press.
2. Satapathy S. (2009) Psychosocial care in Disaster management, A training of trainers manual (ToT), NIDM publication.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Analyze and differentiate the types of disasters, causes and their impact on environment and society.	2	2				3	3	3	2	2		2			2
CO2	Assess vulnerability and various methods of risk reduction measures as well as mitigation.	2	2				3	2	3	2	3	2	3			1
CO3	Draw the hazard and vulnerability profile of India, scenarios in the Indian context.			2			3	3	3		2	2	2			1
CO4	Analyze Disaster damage assessment and mitigation.	1	1				3	3	3		1	2	2			1
CO5	Develop disaster management alternatives flow through case studies.	1	1				3	3	3		1		2			1

618CHE06 **FOOD SCIENCE AND TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To create awareness on the need for processing and preservatives of Foods.
- To design processing equipment's for Food Industries.
- To learn about the food microbiology.

UNIT – I **AN OVERVIEW OF FOOD INDUSTRY, FOOD CONSTITUENTS QUALITY AND DETERIORATIVE FACTOR** **09**

General aspects of food industry, World food needs and Indian situation. Constituents of food – Carbohydrates, Proteins, Lipids and Vitamins, Quality and nutritive aspects, Food additives, Preservatives, Flavours, Food standards, Deteriorative factors and their control.

UNIT – II **GENERAL ENGINEERING ASPECTS IN FOOD MICROBIOLOGY AND PROCESSING METHODS** **09**

Food and microorganisms, Microbes in food spoilage and control; Microbial agents in food borne illness; Food engineering operations, food sorting, cleaning, grading, harvesting, winnowing, drying and storage. Conversion and preservation operations.

UNIT – III **HEAT PRESERVATION AND PROCESSING** **09**

Degrees of preservation, Selection of Heat treatments, Heat resistance of microorganisms, heat transfer, Protective effects of Food constituents, Dehydration, Concentration, Microwave heating, Sterilization and Pasteurization, Drying and Irradiation, Inoculated Pack studies, Temperature-Time combinations, Heating before or after packaging.

UNIT – IV **COLD PRESERVATION AND PROCESSING** **09**

Preservation by Refrigeration and cool storage, Freezing and Frozen storage, Freeze drying and Cryogenic preservation, Fermentation and pickling, Packing methods.

UNIT – V **PRODUCTION AND UTILIZATION OF FOOD PRODUCTS** **09**

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. Food detoxification, Production of starch and amino acids.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the problems related to food and food industries by implementing properties related to food

CO2 Apply the knowledge in aspects of food microbiology, production and utilization of various food products and the processing

CO3 Apply the basic skills related to heat preservation, with processing and various methods followed in food processing industries.

CO4 Apply the basic skills related to cold preservation, with processing and various methods followed in food processing industries.

CO5 Understand the Production and Utilization of Food Products

TEXT BOOKS:

1. Potter N.N., "Food Science", 5th Ed., CBS Publishers, 2007.
2. Frazier W.C., Westhoff D.C., "Food Microbiology", 5th Ed., McGraw Hill Publishing Co., 2013.
3. Heid J.L. Joslyn M.A., "Fundamentals of Food Processing Operation", The AVI publishing Co., West port, 1967.
4. Sivasankar. B, "Food Processing and Preservation", PHI publications, 2002.

REFERENCES:

1. Heldman D.R., "Food Process Engineering", The AVI publishing co., 1981.
2. Charm S.E., "The Fundamentals of Foods Engineering", 2nd Edition, The AVI Publishing Co., Westport, 1971.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the problems related to food and food industries by implementing properties related to food	1	1			1	1	2		1			2			1
CO2	Apply the knowledge in aspects of food microbiology, production and utilization of various food products and the processing	2	2		1		1	1	2				2			1
CO3	Apply the basic skills related to heat preservation, with processing and various methods followed in food processing industries.	2	2				2	2	2	1						1
CO4	Apply the basic skills related to cold preservation, with processing and various methods followed in food processing industries.	2					2	2	2	1	2		2			1
CO5	Understand the Production and Utilization of Food Products	2					2	2	1	1	2		1			

718CHE01 MATHEMATICAL METHODS FOR CHEMICAL ENGINEERS L T P C

3 0 0 3

COURSE OBJECTIVES

- The objective of this course is to introduce the student to analytical methods of solving linear algebraic, ordinary differential and partial differential equations.
- The course will also cover numerical methods to solve algebraic and differential equations.

UNIT – I **09**

Review of Matrix Algebra; Solvability conditions for systems of linear algebraic equations. Vector Algebra; Linear independence, Norm and Inner Product; Linear Operators, Adjoint of an operator, Self-adjoint operators.

UNIT – II **09**

Transformations under change of basis, eigen values and eigen vectors. Applications to solution of systems of linear algebraic equations and systems of first order ordinary differential equations (ODEs). Stability analysis; Examples from reaction engineering, process control etc.

UNIT – III **09**

Second order linear ODEs, Sturm Liouville Operators, Spectral expansion, Special functions. Inverse of second order operators and Green's function.

UNIT – IV **09**

Second order linear partial differential equations (PDEs): Classification, canonical forms. Solution methods for hyperbolic, elliptic and parabolic equations: Eigen function expansion, separation of variables, transform methods. Applications from heat and mass transfer, reaction engineering.

UNIT – V **09**

Numerical solution of linear and nonlinear algebraic equations, Gauss elimination methods, LU decomposition, Newton-Raphson method; Finite difference method for solving ODEs and PDEs. Chemical engineering applications from separation processes, reaction engineering, fluid mechanics etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the involvement of matrix and linear Algebric equations in chemical engineering.

CO2 Know the application of eigen values and eigen vectors in process control.

CO3 Understand the application of ordinary differential equations in chemical reaction engineering.

CO4 Students will have an ability to know the application of hyperbolic, elliptic and parabolic equations in mass transfer.

CO5 Understand the application of numerical solution of linear and nonlinear algebraic equations in fluid mechanics and separation processes.

TEXT BOOKS:

1. Schneider,H., Barker, G.P.Matrices and Linear Algebra, Dover, NY (1972).
2. Ray, A. K., Gupta, S. K. Mathematical Methods in Chemical and Environmental Engineering, International Thomson Learning,Singapore (2004).
3. Pushpavanam, S. Mathematical Methods in Chemical Engineering, Prentice-Hall of India, New Delhi (2004).

REFERENCES:

1. Ramkrishna, D., Amundson, N. R.; Linear Operator Methods in Chemical Engineering; Prentice-Hall: Englewood Cliffs, New Jersey, 1985.
2. Chapra, S. C., Canale, R. P. Numerical Methods for Engineers, Tata McGraw-Hill, New Delhi (2006).
3. Hoffman, J. D. Numerical Methods for Engineers and Scientists, Taylor and Francis, Boca Raton (2001).

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the involvement of matrix and linear Algebric equations in chemical engineering.	3	2	1	2									2	2	
CO2	Know the application of eigen values and eigen vectors in process control.	3	2	2	1									2	3	
CO3	Understand the application of ordinary differential equations in chemical reaction engineering.	3	2	2										2	3	
CO4	Students will have an ability to know the application of hyperbolic, elliptic and parabolic equations in mass transfer.	3	2	2	1	1								2	2	
CO5	Understand the application of numerical solution of linear and nonlinear algebraic equations in fluid mechanics and separation processes.	3	2	2	1	1								2	2	

718CHE02 BIOCHEMICAL ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on the role of microorganism in different types of Bio-chemical reaction
- To design Bio-chemical reactors with proper knowledge on Enzyme Engineering

PREREQUISITE

Kinetics and Design knowledge of various types of reactors and basic fundamentals on biological science

UNIT – I CONVENTIONAL CHEMICAL PROCESSES AND BIOCHEMICAL PROCESS AND ROLE OF MICROORGANISMS **09**

An overview of 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, typical examples of microbial synthesis of biological.

UNIT – II MICROBIAL KINETICS **09**

Typical growth characteristics of microbial cells, factors affecting growth, Monod model, modeling of batch and continuous cell growth, immobilized whole cells and their characteristics, free cell and immobilized cell reactors, typical industrial examples; transport in cells.

UNIT – III ENZYMES AND ENZYME KINETICS **09**

Enzyme used in industry medicine and food, their classification with typical examples of industrially important enzymes, mechanism of enzymatic reactions, Michaelis-Menten kinetics, enzymes inhibition and types, factors affecting the reaction rates, Types of immobilization of enzyme.

UNIT – IV BIOREACTORS **09**

Batch and continuous types, immobilized whole cell and enzyme reactors, high performance bioreactors, sterile and non-sterile operations, reactors in series with and without recycle, design of reactors and scale up with typical examples.

UNIT – V DOWNSTREAM PROCESSES **09**

Different unit operations in down streaming with special reference to membrane separations, extractive fermentation, typical industrial examples for downstream processing. Application of biochemical engineering principles (advanced) in treatment of industrial effluents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Able to implement the knowledge of microorganisms and enzymes to study different biochemical reactions and rate equations.

CO2 Able to understand transport mechanisms including mass transfer and heat transfer and sterilization concepts to design and analyze bioreactors.

CO3 Acquire knowledge on various downstream processing for product recovery and purification and design of industrial bioreactors.

CO4 Acquire knowledge about bioreactors

CO5 Acquire knowledge about downstream processes.

TEXT BOOKS:

1. Bailey J.E., Ollis, D.F. Biochemical Engineering Fundamentals, McGraw-Hill, International Edition, 2nd Edition, New York, 1986.
2. Shuler M. L., Kargi. F., "Bioprocess Engineering: Basic Concepts", 2nd ed. Prentice Hall,2001.

REFERENCES:

1. Aiba, S; Humphrey, A.E., Milli, N.R., Biochemical Engineering 2nd ed., Academic Press, 1973.
2. Web, F.C., Biochemical Engineering, Van Nostrand, 1964.
3. Atkinson, B., Biochemical Reactors, Pion Ltd., 1974

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Able to implement the knowledge of microorganisms and enzymes to study different biochemical reactions and rate equations.	2	2	2										3	2	
CO2	Able to understand transport mechanisms including mass transfer and heat transfer and sterilization concepts to design and analyze bioreactors.	1	3	3	2									3	2	
CO3	Acquire knowledge on various downstream processing for product recovery and purification and design of industrial bioreactors.	1	2	3	2									3		
CO4	Acquire knowledge about bioreactors	2		1	1									3		
CO5	Acquire knowledge about downstream processes.	2		1	1									3		

718CHE03 MODERN SEPARATION TECHNIQUES L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the recent advances in separation techniques and their applications in different chemical processes.

UNIT – I INTRODUCTION TO SEPARATION TECHNIQUES 09

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 electrofiltration, dual functional filter, Surface based solid – liquid separations involving a second liquid, Sirofloc filter.

UNIT – II MEMBRANE SEPARATIONS 09

Types and choice of membranes: Plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, Commerical, pilot plant and laboratory membrane permeators involving dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis, Economics of membrane operations, Ceramic membranes.

UNIT – III SEPARATIONS BY ADSORPTION TECHNIQUES 09

Mechanism, Types and choice of adsorbents: Normal adsorption techniques, Affinity chromatography and immuno Chromatography, Types of equipment and commercial process, Recent advances and process economics.

UNIT – IV IONIC SEPARATIONS 09

Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, ion exchange chromatography and electrodialysis, Commercial processes.

UNIT – V OTHER TECHNIQUES 09

Separations involving Lyophilisation, Pervaporation and permeation tchniques for solids, liquids and gases, Industrial viability and examples, zone melting, Addluctive crystallization, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Explain different types of separation techniques based on size, surface properties, cross flow filtration and derive the equations for the same.
CO2 Develop design equations for membrane separation processes such as RO&UF.
CO3 Design the affinity and immune chromatographic columns.
CO4 Understand type of equipment employed for electrophoresis.
CO5 Design the ion exchange chromatography and industrial effluent treatment by modern techniques.

TEXT BOOKS:

1. Lacey, R.E. and S.Looeb – Industrial Processing with Membranes Wiley – Inter Science, N.Y.1972.
2. King, C.J. Separation Processes, Tata McGraw-Hill Publishing Co. Ltd., 1982

REFERENCES:

1. Schoew, H.M. – New Chemical Engineering Separation Techniques, Interscience Publishers, 1972.
2. Ronald W. Roussel – Handbook of Separation Process Technology, John Wiley, New York, 1987.
3. Kestory, R.E. – Synthetic polymeric membranes, Wiley. Interscience, N.Y. 1985.
4. Osadar, VaridNakagawal – Membrane Science and Technology, Marcel Dekkar (1992).

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Explain different types of separation techniques based on size, surface properties, cross flow filtration and derive the equations for the same.	2					2						2	3		
CO2	Develop design equations for membrane separation processes such as RO&UF..	2		3			2	2			1		2	3		
CO3	Design the affinity and immune chromatographic columns			2				2		1				2		
CO4	Understand type of equipment employed for electrophoresis,	2					2	2					2	3		
CO5	Design the ion exchange chromatography and industrial effluent treatment by modern techniques.	2		3			2	2					2	3		

718CHE04 **PROCESS AUTOMATION** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the principles of process instrumentation and need of automation in present industries
- To know about the advanced techniques in process control

UNIT – I INTRODUCTION **09**

Principles of measurement and classification of process control instruments; temperature, pressure fluid flow, liquid level, velocity, fluid density, viscosity, conductivity etc., instrument scaling; sensors; transmitters and control valves; instrumentation symbols and labels

UNIT – II PROCESS AUTOMATION **09**

Basic concepts; terminology and techniques for process control; control modes; Tuning process controllers.

UNIT – III ADVANCED CONTROL **09**

Advanced control techniques, feed forward and ratio control; controller design; adaptive control system; statistical process control; expert system; multivariable control techniques; supervisory control

UNIT – IV DIGITAL CONTROL **09**

Digital control techniques; z transforms; sampling and filtering; response of discrete time systems; sampled data control systems; design of digital controllers.

UNIT – V **09**

Optimisation and simulation; optimisation techniques; single and multivariable constrained optimisation; dynamic simulation of distillation columns and reactors.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Able to Learning the application of process control instruments.
CO2 Able to understand the basic concept of Process Automation and advance control techniques.
CO3 Able to apply the digital control and optimal control to real time problems
CO4 Able to apply digital control.
CO5 Able to apply optimal control.

TEXT BOOKS:

1. Nakara, B.C.; Choudary, K.K.; “Instrumentation and Analysis”, Tata McGraw-Hill, New Delhi, Eigth Reprint, 1993.
2. Stephanopoulos, G.; “Chemical Process Control”, Tata McGraw-Hill, New Delhi, 1993.

REFERENCES:

1. Karl J.Astrom, Bjorn Willermans; “Computer Controlled Systems”, Prentice Hall of India Pvt. Ltd., 1994.
2. Chemical Engineering Refresher Series on “Process Automation”, McGraw-Hill Publications, New York, 1991.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Able to implement the knowledge of microorganisms and enzymes to study different biochemical reactions and rate equations.	2	2		1	2								2	3	
CO2	Able to understand the basic concept of Process Automation and advance control techniques.	2	1		1	3								2	3	
CO3	Able to apply the digital control and optimal control to real time problems	2	1		1	2								2	3	
CO4	Able to apply digital control.	2	1		1	2								2	3	
CO5	Able to apply optimal control.	2	1		1	2								2	3	

718CHE05 **SOLID WASTE MANAGEMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

UNIT – I SOURCES AND TYPES **09**

Sources and types of municipal solid wastes-waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes-Public health and environmental effects. Elements of solid waste management –Social and Financial aspects – Municipal solid waste (M&H) rules – integrated management-Public awareness; Role of NGO's

UNIT – II ON-SITE STORAGE AND PROCESSING **09**

On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – waste segregation and storage – case studies under Indian conditions – source reduction of waste – Reduction, Reuse and Recycling.

UNIT – III COLLECTION AND TRANSFER **09**

Methods of Residential and commercial waste collection – Collection vehicles – Manpower- Collection routes – Analysis of collection systems; Transfer stations – Selection of location, operation & maintenance; options under Indian conditions – Field problems- solving.

UNIT – IV OFF-SITE PROCESSING **09**

Objectives of waste processing – Physical Processing techniques and Equipments; Resource recovery from solid waste composting and biomethanation; Thermal processing options – case studies under Indian conditions.

UNIT – V DISPOSAL **09**

Land disposal of solid waste; Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor- Dumpsite Rehabilitation

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the nature and characteristics of municipal solid wastes and the regulatory requirements regarding municipal solid waste management.
CO2 Plan waste minimization, design and storage to reduce waste.
CO3 Understand the collection, transport, processing of municipal waste.
CO4 Understand the thermal processing of waste.
CO5 Understand disposal of municipal solid waste.

TEXT BOOKS:

1. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". McGraw Hill, New York, 1993.
2. Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", Prentice Hall, Inc., 1981.
3. Paul T Willams, "Waste Treatment and Disposal", John Wiley and Sons, 2000

REFERENCES:

1. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of UrbanDevelopment, New Delhi, 2000.
2. Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection", Processing and Disposal, 2001
3. Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996
4. George Tchobanoglous and Frank Kreith"Handbook of Solidwaste Management", McGraw Hill, New York, 2002

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the nature and characteristics of municipal solid wastes and the regulatory requirements regarding municipal solid waste management.	1	1		2		2	3						1		2
CO2	Plan waste minimization, design and storage to reduce waste.	1	1		1					1				1		3
CO3	Understand the collection, transport, processing of municipal waste.	1	3		3									1		3
CO4	Understand the thermal processing of waste.	1	2	3	3									1		3
CO5	Understand disposal of municipal solid waste.	1	2	3	3					3				1		3

718CHE06 **PROGRAMMING USING MATLAB** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- This course gives a complete programming knowledge about MATLAB
- The students would be acquired with the basic concepts of MATLAB, variables, arrays and functions of MATLAB

UNIT – I INTRODUCTION TO MATLAB 09

Introduction to MATLAB- Creating Variables- Some useful MATLAB functions- Data types- Script files – video lecture on plotting, Introduction to arrays, Graphing, Exercises- Graphing Functions Using MATLAB

UNIT – II PROGRAMMING PRACTICES 09

Planning Code-Creating Code- Video Lectures on Input Statements, Output Statements Exercises: Input/Output Statements

UNIT – III CONDITIONAL STATEMENTS AND LOOPS 09

Conditional Statements: Logical Operators, if, else, and elseif, Switch, Exercises- conditional statement

Loops: Repetition Structure: Introduction to Loops, For Loops, While Loops

Exercises: Loops

UNIT – IV NESTED LOOPS 09

Nested Loops Breaks - Video Lecture: Repetition Structures: Nested Loops and the Break Statement

UNIT – V ARRAYS AND ARRAY FUNCTIONS 09

Arrays-Exercises: Arrays, Video Lecture: Some Useful Functions for Arrays-Exercises: Array Functions

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply MATLAB basics in solving complex problems
CO2 Find the solution for Problems related to chemical engineering
CO3 Implement algorithms to find solutions using arrays, functions and statements
CO4 Implement concepts of MATLAB in various field of Chemical Engineering
CO5 Find the solutions for multidisciplinary problems.

TEXT BOOKS:

1. MATLAB: A Practical Introduction to Programming and Problem Solving, 3rd edition, Stormy Attaway, Elsevier, 2013.
2. Chemical Engineering Computational with MATLAB, Yeong Koo Yeo, Hanyang University, CRC Press, Inc., 2018

REFERENCES:

Problem Solving in Chemical and Biochemical Engineering with POLYMATH, Excel, and
1. MATLAB 2nd Edition ,MichealB.Cutlip, Mordechai Shacham, 2007.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply MATLAB basics in solving complex problems	3	3	2	2									1	3	3
CO2	Find the solution for Problems related to chemical engineering	3	3	2	2									1	3	3
CO3	Implement algorithms to find solutions using arrays, functions and statements	3	3	2	2									1	3	3
CO4	Implement concepts of MATLAB in various field of Chemical Engineering	3	3	2	2									1	3	3
CO5	Find the solutions for multidisciplinary problems.	3	3	2	2	2								1	3	3

718CHE07 OPTIMIZATION OF CHEMICAL PROCESSES L T P C
3 0 0 3

COURSE OBJECTIVES

- To impart the basic concepts of optimization
- To understand the concepts and techniques of single variable and multivariable optimization using numerical search and analytical methods.

UNIT – I **09**

The nature and organization of optimization problems: Scope and Hierarchy, Applications, General procedure, obstacles.

Developing models for optimization: Classification of models, building models, selecting functions to fit empirical data, factorial experimental design and degrees of freedom.

UNIT – II **09**

Formulation of objective function: Economic objective function, time value of money in objective function.

Basic concepts of optimization: Function continuity, NLP programming, convexity and its application, quadratic approximation, conditions for extreme of an unconstrained function.

UNIT – III **09**

Optimization of unconstrained function: One dimensional search: Numerical methods for optimization function with one variable, scanning and bracketing procedure, polynomial approximation methods. Quadratic interpolation & Cubic interpolation. One Dimensional search is applied in a multidimensional problem.

UNIT – IV **09**

Unconstrained multivariable optimization: Methods using functions values only - Random search, grid search, univariate search, simplex search and conjugate search.

Methods using first derivative-steepest descent, conjugate gradient. Newton's method, Forcing the Hessain Matrix to be positive- definite and moment in the search direction. Termination and Safe guarded Newton's Method and computation of derivatives - Quasi Newton's method.

UNIT – V **09**

Linear programming and its application: Geometry of linear programs, Basic Linear programming definitions and rules, simplex algorithm, Barrier method, Sensitivity analysis, Linear mixed integer program.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Design experiments and formulate models of chemical processes/ equipments.
CO2 Apply different search and linear programming methods for solutions of chemical process problems.
CO3 Apply the non- linear programming methods for application in R&D.
CO4 Optimize Unconstrained multivariable.
CO5 Understand linear programming and its applications.

TEXT BOOKS:

1. Edger,T.F.and Himmelblau,D.M., "Optimization of Chemical Processes", Mc.Graw Hill,2001.

REFERENCES:

1. G.S.Beveridge and R.S.Schechter, "Optimization Theory and Practice", Mc.Graw Hill, 1970.
2. Kalyanmoy Deb, "Optimization for Engineering Design", John Wiley, 1995.
3. V.Kafarov, "Cybernetic Methods in Chemistry and Chemical Engineering, "MIR Publishers 1976.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Design experiments and formulate models of chemical processes/ equipments.	2	2	3										2	3	
CO2	Apply different search and linear programming methods for solutions of chemical process problems.	2	2											2	3	
CO3	Apply the non- linear programming methods for application in R&D.	2	2	2										2	2	
CO4	Optimize Unconstrained multivariable.	2	2		2									2	3	
CO5	Understand linear programming and its applications.	2	2											2	2	

718CHE08 INDUSTRIAL WASTE WATER TREATMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To learn constituents associated with wastewater and their effects
- To learn fundamentals of biological treatment
- To learn most commonly applied wastewater treatment technologies for industrial wastes and classify the technologies based on the conventional series of primary, secondary, tertiary, and in-plant treatment

UNIT – I SOURCES AND TYPES OF INDUSTRIAL WASTEWATER 09

Sources and types of industrial wastewater – Characterization: Physical, Inorganic non metallic constituents, metallic constituents, organic constituents, biological Characteristic.

UNIT – II INTRODUCTION TO PROCESS SELECTION 09

Physical unit operation: Screening, coarse solid reduction, Mixing and flocculation, equalization, Gravity separation, Grit removal, Sedimentation, Neutralization, Clarification, Floatation.

Role of Chemical unit operations in wastewater treatment, Chemical unit Process: Chemical Coagulation, Chemical Precipitation – Heavy metal removal, Phosphorous removal, Chemical oxidation.

UNIT – III BIOLOGICAL TREATMENT 09

Composition and Classification, bacterial growth, Microbial growth, Aerobic biological oxidation, biological nitrification, Anaerobic fermentation and oxidation, Activated sludge process, Trickling filters, Rotating biological contactors, Combined aerobic treatment processes, Anaerobic treatment process, Anaerobic sludge blanket process, Attached growth process.

UNIT – IV ADVANCED WASTEWATER TREATMENT 09

. Depth filtration, surface filtration, Adsorption, Ion Exchange, advanced oxidation process, Photo catalysis, wet air oxidation, Evaporation, Disinfection Processes: Disinfection with chlorine, Disinfection with chlorine dioxide, Dechlorination, Disinfection with ozone.

UNIT – V EFFLUENT TREATMENT PLANTS 09

Individual and common Effluent Treatment plants – Zero effluent discharge systems – wastewater reuse – Disposal of effluent on land – Quantification, characteristics and disposal of Sludge.

Industrial process description, wastewater characteristics, source reduction options and waste treatment flow sheet for textiles – tanneries – pulp and paper – metal finishing – petrochemical – pharmaceuticals – thermal power plants.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the fundamentals of wastewater treatments.
CO2 Understand the common physical, chemical and biological unit operations encountered in treatment processes.
CO3 Analyse various characteristics of wastewater.
CO4 Able to understand importance of advanced waste water treatment processes.
CO5 Able to understand various effluent treatment plants and find solutions.

TEXT BOOKS:

1. George Tchobanoqlous, Franklin L. Burton, H.DavidStensel, Waste water Engineering Treatment and Reuse: Mc Graw Hill,4th Edition, 2002.
2. Metcalf and Eddy. Wastewater Engineering, Treatment and reuse, Tata McGraw Hill Education, 4th Edition, 2003.

REFERENCES:

1. Water Environment Federation, Industrial Waste Water Management Treatment and Disposal, Tata-Graw Hill 3rd Edition, 2008.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the fundamentals of wastewater treatments	1					1	2								2
CO2	Understand the common physical, chemical and biological unit operations encountered in treatment processes	1	2	2				2								2
CO3	Analyse various characteristics of wastewater	1	2	2				2								2
CO4	Able tounderstand importance of advanced waste water treatment processes	2	1	1				2								2
CO5	Able to understand various effluent treatment plants and find solutions.	3	3	3	1			2								2

718CHE09 **CATALYST SCIENCE AND TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- The students would be acquired with the basic concept of catalytic reactions and rectors.
- To acquire knowledge in kinetic modelling of catalytic reactors.

UNIT – I **09**

Introduction to Heterogeneous catalytic processes, types of heterogeneous reactions. Adsorption on solid surfaces, Adsorption, adsorption isotherms, rates of adsorption, Physisorption and chemisorptions. Solid catalysis, types of catalysts, catalyst formulations and Preparation methods.

UNIT – II **09**

Catalysts Characterization methods: Surface area and pore volume determinations, pore size distribution, XRD, EDAX, composition analysis, various Spectroscopic techniques, Temperature programmed reduction & oxidation, Electron microscopy.

UNIT – III **09**

Testing of catalysts, various types of catalytic reactors, activity and selectivity studies. Effect of external transport processes on observed rate of reactions. Effect of internal transport processes: reactions and diffusion in porous catalysts

UNIT – IV **09**

Mechanism of catalytic reactions, Mechanism and kinetics study -Rates of adsorption, desorption, surface reactions, rate determining steps. Kinetic modelling and Parameter estimations, Model discriminations. Catalysts promoters, Inhibitors, catalyst deactivations, kinetics of catalyst deactivations.

UNIT – V **09**

Industrial processes involving heterogeneous solid catalysts. New development in solid catalysis, monolith catalysts, nanocatalysts, Fuel cell catalysts, Environmental catalysts, Insitu characterization. Design of catalysts; simulation techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Have an ability to know catalytic process and heterogeneous reaction and their kinetics.

CO2 Have an ability to know catalytic process and heterogeneous reaction and their kinetics.

CO3 Understand types of catalytic reactors and the transport.
CO4 Design of new catalytic reactors for industrial process.
CO5 Understand Modelling and simulation of catalytic reactor.

TEXT BOOKS:

1. G. Ertl, H. Knozinger and J. Weitkamp, "Handbook of Heterogeneous Catalysis" Vol 1-5, Wiley - VCH.
2. B. Viswanathan, S. Sivasanker , A.V. Ramaswamy, "Catalysis : Principles & Applications" CRC Press
3. J. M. Smith , "Chemical Engineering Kinetics" McGraw-Hill Book Company.

REFERENCES:

1. J. M. Thomas and W. J. Thomas, "Principles and Practice of Heterogeneous Catalysis", Wiley- VCH
2. H. S. Fogler, "Elements of Chemical reaction engineering" Prentice – Hall of India.
3. J.J. Carberry , "Chemical and catalytic reaction Engineering", Dover Publications.
4. C. H. Bartholomew and R. J. Farrauto "Fundamentals of Industrial catalytic Processes", Wiley- VCH.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Have an ability to know catalytic process and heterogeneous reaction and their kinetics.	2												2	2	
CO2	Have an ability to know catalytic process and heterogeneous reaction and their kinetics.	2		2										2	2	
CO3	Understand types of catalytic reactors and the transport.	2												2	2	
CO4	Design of new catalytic reactors for industrial process.	3		3										2	3	
CO5	Understand Modelling and simulation of catalytic reactor.	3	3	3	2	2								2	3	

718CHE10 FUNDAMENTALS OF NANOTECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the description of nanotechnology, its technological development and different applications.
- To get exposure to the general preparation methods of nano-materials and different techniques in their preparation

UNIT – I **09**

Introduction Background and Definition of Nanotechnology. Why Nano? Applications in Different Fields, Chemical Approaches to Nanostructured Materials, Molecular Switches and Logic Gates, Solid State Devices

UNIT – II **09**

Carbon Nanotubes - Structure of Carbon Nanotubes, Synthesis of Carbon Nanotubes, Growth Mechanisms of Carbon Nanotubes, Properties of Carbon Nanotubes, Carbon Nanotube-Based Nano-Objects, Applications of Carbon Nanotubes, Nano wires – Synthesis, Characterization and Physical Properties of Nanowires, Applications

UNIT – III **09**

Basic Microfabrication Techniques, MEMS Fabrication Techniques, Nanofabrication techniques, Stamping techniques - High Resolution Stamps, Microcontact Printing, Nanotransfer Printing, Applications.

UNIT – IV **09**

Friction reduction, cleaning, coating, , Automatic control systems, leak detection –mass balance Material aspects of NEMS and MEMS – Silicon, Germanium-Based Materials, Metals, GaAs, InP, and Related III-V Materials, MEMS Devices and Applications - Pressure Sensor, Inertial Sensor, Optical MEMS, RF MEMS, NEMS Devices and Applications, Current Challenges and Future Trends.

UNIT – V **09**

Microscopy - Scanning Tunneling Microscope, Atomic Force Microscope, Scanning Electron Microscopy, FESEM, TEM, Principles of Noncontact Atomic Force Microscope (NCAFM).

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Learn and understand the purpose of Nanotechnology.
CO2 Understand application of carbon nanotubes and process the involved, learn microfabrication.
CO3 Understanding different types of NEMS, MEMS and learn principles of microscopes
CO4 Understand material aspects of NEMS, MEMs and their applications
CO5 Understand the principle and applications of Microscopy.

TEXT BOOKS:

1. B. Bhushan, "Springer handbook of nanotechnology", 3rd Edition, Springer – Verlag, 2010.

REFERENCES:

1. Charles P. Poole; Frank K. J Owens, "Introduction to Nanotechnology", A John Wiley.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Learn and understand the purpose of Nanotechnology.	2		2										3		
CO2	Understand application of carbon nanotubes and process the involved, learn microfabrication.	2		2										3		
CO3	Understanding different types of NEMS, MEMS and learn principles of microscopes	2												3		
CO4	Understand material aspects of NEMS, MEMs and their applications	2												3		
CO5	Understand the principle and applications of Microscopy.	2												3		

718CHE11 **COMPUTATIONAL FLUID DYNAMICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on computational aspects of fluid flow.
- To provide exposure on various mathematical models for different fluid regimes and flow, boundary conditions.

UNIT – I INTRODUCTION **09**

Advantages of Fluid dynamics, Typical Complex problem – complex geometry, simpler geometry, Preliminary computational Techniques –Discretisation, a Approximation to derivatives and other related methods.

UNIT – II FLUID DYNAMICS GOVERNING EQUATIONS AND TRANSFORMATION RELATIONSHIP **09**

Equation of motion, evaluations of the transformations parameters – finite element evaluation, finite volume evaluation grid generation by partial differential equation solution and algebraic mapping.

UNIT – III BOUNDARY LAYER FLOW **09**

Simple boundary layer flow-implicit scheme, LAMEL, Keller box scheme. Complex boundary layer flow –change of variables, Davis coupled scheme. Three dimensional Boundary layer flow – Sub characteristic behavior, implicit split marching algorithm.

UNIT – IV FLOW GOVERNED BY REDUCED NAVIER STROKE EQUATIONS **09**

Introduction. Fourier analysis for qualitative solutions behavior, order of magnitude analysis, THRED-Thermal entry problem. Internal flow-internal swirling flow, flow in straight rectangular duct. External Flow- supersonic flow, subsonic flow

UNIT – V COMPRESSIBLE VISCOUS FLOW **09**

Introduction – Physical Simplification-eddy viscosity turbulence modeling, thin layer approximation, Explicit scheme-explicit MacCormack scheme Implicit scheme- Implicit MacCormac scheme Group finite Element method

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Able to understand the nature of compressible and incompressible fluids and basis of piping design.
CO2 Able to Design and operation of pipeline for different fluid systems.
CO3 Learn the maintenance of pipe lines.
CO4 Learn the pipeline operations.
CO5 Learn the pipeline failure and maintenance.

TEXT BOOKS:

1. Fletcher. C. A. J., “Computational Techniques for Fluid Dynamics”, Volume I & II, Springer Series, Springer

REFERENCES:

1. Thomasset. F., “Implementation of Finite Element Method for Navier-Stroke Equations”, Springer Series, Springer-Verlag, Berlin, 2003.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand CFD techniques in developing fluid flow models	2	2	2										2	3	
CO2	Apply finite volume model for solution of steady state diffusion and convection diffusion problems	2	3								2	3	3	2	3	
CO3	Demonstrate the application of SIMPLER, SIMPLEC and PISO algorithms for solution of industry and R&D problems	2	3	3								2		2	3	
CO4	Understand Navier stroke equations and behavior of flow	3		2							2	2		2	3	
CO5	Understand the nature of Compressible viscous flow	2		2										2	3	

718CHE12 **PIPING ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the design of pipe line system for various industries
- To know about the piping maintenance and operation.
- To know about pipeline operations.

UNIT – I INTRODUCTION **09**

Definition & Scope, history of pipe lines, existing pipe lines, importance of pipe lines, transport by pipe lines, types of pipe lines, components and advantages of pipe lines

UNIT – II SINGLE PHASE INCOMPRESSIBLE NEWTONIAN FLUIDS **09**

Flow regimes - flow equation - Continuity, Energy, Momentum – Cavitation in piping systems -pipe in series and parallel. Pipe network. Complex piping system.

UNIT – III SINGLE PHASE COMPRESSIBLE FLOW OF NON-NEWTONIAN FLUIDS **09**

Classification of non-Newtonian fluids, rheological properties and laws of non-Newtonian fluids, non-Newtonian pipe flow –Power law fluids, Bingham fluids, Tomita's equations

UNIT – IV PIPELINE OPERATION **09**

Friction reduction, cleaning, coating, , Automatic control systems, leak detection –mass balance method ,pressure drop method, computational modelling of pipeline systems

UNIT – V PIPELINE FAILURE AND MAINTENANCE **09**

Pipeline failure- outside force damage, internal pressure, subsidence strains, Rupture. Pipeline economics and cost. Piping insulations and repair techniques

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Able to understand the nature of compressible and incompressible fluids and basis of piping design
CO2 Able to Design and operation of pipeline for different fluid systems
CO3 Learn the maintenance of pipe lines
CO4 Learn the pipeline operations
CO5 Learn the pipeline failure and maintenance

TEXT BOOKS:

1. John J.Mcketta, "Piping Design Handbook", Marcel Dekker Publication, 1992.
2. Henry Liu, "Pipeline Engineering", Lewis Publishers, 2003.

REFERENCES:

1. George A. Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity and Repair", Marcel Dekker Publication, 2003.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Able to understand the nature of compressible and incompressible fluids and basis of piping design	2													2	
CO2	Able to Design and operation of pipeline for different fluid systems	2	2	3								2	3		2	
CO3	Learn the maintenance of pipe lines.	2	2	2								2	2		2	
CO4	Learn the pipeline operations.	2	2	2								2	2		2	
CO5	Learn the pipeline failure and maintenance.	2	2	2											2	

818CHE01 **FERMENTATION ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To enable the students to understand the role of fermentation microorganisms and (bio) chemical activities
- To understand conversions that takes place during fermentations, and their impact on quality.
- To predict market potential of fermentation products and recovery cost

UNIT – I INTRODUCTION TO FERMENTATION PROCESSES 09

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

UNIT – II INSTRUMENTATION AND CONTROL 09

Measurement of process variables – Temperature and its control – Flow measurement and control – Gases and Liquids – Pressure measurement and control – Cenline analysis – Control System – Combination of Control Systems – Computer application in fermentation technology.

UNIT – III RECOVERY AND PURIFICATION OF FERMENTATION PRODUCTS 09

Removal of Microbial cells – Foam Separation – Precipitation Filtration – Different Filtration process – Centrifugation – Different centrifuge cell description – Different methods – Solvent recovery – Superfluid extraction – Chromatography – Membrane processes – Drying – Crystallization – Whole growth processing.

UNIT – IV EFFLUENT TREATMENT 09

Strength of fermentation effluent – Treatment and disposal – Treatment Processes – Physical, chemical and biological – Aerobic process – Anaerobic treatment

UNIT – V FERMENTATION ECONOMICS 09

Introduction – Isolation of micro organisms of industrial interest – Strain improvement – Market potential – Plant and equipment – Media – Air sterilization – Heating and cooling – Recovery costs.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Know the Microbial metabolites and Microbial growth Kinetics.
CO2 Know how to measure the process variables and the principles of instrumentation and control in fermentation.
CO3 Explain recovery and purification of fermentation products.
CO4 Understand treatment and disposal of waste effluent.
CO5 Understand the economical aspect of fermentation process.

TEXT BOOKS:

1. Principles of fermentation Technology - Peter F Stanbury, Allan Whitaker, Stephen J Hall, Joe Hayton, Third Edition, Third Edition, 2017.
2. Bioprocess Engineering: Basic Concepts - Michael L. Shuler, Fikret Kargi, Matthew De Lisa, Prentice Hall, 2017

REFERENCES:

1. Fermentation and Biochemical Engineering Handbook , C.C Haber, William Andrew II Edition, 2007.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Know the Microbial metabolites and Microbial growth Kinetics.				3							3	3			2
CO2	Know how to measure the process variables and the principles of instrumentation and control in fermentation.								2			3	3			2
CO3	Explain recovery and purification of fermentation products.								2			2	3			2
CO4	Understand treatment and disposal of waste effluent.								2			2	3			2
CO5	Understand the economical aspect of fermentation process.						3	3			1	2	3			2

818CHE02 **PETROLEUM REFINERY ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To well verse with the properties of petroleum products
- To provide knowledge on crude petroleum exploration
- To understand separation processes involved in petroleum refining, conversion processes and treatment methods

UNIT – I INTRODUCTION **09**

Origin Formation, World petroleum resources, petroleum industries in India. Composition and classification of crude oil: evaluation of petroleum ASTM, TBP and EFV distillation, Correlation index, density, carbon distribution.

UNIT – II EXPLORATION TECHNIQUES **09**

Methods of exploration, drilling and production of petroleum crude, Drilling rigs, Drilling Procedure, Transportation of crude and product. Crude pretreatment

UNIT – III PROPERTIES AND SPECIFICATIONS OF PETROLEUM PRODUCTS **09**

Composition and Properties of products FG, Gasoline, naphtha, kerosene, diesel oils, lubricating oils, waxes and hydrocarbon compounds- paraffinic, naphthanic, aromatic and olefinic.

UNIT – IV SEPARATION PROCESSES **09**

Fractionation of Petroleum: dehydration and desalting of crudes, heating of crude-pipe still heaters, distillation of petroleum, blending of gasoline. Operation of topping and vacuum distillation units. Tube still furnaces, Solvent extraction processes for lube oil base stocks, aromatics, naphtha and kerosene streams. Solvent de-waxing.

UNIT – V CONVERSION PROCESSES AND TREATMENT METHODS **09**

Conversion process: Thermal cracking, vis-breaking and coking processes, catalytic cracking, reforming, hydro processing, alkylation, polymerization and isomerization.

Treatment methods: Sweetening, Hydrodesulphurization, and Smoke point Improvement. Safety and pollution consideration in refineries and Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Have knowledge on petroleum properties, resources and composition.
CO2 Familiarize on different exploration techniques.
CO3 Identify the petroleum products based on the properties and give specifications.
CO4 Differentiate separation processes required for refining of petroleum.
CO5 Understand different conversion processes and treatment methods of petroleum refining.

TEXT BOOKS:

1. Nelson. E.L., “Petroleum Refinery Engineering”, Fourth Edition, McGraw Hill, New York, 1985.
2. Bhaskara Rao. B.K. “Modern Petroleum Refining Process”, Oxford & IBH, New Delhi, 2010.

REFERENCES:

1. Sarkar. G.N. “Petroleum Refining”, Khanna Publishers, New Delhi, 1998.
2. Gary. J.H. and Glen. E.H., “Petroleum Refining: Technology and Economic”, Volume. V, Marcel Dekker Inc., New York, 1975.
3. Meyers. R.E., “Handbook of Petroleum Refining Process”, McGraw Hill, New York, 1986.
4. Ram Prasad., “Petroleum Refining Technology”, Khanna Publishers, 1st Edition, 2008

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Have knowledge on petroleum properties, resources and composition.	1		2				1						1	1	
CO2	Familiarize on different exploration techniques.	1		2				1						1	1	
CO3	Identify the petroleum products based on the properties and give specifications.	1		2				1						1	1	
CO4	Differentiate separation processes required for refining of petroleum.	1		2				1						1	1	
CO5	Understand different conversion processes and treatment methods of petroleum refining.	1		2				1						1	1	

818CHE03 **CHEMICAL PROCESS FLOW SHEETING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand importance of Flowsheets for Specific Processes.
- To understand the methods to generate and develop process alternatives, and how to evaluate and screen them quickly.
- To simulate the steady-state behavior of process flowsheets using a suitable simulation software.

UNIT – I FLOWSHEETING **09**

Introduction, Symbols, Flowsheet presentation with examples, Manual flowsheet calculation, Constrains and their applications in flowsheet calculations, Types of flow sheets, Synthesis of steady state flow sheet.

UNIT – II SEQUENTIAL MODULAR APPROACH TO FLOWSHEETING **09**

Solution, partitioning and tearing a flowsheet, convergence of tear streams with example.

UNIT – III FLOWSHEETING BY EQUATION SOLVING METHODS **09**

Selection, decision and tearing of variables in a flowsheet with simple and complex examples

UNIT – IV DEVELOPMENT OF FLOWSHEET **09**

Piping& Instrumentation Diagram (P&ID) development, typical stages and Applications of P&ID in design.

– Construction stage - Commissioning stage - Operating stage -Revamping stage

UNIT – V FLOWSHEET APPLICATIONS **09**

Flowsheeting software, Applications of P&ID in HAZOPS and Risk analysis in Pharma industries

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Know the basic concepts of flowsheeting on symbols and their presentation, the calculations involving constraints prevention.
CO2 Apply the sequential method for modular approach.
CO3 Gain the ability to solve complex problems using Equation modular approach.
CO4 Suitably apply P&ID methods for any process.
CO5 Understand various applications for Chemical Process plant Safety.

TEXT BOOKS:

1. Ernest E. Ludwig, Applied Process Design for Chemical and Petrochemical Plants Vol.I Gulf Publishing Company, Houston, 1989.
2. Max. S. Peters and K. D. Timmerhaus, Plant Design and Economics for Chemical Engineers, McGraw Hill, Inc., New York, 1991.

REFERENCES:

1. Anil Kumar, Chemical Process Synthesis and Engineering Design, Tata McGraw Hill publishing Company Limited, New Delhi 1981.
2. A.N. Westerberg, et al., Process Flowsheeting, Cambridge University Press, 1979.
3. Paul Benedek, Steady state flow sheeting of Chemical Plants, Elsevier.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Know the basic concepts of flowsheeting on symbols and their presentation, the calculations involving constraints prevention.	2	2											2	2	
CO2	Apply the sequential method for modular approach.	3	2											2	2	
CO3	Gain the ability to solve complex problems using Equation modular approach.	2	2		3									2	2	
CO4	Suitably apply P&ID methods for any process.	2												2	3	
CO5	Understand various applications for Chemical Process plant Safety.		2	2										2		

818CHE04 **ENTREPRENEURSHIP DEVELOPMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To give fundamentals of entrepreneurship and enhance the creativity to develop new chemical product and processes.
- To gain knowledge about Technological investment transfer of technology and characteristics of entrepreneur.
- To create an awareness about production efficiency and reduce sickness.

UNIT – I INTRODUCTION **09**

Introduction – productivity in India – resources – availability and mobilization – land, labour and capital – industrial growth in five year plan period – Human resource development

UNIT – II TECHNOLOGY AND INVESTMENT **09**

Technology and investment – industrial climate in India – Technological investment transfer of technology, factors influencing technical investment, NRI, capital market in India, technocrats, role of educational institutions – psychology of Indian technocrats as entrepreneur, characteristics of entrepreneur.

UNIT – III ENTREPRENEURSHIP DEVELOPMENT PROGRAMS **09**

Leadership – attitudes and aptitudes – qualities and development – risk taking and decision making – personal involvement value engineering techniques – value added products – value adding techniques – cost reduction techniques – waste control – alternate product application, functional value of the product – improvement and expansion.

UNIT – IV FINANCING **09**

Procedures for getting subsidies & licenses from both centre & state governments. - key elements of developing project report for getting financial assistance-Institutions involved in getting financial assistance.

UNIT – V MARKETING **09**

Marketing – India and International markets – market surveys – strategies and development of markets – need based marketing techniques. Business laws and regulations – company laws of India – taxation laws – labor laws – factories act – ESI act – workman compensation act.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the principle of Entrepreneurship and enhance the creativity to develop new chemical product and processes.

CO2 Analyze source of finance and financial management of new enterprises and prepare business plans.

CO3 Apply the principles of operation management to improve production efficiency and reduce sickness

CO4 Acquire sound knowledge about applications of various instruments in the required fields.

CO5 Apply importance of Human resource development, Leadership, Procedures for getting subsidies & Marketing.

TEXT BOOKS:

1. Meredith G, Nelson R.E., and P.A. Nech. The Practice of Entrepreneurship, I.L.O Published Geneva, 1982
2. Dirk Larkran, R. Profit Improvement Technology, College Book Publishing Company, Canada, 1981.

REFERENCES:

1. Sukumar Bhattacharya, Indian Direct, Taxes Wadhwa and Co., 1983.
2. Charantimath, Entrepreneurship Development & Small Business Enterprise, 1st Edition, Pearson Publications, 2009
3. Srivasthave, K.D.,Commentaries on Factories Act, 1948.
4. Khanka S.S, Entrepreneurial Development,16th Edition, Sultan Chand & Co.,2010
5. Vasant Desai, Dynamics of Entrepreneurial Development and Management, 13th Edition, Himalaya Publishing House, 2009.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the principle of Entrepreneurship and enhance the creativity to develop new chemical product and processes.						3	2	2	2	2		3	2		2
CO2	Analyze source of finance and financial management of new enterprises and prepare business plans.						3				2	3	3			2
CO3	Apply the principles of operation management to improve production efficiency and reduce sickness						2					3	3			2
CO4	Acquire sound knowledge about applications of various instruments in the required fields.						2						3	2		2
CO5	Apply importance of Human resource development, Leadership, Procedures for getting subsidies & Marketing.						3		2	3	3	3	3			3

818CHE05 AIR POLLUTION CONTROL AND DESIGN OF EQUIPMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To know the effects, sources and laws& regulations related to air pollution.
- To have knowledge of terminology, design equations for various equipment used for air pollution control.
- To design air pollution control equipments.

UNIT – I AIR POLLUTION-SELECTION OF AIR CONTROL EQUIPMENT 09

Introduction to air pollution, sources and effects, nature of pollutants from different process industries, laws and regulations.

Process parameters, operating conditions, gas characteristics, dust characteristics, performance required, process of selection, auxiliary equipment.

UNIT – II AIR POLLUTION MONITORING 09

Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants -Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Transport & Dispersion of Air Pollutants – Air Pollution Climatology.

UNIT – III CYCLONE SEPARATORS& FABRIC FILTERS 09

Introduction, principle and theory, terminology, design, operation and maintenance, improving performance of cyclone separator, bag filter and fabric filter.

UNIT – IV ELECTROSTATIC PRECIPITATOR &WET SCRUBBERS 09

Introduction, principle and theory, terminology on the following equipment: Electrostatic Precipitator, Spray towers and Venturi Scrubbers

UNIT – V AIR (P&CP) ACT, 1981 09

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand sources and effects of air pollution.
CO2 Know the techniques of monitoring air pollution
CO3 Design and improvise cyclone separator and fabric filter
CO4 Design and improvise electrostatic precipitator and wet scrubber
CO5 Understand Air act 1981

TEXT BOOKS:

1. Louis Theodore, "Air Pollution Control Equipment Calculations",John Wiley and Sons,2008.
2. Lawrence K. Wang, Norman C. Pereira, Yung-Tse Hung ,"Air Pollution Control Engineering", Volume 1,Humana Press,2004
3. Noel de Nevers, "Air Pollution Control Engg"., Mc Graw Hill, New York, 1995

REFERENCES:

1. Karl B. Schnelle,Jr, Charles A. Brown, "Air pollution control technology Handbook", CRC Press,2002.
2. Anjaneyulu. Y, “Air Pollution & Control Technologies” Allied Publishers (P) Ltd., India, 2002

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand sources and effects of air pollution.	2	2				2	3								2
CO2	Know the techniques of monitoring air pollution	2	2			1		3								2
CO3	Design and improvise cyclone separator and fabric filter		2	3	3			3						2		2
CO4	Design and improvise electrostatic precipitator and wet scrubber		2	3	3			3						2		2
CO5	Understand Air act 1981							3								2

818CHE06 DRUGS AND PHARMACEUTICAL TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- To gain fundamental knowledge about drugs, the basic engineering principles and unit operations pertaining to pharmaceutical plants.
- To learn about pharmacokinetic parameters like drug disposition, absorption, nonlinear and time dependant pharmacokinetics.
- To understand the principles involved in the determination and analysis of different bulk drugs and their formulation

UNIT – I INTRODUCTION 09

Development of drugs and pharmaceutical industry; organic therapeutic agents uses and Economics.

UNIT – II DRUG METABOLISM AND PHARMACO KINETICS & MICROBIOLOGICAL AND ANIMAL PRODUCTS 09

Drug metabolism; physicochemical principles; pharmaco kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones

UNIT – III IMPORTANT UNIT PROCESSES AND APPLICATIONS 09

Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation

UNIT – IV MANUFACTURING PRINCIPLES, PACKING AND QUALITY CONTROL 09

Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parential solutions, oral liquids; injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control

UNIT – V PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS 09

Products: Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others.

Analytical methods and tests: spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pH-metry

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the Drug Metabolism and pharmaco-kinetics principles .
CO2 Apply knowledge of unit processes and analytical methods to develop new processes and product formulations.
CO3 Demonstrate statistical quality control procedure and quality assurance programmes in various stages of pharmaceutical process.
CO4 Understand the formulation and use of excipients in tablets, powders, capsules, microcapsules and coating techniques.
CO5 Apply knowledge to design and develop new drug.

TEXT BOOKS:

1. Rawlines, E.A.; “Bentleys Text book of Pharmaceutics”, III Edition, Bailliere Tindall, London, 1977.

REFERENCES:

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the Drug Metabolism and pharmaco-kinetics principles .	2	1				1							2		2
CO2	Apply knowledge of unit processes and analytical methods to develop new processes and product formulations.	2		3										2		2
CO3	Demonstrate statistical quality control procedure and quality assurance programmes in various stages of pharmaceutical process.	2										2		2		
CO4	Understand the formulation and use of excipients in tablets, powders, capsules, microcapsules and coating techniques.	1	2	2			2	1	2				2	2		1
CO5	Apply knowledge to design and develop new drug.	1	2	3			2	1	2				2	2		1

818CHE07 **HETEROGENEOUS CATALYSIS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To gain knowledge about different types of heterogeneous catalysts, their structures, synthesis processes, characterisation.
- To understand the mechanism and kinetics of heterogeneous catalytic reactions
- To overview selected applications of heterogeneous catalysis

UNIT – I INTRODUCTION **09**

Catalyst- definition, Properties of catalyst, types of catalysis reaction, Heterogeneous catalytic processes and types of heterogeneous reactions. General definition of catalysis, Adsorption, adsorption isotherms, rates of adsorption, Physisorption and chemisorptions. Introduction and basic concept of green catalysis

UNIT – II CATALYST PREPARATION AND CHARACTERIZATION **09**

Selection, design, types and preparation of catalysts. Structure-property relationship and analysis: BET surface area and pore volume analysis, X-ray diffraction, scanning electron microscopy, infrared spectroscopy, Thermo analytical techniques.

UNIT – III KINETIC MODELING AND INTERPRETATION OF HETEROGENEOUS DATA ANALYSIS **09**

Mechanisms of solid catalyzed reactions: Rates of adsorption, desorption, surface reactions, rate determining steps, development of reaction mechanism. Deducing a rate law from the experimental data, Evaluation of Rate law parameters. Kinetic modeling and parameter estimations. Effect of external and internal transport processes on observed rate of reactions

UNIT – IV INDUSTRIAL CATALYTIC REACTORS AND LATEST DEVELOPMENTS **09**

Commercial Catalytic Reactors (Adiabatic, packed and fluidized bed, trickle bed and slurry reactors). Industrially important catalysts and processes such as oxidation, regeneration,New development in solid catalysis, monolith catalysts, nanocatalysts, Fuel cell catalysts, Environmental catalysts.
Heat and Mass transfer effects in heterogeneous catalysis, internal and external mass transfer

UNIT – V CATALYST DEACTIVATION **09**

Reactor design, catalyst applications and deactivation kinetics: Applications of heterogeneous catalysts in different fields, various deactivation models of solid catalysts

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the properties and adsorption characteristic of catalyst
CO2 Prepare and characterize various catalysts for heterogeneous catalytic reactionS.
CO3 Model the different systems and interpret the data
CO4 Apply the knowledge and design reactors for heterogeneous catalytic reactions
CO5 Develop deactivation mechanism and kinetics of catalyst

TEXT BOOKS:

1. Fogler H.S., “Elements of Chemical Reaction Engineering”, 4th ed., PHI, 2005.
2. J.J. Carberry, "Chemical and catalytic reaction Engineering", Dover Publications, 2001
3. R.A Sheldon, I. Arends, U. Hanefeld ‘Green Chemistry and Catalysis’, Wiley-VCH 2007

REFERENCES:

1. Lann D. Schmidt, “The Engineering of Chemical Reactions”, 2nd Edition, Oxford University Press, 2007.
2. J. M. Smith, “Chemical Engineering Kinetics”, 3 rd ed., MGH, 1981

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the properties and adsorption characteristic of catalyst	2												2		
CO2	Prepare and characterize various catalysts for heterogeneous catalytic reactions.	3	2											2		
CO3	Model the different systems and interpret the data	3	2											2		
CO4	Apply the knowledge and design reactors for heterogeneous catalytic reactions	2	2											2		
CO5	Develop deactivation mechanism and kinetics of catalyst	2												2		

818CHE08 **BIOREACTOR DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- Acquire the basic knowledge of fermentation its kinetics and designing of reactors and agitators.
- Understand the concept of mass transfer between two different phases in bioreactors.
- Impart the knowledge in various types of bioreactors and its functions.

UNIT – I FERMENTATION KINETICS **09**

Microbial, plant and animal cell culture – Batch, Continuous and Fed-batch culture. Kinetic relationships – parameters, variables and constraints, simple problems numerical problems.

UNIT – II MASS TRANSFER IN BIOREACTORS **09**

Importance of interfacial mass transfer in Biotechnology. Mass Transfer between phases – factors affecting mass transfer between phases. Mass Transfer in porous solids. Oxygen uptake in fermenters. Simple problems on topics. Study of mass transfer coefficient – KLA studies.

UNIT – III RHEOLOGY, AERATION AND AGITATION IN ANIMAL CELL BIOREACTORS **09**

Design, Operation and types of agitators and spargers, power and time requirements for agitation. Effects of agitation on mass transfer, Oxygen delivery system, foam control system, factors affecting antifoam requirements, Antifoam addition system.

UNIT – IV TYPES OF BIOREACTORS AND ACCESSORIES **09**

Description, working, advantages and limitations of stirred tank, Airlift, Bubbledriven, packed bed, fluidized bed, trickle bed, single use CV purified bioreactor and flocculated cell Bioreactors.

Description and functions of the following accessories for bioreactors: Pumps, filters, valves, steam traps and gas flow meters.

UNIT – V DESIGN OF A BIOREACTOR **09**

Basic functions of a fermenter for microbial or animal cell culture. Aseptic operation, sterilization and containment, temperature control. Reactor body construction – construction material. Reactor Dynamics. Design calculation for stirred tank Bioreactor. Simple problem on it.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Predict fermentation kinetics of growth, product formation, substrate utilization kinetics of bacteria
CO2 Design a bioreactor considering mass transfer between different phases
CO3 Design all accessories and internals like agitator, sterilizer, controllers etc
CO4 Analyze differences between reactor types and modes of operation, and exploit these differences for various design goals
CO5 Design of a bioreactor considering all its related problems

TEXT BOOKS:

1. Bailey and Ollis, Biochemical engineering fundamentals,2nd Ed. McGrawHill, 1986.
2. Michael L. Shuler, Fikret Kargi, Matthew DeLisa, Bioprocess Engineering: Basic Concepts, PHI, 3rd Ed, 2017
3. Atkinson B, Biochemical Reactors, Law Book Co of Australia, 1974

REFERENCES:

1. D.G.Rao, Introduction to Biochemical Engineering, Tata McGrawHill2005.
2. Van't Riet, K & J,Tramper,Basic Bioreactor Design –Marcel Dekkar Inc. New York 1991
3. Stanbury, P.F.A., Principles of Fermentation Technology, Whitaker & Hall, 1997. Aditya books

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Predict fermentation kinetics of growth, product formation, substrate utilization kinetics of bacteria	3											2	2		
CO2	Design a bioreactor considering mass transfer between different phases	2	1	3									2	2	2	
CO3	Design all accessories and internals like agitator, sterilizer, controllers etc	2	2	2									2	2		
CO4	Analyze differences between reactor types and modes of operation, and exploit these differences for various design goals	2	2	3									2	2	2	
CO5	Design of a bioreactor considering all its related problems	2	1	3									2	2	2	

818CHE09 **SUPPLY CHAIN MANAGEMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- Understand scope and different phases of Supply chain management
- Design fundamentals of supply chain network
- Gain knowledge on revenue flow and applications of technology in supply chain management

UNIT – I INTRODUCTION **09**

Definition of Logistics and SCM: Evolution, Scope, Importance& Decision Phases – Drivers of SC Performance and Obstacles

UNIT – II LOGISTICS MANAGEMENT **09**

Factors – Modes of Transportation - Design options for Transportation Networks-Routing and Scheduling – Inbound and outbound logistics- Reverse Logistics – 3PL- Integrated Logistics Concepts- Integrated Logistics Model – Activities - Measuring logistics cost and performance- Warehouse Management - Case Analysis

UNIT – III SUPPLY CHAIN NETWORK DESIGN **09**

Distribution in Supply Chain – Factors in Distribution network design –Design options-Network. Design in Supply Chain – Framework for network Decisions - Managing cycle inventory and safety.

UNIT – IV SOURCING, AND PRICING IN SUPPLY CHAIN **09**

Supplier selection and Contracts - Design collaboration - Procurement process. Revenue management in supply chain

UNIT – V COORDINATION AND TECHNOLOGY IN SUPPLY CHAIN **09**

Supply chain coordination - Bullwhip effect – Effect of lack of co-ordination and obstacles – IT and SCM - supply chain IT frame work. E Business & SCM. Metrics for SC performance – Case Analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply basic terminology and supply chain operations in the context of today's business environment.
CO2 Describe the logistics/supply chain system in oral and written presentations.
CO3 Analyse areas for improvement in logistics and supply chain operations.
CO4 Implement effective inventory management policy, demand variability, forecasting of revenue management.
CO5 Incorporate coordination and technology in supply chain.

TEXT BOOKS:

1. Sunil Chopra and Peter Meindl,Supply Chain Management, Strategy, Planning, and operation -- PHI, 2nd Edition, 2007.
2. David J.Bloomberg, Stephen Lemay and Joe B.Hanna,Logistics, PHI 2002.

REFERENCES:

1. Martin Christopher,Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service. Pearson Education Asia, 2ndEdition 1998.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply basic terminology and supply chain operations in the context of today's business environment.						2			3	2		2			2
CO2	Describe the logistics/supply chain system in oral and written presentations.									3	3		2			2
CO3	Analyse areas for improvement in logistics and supply chain operations.						2	2		2	3		2			2
CO4	Implement effective inventory management policy, demand variability, forecasting of revenue management.								1	2	3	2	2			2
CO5	Incorporate coordination and technology in supply chain.									3	3	2	2			2

818CHE10 **CORROSION ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To study the principles of different forms of corrosion
- To study the testing procedures and protection systems of corrosive materials
- To acquire knowledge regarding predicting corrosion behavior and designing process

UNIT – I INTRODUCTION **09**

Corrosion principles - electro-chemical aspects, environmental effects, economical, metallurgical and other aspects

UNIT – II FORMS OF CORROSION **09**

Forms of corrosion uniform attack, galvanic, crevice, pitting, Inter granular, selective, leaching, erosion and stress corrosion

UNIT – III CORROSION TESTING **09**

Classification - purpose - materials and specimens - Surface Preparation - Exposure Techniques - Standard Expression for Corrosion Rate - Huey Test for Stainless Steel - Streicher Test for Stainless Steel - Warren Test - NACE Test Methods - Slow - Strain - Rate Tests

UNIT – IV CORROSION PREVENTION **09**

Material Selection - Alteration of Environment - Design - Cathodic and Anodic Protection – Coatings

UNIT – V DESIGNING PROTECTION **09**

Modern Theory - Principles - Thermodynamics and Electrode Kinetics.
Modern Theory Applications - Predicting Corrosion Behavior - Corrosion Prevention - Corrosion Rate Measurement.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Learn the principles of Corrosion and understand the environmental effects.
CO2 Differentiate possible types of corrosion in a particular situation.
CO3 Apply different corrosion testing methods for a system.
CO4 Adopt different corrosion prevention methods.
CO5 Design and apply modern protection coatings.

TEXT BOOKS:

1. Fontana, M.G., Corrosion engineering, McGraw Hill, 3rd Ed., 2005.
2. Pierre R. Roberge,Corrosion Engineering Principles and Practice**,** McGraw Hill, 1stEdition, 2008.

REFERENCES:

1. R. Winston Revie, Uhlig'sHandbook of Corrosion, Wiley, 3rdedition, 2011.
2. Zaki Ahmad, Principles of Corrosion Engineering and Corrosion Control,Butterworth Heinemann,2006.

Course Articulation Matrix:

Cos	Course outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Learn the principles of Corrosion and understand the environmental effects.	2						2						3		
CO2	Differentiate possible types of corrosion in a particular situation.	2	2		2		1							2		
CO3	Apply different corrosion testing methods for a system.	2	1		2		1							2		
CO4	Adopt different corrosion prevention methods.	2					1							2		
CO5	Design and apply modern protection coatings.	1		3									2	1		

818CHE11 **MIXING TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To have complete knowledge on basic concepts, flow patterns in mixing processes involving low viscous and high viscous fluids.
- Understand inter-phase mass transfer effects in continuous and dispersed phase during agitation.
- Acquire knowledge of various parameters considered in the design of an agitated vessel for a process and scale-up..

UNIT – I INTRODUCTION TO MIXING **09**

Mixing-Application, Fluid Motion and Mixing – Description of diffusion and Mixing Process, Criteria for mixing, Laminar and Turbulent mixing. Impeller Characteristics – Power theory, Power correlations.

UNIT – II FLOW PATTERNS, AND FLOW VELOCITIES FOR LOW VISCOUS LIQUIDS **09**

Flow pattern and Power, Fluid property effects- Impeller and Power process selection. Relationship between flow pattern, fluid velocities, flow rates and mixing, Impelled discharge rates, Batch mixing and continuous mixing in agitated vessel, Flow regime and Flow map in agitated vessel.

UNIT – III MIXING OF HIGH VISCOSITY LIQUIDS& MASS TRANSFER **09**

Mixing of high viscosity materials – Fundamental Concepts, equipment, evaluation of goodness of mixing.

The role of dispersion in mass transfer, Measurement of physical properties of liquid dispersion, the mechanics of dispersion of liquids, Theory of mass transfer in continuous phases, continuous phase heat and mass transfer properties of dispersion.

UNIT – IV SUSPENSION OF SOLIDS **09**

Variable which affects uniformity of solid suspension, impellers and circulation patterns- Effects of vessel and auxiliary equipment on suspension, operating techniques, extrapolation of small-scale tests, Zwietering criteria of solid suspension.

UNIT – V SCALE-UP OF EQUIPMENT FOR AGITATING LIQUIDS **09**

Principles of similarity, design correlations, Common rules of thumb, agitation intensity, Scaling based on tests Procedure for scale-up.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Identify required mixing process for a system.
CO2 Characterize flow patterns and velocities in mixing of different fluids.
CO3 Apply the effects of viscosity and mass transfer in a mixing process.
CO4 Elaborate on a suitable mixing process for heterogeneous systems.
CO5 Design equipment for a mixing process.

TEXT BOOKS:

1. Uhl V.W. and Gray J.B. “Mixing Theory and Practice”, Volume I, II and III, Academic Press. Inc., 1966.

REFERENCES:

1. Nagata S., “Mixing Principles and Applications”, Kodansha Ltd., Tokyo, 1975

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Identify required mixing process for a system.	2	2											2		
CO2	Characterize flow patterns and velocities in mixing of different fluids.	3	2	2										3		
CO3	Apply the effects of viscosity and mass transfer in a mixing process.	3	2											3		
CO4	Elaborate on a suitable mixing process for heterogeneous systems.	3												3		
CO5	Design equipment for a mixing process.	3	2	3										3	2	

818CHE12 PROFESSIONAL ETHICS AND HUMAN VALUES L T P C
3 0 0 3

COURSE OBJECTIVES

- Create awareness on professional ethics and human values.
- Provide basic familiarity about engineers as responsible experimenters, research ethics, codes of ethics, industrial standards.
- Inculcate knowledge and exposure on different safety aspects of a process and intellectual property rights.

UNIT – I HUMAN VALUES 09

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality.

UNIT – II ENGINEERING ETHICS 09

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 09

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law – The NASA's Challenger Case Study

UNIT – IV SAFETY, RESPONSIBILITIES AND RIGHTS 09

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – The Three Mile Island and Chernobyl Case Studies Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

UNIT – V GLOBAL ISSUES 09

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Sample Code of Conduct

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Implement awareness of professional ethics and human values.
CO2 Pursue career with professional ethics by adopting ethical theories
CO3 Work with more responsibility by understanding various social issues by adopting various industrial standards.
CO4 Adopt various safety procedures in the professional environment and safe guard IPR.
CO5 Judge role in various global issues and apply ethical principles to resolve situations

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.

REFERENCES:

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", Thompson Wadsworth, A Division of Thomson Learning Inc., United States, 2000
3. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Implement awareness of professional ethics and human values.						3		3	2	3		3			3
CO2	Pursue career with professional ethics by adopting ethical theories						2		3	2			3			3
CO3	Work with more responsibility by understanding various social issues by adopting various industrial standards.						2		3				3			3
CO4	Adopt various safety procedures in the professional environment and safe guard IPR.						2	3	3				3			3
CO5	Judge role in various global issues and apply ethical principles to resolve situations						2		3				3			3

OPEN ELECTIVES

618BTO04 HEALTH & PHARMACEUTICAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To have the basic knowledge of pharmacology
- To gain knowledge in various dosage forms and biopharmaceutics
- To be able to understand in pharmacokinetics and drug discovery

PREREQUESTIE

Biochemistry

UNIT – I INTRODUCTION TO PHARMACOLOGY 09

Historical outlines of drugs, classifications of drugs, physico-chemical properties of drugs, Routes of administration of drugs, drug metabolism, controlled release drug delivery system, drug stability, Sources: plant, marine and microorganisms

UNIT – II DRUG DISCOVERY AND DEVELOPMENT 09

Introduction, basic clinical evolution of new drugs, bioavailability of drugs, quantitative and qualitative assay of drugs by biological testing, packing techniques like compression of tablets, wet & dry granulation, direct compression, tablet presses and coating

UNIT – III PHARMACOKINETICS AND BIOTRANSFORMATION 09

Pharmacokinetics: introduction, absorption, distribution, elimination and metabolism of drugs, site of action, Phase I and Phase II reactions, pro drugs, adverse drug effects, Role of Enzymes in drug metabolism

UNIT – IV PHARMACEUTICAL DOSAGE FORMS AND APPLICATIONS 09

Oral solid dosage forms, compressed tablets, types, pills, solutions, syrups, juices, nasal solutions, emulsions, lotions and extracts. Applications of various drugs in human body and site of action

UNIT – V BIO PHARMACEUTICALS 09

Various categories of therapeutics like vitamins, laxatives, analgesics, contraceptives, common drugs which are abused, antibiotics, human insulin, interferon, somatostatin, somatotropin - its preservation and analytical methods

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Drugs, drugs action, drug metabolism
CO2 Drug development, bioavailability
CO3 Various dosage forms of Biopharmaceuticals
CO4 The recent evolution in pharmaceutical biotechnology
CO5 Evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market

TEXT BOOKS:

1. Remington, “The science and practice of pharmacy”, Lippincott Williams and Wilkins, 20th edition,2001
2. Gareth Thomas, Medicinal Chemistry an Introduction”, John Wiley, New Delhi, 2000
3. RamI.Mahato,AjitS.Narang,“PharmaceuticalDosageFormsandDrugDelivery”,2nd Edition CRC Press, 2011

REFERENCES:

1. Katzung, B.G. “Basic and Clinical Pharmacology”, Prentice Hall of India, New Delhi., 1995
2. Tripathi, K.D. “Essentials of Medical Pharmacology”, Jaypee Brothers Medical Publishers (P) Ltd, 6th edition, John Wiley, New Delhi, 2000

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Drugs, drugs action, drug metabolism	3			2						1	1				3
CO2	Drug development, bioavailability		2		2				2			2			2	
CO3	Various dosage forms of Biopharmaceuticals		2	2		2			1			1			2	
CO4	The recent evolution in pharmaceutical biotechnology		2		2				2			2			2	
CO5	Evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market					2		2				2			2	

518BTO06 ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the fundamentals of biotechnological concepts
- To develop the skills in the area of environmental biotechnology
- To know the conversion of waste into energy using microorganisms
- To understand about the eco-friendly bio products from renewable sources
- To improve the skills in the area of wastewater treatment technology

PREREQUESTIE

Environmental Science & Engineering

UNIT – I BIOGEOCHEMICAL ROLE OF SOIL MICROORGANISMS **09**

Microbial flora of soil-Interactions among soil microorganisms-Nitrogen cycle-Carbon cycle-Sulfur cycle- Phosphorous cycle

UNIT – II BIODEGRADATION **09**

Aerobic degradation of recalcitrant organic compounds by microorganisms-Growth associated degradation of aliphatic-Diversity of aromatic compounds-Co-metabolic degradation of organopollutants – Degradative capacities of fungi. Anaerobic degradation of organic compounds -Degradation of hydrocarbons-Alkyl compounds-ketones-Aromatic compounds-Halogenated organics-Sulfonates-Nitroorganics.

UNIT – III BIOREMEDIATION TECHNOLOGIES **09**

Remediation technologies-Bioventing-Biosparging and bioslurping- Phytoremediation-Bio Desulphurization of coal and oil-Microbial transformation of heavy metals-Bioleaching, bioaccumulation – Bio sorption and bio precipitation of heavy metals

UNIT – IV ECO-FRIENDLY BIOPRODUCTS FROM RENEWABLE SOURCES **09**

Fundamentals of composting process-Composting technologies-Composting systems-Compost quality-Biofertilizers-Biopesticides-Scientific aspects and prospects of biofuel production-Bioethanol-Bio hydrogen and biodiesel- Biogas plant digester.

UNIT – V BIOLOGICALTREATMENT OFWASTE WATER **09**

Physical and chemical characteristics of wastewater-Biological processes for wastewater treatment- Activated sludge process-Trickling filter-Rotating biological contactors-Fluidized bed reactor-Upflow anaerobic sludge blanket reactor(UASB)-High-rate anaerobic waste water treatment.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Develop and improve in standard of living
CO2 Understand the dynamic process integrated themes related to biodiversity
CO3 Envision the surrounding environment its function with technology
CO4 Understand the structure and biochemical aspects of various microbes
CO5 Acquire knowledge about the renewable forms of energy and its features of biomass and its utilization

TEXT BOOKS:

1. Jordening,H.J.andWinter,J.,"EnvironmentalBiotechnology:ConceptsandApplication", Wiley- VCHVerlag,2005
2. Evans,G.M.andFurlong,J.C.,"EnvironmentalBiotechnology:TheoryandApplication",JohnWileyand Sons, 2003.
3. Bhattacharya,B.C.andBanerjee,R.,"EnvironmentalBiotechnology",OxfordUniversityPress, 2007.
4. Rajagopalan,R,' Environmental Studies- Crisisto Cure', Oxford University Press, 2005.
5. G.Tyler Miller and Scott E. Spoolman," Environmental Science", Cengage Learning India PVT,LTD, Delhi, 2014.

REFERENCES:

1. Pelczar,M.J.,Chan,E.C.S.andKrieg,N.R.,"Microbiology",TataMcGraw-Hill,2005.
2. Rittmann,B.E.and Mc Carty,P.L.,"Environmental Biotechnology:Principles and Applications",McGraw-Hill,2001.
3. DharmendraS.Sengar,'Environmental law',Prentice hall of India PVTLTD,New Delhi,2007.
4. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I)Pvt,Ltd, Hydrabad,2015.

EBOOKS/WEBLINKS

1. http://www.pdfdrive.com/environmental-biotechnology-principles-and-applications-e157042082.html
2. http://www.pdfdrive.com/environmental-science-e12033451.html
3. http://www.pdfdrive.com/environmental-biotechnology-theory-and-application-e7353867.html

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Develop and improve in standard of living	3			2						1	1				
CO2	Understand the dynamic process integrated themes related to biodiversity		2		2				2			2			2	
CO3	Envision the surrounding environment its function with technology		2	2		2			1			1			2	
CO4	Understand the structure and biochemical aspects of various microbes		2		2				2			2			2	
CO5	Acquire knowledge about the renewable forms of energy and its features of biomass and its utilization					2		2				2			2	

518MEO01 **FINITE ELEMENT ANALYSIS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To interpret the mathematical and physical principles underlying the Finite Element Analysis.
- To acquire knowledge about the characteristics of various one dimensional elements for the problems being solved.
- To explain about the finite element equations for simple and complex elements.
- To learn how the finite element method is implemented in vibration analysis.
- To develop finite element formulations of engineering problems from a variety of application areas including heat transfer and fluid flow analysis

PREREQUESTIE

Knowledge of Engineering Mathematics, Strength of Materials, Engineering Thermodynamics, Dynamics of Machinery are required

INTRODUCTION (Not for examination) **04**

Solution to engineering problems - Mathematical modeling - Discrete and Continuum modeling - need for numerical methods of solution - Relevance and scope of finite element methods - engineering applications of FEA

UNIT – I **FINITE ELEMENT FORMULATION OF BOUNDARY VALUE PROBLEMS** **08**

Weighted residual methods -Cieneral weighted residual statement - Weak formulation of the weighted residual statement - Piecewise continuous irial functions- Principle of stationary tolal potential - Rayleigh Ritz method - Piecewise continuous trial functions – Solution of equilibrium problems – Gaussian elimination method – Rayleigh Ritz method – Galerkin method.

UNIT – II **ONE DIMENSIONAL FINITE ELEMENT ANALYSIS** **08**

General form of total potential for 1 D applications - Generic form of finite element equations - linear bar element – Quadratic bar element -Nodal approximation - Development of shape functionsElement matrices and vectors - Example problems - Extension to plane truss- Development of Element equations - assembly - Element connectivity - Global equations - Solution methods - Beam element - Nodal approximation - Shape functions - Element matrices and vectors - A.ssembly - solution - Example problems.

UNIT – III **TWO DIMENSIONAL FINITE ELEMENT ANALYSIS** **09**

Introduction - Approximation of geometry and field variable - S noded triangular elements - four noded rectangular elements - Higher order elements - Natural coordinates and coordinate transformations - Triangular and quadrilateral elements - Iso-parametric elements - Structural mechanics applications in 2 Dimensions - Elasticity equations - stress strain relations - plane problems of elasticity - Element equations - Assembly - Need for quadrature formule - transformations to natural coordinates - Gaussian quadrature - Example problems in plane stress, Plane strain and Axisymmetric applications

UNIT – IV **DYNAMIC ANALYSIS USING FINITE ELEMENT METHOD** **08**

Introduction - Vibrational Problems - Equations of motion based on weak form - Axial vibration of bars - Transverse vibration of beams - Consistent mass malices and lumped mass matrices- element equations -Solution of eigen value problems - Vector iteration methods.

UNIT – V **APPLICATIONS IN HEAT TRANSFER & FLUID FLOW ANALYSIS** **08**

Basic equation of steady state heat transfer and fluid flow problems – I D finite element formulation – I D heat transfer and fluid flow problems - Scalar variable problems in 2Dimensions - Applications to heat transfer in 2 Dimension

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Identify mathematical model for solution of common engineering problems
CO2 Formulate one dimensional finite element equation for simple problems
CO3 Examine 2-D finite element continuum for structural applications
CO4 Formulate and solve vibration problems using finite element techniques
CO5 Solve 1-D and 2-D heat transfer and fluid flow problems using finite element approach

TEXT BOOKS:

1. Logan D.L., "A First Course in the Finite Element Method", 6" Edition, Thomson Learning. 2016
2. P.Seshu, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2012.

REFERENCES:

1. Rao S.S, "The Finite Element Method in Engineering", Butterworth-Heinemann (An imprint of Elsevier), 6th Edition, 2018.
2. I.N.Reddy, "An Introduction to the Finite Element Method", McGraw-Hill International 3rd Editions, 2017.
3. David V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Edition 2017.
4. Chandrupatla T.R. & Belagundu A.D., "Introduction to Finite Elements in Engineering", Pearson Education, New Delhi, 4 Edition, 2014.
5. K.J. Bathe, "Finite Element Procedures", Prentice-Hall India Pvt. Ltd., New Delhi, 2" Edition, 2014.
6. Chennakesava R Alavela, "FEM: Basic Concepts and Applications", Prentice Hall India Pvt. Ltd, New Delhi, 2012
7. Cook R.D., Malkus D.S., Plesha M.E., and Witt R.J., "Concepts and Applications of Finite Element Analysis", Wiley India (P) Ltd., New Delhi, 4 th Edition, 2007.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Identify mathematical model for solution of common engineering problems	3		2			1				1	1				1
CO2	Formulate one dimensional finite element equation for simple problems	3		2			1				1	1			2	
CO3	Examine 2-D finite element continuum for structural applications		2	2		1		1						1		
CO4	Formulate and solve vibration problems using finite element techniques	3		2			2		2			2		1		
CO5	Solve 1-D and 2-D heat transfer and fluid flow problems using finite element approach	3		2			2		2			2		1		

MANDATORY COURSE

418MC01	INDIAN CONSTITUTION	L	T	P	C
		1	0	0	0

COURSE OBJECTIVES

- To know about Indian constitution.
- To know about central and state government functionalities in India.
- To know about Indian society

UNIT – I INTRODUCTION **03**

Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.

UNIT – II STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT **03**

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review

UNIT – III STRUCTURE AND FUNCTION OF STATE GOVERNMENT **03**

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts

UNIT – IV CONSTITUTION FUNCTIONS **03**

Indian Federal System – Center – State Relations – President‟s Rule – Constitutional Amendments – Constitutional Functionaries – Assessment of working of the Parliamentary System in India

UNIT – V INDIAN SOCIETY **03**

Society : Nature, Meaning and definition; Indian Social Structure; Caste, Religion, Language in India; Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections

TOTAL: 15 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the functions of the Indian government
CO2 Understand and abide the rules of the Indian constitution
CO3 Understand and appreciate different culture among the people.

TEXT BOOKS & REFERENCES

1. Durga Das Basu. Introduction to the Constitution of India. Prentice Hall of India, New Delhi
2. R. C. Agarwal. Indian Political System. S. Chand and Company, New Delhi:1997.
3. Maciver and Page. Society: An Introduction Analysis, Mac Milan India Ltd., New Delhi.
4. K. L. Sharma. Social Stratification in India: Issues and Themes. Jawaharlal Nehru University, New Delhi:1997.

Gender based Courses

X18ECT01	GENDER, CULTURE AND DEVELOPMENT	L	T	P	C
		1	0	0	0

COURSE OBJECTIVES

- To familiarize with the concepts of sex and gender through literary and media.
- To help students ask critical questions regarding gender roles in society.
- To provide students with the material to discuss gender issues such as gender based discrimination, violence and development.
- To help students think critically about gender-based problems and solutions.
- To help students to analyse impact of gender-based society and culture.

UNIT – I INTRODUCTION TO GENDER **03**

Definition of Gender - Basic Gender Concepts and Terminology -Exploring Attitudes towards Gender -Social Construction of Gender

UNIT – II GENDER ROLES AND RELATIONS **03**

Types of Gender Roles- Gender Roles and Relationships Matrix -Gender-based Division and Valuation of Labour

UNIT – III GENDER DEVELOPMENT ISSUES **03**

Identifying Gender Issues -Gender Sensitive Language- Gender, Governance and Sustainable Development - Gender and Human Rights- Gender and Mainstreaming

UNIT – IV GENDER-BASED VIOLENCE **03**

The concept of violence- Types of Gender-based violence- The relationship between gender, development and violence-Gender-based violence from a human rights perspective

UNIT – V GENDER AND CULTURE **03**

Gender and Film - Gender, Media and Advertisement

TOTAL: 15 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Critically read literary and media texts and understand the underlying gender perspectives in them
- CO2 Analyse current social events in the light of gender perspectives
- CO3 Discuss, analyse and argue about issues related to gender
- CO4 Analyse and differentiate between gender-based violence
- CO5 Discuss the gender based impact on society, culture and development

TEXT BOOKS:

1. Sukhu and Dukhu (Amar Chitra Katha). [Unit 1]
2. The Cat who Became a Queen (Folk tale, J. Hinton Knowles, Folk-Tales of Kashmir.London: Kegan Paul, Trench, Trübner, and Company, 1893, pp. 8-10.). [Unit 1]
3. Muniyakka (Short Story, Lakshmi Kannan, Nandanvan and Other Stories, Hyderabad: Orient Blackswan, 2011). [Unit 2]
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