HINDUSTHAN

COLLEGE OF ENGINEERING ANDTECHNOLOGY

(An Autonomous Institution)

Coimbatore– 641032

DEPARTMENT OF CHEMICAL ENGINEERING

CURRICULUM

(UNDER REGULATIONS 2022)

Hindusthan College of Engineering and Technology

Approved by AICTE, New Delhi, Accredited with 'A' Grade by NAAC

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Coimbatore – 641 032

DEPARTMENT OF CHEMICAL ENGINEERING

REGULATION-2022

B.TECH. CHEMICAL ENGINEERING

I TO VIII SEMESTERS CURRICULUM (BATCH 2022-2026)

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER I											
Theory											
1.	**22MA1101**	Matrices and Calculus	BSC	3	1	0	4	4	40	60	100
2.	22ME1201	Engineering Drawing	ESC	1	4	0	3	5	40	60	100
Theory with Lab Component											
3.	22HE1151	English for Engineers	HSC	2	0	2	3	4	50	50	100
4.	22PH1151	Engineering Application of Physics	BSC	2	0	2	3	4	50	50	100
5.	22IT1151	Python Programming and Practices	ESC	2	0	2	3	4	50	50	100
EEC Courses (SE/AE)											
6.	**22HE1095**	Universal Human Values	AEC	2	0	0	1	2	40	60	100
7.	**22HE1072**	Entrepreneurship & Innovation	AEC	1	0	0	1	1	100	0	100
8.	**22HE1073**	Introduction to Soft skills	AEC	2	0	0	1	1	100	0	100
Mandatory Courses											
9.	**22MC1093/ 22MC1094**	□□□□□□□□□□ /Heritage of tamil	MC	2	0	0	**0**	2	0	0	0
			TOTAL	**15**	**5**	**6**	**19**	**27**	**370**	**330**	**700**
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER II											
1	**22MA2104**	Fourier Analysis and Laplace Transforms	BSC	3	1	0	4	4	40	60	100
2	**22PH2101**	Basics of Material Science	BSC	2	0	0	2	2	40	60	100
3	**22CY2101**	Environmental Studies	ESC	2	0	0	2	2	40	60	100
4	22CH2201	Introduction to Chemical Engineering	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5	**22CY2151**	Chemistry for Engineers	BSC	2	0	2	3	4	50	50	100
6	**22HE2151**	Effective Technical Communication	HSC	2	0	2	3	4	50	50	100
Practical											
7.	**22ME2001**	Engineering Practices	ESC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
8.	**22HE2071**	Design Thinking	AEC	1	0	2	2	3	100	0	100
9.	**22HE2072**	Soft Skills and Aptitude-I	SEC	1	0	0	1	1	100	0	100
Mandatory Courses											
10.	**22MC2093**	NCC */NSS / YRC / Sports / Clubs / Society Service - Enrollment	MC	All students shall enroll, on admission, in anyone of the personality and character development programmes and undergo training for about 100 hours							
11.	**22MC2094/ 22MC2095**	□□□□□□□□□□□□□□□□□□□□ □□□□□/ TAMILS AND TECHNOLOGY	MC	2	0	0	0	2	0	0	0
			TOTAL	**18**	**1**	**10**	**22**	**29**	**520**	**380**	**900**
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER III											
Theory											
1.	**22MA3107**	Numerical Methods	BSC	3	1	0	4	4	40	60	100
2.	22CH3201	Chemical Process Calculations	PCC	3	1	0	4	3	40	60	100

3.	22CH3202	Fluid Flow Operations	PCC	3	0	0	3	3	40	60	100
4.	22CH3203	Chemical Engineering Thermodynamics – I	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5.	22CH3251	Mechanical Operations	PCC	2	0	2	3	4	50	50	100
6.	22ME3253	Basic Mechanical Engineering	ESC	2	0	2	3	4	50	50	100
Practical											
7.	22CH3001	Fluid Flow Operations Lab	AEC	0	0	4	2	4	60	40	100
8.	22CH3002	Technical Analysis Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
9.	22HE3071	Soft Skills -2	SEC	1	0	0	1	1	100	0	100
Mandatory Course											
10	22MC3091	Essence of Indian Traditional Knowledge	AC	2	0	0	0	2	100	0	100
			TOTAL	**17**	**2**	**12**	**25**	**30**	480	420	900
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER IV											
Theory											
1.	22HE4101	IPR and Start-ups(Common)	HSC	2	0	0	2	2	40	60	100
2.	22CH4201	Mass Transfer Operations - I	PCC	3	0	0	3	3	40	60	100
3.	22CH4202	Chemical Engineering Thermodynamics – II	PCC	3	0	0	3	3	40	60	100
4.	22CH4203	Process Heat Transfer	PCC	3	0	0	3	3	40	60	100
5.	22CH4204	Chemical Process Industries	PCC	2	0	0	2	2	40	60	100
Theory with Lab Component											
6.	**22EE4251**	Basics of Electrical &Electronics Engineering	ESC	1	0	2	2	3	50	50	100
7.	22CH4251	Chemical Reaction Engineering - I	PCC	2	0	2	3	4	50	50	100
8.	**22MA4151**	Probability and statistics with R programming	BSC	2	0	2	3	4	50	50	100
Practical											
9.	22CH4001	Heat Transfer Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
10.	22HE4071	Soft Skills -3(Common)	SEC3	1	0	0	1	1	100	0	100
Mandatory Courses											
11	22MC4091	Indian Constitution	AC	2	0	0	0	2	100	0	100
			TOTAL	**21**	**0**	**10**	**24**	**31**	510	490	1000
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER V											
Theory											
1.	22CH5201	Mass Transfer Operations - II	PCC	3	0	0	3	3	40	60	100
2.	22CH5202	Process Instrumentation Dynamics and Control	PCC	3	0	0	3	3	40	60	100
3.	22CH53XX	Professional Elective-1	PEC	3	0	0	3	3	40	60	100
4.	22CH53XX	Professional Elective-2	PEC	3	0	0	3	3	40	60	100
5.	22CH53XX	Professional Elective-3	PEC	3	0	0	3	3	40	60	100
Theory with Lab Component											
6.	22CH5251	Chemical Reaction Engineering - II	PCC	2	0	2	3	4	50	50	100
Practical											
7.	22CH5001	Mass Transfer Operations Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
8.	22HE5071	Soft Skills -4/Foreign languages	SEC	1	0	0	1	1	100	0	100
			TOTAL	**17**	**1**	**6**	**21**	**24**	410	390	800

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER VI											
Theory											
1.	22CH6201	Transport Phenomena	PCC	3	0	0	3	3	40	60	100
2.	22CH6202	Instrumental Method of Analysis	PCC	3	0	0	3	3	40	60	100
3.	22HE6101	Professional Ethics (Common)	HSC	3	0	0	3	3	40	60	100
4.	22CH63XX	Professional Elective-4	PEC	3	0	0	3	3	40	60	100
5.	22CH63XX	Professional Elective-5	PEC	3	0	0	3	3	40	60	100
6.	22XX64XX	Open Elective – 1*	OEC	3	0	0	3	3	40	60	100
Practical											
7.	22CH6001	Process Control Lab	PCC	0	0	4	2	4	60	40	100
8.	22CH6002	Computational Chemical Engineering Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
9.	22HE6071	Soft Skills – 5(Common)	SEC	2	0	0	2	2	100	0	100
			TOTAL	**20**	**0**	**8**	**24**	**28**	460	440	900

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER VII											
Theory											
1.	22CH7201	Process Economics and Engineering Management	PCC	3	0	0	3	3	40	60	100
2.	22CH7202	Process Equipment Design	PCC	3	1	0	4	4	40	60	100
3.	22CH7203	Bio Chemical Engineering	PCC	3	0	0	3	3	40	60	100
4.	22CH73XX	Professional Elective-6	PEC	3	0	0	3	3	40	60	100
5.	22XX74XX	Open Elective – 2*	OEC	3	0	0	3	3	40	60	100
Practical											
6.	22CH7001	Design and Simulation Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
7.	22CH7701	Internship	SEC	-	-	-	2	2	100	0	100
			TOTAL	**15**	**1**	**4**	**20**	**22**	360	340	700

* - Four weeks internship carries 2 credit and it will be done in before Semester VI summer vacation/placement training and same will be evaluated in Semester VII.

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER VIII											
EEC Courses (SE/AE)											
1.	22CH8901	Project Work/Granted Patent(Common)	SEC	0	0	20	10		100	0	100
			TOTAL	**0**	**0**	**20**	**10**	**20**	**100**	**0**	**100**

* 1. As per the AICTE guideline, in Semester I, II, III & IV NCC one credit subject is added as Value Added Course with Extra Credit. Further, the students' who enrolled his/her name in HICET NCC and Air Wing are eligible to undergo this subject. The earned extra credits printed in the Consolidated Mark sheet as per the regulation.

2. NCC course level 1 & Level 2 will be added in the list of open elective subjects in the appropriate semester. Further, the students' who have opted NCC subjects in Semester I, II, III & IV are eligible to undergo NCC Open Elective Subjects.

3. The above-mentioned NCC Courses will be offered to theStudents who are going to be admitted in the Academic Year 2021 – 22.

SEMESTER WISE CREDIT DISTRIBUTION

B.E. / B.TECH.PROGRAMMES									
S.No.	**Course Area**	**Credits per Semester**							**Total Credits**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
1	HSC	3	3	-	2	-	3	-	-	**11**
2	BSC	7	9	4	3	-	-	-	-	**23**
3	ESC	6	4	3	2	-	-	-	-	**15**
4	PCC	-	3	15	16	11	10	12	-	**67**
5	PEC	-	-	-	-	9	6	3	-	**18**
6	OEC	-	-	-	-	-	3	3	-	**6**
7	EEC	3	3	3	1	1	2	2	10	**25**
8	MC	✓	✓							
Total		**19**	**22**	**25**	**24**	**21**	**24**	**20**	**10**	**165**

OPEN ELECTIVE I (EMERGING TECHNOLOGIES)
To be offered for the students other than CSE, IT, AI&ML, ECE & BIOMEDICAL

SL. NO.	**Course Code**	**Course Title**	**Category**	**Periods Per week**			**Total Contact Periods**	**Credits**
				L	**T**	**P**		
1	22AI6451	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2	22CS6451	Blockchain Technology	OEC	2	0	2	4	3
3	22EC6451	Cyber security	OEC	2	0	2	4	3
4	22EC6452	IoT Concepts and Applications	OEC	2	0	2	4	3
5	22IT6451	Data Science and Analytics	OEC	2	0	2	4	3
6	22BM6451	Augmented andVirtual Reality	OEC	2	0	2	4	3

OPENELECTIVE I
To be offered for the students other than AUTO, AERO, AGRI, MECH, MCTS, CIVIL, EEE, CHEMICAL, FOOD TECH, E&I

SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PERIODS PERWEEK**			**TOTAL CONTACT PERIODS**	**CREDITS**
				L	**T**	**P**		
1	22AE6401	Space Science	OEC	3	0	0	3	3
2	22MT6401	Introduction to Industrial Engineering	OEC	3	0	0	3	3
3	22MT6402	Industrial Safety and Environment	OEC	3	0	0	3	3
4	22CE6401	Climate Change and its Impact	OEC	3	0	0	3	3
5	22CE6402	Environment and Social Impact Assessment	OEC	3	0	0	3	3

6	22ME6401	Renewable Energy System	OEC	3	0	0	3	3
7	22ME6402	Additive Manufacturing systems	OEC	3	0	0	3	3
8	22EI6401	Introduction to Industrial Instrumentation and Control	OEC	3	0	0	3	3
9	22EI6402	Graphical Programming using Virtual Instrumentation	OEC	3	0	0	3	3
10	22AU6401	Fundamentals of Automobile Engineering	OEC	3	0	0	3	3
11	22AU6402	Automotive Vehicle Safety	OEC	3	0	0	3	3
12	22EE6401	Digital Marketing	OEC	3	0	0	3	3
13	22EE6402	Research Methodology	OEC	3	0	0	3	3
14	22FT6401	Traditional Foods	OEC	3	0	0	3	3
15	22AG6401	Urban Agriculture and Organic Farming	OEC	3	0	0	3	3
16	22CH6401	Waste to Energy Conversion	OEC	3	0	0	3	3

Note:Non Circuit Departments can add one Open Elective course in the above list to offer for the circuit branches

OPENELECTIVE II

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22LS7401	General studies for competitive examinations	OEC	3	0	0	3	3
2	22LS7402	Human Rights, Women Rights and Gender equity	OEC	3	0	0	3	3
3	22LS7403	Indian ethos and Human values	OEC	3	0	0	3	3
4	22LS7404	Financial independence and management	OEC	3	0	0	3	3
5	22LS7405	Yoga for Human Excellence	OEC	3	0	0	3	3
6	22LS7406	Democracy and Good Governance	OEC	3	0	0	3	3
7	22LS7407	NCC Level - II	OEC	3	0	0	3	3
8	22LS7408	Cybercrime And Awareness	OEC	3	0	0	3	3
9	22LS7409	First Aid And Emergency Care	OEC	3	0	0	3	3
10	22LS7410	Business Communication	OEC	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Petroleum Process Technology	Vertical II Energy Engineering	Vertical III Biochemical Engineering	Vertical IV Environmental and Safety Engineering	Vertical V Computation Chemical Engineering	Vertical VI Blue Economy and Ocean Studies
Petroleum Chemistry and Refining Fundamentals	Bioenergy	Biochemistry	Membrane Separation Process	Computational Techniques	Aquaculture and Fisheries Business Management
Primary Refining Technology	Renewable Energy Resources	Bioprocess Technology	Waste Water Treatment	Optimization of Chemical Processes	Climate-Resilient Coastal and Ocean Entrepreneurship
Secondary Refining Technology	Pinch Technology	Fermentation & Bioprocessing	Solid waste Management	Process Modeling and Simulation	Marine and Coastal Resource Management
Refinery Advancements and Environmental Regulations	Hydrogen and Fuel Cell Technology	Bio separation & Downstream Processing	Environmental Impact Assessment	Pinch Analysis and Heat Exchange Network Design	Ocean Engineering
Petroleum Equipment Design	Power Plant Engineering	Enzyme Immobilisation Technology	Chemical Process Plant Safety	Chemical Process Flow sheeting	Sustainable Marine Resources and Circular Economy
Petrochemical Technology	Non-Renewable Energy Sources	Bioreactor Design	Carbon Capture Technology	Computational Fluid Dynamics	Blue Economy Entrepreneurship
Note: Students are permitted to choose all Professional Electives from a particular vertical					

DETAILS OF VERTICAL I :PETROLEUM PROCESS TECHNOLOGY											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5301	Petroleum Chemistry and Refining Fundamentals	PEC	3	0	0	3	3	40	60	100
2.	22CH5302	Primary Refining Technology	PEC	3	0	0	3	3	40	60	100
3.	22CH5303	Secondary Refining Technology	PEC	3	0	0	3	3	40	60	100
4.	22CH5310	Refinery Advancements and Environmental Regulations	PEC	3	0	0	3	3	40	60	100
5.	22CH5311	Petroleum Equipment Design	PEC	3	0	0	3	3	40	60	100
6.	22CH5312	Petrochemical Technology	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL II :ENERGY ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5304	Bioenergy	PEC	3	0	0	3	3	40	60	100
2.	22CH5305	Renewable Energy Resources	PEC	3	0	0	3	3	40	60	100
3.	22CH5306	Pinch Technology	PEC	3	0	0	3	3	40	60	100
4.	22CH5313	Hydrogen And Fuel Cell Technology	PEC	3	0	0	3	3	40	60	100
5.	22CH5314	Power Plant Engineering	PEC	3	0	0	3	3	40	60	100
6.	22CH5315	Non-Renewable Energy Sources	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL III :BIOCHEMICAL ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5307	Biochemistry	PEC	3	0	0	3	3	40	60	100
2.	22CH5308	Bioprocess Technology	PEC	3	0	0	3	3	40	60	100
3.	22CH5309	Fermentation & Bioprocessing	PEC	3	0	0	3	3	40	60	100
4.	22CH5316	Bio separation & Downstream Processing	PEC	3	0	0	3	3	40	60	100
5.	22CH5317	Enzyme Immobilization Technology	PEC	3	0	0	3	3	40	60	100
6.	22CH5318	Bioreactor Design	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL IV: ENVIORNMENTAL AND SAFETY ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH6301	Membrane Separation Process	PEC	3	0	0	3	3	40	60	100
2.	22CH6302	Waste Water Treatment	PEC	3	0	0	3	3	40	60	100
3.	22CH6303	Solid waste Management	PEC	3	0	0	3	3	40	60	100
4.	22CH6304	Environmental Impact Assessment	PEC	3	0	0	3	3	40	60	100
5.	22CH6305	Chemical Process Safety	PEC	3	0	0	3	3	40	60	100
6.	22CHXXXX	Carbon Capture Technology	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL V: COMPUTATIONAL CHEMICAL ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH6307	Computational Techniques	PEC	3	0	0	3	3	40	60	100
2.	22CH6308	Optimization of Chemical Processes	PEC	3	0	0	3	3	40	60	100
3.	22CH6309	Process Modeling and Simulation	PEC	3	0	0	3	3	40	60	100
4.	22CH6310	Pinch Analysis and Heat Exchange Network Design	PEC	3	0	0	3	3	40	60	100
5.	22CH6311	Chemical Process Flow sheeting	PEC	3	0	0	3	3	40	60	100
6.	22CH6312	Computational Fluid Dynamics	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL VI : BLUE ECONOMY AND OCEAN STUDIES											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH7301	Aquaculture and Fisheries Business Management	PEC	3	0	0	3	3	40	60	100
2.	22CH7302	Climate-Resilient Coastal and Ocean Entrepreneurship	PEC	3	0	0	3	3	40	60	100
3.	22CH7303	Marine and Coastal Resource Management	PEC	3	0	0	3	3	40	60	100
4.	22CH7304	Ocean Engineering	PEC	3	0	0	3	3	40	60	100
5.	22CH7305	Sustainable Marine Resources and Circular Economy	PEC	3	0	0	3	3	40	60	100
6.	22CH7306	Blue Economy Entrepreneurship	PEC	3	0	0	3	3	40	60	100

Enrolment for B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation.

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only. For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes.

(i) B.E. / B.Tech. Honours (specialisation in the same discipline):

a. The student should have earned additionally a minimum of 18 credits from a vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(ii) B.E. / B.Tech. Honours:

a. The students should have earned additional courses (minimum of 18 credits) from more than one vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(iii) B.E. / B.Tech. (Minor in other specialisation):

The student should have earned additionally a minimum of 18 credits in any one of the verticals of other B.E. / B.Tech. programmes or from any one of the following verticals

VERTICAL I: FINTECH AND BLOCK CHAIN

VERTICAL II: ENTREPRENEURSHIP

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY

- Students can earn maximum of 6 credits in online mode (SWAYAM platform), out of these 18 credits as approved by Centre for Academic Courses.

- B.E. / B. Tech. (Honours) Specialisation in the same discipline, B.E / B.Tech. Honours and B.E. / B.Tech. Minor in other specialisation degree will be optional for students.

- For the categories (i) to (ii), the students will be permitted to register the courses from V Semester onwards provided the marks earned by the students until III semester should be of CGPA 7.50 and above and cleared all the courses in the first attempt.

- For the category (iii), the students will be permitted to register the courses from Semester V onwards provided the marks earned by the students until Semester III is CGPA 7.50 and above.

- If a student decides not to opt for Honours, after completing certain number of additional courses, the additional courses studied shall be considered instead of the Professional Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of Professional Elective courses required as per the curriculum, the courses with higher grades shall be considered for the calculation of CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- If a student decides not to opt for Minor, after completing certain number of courses, the

additional courses studied shall be considered instead of Open Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of open electives required as per the curriculum, the courses with higher grades shall be considered for calculation of CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- The Head of Department, shall forward the proposal to the Controller of Examinations after getting the approval from Head of the Institution / Dean Academics, before the commencement of the fifth semester of the programme for the students undergo optionally B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation

VERTICALS FOR MINOR DEGREE
CHEMICAL ENGINEERING OFFERING MINOR DEGREE

Minor Specialization in Chemical Process Engineering

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5471	Introduction to Chemical Process	MDC	3	0	0	3	3
2	22CH6471	Fluid Flow Operations in Chemical Engineering	MDC	3	0	0	3	3
3	22CH6472	Fundamentals of Chemical Thermodynamics	MDC	3	0	0	3	3
4	22CH7471	Process Heat and Mass Transfer	MDC	3	1	0	4	4
5	22CH7472	Reaction Engineering	MDC	3	0	0	3	3
6	22CH8471	Unit Operations and Process Laboratory	MDC	0	0	4	4	2

*MDC – Minor Degree Course

In addition to the above the following additional courses for Minor Degree can also be given to the student's common to all the branches.

VERTICAL I: FINTECH AND BLOCK CHAIN								
S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22MB5231	Financial Management	MDC	3	0	0	3	3
2	22MB6231	Fundamentals of Investment	MDC	3	0	0	3	3
3	22MB6232	Banking, Financial Services and Insurance	MDC	3	0	0	3	3
4	22MB7231	Introduction to Block chain and its Applications	MDC	3	0	0	3	3
5	22MB7232	Fintech Personal Finance and Payments	MDC	3	0	0	3	3
6	22MB8231	Introduction to Fintech	MDC	3	0	0	3	3

VERTICAL II: ENTREPRENEURSHIP								
S No	**Course Code**	**Course Title**	**Category**	**Periods Per week**			**Total Contact Periods**	**Credits**
				L	**T**	**P**		
1	22MB5232	Foundations of Entrepreneurship	MDC	3	0	0	3	3
2	22MB6233	Team Building & Leadership Management for Business	MDC	3	0	0	3	3
3	22MB6234	Creativity & Innovation in Entrepreneurship	MDC	3	0	0	3	3
4	22MB7233	Principles of Marketing Management For Business	MDC	3	0	0	3	3
5	22MB7234	Human Resource Management for Entrepreneurs	MDC	3	0	0	3	3
6	22MB8232	Financing New Business Ventures	MDC	3	0	0	3	3

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY								
S No	**Course Code**	**Course Title**	**Category**	**Periods Per week**			**Total Contact Periods**	**Credits**
				L	**T**	**P**		
1	22CE5232	Sustainable infrastructure Development	MDC	3	0	0	3	3
2	22AG6233	Sustainable Agriculture and Environmental Management	MDC	3	0	0	3	3
3	22BM6233	Sustainable Bio Materials	MDC	3	0	0	3	3
4	22ME7233	Materials for Energy Sustainability	MDC	3	0	0	3	3
5	22CE7233	Green Technology	MDC	3	0	0	3	3
6	22CE8232	Environmental Quality Monitoring and Analysis	MDC	3	0	0	3	3

VERTICALS FOR B Tech (Hons) and B Tech (Hons) in Chemical Engineering with Specialization

Vertical I **Computer Aided Process Engineering**	**Vertical II** **Polymer Technology**	**Vertical III** **Petroleum Engineering**	**Vertical IV** **Analytical Instrumentation**
Process Flow Sheeting	Polymer Chemistry	Petroleum Geology	Principles of Mass Spectrometry
Transport Phenomena	Processing Technology	Petroleum Exploration	Advanced Analytical Separation Techniques
Advanced Process Optimization	Rubber Technology	Drilling Technology	Advanced Spectrometry: ICP-MS and LC-MS
Artificial Intelligence in Process Engineering	Polymer Product Design, Blends, and Alloys	Petroleum Production Engineering	Instruments for Morphology and Structural Characterization
Digital Twin and Soft Computing in Process Modelling	Polymer Structure and property relationships	Petroleum Reservoir Engineering	Statistical Analysis and Data Processing (Lab)
Advanced Process Modelling and Simulation	Polymer Compounding Technology	Offshore Engineering	Troubleshooting Analytical Methods and Instruments

B Tech (Hons) Chemical Engineering with Specialization in Computer Aided Process Engineering

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5371	Process Flow Sheeting	MDC	2	0	2	4	3
2	22CH6371	Transport Phenomena	MDC	3	1	0	3	4
3	22CH6372	Advanced Process Optimization	MDC	2	0	2	4	3
4	22CH7371	Artificial Intelligence in Process Engineering	MDC	2	0	2	4	3
5	22CH7372	Digital Twin and Soft Computing in Process Modelling	MDC	2	0	2	4	3
6	22CH8371	Advanced Process Modelling and Simulation	MDC	0	0	4	4	2

B Tech (Hons) Chemical Engineering with Specialization in Polymer Technology

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5372	Polymer Chemistry	MDC	3	0	0	3	3
2	22CH6373	Processing Technology	MDC	3	0	0	3	3
3	22CH6374	Rubber Technology	MDC	3	0	0	3	3
4	22CH7373	Polymer Product Design, Blends, and Alloys	MDC	3	0	0	3	3
5	22CH7374	Polymer Structure and property relationships	MDC	3	0	0	3	3
6	22CH8372	Polymer Compounding Technology	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in Petroleum Engineering

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5373	Petroleum Geology	MDC	3	0	0	3	3
2	22CH6375	Petroleum Exploration	MDC	3	0	0	3	3
3	22CH6376	Drilling Technology	MDC	3	0	0	3	3
4	22CH7375	Petroleum Production Engineering	MDC	3	0	0	3	3
5	22CH7376	Petroleum Reservoir Engineering	MDC	3	0	0	3	3
6	22CH8373	Offshore Engineering	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in ANALYTICAL INSTRUMENTATION

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5374	Principles of Mass Spectrometry	MDC	3	0	0	3	3
2	22CH6377	Advanced Analytical Separation Techniques	MDC	3	0	0	3	3
3	22CH6378	Advanced Spectrometry: ICP-MS and LC-MS	MDC	3	0	0	3	4
4	22CH7377	Instruments for Morphology and Structural Characterization	MDC	3	0	0	3	3
5	22CH7378	Statistical Analysis and Data Processing (Lab)	MDC	3	0	0	4	2
6	22CH8374	Troubleshooting Analytical Methods and Instruments	MDC	3	0	0	3	3

Chairman, Board of Studies **Dean (Academics)** **Principal**

HINDUSTHAN

COLLEGE OF ENGINEERING ANDTECHNOLOGY

(An Autonomous Institution)

Coimbatore– 641032

DEPARTMENT OF CHEMICAL ENGINEERING

CURRICULUM

(UNDER REGULATIONS 2022)

FOR THE BATCH ADMITTED 2024-2025 ONWARDS

Hindusthan College of Engineering and Technology

Approved by AICTE, New Delhi, Accredited with 'A' Grade by NAAC
(An Autonomous Institution, Affiliated to Anna University, Chennai)
Coimbatore – 641 032

DEPARTMENT OF CHEMICAL ENGINEERING
REGULATION-2022
FOR STUDENTS ADMITTED 2024-25 ONWARDS
B.TECH. CHEMICAL ENGINEERING
I TO VIII SEMESTERS CURRICULUM

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER I											
Theory											
1.	22MA1101	Matrices and Calculus	BSC	3	1	0	4	4	40	60	100
Theory with Lab Component											
2	22HE1151	English for Engineers	HSC	2	0	2	3	4	50	50	100
3	22PH1151	Elements of Physical Science	BSC	2	0	2	3	4	50	50	100
4	22IT1151	Python Programming and Practices	ESC	2	0	2	3	4	50	50	100
5	22CH1251	Introduction to Chemical Engineering	ESC	2	0	2	3	4	50	50	100
EEC Courses (SE/AE)											
6	**22HE1072**	Entrepreneurship & Innovation	AEC	1	0	0	1	1	100	0	100
7	**22HE1073**	Introduction to Soft skills	SEC	2	0	0	0	1	100	0	100
Mandatory Courses											
8	**22MC1093/ 22MC1094**	□□□□□□□□□□ / HERITAGE OF TAMIL	MC	2	0	0	1	2	40	60	100
9	**22HE1071**	Universal Human Values	MC	2	0	0	0	2	100	0	100
			TOTAL	**15**	**5**	**6**	**18**	**26**	**580**	**320**	**900**
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER II											
1	**22MA2104**	Fourier Analysis and Laplace Transforms	BSC	3	1	0	4	4	40	60	100
2	22CH2203	Sustainable Practices in Chemical Engineering	BSC	2	0	0	2	3	40	60	100
3	**22CY2101**	Environmental Studies	ESC	2	0	0	2	3	40	60	100
4	22CH2204	Principles of Chemical Engineering	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5	**22CY2151**	Chemistry for Engineers	BSC	2	0	2	3	4	50	50	100
6	**22HE2151**	Effective Technical Communication	HSC	2	0	2	3	4	50	50	100
Practical											
7.	**22ME2001**	Engineering Practices	ESC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
8.	**22HE2071**	Design Thinking	AEC	1	0	2	2	3	100	0	100
9.	**22HE2072**	Soft Skills and Aptitude	SEC	1	0	0	1	1	100	0	100
Mandatory Courses											
10.	**22MC2093**	NCC */NSS / YRC / Sports / Clubs / Society Service - Enrollment	MC	All students shall enroll, on admission, in anyone of the personality and character development programmes and undergo training for about 80 hours							
11.	**22MC2094/ 22MC2095**	□□□□□□□□□□□□□□□□□□□□ □□□□□/ TAMILS AND TECHNOLOGY	MC	2	0	0	1	2	40	60	100
			TOTAL	**18**	**1**	**10**	**23**	**29**	**560**	**440**	**1000**

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER III											
Theory											
1.	**22MA3107**	Numerical Methods	BSC	3	1	0	4	4	40	60	100
2.	22CH3201	Chemical Process Calculations	PCC	3	1	0	4	3	40	60	100
3.	22CH3202	Fluid Flow Operations	PCC	3	0	0	3	3	40	60	100
4.	22CH3203	Chemical Engineering Thermodynamics – I	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5.	22CH3251	Mechanical Operations	PCC	2	0	2	3	4	50	50	100
6.	22ME3253	Basic Mechanical Engineering	ESC	2	0	2	3	4	50	50	100
Practical											
7.	22CH3001	Fluid Flow Operations Lab	AEC	0	0	4	2	4	60	40	100
8.	22CH3002	Technical Analysis Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
9.	22HE3071	Soft Skills -2	SEC	1	0	0	1	1	100	0	100
Mandatory Courses											
10.	22MC3091	Essence of Indian tradition knowledge	MC	2	0	0	0	2	100	0	100
			TOTAL	**17**	**2**	**12**	**25**	**32**	580	420	1000
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER IV											
Theory											
1.	22HE4101	IPR and Start-ups(Common)	HSC	2	0	0	2	2	40	60	100
2.	22CH4201	Mass Transfer Operations - I	PCC	3	0	0	3	3	40	60	100
3.	22CH4202	Chemical Engineering Thermodynamics – II	PCC	3	0	0	3	3	40	60	100
4.	22CH4203	Process Heat Transfer	PCC	3	0	0	3	3	40	60	100
5.	22CH4204	Chemical Process Industries	PCC	2	0	0	2	2	40	60	100
6.	22EE4205	Basics of Electrical &Electronics Engineering	ESC	2	0	0	2	3	40	60	100
Theory with Lab Component											
7.	22CH4251	Chemical Reaction Engineering - I	PCC	2	0	2	3	4	50	50	100
8.	**22MA4151**	Probability and statistics with R programming	BSC	2	0	2	3	4	50	50	100
Practical											
9.	22CH4001	Heat Transfer Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
10.	22HE4071	Soft Skills -3(Common)	SEC3	1	0	0	1	1	100	0	100
Mandatory Courses											
11	22MC4091	Indian Constitution	AC	2	0	0	0	2	100	0	100
			TOTAL	**21**	**0**	**10**	**24**	**31**	510	490	1000
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER V											
Theory											
1.	22CH5201	Mass Transfer Operations - II	PCC	3	0	0	3	3	40	60	100
2.	22CH5202	Process Instrumentation Dynamics and Control	PCC	3	0	0	3	3	40	60	100
3.	22CH53XX	Professional Elective-1	PEC	3	0	0	3	3	40	60	100
4.	22CH53XX	Professional Elective-2	PEC	3	0	0	3	3	40	60	100
5.	22CH53XX	Professional Elective-3	PEC	3	0	0	3	3	40	60	100
Theory with Lab Component											
6.	22CH5251	Chemical Reaction Engineering - II	PCC	2	0	2	3	4	50	50	100
Practical											

7.	22CH5001	Mass Transfer Operations Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
8.	22HE5071	Soft Skills -4/Foreign languages	SEC	1	0	0	1	1	100	0	100
			TOTAL	**17**	**1**	**6**	**21**	**24**	410	390	800
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER VI											
Theory											
1.	22CH6201	Transport Phenomena	PCC	3	0	0	3	3	40	60	100
2.	22CH6202	Instrumental Method of Analysis	PCC	3	0	0	3	3	40	60	100
3.	22HE6101	Professional Ethics (Common)	HSC	3	0	0	3	3	40	60	100
4.	22CH63XX	Professional Elective-4	PEC	3	0	0	3	3	40	60	100
5.	22CH63XX	Professional Elective-5	PEC	3	0	0	3	3	40	60	100
6.	22XX64XX	Open Elective – 1*	OEC	3	0	0	3	3	40	60	100
Practical											
7.	22CH6001	Process Control Lab	PCC	0	0	4	2	4	60	40	100
8.	22CH6002	Computational Chemical Engineering Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
9.	22HE6071	Soft Skills – 5(Common)	SEC	2	0	0	2	2	100	0	100
			TOTAL	**20**	**0**	**8**	**24**	**28**	460	440	900
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER VII											
Theory											
1.	22CH7201	Process Economics and Engineering Management	PCC	3	0	0	3	3	40	60	100
2.	22CH7202	Process Equipment Design	PCC	3	1	0	4	4	40	60	100
3.	22CH7203	Bio Chemical Engineering	PCC	3	0	0	3	3	40	60	100
4.	22CH73XX	Professional Elective-6	PEC	3	0	0	3	3	40	60	100
5.	22XX74XX	Open Elective – 2*	OEC	3	0	0	3	3	40	60	100
Practical											
6.	22CH7001	Design and Simulation Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
7.	22CH7701	Internship	SEC	-	-	-	2	2	100	0	100
			TOTAL	**15**	**1**	**4**	**20**	**22**	360	340	700
* - Four weeks internship carries 2 credit and it will be done in before Semester VI summer vacation/placement training and same will be evaluated in Semester VII.											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER VIII											
EEC Courses (SE/AE)											
1.	22CH8901	Project Work/Granted Patent(Common)	SEC	0	0	20	10		100	0	100
			TOTAL	**0**	**0**	**20**	**10**	**20**	**100**	**0**	**100**

* 1. As per the AICTE guideline, in Semester I, II, III & IV NCC one credit subject is added as Value Added Course with Extra Credit. Further, the students' who enrolled his/her name in HICET NCC and Air Wing are eligible to undergo this subject. The earned extra credits printed in the Consolidated Mark sheet as per the regulation.

2. NCC course level 1 & Level 2 will be added in the list of open elective subjects in the appropriate semester. Further, the students' who have opted NCC subjects in Semester I, II, III & IV are eligible to undergo NCC Open Elective Subjects.

3. The above-mentioned NCC Courses will be offered to theStudents who are going to be admitted in the Academic Year 2021 – 22.

SEMESTER WISE CREDIT DISTRIBUTION

B.E. / B.TECH.PROGRAMMES									
S.No.	Course Area	Credits per Semester							TotalCredits
		I	II	III	IV	V	VI	VII	VIII	
1	HSC	3	3	-	2	-	3	-	-	**11**
2	BSC	7	9	4	3	-	-	-	-	**23**
3	ESC	6	4	3	2	-	-	-	-	**15**
4	PCC	-	3	15	16	11	10	12	-	**67**
5	PEC	-	-	-	-	9	6	3	-	**18**
6	OEC	-	-	-	-	-	3	3	-	**6**
7	EEC	3	3	3	1	1	2	2	10	**25**
8	MC	✓	✓							
Total		**19**	**19**	**22**	**25**	**24**	**21**	**24**	**20**	**10**

OPEN ELECTIVE I AND II (EMERGING TECHNOLOGIES)

To be offered for the students other than CSE, IT, AI&ML, ECE & BIOMEDICAL

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22AI6451	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2	22CS6451	Blockchain Technology	OEC	2	0	2	4	3
3	22EC6451	Cyber security	OEC	2	0	2	4	3
4	22EC6452	IoT Concepts and Applications	OEC	2	0	2	4	3
5	22IT6451	Data Science and Analytics	OEC	2	0	2	4	3
6	22BM6451	Augmented andVirtual Reality	OEC	2	0	2	4	3

OPENELECTIVE I AND II

To be offered for the students other than AUTO, AERO, AGRI, MECH, MCTS, CIVIL, EEE, CHEMICAL, FOOD TECH, E&I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	22AE6401	Space Science	OEC	3	0	0	3	3
2	22MT6401	Introduction to Industrial Engineering	OEC	3	0	0	3	3
3	22MT6402	Industrial Safety and Environment	OEC	3	0	0	3	3
4	22CE6401	Climate Change and its Impact	OEC	3	0	0	3	3
5	22CE6402	Environment and Social Impact Assessment	OEC	3	0	0	3	3
6	22ME6401	Renewable Energy System	OEC	3	0	0	3	3
7	22ME6402	Additive Manufacturing systems	OEC	3	0	0	3	3
8	22EI6401	Introduction to Industrial Instrumentation and Control	OEC	3	0	0	3	3
9	22EI6402	Graphical Programming using	OEC	3	0	0	3	3

		Virtual Instrumentation						
10	22AU6401	Fundamentals of Automobile Engineering	OEC	3	0	0	3	3
11	22AU6402	Automotive Vehicle Safety	OEC	3	0	0	3	3
12	22EE6401	Digital Marketing	OEC	3	0	0	3	3
13	22EE6402	Research Methodology	OEC	3	0	0	3	3
14	22FT6401	Traditional Foods	OEC	3	0	0	3	3
15	22AG6401	Urban Agriculture and Organic Farming	OEC	3	0	0	3	3
16	22CH6401	Waste to Energy Conversion	OEC	3	0	0	3	3

Note:Non Circuit Departments can add one Open Elective course in the above list to offer for the circuit branches

OPEN ELECTIVE III (Offered by Chemical Engineering)

Students shall choose any one of the open elective courses such that the course content or title not belongs to their own programme.

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH7401	Biomass Conversion and Bio refinery	OEC	3	0	0	3	3

OPENELECTIVE IV

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22LS7401	General studies for competitive examinations	OEC	3	0	0	3	3
2	22LS7402	Human Rights, Women Rights and Gender equity	OEC	3	0	0	3	3
3	22LS7403	Indian ethos and Human values	OEC	3	0	0	3	3
4	22LS7404	Financial independence and management	OEC	3	0	0	3	3
5	22LS7405	Yoga for Human Excellence	OEC	3	0	0	3	3
6	22LS7406	Democracy and Good Governance	OEC	3	0	0	3	3
7	22LS7407	NCC Level - II	OEC	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Petroleum Process Technology	Vertical II Energy Engineering	Vertical III Biochemical Engineering	Vertical IV Environmental and Safety Engineering	Vertical V Computational Chemical Engineering	Vertical VI Chemical Plant Design
Petroleum Chemistry and Refining Fundamentals	Bioenergy	Biochemistry	Membrane Separation Process	Computational Techniques	Chemical Plant Design
Primary RefiningTechnology	RenewableEnergy Resources	Bioprocess Technology	Waste Water Treatment	Optimization of Chemical Processes	Plant Layout
Secondary Refining Technology	Pinch Technology	Fermentation & Bioprocessing	Solid waste Management	Process Modeling and Simulation	Design Safety
Refinery Advancements and Environmental Regulations	Hydrogen and Fuel Cell Technology	Bio separation & Downstream Processing	Environmental Impact Assessment	Pinch Analysis and Heat Exchange Network Design	Material Selection
Petroleum Equipment Design	Power Plant Engineering	Enzyme Immobilisation Technology	Process Safety Management	Chemical Process Flowsheeting	Statutory Requirements&Customer Care
Petrochemical Technology	Non-Renewable Energy	Bioreactor Design	Risk and HAZOP Analysis	Computational Fluid Dynamics	Process Plant Utilities

	Sources				
Note: Students are permitted to choose all Professional Electives from a particular vertical					

DETAILS OF VERTICAL I :PETROLEUM PROCESS TECHNOLOGY											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5301	Petroleum Chemistry and Refining Fundamentals	PEC	3	0	0	3	3	40	60	100
2.	22CH5302	Primary Refining Technology	PEC	3	0	0	3	3	40	60	100
3.	22CH5303	Secondary Refining Technology	PEC	3	0	0	3	3	40	60	100
4.	22CH5310	Refinery Advancements and Environmental Regulations	PEC	3	0	0	3	3	40	60	100
5.	22CH5311	Petroleum Equipment Design	PEC	3	0	0	3	3	40	60	100
6.	22CH5312	Petrochemical Technology	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL II :ENERGY ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5304	Bioenergy	PEC	3	0	0	3	3	40	60	100
2.	22CH5305	Renewable Energy Resources	PEC	3	0	0	3	3	40	60	100
3.	22CH5306	Pinch Technology	PEC	3	0	0	3	3	40	60	100
4.	22CH5313	Hydrogen And Fuel Cell Technology	PEC	3	0	0	3	3	40	60	100
5.	22CH5314	Power Plant Engineering	PEC	3	0	0	3	3	40	60	100
6.	22CH5315	Non-Renewable Energy Sources	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL III :BIOCHEMICAL ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5307	Biochemistry	PEC	3	0	0	3	3	40	60	100
2.	22CH5308	Bioprocess Technology	PEC	3	0	0	3	3	40	60	100
3.	22CH5309	Fermentation & Bioprocessing	PEC	3	0	0	3	3	40	60	100
4.	22CH5316	Bio separation & Downstream Processing	PEC	3	0	0	3	3	40	60	100
5.	22CH5317	Enzyme Immobilisation Technology	PEC	3	0	0	3	3	40	60	100
6.	22CH5318	Bioreactor Design	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL IV: ENVIORNMENTAL AND SAFETY ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH6301	Membrane Separation Process	PEC	3	0	0	3	3	40	60	100
2.	22CH6302	Waste Water Treatment	PEC	3	0	0	3	3	40	60	100
3.	22CH6303	Solid waste Management	PEC	3	0	0	3	3	40	60	100
4.	22CH6304	Environmental Impact Assessment	PEC	3	0	0	3	3	40	60	100
5.	22CH6305	Process Safety Management	PEC	3	0	0	3	3	40	60	100
6.	22CH6306	Risk and HAZOP Analysis	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL V: COMPUTATIONAL CHEMICAL ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH6307	Computational Techniques	PEC	3	0	0	3	3	40	60	100
2.	22CH6308	Optimization of Chemical Processes	PEC	3	0	0	3	3	40	60	100
3.	22CH6309	Process Modeling and Simulation	PEC	3	0	0	3	3	40	60	100
4.	22CH6310	Pinch Analysis and Heat Exchange Network Design	PEC	3	0	0	3	3	40	60	100
5.	22CH6311	Chemical Process Flow sheeting	PEC	3	0	0	3	3	40	60	100
6.	22CH6312	Computational Fluid Dynamics	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL VI : CHEMICAL PLANT DESIGN											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH7301	Chemical Plant Design	PEC	3	0	0	3	3	40	60	100
2.	22CH7302	Plant Layout	PEC	3	0	0	3	3	40	60	100
3.	22CH7303	Design Safety	PEC	3	0	0	3	3	40	60	100
4.	22CH7304	Material Selection	PEC	3	0	0	3	3	40	60	100
5.	22CH7305	Statutory Requirements & Customer Care	PEC	3	0	0	3	3	40	60	100
6.	22CH7306	Process Plant Utilities	PEC	3	0	0	3	3	40	60	100

Enrolment for B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation.

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only. For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes.

(i) B.E. / B.Tech. Honours (specialisation in the same discipline):

a. The student should have earned additionally a minimum of 18 credits from a vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(ii) B.E. / B.Tech. Honours:

a. The students should have earned additional courses (minimum of 18 credits) from more than one vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(iii) B.E. / B.Tech. (Minor in other specialisation):

The student should have earned additionally a minimum of 18 credits in any one of the verticals of other B.E. / B.Tech. programmes or from any one of the following verticals

VERTICAL I: FINTECH AND BLOCK CHAIN

VERTICAL II: ENTREPRENEURSHIP

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY

- Students can earn maximum of 6 credits in online mode (SWAYAM platform), out of these 18 credits as approved by Centre for Academic Courses.

- B.E. / B. Tech. (Honours) Specialisation in the same discipline, B.E / B.Tech. Honours and B.E. / B.Tech. Minor in other specialisation degree will be optional for students.

- For the categories (i) to (ii), the students will be permitted to register the courses from V Semester onwards provided the marks earned by the students until III semester should be of CGPA 7.50 and above and cleared all the courses in the first attempt.

- For the category (iii), the students will be permitted to register the courses from Semester V onwards provided the marks earned by the students until Semester III is CGPA 7.50 and above.

- If a student decides not to opt for Honours, after completing certain number of additional courses, the additional courses studied shall be considered instead of the Professional Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of Professional Elective courses required as per the curriculum, the courses with higher grades shall be considered for the calculation of CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- If a student decides not to opt for Minor, after completing certain number of courses, the additional courses studied shall be considered instead of Open Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of open electives required as per the curriculum, the courses with higher grades shall be considered for calculation of CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- The Head of Department, shall forward the proposal to the Controller of Examinations after getting the approval from Head of the Institution / Dean Academics, before the commencement of the fifth semester of the programme for the students undergo optionally B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation

VERTICALS FOR MINOR DEGREE
CHEMICAL ENGINEERING OFFERING MINOR DEGREE

Minor Specialization in Chemical Process Engineering

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5471	Introduction to Chemical Process	MDC	3	0	0	3	3
2	22CH6471	Fluid Flow Operations in Chemical Engineering	MDC	3	0	0	3	3
3	22CH6472	Fundamentals of Chemical Thermodynamics	MDC	3	0	0	3	3
4	22CH7471	Process Heat and Mass Transfer	MDC	3	1	0	4	4
5	22CH7472	Reaction Engineering	MDC	3	0	0	3	3
6	22CH8471	Unit Operations and Process Laboratory	MDC	0	0	4	4	2

*MDC – Minor Degree Course

In addition to the above the following additional courses for Minor Degree can also be given to the student's common to all the branches.

VERTICAL I: FINTECH AND BLOCK CHAIN								
S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22MB5231	Financial Management	MDC	3	0	0	3	3
2	22MB6231	Fundamentals of Investment	MDC	3	0	0	3	3
3	22MB6232	Banking, Financial Services and Insurance	MDC	3	0	0	3	3
4	22MB7231	Introduction to Block chain and its Applications	MDC	3	0	0	3	3
5	22MB7232	Fintech Personal Finance and Payments	MDC	3	0	0	3	3
6	22MB8231	Introduction to Fintech	MDC	3	0	0	3	3

VERTICAL II: ENTREPRENEURSHIP								
S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22MB5232	Foundations of Entrepreneurship	MDC	3	0	0	3	3
2	22MB6233	Team Building & Leadership Management for Business	MDC	3	0	0	3	3
3	22MB6234	Creativity & Innovation in Entrepreneurship	MDC	3	0	0	3	3
4	22MB7233	Principles of Marketing Management For Business	MDC	3	0	0	3	3
5	22MB7234	Human Resource Management for Entrepreneurs	MDC	3	0	0	3	3
6	22MB8232	Financing New Business Ventures	MDC	3	0	0	3	3

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY								
S No	**Course Code**	**Course Title**	**Category**	**Periods Per week**			**Total Contact Periods**	**Credits**
				L	**T**	**P**		
1	22CE5232	Sustainable infrastructure Development	MDC	3	0	0	3	3
2	22AG6233	Sustainable Agriculture and Environmental Management	MDC	3	0	0	3	3
3	22BM6233	Sustainable Bio Materials	MDC	3	0	0	3	3
4	22ME7233	Materials for Energy Sustainability	MDC	3	0	0	3	3
5	22CE7233	Green Technology	MDC	3	0	0	3	3
6	22CE8232	Environmental Quality Monitoring and Analysis	MDC	3	0	0	3	3

VERTICALS FOR B Tech (Hons) and B Tech (Hons) in Chemical Engineering with Specialization

Vertical I Computer Aided Process Engineering	**Vertical II Polymer Technology**	**Vertical III Petroleum Engineering**	**Vertical IV Instrumental Chemical Analysis**
Process Flow Sheeting	Polymer Chemistry	Petroleum Geology	Principles of Mass Spectrometry
Transport Phenomena	Processing Technology	Petroleum Exploration	Advanced Analytical Separation Techniques
Advanced Process Optimization	Rubber Technology	Drilling Technology	Advanced Spectrometry: ICP-MS and LC-MS
Artificial Intelligence in Process Engineering	Polymer Product Design, Blends, and Alloys	Petroleum Production Engineering	Instruments for Morphology and Structural Characterization
Digital Twin and Soft Computing in Process Modelling	Polymer Structure and property relationships	Petroleum Reservoir Engineering	Statistical Analysis and Data Processing (Lab)
Advanced Process Modelling and Simulation	Polymer Compounding Technology	Offshore Engineering	Troubleshooting Analytical Methods and Instruments

B Tech (Hons) Chemical Engineering with Specialization in Computer Aided Process Engineering

S No	**Course Code**	**Course Title**	**Category**	**Periods Per week**			**Total Contact Periods**	**Credits**
				L	**T**	**P**		
1	22CH5371	Process Flow Sheeting	MDC	2	0	2	4	3
2	22CH6371	Transport Phenomena	MDC	3	1	0	3	4
3	22CH6372	Advanced Process Optimization	MDC	2	0	2	4	3
4	22CH7371	Artificial Intelligence in Process Engineering	MDC	2	0	2	4	3
5	22CH7372	Digital Twin and Soft Computing in Process Modeling	MDC	2	0	2	4	3
6	22CH8371	Advanced Process Modelling and Simulation	MDC	0	0	4	4	2

B Tech (Hons) Chemical Engineering with Specialization in Polymer Technology

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5372	Polymer Chemistry	MDC	3	0	0	3	3
2	22CH6373	Processing Technology	MDC	3	0	0	3	3
3	22CH6374	Rubber Technology	MDC	3	0	0	3	3
4	22CH7373	Polymer Product Design, Blends, and Alloys	MDC	3	0	0	3	3
5	22CH7374	Polymer Structure and property relationships	MDC	3	0	0	3	3
6	22CH8372	Polymer Compounding Technology	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in Petroleum Engineering

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5373	Petroleum Geology	MDC	3	0	0	3	3
2	22CH6375	Petroleum Exploration	MDC	3	0	0	3	3
3	22CH6376	Drilling Technology	MDC	3	0	0	3	3
4	22CH7375	Petroleum Production Engineering	MDC	3	0	0	3	3
5	22CH7376	Petroleum Reservoir Engineering	MDC	3	0	0	3	3
6	22CH8373	Offshore Engineering	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in Instrumental Chemical Analysis

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5374	Principles of Mass Spectrometry	MDC	3	0	0	3	3
2	22CH6377	Advanced Analytical Separation Techniques	MDC	3	0	0	3	3
3	22CH6378	Advanced Spectrometry: ICP-MS and LC-MS	MDC	3	0	0	3	4
4	22CH7377	Instruments for Morphology and Structural Characterization	MDC	3	0	0	3	3
5	22CH7378	Statistical Analysis and Data Processing (Lab)	MDC	3	0	0	4	2
6	22CH8374	Troubleshooting Analytical Methods and Instruments	MDC	3	0	0	3	3

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HINDUSTHAN COLLEGE OF ENGG. & TECH.

Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22HE1151	ENGLISH FOR ENGINEERS (Common to all Branches)	2	0	2	3

Course Objective	The student should be able	
	1.	To help the students of engineering and technology develop a strong base in the use of English.
	2.	To help learners use language effectively in professional writing.
	3.	To impart basic English grammar and essentials of important language skills
	4	To impart knowledge about the importance of vocabulary and grammar
	5	To develop the communication skills of the students in both formal and informal situations

Unit	Description	Instructional Hours
I	**Language Proficiency**: Parts of Speech, Degrees of Comparison, Abbreviation& Acronyms Writing: Process Description, Instructions. Vocabulary – Words on Environment. Practical Component: Listening- Watching Short Videos and answer the questions, Speaking- Self introduction , Narrating personal experiences / events; Interviewing a celebrity; Reporting / and summarizing of documentaries / podcasts / interviews Reading- Purpose of Reading - Churning & Assimilation, Interpreting Ideas - Interpreting Graphs in Technical Writing.	7+2
II	**Language Proficiency:** Types of Sentences, Framing Question, One Word Substitution Writing: Writing Checklist, Reading Comprehension. Vocabulary– Words on Entertainment. Practical Component: Listening-Comprehensions based on TED talks Speaking- Story Telling Reading - Skimming – Scanning – Reading: Scientific Texts	7+2
III	Language Proficiency: Tenses, Conditional Clause ('If' clause), Active and Passive voices, Writing: Formal letter (invitation, acceptance, decline, Congratulation) Cloze test. Vocabulary – Words on Tools. Practical Component: Listening-Listening pre-recorded English language learning programme Speaking - Just a minute Reading- Reading feature articles (from newspapers and magazines) -Reading to identify point of view and perspective (opinion pieces, editorials etc.)	5+4
IV	Language Proficiency: Subject Verb Concord, Articles, The Use of Prefixes and Suffixes Writing: Preparing Agenda &Minutes, Writing Recommendations. Vocabulary– Words on Engineering process. Practical Component: Listening-An interview with someone who works for recruitment personnel. Speaking-Presentation on a general topic. Reading-Reading Comprehension - Literary Texts.	5+4
V	Language Proficiency: Prepositions, Phrasal Verbs, Modal Auxiliaries, Writing: Letter to the Editor, Sequencing of Sentences Vocabulary –Words on Engineering material Practical Component: Listening- Listening- Comprehensions based on Nat Geo/Discovery channel videos Speaking- Preparing posters and presenting as a team. Reading- Biographies, Travelogues, Technical blogs.	6+3
	Total Instructional Hours	45

Course Outcome	CO1	Understand English and converse effectively.
	CO2	Enable the students to write coherently and cohesively.
	CO3	Enable the development of basic grammar to enhance language for a better communication
	CO4	Use suitable vocabulary and grammar with confidence and express their ideas in speech and writing.
	CO5	follow the etiquettes in formal and informal communication

TEXT BOOK:

T1	Raymond Murphy, "English Grammar in Use"-5th editionCambridgeUniversityPress, 2019.
T2	Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press, 2016.

REFERENCES:

R1	Kapoor A.N., Business Letters for Different Occasions, New Delhi: S. Chand & Co. Pvt. Ltd., 2012. .
R2	RaymondMurphy, " English Grammar For ESL Learners - Premium Fourth Edition.
R3	McCarthy, Michael et.al (2011) English Vocabulary in Use – advanced, Cambridge University Press.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	2	-	3	2	1	-	-
CO2	-	-	-	-	2	3	2	3	1	3	1	-	-	-
CO3	-	-	-	3		2	-	2	2	3	2	2	-	-
CO4	-	-	-	-	-	2	-	2	1	3	1	1	-	-
CO5	-	-	-	2	-	-	-	2	3	3	3	1	-	-

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22PH1151	ELEMENTS OF PHYSICAL SCIENCE (For B.Tech. Agricultural Engineering, Chemical Engineering & Food Technology)	2	0	2	3

Course Objective	**The student should be able to**	
	1.	Have knowledge on heat and thermodynamics.
	2.	Acquire knowledge on Ultrasound and their applications.
	3.	Enhance the fundamental knowledge in properties of materials
	4	Adequate knowledge on laser fundamentals and their applications
	5	Extend the knowledge about wave optics.

Unit	Description	Instructional Hours
I	**THERMAL PHYSICS:** Thermal expansion - thermal conduction, convection and radiation- thermal stress - Thermal expansion- Expansion joints - bimetallic strips - thermal conductivity -Lee's disc method to determine the thermal conductivity of bad conductor. - heat conductions in solids - flow of heat through compound media (series and parallel) – applications: refrigerators and solar water heaters.	6
II	**ULTRASONICS:** Production – Piezoelectric generator – Properties of Ultrasonic waves. Determination of velocity using acoustic grating –Industrial applications – Drilling and welding – Nondestructive testing (pulse echo system). Medical applications – Ultrasound Scanner – A – mode – B- mode and C –mode	6
III	**MECHANICAL PROPERTIES OF MATERIAL:** Elasticity – Hooke's law –Poisson's ratio – Bending moment – Depression of a cantilever – Derivation of Young's modulus of the material of the beam by Uniform bending theory and experiment. Twisting couple - torsion pendulum: theory and experiment.**Determination of Young's modulus by uniform bending method .Determination of Rigidity modulus – Torsion pendulum**	12
IV	**PHOTONICS:** Characteristics of Laser - Principle of spontaneous emission and stimulated emission - Active medium - Types of laser -.Principle, Construction, Working, Properties, Merits, Demerits and applications of Nd-YAG laser – Applications – Holography (3D profiling), laser drilling, and laser welding. **Determination of Wavelength and particle size using Laser Visit to IDA lab**	9
V	**WAVE MECHANICS :** Interference -Conditions for sustained Interference - Antireflection coating – air wedge and it's applications. Determination of thickness of a thin wire - Diffraction of light –Fraunhofer diffraction at single slit –Diffraction grating – Rayleigh's criterion of resolution power - resolving power of grating. **Determination of wavelength of mercury spectrum – spectrometer grating** **Determination of thickness of a thin wire – Air wedge method..**	12
	Total Instructional Hours	45

Course Outcome	CO1	Familiarize the concepts of heat and thermodynamics
	CO2	Relate the Ultrasound and their applications
	CO3	Illustrate the fundamental properties of materials
	CO4	Relate the advanced technology of LASER in the field of Engineering
	CO5	Analyze the wavelength of different colors by spectral analysis

TEXT BOOK:

T1	Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017
T2	Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2018.

REFERENCES:

R1	M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., New Delhi 2018
R2	Halliday, D., Resnick, R. and Walker, J. "Principles of Physics". Wiley, 2020.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1	1	-	1	1	1	2	3	2	2
CO2	3	3	3	2	2	1	1	-	1	1	1	2	3	2	2
CO3	3	3	3	2	2	1	1	-	1	1	1	2	3	2	2
CO4	3	3	3	1	1	1	1	-	1	1	1	2	3	2	1
CO5	3	3	3	3	3	1	1	-	1	1	1	2	3	2	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22MA1101	MATRICES AND CALCULUS (Common to all Branches)	3	1	0	4

Course Objective	The student should be able to	
	1.	Construct the characteristic polynomial of a matrix and use it to identify Eigen values and Eigenvectors
	2.	Impart the knowledge of single variate calculus.
	3.	Familiarize the student with functions of several variables.
	4	Acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
	5	Make a vector differential operator for vector function and theorems to solve engineering problems

Unit	Description	Instructional Hours
I	**Matrices:** Eigen values and Eigen vectors – Properties of Eigen values and Eigen vectors (without proof) - Cayley - Hamilton Theorem (excluding proof) - Reduction of a quadratic form to canonical form by orthogonal transformation.	12
II	**Single Variate Calculus:** Rolle's Theorem – Lagrange's Mean Value Theorem - Maxima and Minima – Taylor's and Maclaurin's Series.	12
III	**Functions of Several Variables:** Partial derivatives - Total derivative - Jacobians – Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.	12
IV	**Integral Calculus:** Double integrals in Cartesian coordinates – Area enclosed by plane curves (excluding surface area) – Triple integrals in Cartesian co-ordinates – Volume of solids (Sphere, Ellipsoid, Tetrahedron) using Cartesian co-ordinates.	12
V	**Vector Calculus:** Gradient, divergence and curl vectors - Green's theorem - Stoke's and Gauss divergence theorem (statement only) for cubes only.	12
	Total Instructional Hours	60

Course Outcome	CO1	Compute Eigen values and Eigen vectors of the given matrix and transform given quadratic form into canonical form.
	CO2	Apply the concept of differentiation to identify the maximum and minimum values of curve.
	CO3	Use differential calculus ideas on several variable functions.
	CO4	Apply multiple integral ideas in solving areas, volumes and other practical problems.
	CO5	Apply the concept of vector calculus in two and three-dimensional spaces

TEXT BOOK:

T1	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th edition, 2019
T2	K. P. Uma and S. Padma, "Engineering Mathematics I (Matrices and Calculus) ", Pearson Ltd,2022.

REFERENCES:

R1	Jerrold E. Marsden, Anthony Tromba, "Vector Calculus", W.H.Freeman, 2003-Strauss M. J, G. L Bradley and K. J .Smith, "Multivariable calculus", 6th edition, Prentice Hall, 2011.
R2	T, "Engineering Mathematics", 5th edition, Mc Graw Hill Education(India) Pvt Ltd, New Delhi, 2016
R3	G. B. Thomas and R. L. Finney, "Calculus and Analytical Geometry", 9th Edition, Addison Wesley Publishing Company, 2016.

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	2	-	-	1	2	2	3	2
CO2	3	3	3	3	2	2	2	-	-	1	2	2	2	2
CO3	3	3	3	3	2	2	2	-	-	1	2	2	2	2
CO4	3	3	3	3	2	2	2	-	-	1	2	2	2	2
CO5	3	3	3	3	2	2	2	-	-	1	2	2	3	3
AVG	3	3	3	3	2.2	2	2			1	2	2	2.4	2.2

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/	**22HE1095**	**UNIVERSAL HUMAN VALUES** **(COMMON TO ALL BRANCHES)**	2	0	0	0

Course Objectives	**The studentshouldbemade** 1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings. 2. TofacilitatethedevelopmentofaHolisticperspectiveamongstudentstowardslifeandprofession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way. 3. TohighlightplausibleimplicationsofsuchaHolisticunderstandingIntermsofethicalhumanconduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Unit	Description	Instructional Hours
I	**Introduction to Value Education** Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)-Understanding Value Education - Self-exploration as the Process for Value Education - Continuous Happiness and Prosperity – the Basic Human Aspirations - Happiness and Prosperity – Current Scenario - Method to Fulfill the Basic Human Aspirations	6
II	**Harmony in the Human Being and Harmony in the Family** Understanding Human being as the Co-existence of the Self and the Body - Distinguishing between the Needs of the Self and the Body - The Body as an Instrument of the Self - Understanding Harmony in the Self- Harmony of the Self with the Body - Programme to ensure self-regulation and Health	6
III	**Harmony in the Family and Society** Harmony in the Family – the Basic Unit of Human Interaction. Values in Human to Human Relationship 'Trust' – the Foundational Value in Relationship Values in Human to Human Relationship 'Respect' – as the Right Evaluation Understanding Harmony in the Society	6
IV	**Harmony in the Nature / Existence** Understanding Harmony in the Nature.Inter connectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature- Understanding Existence as Co-existence of mutually interacting units in all pervasivespace Realizing Existence as Co-existence at All Levels The Holistic Perception of Harmony in Existence. Vision for the Universal Human Order	6
V	**Implications of the Holistic Understanding – a Look at Professional Ethics** Natural Acceptance of Human Values Definitiveness of (Ethical) Human Conduct A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order-Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies Strategies for Transition towards Value-based Life and Profession	6
	Total Instructional Hours	**30**

Course Outcome	At the end of the course, the learner will be able CO1: To become more aware of holistic vision of life - themselves and their surroundings. CO2: To become more responsible in life, in the Society and in handling problems with sustainable Solutions. CO3: To sensitive towards their commitment towards what they understood towards environment and Socially responsible behavior. CO4: To able to apply what have learnt to their own self in different day-to-day settings in real life and In handling problems with sustainable solutions. CO5: To develop competence and capabilities for maintaining Health and Hygiene.

Reference Books:

R1.A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
R2.Teachers'ManualforAFoundationCourseinHumanValuesandProfessionalEthics,RRGaur, R Asthana,G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93- 87034-53-2
R3.JeevanVidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak,1999.
R4.Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	-	2	-	-	-	2	-	-	2
CO2	2	3	3	-	2	-	-	-	2	-	-	2
CO3	2	3	3	-	2	-	-	-	2	-	-	2
CO4	2	3	3	-	2	-	-	-	2	-	-	2
CO5	2	3	3	-	2	-	-	-	2	-	-	2
AVG	2	3	3	-	2	-	-	-	2	-	-	2

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Programme B.E./B.Tech	Course Code	Name of the Course	L	T	P	C
	22HE1072	**ENTREPRENEURESHIP AND INNOVATION (Common to all Branches)**	1	0	0	1

Course Objectives	**The student should be made** 1. To acquire the knowledge and skills needed to manage the development of innovation. 2. To recognize and evaluate potential opportunities to monetize these innovations. 3. To plan specific and detailed method to exploit these opportunities. 4. To acquire the resources necessary to implement these plans. 5. To make students understand organizational performance and its importance.

Module	Description
1	**Entrepreneurial Thinking**
2	**Innovation Management**
3	**Design Thinking**
4	**Opportunity Spotting / Opportunity Evaluation**
5	**Industry and Market Research**
6	**Innovation Strategy and Business Models**
7	**Financial Forecasting**
8	**Business Plans/ Business Model Canvas**
9	**Entrepreneurial Finance**
10	**Pitching to Resources Providers / Pitch Deck**
11	**Negotiating Deals**
12	**New Venture Creation**
13	**Lean Start-ups**
14	**Entrepreneurial Ecosystem**
15	**Velocity Venture**
	TOTAL INSTRUCTIONAL HOURS 15

Course Outcome	**At the end of the course, the learner will be able to** CO1: Understandthenatureofbusinessopportunities,resources,andindustriesincriticalandcreative aspects. CO2: Understand the processes by which innovation is fostered, managed, and commercialized. CO3:Remember effectively and efficiently the potential of new business opportunities. CO4:Assess the market potential for a new venture, including customer need, competitors, and industry attractiveness.. CO5:Developabusiness model for a new venture, including revenue. Margins, operations, Working capital, and investment

TEXT BOOKS

T1:AryaKumar"Entrepreneurship–CreatingandleadinganEntrepreneurialOrganization",Pearson,SecondEdition(2012).
T2:EmrahYayici"DesignThinkingMethodology", Artbiztech, FirstEdition(2016).

REFERENCE BOOKS

R1: Christopher Golis "Enterprise & Venture Capital", Allen &Unwin Publication, Fourth Edition (2007).
R2: ThomasLockWood&EdgerPapke"InnovationbyDesign",CareerPress.com,SecondEdition(2017).
R3: Jonathan Wilson "Essentials of Business Research", Sage Publication, First Edition(2010).

WEB RESOURCES

W1:https://blof.forgeforward.in/tagged/startup-lessons
W2:https://blof.forgeforward.in/tagged/entrepreurship
W3:https://blof.forgeforward.in/tagged/minimum-viable-product
W4:https://blof.forgeforward.in/tagged/minimum-viable-product
W5:https://blof.forgeforward.in/tagged/innovation

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22HE1072 ENTREPRENEURSHIP&INNOVATION

PO CO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO 7	PO 8	PO9	PO 10	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	3	3	3	3	-	-	-	-	-	-	2	2	1
CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO3	3	3	3	2	3	-	-	-	-	-	-	2	2	2
CO4	3	3	3	3	3	-	-	-	-	-	-	2	2	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	1	2
AV G	3	3	3	2.6	2.8	-	-	-	-	-	-	2	1.8	2

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Programme B.E./B.Tech	Course Code	Name of the Course	L	T	P	C
	22MC1094	**HERITAGE OF TAMIL (Common to all Branches)**	2	0	0	1

Course Objective	**The learner should be able to** 1. Introduce students to the great History of Tamil literature. 2. Establish the heritage of various forms of Rock art and Sculpture art. 3. To study and understand the various folk and Martial arts of Tamil culture 4. Introduce students to Ancient Tamil concepts to understand the richness of Tamil literature. 5. To learn about the various influences or impacts of Tamil language in Indian culture.

Unit	Description	Instructional Hours
I	**Language and Literature** Language families in India – Dravidian Languages – Tamil as a classical language – Classical Literature in Tamil- Secular nature of Sangam Literature – Distributive justice in Sangam Literature – Management principles in Thirukural – Tamil epics and impacts of Buddhism & Jainism in Tamil and Bakthi literature of Azhwars and Nayanmars – Forms of minor poetry _ Development of Modern literature in Tamil – Contribution of Bharathiyar and Bharathidasan.	6
II	**Heritage _ Rock Art Paintings to Modern Art – Sculpture** Hero Stone to Modern Sculpture – Bronze icons – Tribes and their handcrafts - Art of temple car making – Massive Terracotta sculptures, Village deities, Thiruvalluvar statue at Kanyakumari, Making of musical instruments – Mridangam, Parai, Yazh and Nadhaswaram - Role of Temples in social and economic life of Tamils.	6
III	**Folk and Martial Arts** Therukoothu, Karagattem, Villupattu, Kaniyankoothu, Oyilattam, Leather puppertry, Silambattam.,Valari Tiger dance – Sports and Games of Tamils.	6
IV	**Thinai Concept of Tamils** Flora and Fauna of Tamils – Aham and Puram Concept from Tholkappiyam and Sangam Literature – Aram concept of Tamils – Education and Literacy during Sangam Age - Ancient cities and ports of Sangam age – Exporot and Import during Sangam age – Overseas conquest of Cholas.	6
V	**Contribution of Tamils to Indian National Movement and Indian Culture** Contribution of Tamils to Indian freedom struggle – The cultural influence of Tamils over the other parts of India – Self respect movement – Role of Siddha Medicine in indigenous systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil books.	6
	Total Instructional Hours	**30**

Course Outcome	**At the end of the course, the learner will be able to** CO1: Learn about the works pertaining to Sangam age CO2: Aware of our Heritage in art from Stone sculpture to Modern Sculpture. CO3Appreciate the role of Folk arts in preserving, sustaining and evolution of Tamil culture. CO4: Appreciate the intricacies of Tamil literature that had existed in the past. CO5: Understand the contribution of Tamil Literature to Indian Culture

TEXT BOOKS:

T1: Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

T2: Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by:International Institute of Tamil Studies.

T3: Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu)(Published by: International Institute of Tamil Studies).

REFERENCE BOOKS:

R1-The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)

R2- Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu TextBookand Educational Services Corporation, Tamil Nadu)

R3-Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – ReferenceBook.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech	22MC1093	TAMIZHAR MARABHU	2	0	0	1

GE3152 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I **மொழி மற்றும் இலக்கியம்:** 3
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை:** 3
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பண்ரு, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:** 3
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV **தமிழர்களின் திணைக் கோட்பாடுகள்:** 3
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:** 3
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12
CO1	2	3	3	-	-	-	-	-	2			2
CO2	2	3	3	-	-	-	-	-	2			2
CO3	2	3	3	-	-	-	-	-	2			2
CO4	2	3	-	-	-	-	-	-	2			2
CO5	2	3	-	-	-	-	-	-	2			2
AVG	2	3	1.8	-	-	-	-	-	2			2

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Programme	Course Code	Course Title	L	T	P	C
B.E/B.TECH	22HE1073	INTRODUCTION TO SOFT SKILLS	2	0	0	0

Course Objectives:

1. To develop and nurture the soft skills of the students through instruction, knowledge acquisition, demonstration and practice.
2. To enhance the students ability to deal with numerical and quantitative skills.
3. To identify the core skills associated with critical thinking.
4. To develop and integrate the use of English language skills.

Unit	Description	Instructional Hours
I	**Lessons on excellence** Skill introspection, Skill acquisition, consistent practice	2
II	**Logical Reasoning** Problem Solving - Critical Thinking- Lateral Thinking - Coding and Decoding – Series – Analogy - Odd Man Out - Visual Reasoning - Sudoku puzzles - Attention to detail	11
III	**Quantitative Aptitude** Addition and Subtraction of bigger numbers - Square and square roots - Cubes and cube roots - Vedic maths techniques - Multiplication Shortcuts - Multiplication of 3 and higher digit numbers – Simplifications - Comparing fractions - Shortcuts to find HCF and LCM - Divisibility tests shortcuts - Algebra and functions	11
IV	**Recruitment Essentials** Resume Building - Impression Management	2
V	**Verbal Ability** Nouns and Pronouns – Verbs - Subject-Verb Agreement - Pronoun-Antecedent – Agreement – Punctuations	4
	Total Instructional Hours	30

Course Outcome:

CO1: Students will analyze interpersonal communication skills. public speaking skills.
CO2: Students will exemplify tautology, contradiction and contingency by logical thinking.
CO3: Students will be able to develop an appropriate integral form to solve all sorts of quantitative problems.
CO4: Students can produce a resume that describes their education, skills, experiences and measurable achievements with proper grammar, format and brevity.
CO5: Students will be developed to acquire the ability to use English language with an error while making optimum use of grammar.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH1251	INTRODUCTION TO CHEMICAL ENGINEERING	2	0	2	3

Course Objective	The student should be able to	
	1.	Understand the history of chemical engineering and pervasive presence of Chemical Engineering in daily life applications.
	2.	Outline the interdisciplinary intersections and understand the importance of units and dimensions in chemical engineering.
	3.	Interpret the paradigm shifts shaping the current landscape of Chemical Engineering.

Unit	Description	Instructional Hours
I	**FOUNDATION & SIGNIFICANCE**: What is Chemical Engineering? Origin and growth of chemical Engineers in chemical process industries; Personalities of Chemical Engineering; Greatest achievements of Chemical Engineering - plastics, cleaner fuels, synthetic rubbers; Roles of the modern chemical engineer – mining, construction, waste management; Traditional vs. modern chemical engineering	9
II	**VERSATILITY OF CHEMICAL ENGINEERS**: Relation between Chemical Engineering and other engineering disciplines; Role of Chemical Engineers - Food, Medical, Energy, Environmental, Biochemical, Electronics; Portable Devices;	6
III	**BASICS OF CHEMICAL ENGINEERING:** Units and dimensions, Concept and classification of unit processes and unit operations; Flowsheet representation of process plants-synthesis gas, natural gas, coke oven gas; Batch, continuous, recycle, bypass and purge process.	9
IV	**DYNAMICS OF CHEMICAL ENGINEERING:** Chemical Engineering in Everyday Life; Similarities in Dissimilar Applications; Scaling Up or Down; **Waste management (solid, liquid and gas) – Removal of color and noxious compounds from effluent and air; Segregation of E-waste to recover valuable products.**	6+6
V	**CONTEMPORARY STATUS**: Role of Computer in Chemical Engineering; Chemical Engineering Software – **Design of Plant Process using Aspen Plus, CAD.**Paradigm shifts in Chemical Engineering; Opportunities for Chemical Engineers; Future of Chemical Engineering.	6+3
	Total Instructional Hours	45

Course Outcome	CO1	Explain the fundamental relationships and significance of Chemistry, Chemical Engineering, and Chemical Technology in industrial and societal contexts.
	CO2	Recognize and articulate the diverse applications of Chemical Engineering principles in everyday life scenarios.
	CO3	Demonstrate an understanding of the interdisciplinary nature of Chemical Engineering through exploration of its connections with other engineering disciplines.
	CO4	Acquire proficiency in using units and dimensions relevant to Chemical Engineering, and classify unit processes and operations used in industry.
	CO5	Make use of paradigm shifts on modern Chemical Engineering practices, and identify emerging opportunities and trends in the field.

TEXT BOOK:

T1	S. Pushpavanam, Introduction to Chemical Engineering, Prentice Hall India, 2011
T2	K.A. Solen and J.N. Harb, Introduction to Chemical Engineering – Tools for Today and Tomorrow, 5th Edition, Wiley, 2011.

REFERENCES:

R1	Morton M. Denn, Chemical Engineering – An Introduction, Cambridge University Press, 2012
R2	Walter L. Badger and Julius T. Banchero, Introduction to Chemical Engineering, Tata McGraw-Hill, 1955

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	-	-	-	-	-	-	-	3	3	1
CO2	3	3	2	1	-	-	-	-	-	-	-	3	3	1
CO3	3	3	2	1	-	-	-	-	-	-	-	3	3	1
CO4	3	3	1	1	-	-	-	-	-	-	-	3	3	1
CO5	3	3	1	1	-	-	-	-	-	-	-	3	3	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH2203	SUSTAINABLE PRACTICES IN CHEMICAL ENGINEERING	2	0	0	2

Course Objective	The student should be able to	
	1.	Understand the fundamental concepts of sustainability in chemical engineering.
	2.	Develop an understanding of green chemistry and sustainable process design principles.
	3.	Familiarize students with sustainable manufacturing techniques and circular economy models.

Unit	Description	Instructional Hours
I	**INTRODUCTION**: Sustainability Concepts-Definition of sustainability- triple bottom line: economic, environmental, and social aspects-Sustainable development goals (SDGs) related to the chemical industry.	6
II	**ENERGY EFFICIENCY AND RESOURCE MANAGEMENT:** Energy Efficiency in Process Design-Process design and analysis for energy efficiency-Pinch technology for heat integration-Energy recovery in chemical processes (heat exchangers, combined heat and power systems).	6
III	**GREEN PROCESS DESIGN AND LIFE CYCLE ASSESSMENT (LCA):** Design for Sustainability-Green design principles: Inherently safer design, efficient resource use. Life Cycle Assessment (LCA)-Steps in conducting LCA-Applications of LCA in evaluating environmental impact.	6
IV	**SUSTAINABLE MANUFACTURING AND CIRCULAR ECONOMY:** Sustainable Manufacturing Principles-Resource efficiency, waste minimization, and pollution prevention in manufacturing-Lean manufacturing and Six Sigma for sustainability-Sustainable Supply Chains.	6
V	POLICY, REGULATIONS, AND FUTURE TRENDS: Environmental Policies and Regulations-Key global environmental regulations and policies (e.g., Paris Agreement, REACH, Kyoto Protocol)-Environmental compliance and sustainability reporting for chemical industries- Emerging Technologies for Sustainability.	6
	Total Instructional Hours	**30**

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the fundamentals of sustainability in chemical engineering.
	CO2	Analyze energy efficiency and resource management techniques in chemical processes.
	CO3	Apply principles of green chemistry and process design for sustainable engineering.
	CO4	Evaluate the environmental impact of chemical processes using Life Cycle Assessment
	CO5	Design sustainable manufacturing systems and circular economy models.

TEXT BOOK:

T1	Paul T. Anastas, John C. Warner., Green Chemistry: Theory and Practice",Oxford University Press ,NewYork,1998..
T2	James Clark, Duncan Macquarie."Handbook of Green Chemistry and Technology" . Blackwell Science , 4th edn, 2002
T3	David T. Allen, David R. Shonnard " Sustainable Engineering: Concepts, Design, and Case Studies " , Pearson Education , New York, 2011

REFERENCES:

R1	G.P. Peters, M. Hunsaker ., "Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products" , Wiley Publishers, 2009.
R2	Godfrey Boyle, "Renewable Energy: Power for a Sustainable Future" Oxford University Press 2006
R3	Heck, R.M., and Farrauto, R.J., Catalytic "Sustainable Chemical Processes and Products" , Springer, 2009
R4	Clair Gough, Simon Shackley, "Carbon Capture and Storage: Efficiency and Innovation" , Earth scan , 2006.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	1	3	1	1	1	1	3	2	2
CO2	3	3	2	2	1	1	3	1	1	1	1	3	2	2
CO3	3	3	3	2	1	1	3	1	1	1	1	2	2	2
CO4	3	3	2	3	3	1	3	1	1	1	1	3	2	2
CO5	3	3	3	2	2	1	3	1	1	1	1	3	2	2

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	1	3	1	1	1	1	3	2	2	2
CO2	3	3	2	2	1	1	3	1	1	1	1	3	2	2	2
CO3	3	3	3	2	1	1	3	1	1	1	1	2	2	2	2
CO4	3	3	2	3	3	1	3	1	1	1	1	3	2	2	2
CO5	3	3	3	2	2	1	3	1	1	1	1	3	2	2	2

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Programme/sem	Course Code	Name of the Course	L	T	P	C
B.E.,B.TECH/ II	22CY2101	ENVIRONMENTAL STUDIES (common to all branches except CSE, IT, AIML & CS)	2	0	0	2

Course Objective

1. Introduce the basic concepts of environment, ecosystems, and biodiversity and emphasize on the biodiversity of India and its conservation.
2. Impart knowledge on the causes, effects, and control or prevention measures of environmental pollution and natural disasters.
3. Facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation, and measures to preserve them.
4. Gain knowledge on the scientific, technological, economic and political solutions to environmental problems.
5. Familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit, and the challenges of environmental management.

Unit	Description	Instructional Hours
I	**ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY** Scope and objectives of environmental studies-Importance of environment – need for public awareness - Eco-system and Energy flow–ecological succession- Structure and function of the forest and ponds ecosystem – Types of biodiversity:– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity – endangered and endemic species of India – conservation of biodiversity: Insitu and ex-situ.	6
II	**UNIT II ENVIRONMENTAL POLLUTION** Definition – causes, effects and control measures of: Air pollution- Water pollution – Water quality parameters- Soil pollution - Noise pollution- Nuclear hazards – role of an individual in prevention of pollution.	6
III	**UNIT III RENEWABLE SOURCES OF ENERGY** Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.	6
IV	**SOCIAL ISSUES AND THE ENVIRONMENT** From unsustainable to sustainable development – urban problems related to energy- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- Municipal solid waste management. Global issues – Climatic change, acid rain, greenhouse effect and ozone layer depletion – Disaster Management – Tsunami and cyclones.	6
V	**SUSTAINABILITY AND MANAGEMENT** Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols. Sustainable Development Goals-targets, indicators and intervention areas. Climate change- Global, Regional, and local environmental issues and possible solutions (global warming, acid rain and ozone layer depletion). Concept of Carbon Footprint.	6
	Total Instructional Hours	45

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Course Outcome	**CO1**: Recognize and understand the functions of environment, ecosystems and biodiversity and their conservation. **CO2**: Identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society. **CO3**: Identify and apply the understanding of renewable and non-renewable resources and contribute to sustainable measures to preserve them for future generations. **CO4**: Demonstrate an appreciation for need for sustainability, management and understand the various social issues and solutions to solve the issues. **CO5**: Recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.

TEXT BOOKS

T1 - Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.

T2 - Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.

REFERENCES

R1 – Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.

R2 - Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	2	3	-	-	-	-	2
CO2	3	2	-	-	-	3	3	-	-	-	-	2
CO3	3	-	1	-	-	2	2	-	-	-	-	2
CO4	3	2	1	1	-	2	2	-	-	-	-	2
CO5	3	2	1	-	-	2	2	-	-	-	-	1
AVG	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH2204	PRINCIPLES OF CHEMICAL ENGINEERING	3	0	0	3

Course Objective	The student should be able to	
	1.	Understand the basic principles of fluid flow, thermodynamics, heat transfer, and mass transfer.
	2.	Familiarize with key engineering processes such as pressure measurement, energy systems, heat exchange, and mass transfer operations.
	3.	Realize foundational concepts of chemical reaction engineering and reactor design.

Unit	Description	Instructional Hours
I	**MOMENTUM TRANSFER**: Nature of fluids - properties of fluids; Types of fluids - Hydrostatic equilibrium; Pressure measurement – Types of flow - Equation of Continuity- Bernoulli's equation and applications- and selection of flow meters; variable head and variable area meters - Classification of fluid moving machinery - Introduction to valves and pipe fittings.	9
II	**THERMODYNAMICS**: Scope of thermodynamics; Definition of system, control volume, state and path function, equilibrium, reversibility, energy, work and heat. Zeroth law; temperature scales. Joule's experiment, internal energy, first law -Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale.	9
III	**HEAT TRANSFER:** Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer- thermal conductivity; Heat conduction through a series of resistances - Concepts of heat transfer by convection - Boiling regimes – Radiation - Laws of radiation - types of Heat exchangers	9
IV	**MASS TRANSFER:** Introduction to mass transfer operations- Molecular diffusion in gases, liquids and solids- Humidification - theory and types of cooling tower - Drying – Crystallization - Gas Absorption and Stripping - distillation – types of distillation – Extraction and leaching	9
V	**MECHANICAL OPERATIONS:** Particle Shape, Size, Mixed Particle Sizes and Size Analysis- Principles of Comminution-Laws of Crushing-Theory of filtration, Batch and continuous filters-Concept of mixing, Homogeneous and Heterogeneous mixtures.	9
	Total Instructional Hours	45

Course Outcome	CO1	Describe the fundamental concepts of fluid flow, including types of fluids, pressure measurement, and Bernoulli's equation.
	CO2	Explain the basic laws of thermodynamics and their application to energy transformation in heat engines and refrigerators.
	CO3	Identify the different modes of heat transfer and the principles governing heat conduction, convection, and radiation.
	CO4	List various mass transfer operations, such as distillation, drying, and gas absorption, and their practical applications in chemical engineering.
	CO5	Outline the basic concepts of chemical reaction kinetics and reactor design, including the different types of reactors and their performance characteristics.

TEXT BOOK:

T1	Basic principles and calculations in chemical engineering by D.H. Himmelblau. 7th Ed. PHI. 2013
T2	Fundamentals of Momentum, Heat and Mass Transfer, 3rd ed., J.R. Welty, C.E. Wicks and R.E. Wilson, John Wiley & Sons, New York, 1984.
T3	K. V. Narayanan, Chemical Engineering Thermodynamics, PHI,2001.

REFERENCES:

R1	Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, Mc Graw Hill 7th ed. 2001.
R2	Elements of Chemical Reaction Engineering, 2nd ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	-	-	-	-	-	-	-	3	3	1
CO2	3	3	2	1	-	-	-	-	-	-	-	3	3	1
CO3	3	3	2	1	-	-	-	-	-	-	-	3	3	1
CO4	3	3	1	1	-	-	-	-	-	-	-	3	3	1
CO5	3	3	1	1	-	-	-	-	-	-	-	3	3	1

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
B.E., B.Tech/ II	22CY2153	CHEMISTRY FOR BIOCHEMICAL ENGINEERING (AGRI, CHEM)	2	0	2	3

Course Objective

The student should be conversant with

1. Sound understanding of water quality parameters and water treatment techniques.
2. The principles of electrochemistry and the mechanism of corrosion and its control
3. The understanding of principles and significance of nanochemistry, including the unique properties of nanoscale materials compared to bulk materials, and familiarize students with various methods for synthesizing nanomaterials.
4. A detailed understanding of the key components of batteries and familiarize students with various battery types.
5. Acquire the concept and working principle of spectral analytical instruments and applications.

Unit	Description	Instructional Hours
I	**WATER SCIENCE** Impurities in Water, Hardness of Water and Boiler feed Water – Boiler troubles -Sludge and scale formation, Caustic embrittlement, priming and foaming, boiler corrosion- -Softening Methods - Ion-Exchange Method, Desalination of Brackish Water - Reverse Osmosis. Estimation of hardness **of water by EDTA. Determination of Dissolved Oxygen in sewage water by Winkler's method. Estimation of alkalinity of water sample by indicator method.**	6+9=15
II	**ELECTROCHEMISTRY AND CORROSION** Electrochemical cells – reversible and irreversible cells - EMF- Single electrode potential – Nernst equation (derivation only). Chemical corrosion – Pilling – Bedworth rule – electrochemical corrosion – different types – galvanic corrosion – differential aeration corrosion – corrosion control – sacrificial anode and impressed cathodic current methods - protective coatings – paints – constituents and functions. **Determination of rate of corrosion of mild steel by weight loss method. Estimation of Ferrous iron by Potentiometry.**	6+6=12
III	**NANOCHEMISTRY** Introduction, size-dependent properties of nanomaterial (surface area, catalytical and thermal), synthesis of nanoparticles by sol-gel, and co-precipitation method. Nanomaterials: Introduction, properties and engineering applications of carbon nanotubes and graphene.	6
IV	**ENERGY SOURCES** Batteries - Characteristics - types of batteries – primary battery (alkaline battery), secondary battery (lead acid, lithium-ion-battery)- emerging batteries – nickel-metal hydride battery, aluminum air battery, batteries for automobiles and satellites - Fuel cells (Types) – H_2-O_2 fuel cell. Renewable Energy: Solar- solar cells, DSSC	6
V	**SPECTRAL ANALYSIS** Introduction- UV- Visible Spectroscopy- Beer – Lambert's Law- IR-Spectroscopy, principles – instrumentation (block diagram only)and applications – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry.	6
	Total Instructional Hours	45

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Course Outcome	**At the end of the course, the learner will be able to** CO1: Demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for domestic and industrial purposes. CO2: Apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion. CO3: Identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials. CO4: Study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries. CO5: Extend the knowledge on the concepts of spectroscopy and its applications on analytical instrumentation.

TEXTBOOKS

T1 - P.C.Jain& Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi (2018).

T2 -O.G.Palanna, "Engineering Chemistry" McGraw Hill Education India (2017).

REFERENCES

R1 – Shikha Agarwal "Engineering Chemistry -Fundamentals and Applications, Cambridge University Press, Delhi, 2019

R2 - S.S.Dara "A Textbook of Engineering Chemistry" S.Chand & Co. Ltd., New Delhi (2018).

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	1	1	1	1	-	1	-	1	2
CO2	2	3	2	1	1	1	1	-	1	-	1	2
CO3	2	2	2	2	1	1	1	-	1	-	1	2
CO4	2	2	2	2	1	1	1	-	1	-	1	2
CO5	2	3	2	-	-	-	3	-	-	-	-	-
AVG	2	2.6	2.2	1.5	1	1	1.4	-	1	-	1	2

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/II	22HE2151	EFFECTIVE TECHNICAL COMMUNICATION (Common to all Branches)	2	0	2	3

Course Objective	**The learner should be able to** 1. Improve essential business communication skills. 2. Enrich employability knowledge. 3. Acquire the crucial organizing ability in official forum. 4. Develop study skills and communication skills in formal and informal situations. 5. Improve the language proficiency of students in English with an emphasis on Vocabulary, Grammar, Reading and Writing skills

Unit	Description	Instructional Hours
I	**Language Proficiency**: Sentence Pattern, Writing definitions **Writing**: Describing product, work place and service (purpose, appearance, function) **Vocabulary** – Words on Nature **Practical Component:** **Listening**-Watching and interpreting advertisements /short films **Speaking**-Extempore / Public Speaking, Difference between Extempore / Public Speaking, Communication Guidelines for Practice	7+2
II	**Language Proficiency**: The Concept of Word Formation, Direct and Indirect Speech. **Writing** :Formal Memos, Job application and Resume preparation **Vocabulary** - Words on Offense and Ethics **Practical Component :** **Listening**- Comprehensions based on telephonic conversation **Speaking**- Vote of thanks& welcome address	7+2
III	**Language Proficiency**: Homophones and Homonyms, Question Tag **Writing**: Preparing a detail plan for an official visit, Schedule and Itinerary, Spotting Errors **Vocabulary**– Words on Society **Practical Component :** **Listening**- Listening-paraphrasing the listened content **Speaking**-Group Discussion with preparation	5+4
IV	**Language Proficiency**: Idioms, Commonly Confused Words **Writing**: Report Writing (marketing, investigating) **Vocabulary** - words involved in business **Practical Component:** **Listening**-Watching technical discussions and preparing MoM**Speaking**- On the spot Group Discussion	5+4
V	**Language Proficiency** :Relative Pronoun , Regular and Irregular verb **Writing:** Making/ Interpreting Chart, Sequencing of Sentences **Vocabulary**-Words involved in Finance **Practical Component:** **Listening**-Comprehensions based on announcements **Speaking**-Presentation on a Technical topic with ppt.	6+3
	Total Instructional Hours	45

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Course Outcome	**At the end of the course, learners will be able to** CO1: Use English Language effectively in spoken and written forms CO2: Make oral and written presentation in corporate forum. CO3: Acquire basic proficiency in English including reading and listening comprehension, Writing and speaking skills. CO4: Take an effective role and manage in an organizational sector. CO5: Prepare and demonstrate a professional presentation

TEXTBOOKS:

T1- Technical Communication by Gajendra Singh Chauhan and Et al, Cengage learning India Pvt Limited [Latest Revised Edition] - 2019

T2-Raymond Murphy, "Essential English Grammar", 5 the Edition Cambridge University Press, 2019.

T3-Technical Communication – Principles and Practice, Third Edition by Meenakshi Raman and Sangeetha Sharma, Oxford University Press 2017.

REFERENCEBOOKS:

R1- A Course in Technical English–D Praveen Sam, KN Shoba, Cambridge University Press – 2020

R2-English Language Communication Skills – Lab Manual cum Workbook, Cengage learning India Pvt Limited [Latest Revised Edition] – 2019.

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MANDATORY COURSES FOR II SEMESTER

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	22MC2094/2095	TAMILS AND TECHNOLOGY	2	0	0	1

Course Course Objectives:

The student should be able to

1. **Acquiring knowledge of industry during the Sangam Period.**
2. **Collaborate learning about house design, sculpture and temples during Sangam Period.**
3. **Develop Knowledge in metallurgical studies as a source of historical and archaeological evidence.**
4. **Acquiring knowledge about ancient techniques used in agriculture and agro processing**
5. **Knowledge of Tamil language literature.**

UNIT I WEAVING AND CERAMIC TECHNOLOGY

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY

Designing and Structural construction House & Designs in household materials during Sangam Age – Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram – Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places – Temples of Nayaka Period – Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo – Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY

Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting, steel -Copper and goldCoins as source of history – Minting of Coins – Beads making-industries Stone beads -Glass beads – Terracotta beads -Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period. Animal Husbandry – Wells designed for cattle use – Agriculture and Agro Processing – Knowledge of Sea – Fisheries – Pearl – Conche diving – Ancient Knowledge of Ocean – Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING

Development of Scientific Tamil – Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

Course Outcome:

After completion of the course the learner will be able to

CO1:Recognize ancient business
CO2: Distinguish Sangam period building material and types of sculpture.
CO3: Identify the source of historical and archaeological
CO4: Demonstrate the techniques used in agriculture and agro processing.
CO5:Understand the new software of Tamil language.

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2MC2094/2095TAMILS AND TECHNOLOGY

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO1 2
CO1	2	3	3	-	-	-	-	-	2			2
CO2	2	3	3	-	-	-	-	-	2			2
CO3	2	3	3	-	-	-	-	-	2			2
CO4	2	3	-	-	-	-	-	-	2			2
CO5	2	3	-	-	-	-	-	-	2			2
AVG	2	3	1.8	-	-	-	-	-	2			2

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	22MC2093	SOCIAL SERVICES AND COMMUNITY DEVELOPMENT	1	0	0	1

Course Objectives:

The student should be able to

1. Acquire the knowledge and active participate in social service and community development activities.
2. Understand the concept of disaster management and role of NCC cadets in disaster management..
3. Understand the concept thinking and reasoning process..
4. Understand about maps and use of bearing and service protector
5. Know about the principles of flight and Aero foil structure and ATC procedures.

Unit	Description	Instructional Hours
I	**SOCIAL SERVICES AND COMMUNITY DEVELOPMENT** Basics of social services and its need - Rural development programs - Contribution of youth towards social welfare - NGOs in social services SwachbharathAbhiyan - Social evils - Mission Indradanush - BetibachoBetipado - Digital awareness - Constitution day.	3
II	**DISASTER MANAGEMENT** Organization of Disaster management -Types of emergencies - Natural and manmade disasters - fire service and fire fighting - prevention of fire.	3
III	**PERSONALITY DEVELOPMENT** Introduction to personality development - public speaking Intra and Inter personal skills -self awareness - critical thinking - Decision making and problem solving.	3
IV	**MAP READING** Types of maps - conventional signs - scales and Grid system - relief and contour gradient - cardinal points - Types of North - types of bearing and use of service protector - Prismatic compass and its uses - setting of map - finding North and own position.	3
V	**PRINCIPLES OF FLIGHT AND AIRMANSHIP** Introduction to principle of flight - Forces acting on the aircraft - Angle of attack - Angle of incidence - Newton's - law of motion - Bernauli's theorem and Venturi effect - Aerofoil - Airfield layout - ATC (Air Traffic Control) - circuit procedures - Aviation medicine.	3
	Total Instructional Hours	15

Course Outcome:

After completion of the course the learner will be able to

CO1:Perform the social services on various occasions for better community and social life
CO2:Appreciate the need and requirement for disaster management and NCC role in disaster management activities.
CO3: Define thinking, reasoning, critical thinking and creative thinking
CO4:Use of bearing and service protector and locate the places and objects on the ground.
CO5:Understand the principles of flight and Aerofoil structure

Reference:

1. UGC and AICTE circulated syllabus.

Text Books :

1. NCC cadet Guide (SD/SW) Army
2. NCC cadet Guide (SD/SW) Airforce.
3. ANOs Guide (SD/SW) by DG NCC, Ministry of Defence, New Delhi
4. Digital Forum App 1.0 & 2.0, by DG NCC DG NCC, Ministry of Defence, New Delhi

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
BE/B.TECH II	22HE2072	SOFT SKILLS AND APTITUDE	1	0	0	1

Course Objective

The student should be able to

1. To develop and nurture the soft skills of the students through instruction, knowledge acquisition demonstration and practice.
2. To enhance the students ability to deal with numerical and quantitative skills.
3. To identify the core skills associated with critical thinking.
4. To develop and integrate the use of English language skills

Unit	Description	Instructional Hours
I	**Lessons on excellence** Skill introspection, Skill acquisition, consistent practice	2
II	**Logical Reasoning** Problem Solving - Critical Thinking- Lateral Thinking - Coding and Decoding – Series – Analogy - Odd Man Out - Visual Reasoning - Sudoku puzzles - Attention to detail	11
III	**Quantitative Aptitude** Addition and Subtraction of bigger numbers - Square and square roots - Cubes and cube roots - Vedic maths techniques - Multiplication Shortcuts - Multiplication of 3 and higher digit numbers – Simplifications - Comparing fractions - Shortcuts to find HCF and LCM - Divisibility tests shortcuts - Algebra and functions	11
IV	**Recruitment Essentials** Resume Building - Impression Management	4
V	**Verbal Ability** Nouns and Pronouns – Verbs - Subject-Verb Agreement - Pronoun-Antecedent – Agreement - Punctuations	4
	Total Instructional Hours	30

Course Outcome

After completion of the course the learner will be able to

CO1: Students will analyze interpersonal communication skills. public speaking skills.
CO2: Students will exemplify tautology, contradiction and contingency by logical thinking.
CO3: Students will be able to develop an appropriate integral form to solve all sorts of quantitative problems.
CO4:Students can produce a resume that describes their education, skills, experiences and measurable achievements with proper grammar, format and brevity
CO5: Students will be developed to acquire the ability to use English language with an error while making optimum use of grammar

REFERENCE BOOKS:

R1 - Quantitative Aptitude – Dr. R S Agarwal
R2 -Speed Mathematics: Secret Skills for Quick Calculation - Bill Handley
R3 -Verbal and Non – Verbal Reasoning – Dr. R S Agarwal
R4- Objective General English – S.P.Bakshi

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
BE/B.TECH II	22HE2071	DESIGN THINKING	2	0	0	2

Course Objective

The student should be able to

1. To expose students to the design process
2. To develop and test innovative ideas through a rapid iteration cycle.
3. To provide an authentic opportunity for students to develop teamwork and leadership skills

Unit	Description	Instructional Hours
I	**DESIGN ABILITY** Asking Designers about what they Do – Deconstructing what Designers Do – Watching what Designers Do – Thinking about what Designers Do – The Natural Intelligence of Design Sources	6
II	**DESIGNING TO WIN** Formula One Designing – Radical Innovations – City Car Design – Learning From Failures – Design Process and Working Methods	5
III	**DESIGN TO PLEASE AND DESIGNING TOGETHER** Background – Product Innovations – Teamwork versus Individual work – Roles and Responsibilities – Avoiding and Resolving Conflicts.	6
IV	**DESIGN EXPERTISE** Design Process – Creative Design - Design Intelligence – Development of Expertise – Novice to Expert. Critical Thinking – Case studies: Brief history of Albert Einstein, Isaac Newton and Nikola Tesla	6
V	**DESIGN THINKING TOOLS AND METHODS** Purposeful Use of Tools and Alignment with Process - Journey Mapping - Value Chain Analysis - Mind Mapping – Brainstorming - Design Thinking Application: Design Thinking Applied to Product Development	7
	Total	**30**

Instructional Hours

Course Outcome

After completion of the course the learner will be able to

CO1: Develop a strong understanding of the Design Process
CO2: Learn to develop and test innovative ideas through a rapid iteration cycle.
CO3: Develop teamwork and leadership skills

TEXT BOOKS:

T1 - 1. Nigel Cross, "Design Thinking", Kindle Edition.

REFERENCE BOOKS:

R1 - Tom Kelley, "Creative Confidence", 2013.
R2 - 3. Tim Brown, "Change by Design", 2009.

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Course Code & Name: 22HE2071 Design Thinking

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	1	3	2	1	0	0	2	0	0	1	1	0
CO2	3	2	1	3	2	3	0	1	2	0	0	2	1	1
CO3	3	3	1	3	2	1	0	1	2	0	0	1	1	1
CO4	3	2	1	3	0	1	0	1	0	0	0	2	1	1
CO5	3	1	1	3	2	2	0	0	2	0	0	1	1	0
Avg	3	2	1	3	2	2	0	1	2	0	0	1	1	1

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DEPARTMENT OF CHEMICAL ENGINEERING
R-2022
REVISION COURSES

SL.NO	COURSE CODE	NAME OF THE COURSE	EXISTING SYLLABUS	SUGGESTIONS AND COMMENTS GIVEN BY EXPERTS	ACTION TAKEN	% OF CHANGE
1.	22CH1251 Batch admitted from 2024 – 2025 onwards	Introduction to Chemical Engineering	UNIT-I- Historical evolution of chemical engineering; What is Chemical Engineering? Origin and growth of chemical Engineers in chemical process industries;Roles of the modern chemical engineer – UNIT-II- Role of Chemical Engineers - Food, Medical, Energy, Environmental, Biochemical, Electronics; Portable Devices; UNIT-IV- Chemical Engineering in Everyday Life; Similarities in Dissimilar Applications; Scaling Up or Down;	Recommended to incorporate the following, UNIT-I- Personalities of Chemical Engineering; Greatest achievements of Chemical Engineering, ; Traditional vs. modern chemical engineering UNIT-II- Relation between Chemical Engineering and other engineering disciplines. UNIT-IV- Waste management – Removal of color and noxious compounds from effluent and air; Segregation of E-waste to recover valuable products	Incorporated	20

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HINDUSTHAN
COLLEGE OF ENGINEERING ANDTECHNOLOGY

(An Autonomous Institution)

Coimbatore– 641032

DEPARTMENT OF CHEMICAL ENGINEERING

CURRICULUM

(UNDER REGULATIONS 2022)

(Academic Council Meeting held on 19.06.2023)

HICET

Hindusthan College of Engineering and Technology

Approved by AICTE, New Delhi, Accredited with 'A' Grade by NAAC (An
Autonomous Institution, Affiliated to Anna University, Chennai)
Coimbatore – 641 032

DEPARTMENT OF CHEMICAL ENGINEERING

R2022

Sl. No	Course Code & Name	Existing Syllabus	Revised Content	Type of Revision (Deletion/Insertion/Modification)	% Revision
R2022					
1	**22CH3201-CHEMICAL PROCESS CALCULATIONS**	**UNIT-V-** Application of energy balances; Unsteady state material and energy balances; Solving material and energy balances using process simulators.	**UNIT-V-** Calorific value of fuels, Flue gas analysis, Orsat analysis, theoretical and excess air requirement for solid, liquid and gaseous fuels	**Insertion**	**20**
2	**22CH3202-FLUID FLOW OPERATIONS**	**UNIT-II-** Types of flow – laminar and turbulent flow in pipes and closed channels;Equation of Continuity; shear stress distribution; friction factors; Bernoulli's equation and applications; Introduction - Boundary layer concept. **Dimensional analysis:** Basics of dimensional analysis: Rayleigh's method and Buckingham's-π method.	**UNIT-II-** Looses in Pipes.	**Insertion**	**20**
		UNIT-III-Drag- types, drag coefficient, friction factor for flow through beds of solids, applications to packed and fluidized beds; packing materials; determination of pressure drop using Ergun equation, Fluidization-types, determination of minimum fluidization velocity and pressure drop; Motion of particles through fluids – calculation of terminal settling velocity.	**UNIT-III-** Buoyancy, Condition of Equilibrium for Submerged and Floating Bodies, Centre of Buoyancy, Metacentre– Determination of Metacentric Height.		

		UNIT-V- Classification of fluid moving machinery; Centrifugal pump-characteristics and applications; elementary principles of Reciprocating, gear, air lift, diaphragm and submersible pumps; Introduction to valves and pipe fittings.	**UNIT-V-** performance of multistage pumps - Cavitation - methods of prevention.		
3	**22CH3203-CHEMICAL ENGINEERING THERMODYNAMICS-I**	**UNIT-II-** PVT behaviour of fluids; Mathematical representation of PVT behavior; generalized compressibility factor correlation; generalized equations of state.	**UNIT-II-** Heat effect accompanying chemical reaction.	**Insertion**	**20**
		UNIT-III- Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume. Third law of thermodynamics, entropy from a microscopic point of view.	**UNIT-III-** heat pump, entropy balances for open system, Clausius Inequality		
		UNIT-IV- Internal energy, Enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations - partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams.	**UNIT-IV-** Fugacity and activity		
		UNIT-V- Duct flow of compressible fluids, Compression and expansion processes, steam power plant,internal combustion engines, jet and rocket engines.	**UNIT-V-** Gas-turbine power plant		

4	**22CH3251- MECHANICAL OPERATIONS**	**UNIT-I-** General characteristics of solids, different techniques of size analysis- Static - Image analysis and Dynamic analysis - Light scattering techniques, shape factor, surface area determination, estimation of particle size. Advanced particle size analysis techniques. Screening methods and equipment, screen efficiency, ideal and actualscreens: **Sieve analysis.**	**UNIT-I-** Particle Shape, Size, Mixed Particle Sizes and Size Analysis – Cumulative and Differential Analysis.	**Insertion**	**20**
		UNIT-II- Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; Advanced size reduction techniques-Nanoparticle fabrication-Topdown approach - Bottom-up approach. Size enlargement - Importance of size enlargement, principle of granulation, briquetting, pelletisation, and flocculation. Fundamentals of particle generation: **Reduction ratio in Jaw Crusher, Ballmill, Drop Weight Crusher.**	**UNIT-II-** Principles of Comminution - Energy and Power requirements in Comminution - Mechanical Efficiency		

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DEPARTMENT OF CHEMICAL ENGINEERING
REGULATION-2022
B.TECH. CHEMICAL ENGINEERING
I TO VIII SEMESTERS CURRICULUM

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER I											
Theory											
1.	**22MA1101**	Matrices and Calculus	BSC	3	1	0	4	4	40	60	100
2.	22ME1201	Engineering Drawing	ESC	1	4	0	3	5	40	60	100
Theory with Lab Component											
3.	22HE1151	English for Engineers	HSC	2	0	2	3	4	50	50	100
4.	22PH1151	Physics of Materials	BSC	2	0	2	3	4	50	50	100
5.	22IT1151	Python Programming and Practices	ESC	2	0	2	3	4	50	50	100
EEC Courses (SE/AE)											
6.	**22HE1071**	Universal Human Values	AEC	2	0	0	2	2	40	60	100
7.	**22HE1072**	Entrepreneurship & Innovation	AEC	1	0	0	1	1	100	0	100
Mandatory Courses											
8.	**22MC1091/ 22MC1092**	**தமிழர்மரபு**/ Heritage of Tamil	MC	2	0	0	0	2	0	0	0
			TOTAL	**15**	**5**	**6**	**19**	**27**	**370**	**330**	**700**
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER II											
1	**22MA2104**	Fourier Analysis and Laplace Transforms	BSC	3	1	0	4	4	40	60	100
2	**22PH2101**	Basics of Material Science	BSC	2	0	0	2	2	40	60	100
3	**22CY2101**	Environmental Studies	ESC	2	0	0	2	2	40	60	100
4	22CH2201	Introduction to Chemical Engineering	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5	**22CY2151**	Chemistry for Engineers	BSC	2	0	2	3	4	50	50	100
6	**22HE2151**	Effective Technical Communication	HSC	2	0	2	3	4	50	50	100
Practical											
7.	**22ME2001**	Engineering Practices	ESC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
8.	**22HE2071**	Design Thinking	AEC	1	0	2	2	3	100	0	100
9.	**22HE2072**	Soft Skills and Aptitude-I	SEC	1	0	0	1	1	100	0	100
Mandatory Courses											
10.	**22MC2093**	NCC */NSS / YRC / Sports / Clubs / Society Service - Enrollment	MC	All students shall enroll, on admission, in anyone of the personality and character development programmes and undergo training for about 80 hours							
11.	**22MC2091/ 22MC2092**	**தமிழரும் தொழில்நுட்பமும் / TAMILS AND TECHNOLOGY**	MC	2	0	0	0	2	0	0	0
			TOTAL	**18**	**1**	**10**	**22**	**29**	**520**	**380**	**900**
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER III											
Theory											
1.	**22MA3107**	Numerical Methods	BSC	3	1	0	4	4	40	60	100

2.	22CH3201	Chemical Process Calculations	PCC	3	1	0	4	3	40	60	100
3.	22CH3202	Fluid Flow Operations	PCC	3	0	0	3	3	40	60	100
4.	22CH3203	Chemical Engineering Thermodynamics – I	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5.	22CH3251	Mechanical Operations	PCC	2	0	2	3	4	50	50	100
6.	22ME3253	Basic Mechanical Engineering	ESC	2	0	2	3	4	50	50	100
Practical											
7.	22CH3001	Fluid Flow Operations Lab	AEC	0	0	4	2	4	60	40	100
8.	22CH3002	Technical Analysis Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
9.	22HE3071	Soft Skills -2	SEC	1	0	0	1	1	100	0	100
Mandatory Course											
10	22MC3091	Essence of Indian Traditional Knowledge	AC	2	0	0	0	2	100	0	100
			TOTAL	**17**	**2**	**12**	**25**	**30**	480	420	900
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER IV											
Theory											
1.	22HE4101	IPR and Start-ups(Common)	HSC	2	0	0	2	2	40	60	100
2.	22CH4201	Mass Transfer Operations - I	PCC	3	0	0	3	3	40	60	100
3.	22CH4202	Chemical Engineering Thermodynamics – II	PCC	3	0	0	3	3	40	60	100
4.	22CH4203	Process Heat Transfer	PCC	3	0	0	3	3	40	60	100
5.	22CH4204	Chemical Process Industries	PCC	2	0	0	2	2	40	60	100
Theory with Lab Component											
6.	**22EE4251**	Basics of Electrical &Electronics Engineering	ESC	1	0	2	2	3	50	50	100
7.	22CH4251	Chemical Reaction Engineering - I	PCC	2	0	2	3	4	50	50	100
8.	**22MA4151**	Probability and statistics with R programming	BSC	2	0	2	3	4	50	50	100
Practical											
9.	22CH4001	Heat Transfer Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
10.	22HE4071	Soft Skills -3(Common)	SEC3	1	0	0	1	1	100	0	100
			TOTAL	**19**	**0**	**10**	**24**	**29**	510	490	1000
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER V											
Theory											
1.	22CH5201	Mass Transfer Operations - II	PCC	3	0	0	3	3	40	60	100
2.	22CH5202	Process Instrumentation Dynamics and Control	PCC	3	0	0	3	3	40	60	100
3.	22CH53XX	Professional Elective-1	PEC	3	0	0	3	3	40	60	100
4.	22CH53XX	Professional Elective-2	PEC	3	0	0	3	3	40	60	100
5.	22CH53XX	Professional Elective-3	PEC	3	0	0	3	3	40	60	100
Theory with Lab Component											
6.	22CH5251	Chemical Reaction Engineering - II	PCC	2	0	2	3	4	50	50	100
Practical											
7.	22CH5001	Mass Transfer Operations Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
8.	22HE5071	Soft Skills -4/Foreign languages	SEC	1	0	0	1	1	100	0	100
			TOTAL	**17**	**1**	**6**	**21**	**24**	410	390	800
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER VI											
Theory											

SEMESTER WISE CREDIT DISTRIBUTION

B.E. / B.TECH.PROGRAMMES									
S.No.	Course Area	Credits per Semester							TotalCredits
		I	II	III	IV	V	VI	VII	VIII	
1	HSC	3	3	-	2	-	3	-	-	**11**
2	BSC	7	9	4	3	-	-	-	-	**23**
3	ESC	6	4	3	2	-	-	-	-	**15**
4	PCC	-	3	15	16	11	7	9	-	**61**
5	PEC	-	-	-	-	9	6	3	-	**18**
6	OEC	-	-	-	-	-	6	6	-	**12**
7	EEC	3	3	3	1	1	2	2	10	**25**
8	MC	✓	✓							
Total		**19**	**22**	**25**	**24**	**21**	**24**	**20**	**10**	**165**

OPEN ELECTIVE I AND II (EMERGING TECHNOLOGIES)

To be offered for the students other than CSE, IT, AI&ML, ECE & BIOMEDICAL

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22AI6451	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2	22CS6451	Blockchain Technology	OEC	2	0	2	4	3
3	22EC6451	Cyber security	OEC	2	0	2	4	3
4	22EC6452	IoT Concepts and Applications	OEC	2	0	2	4	3
5	22IT6451	Data Science and Analytics	OEC	2	0	2	4	3
6	22BM6451	Augmented andVirtual Reality	OEC	2	0	2	4	3

OPENELECTIVE I AND II

To be offered for the students other than AUTO, AERO, AGRI, MECH, MCTS, CIVIL, EEE, CHEMICAL, FOOD TECH, E&I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	22AE6401	Space Science	OEC	3	0	0	3	3
2	22MT6401	Introduction to Industrial Engineering	OEC	3	0	0	3	3
3	22MT6402	Industrial Safety and Environment	OEC	3	0	0	3	3
4	22CE6401	Climate Change and its Impact	OEC	3	0	0	3	3
5	22CE6402	Environment and Social Impact Assessment	OEC	3	0	0	3	3
6	22ME6401	Renewable Energy System	OEC	3	0	0	3	3
7	22ME6402	Additive Manufacturing systems	OEC	3	0	0	3	3
8	22EI6401	Introduction to Industrial	OEC	3	0	0	3	3

1.	22CH6201	Transport Phenomena	PCC	3	0	0	3	3	40	60	100
2.	22HE6101	Professional Ethics (Common)	HSC	3	0	0	3	3	40	60	100
3.	22CH63XX	Professional Elective-4	PEC	3	0	0	3	3	40	60	100
4.	22CH63XX	Professional Elective-5	PEC	3	0	0	3	3	40	60	100
5.	22XX64XX	Open Elective – 1*	OEC	3	0	0	3	3	40	60	100
6.	22XX64XX	Open Elective – 2*	OEC	3	0	0	3	3	40	60	100
Practical											
7.	22CH6001	Process Control Lab	PCC	0	0	4	2	4	60	40	100
8.	22CH6002	Computational Chemical Engineering Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
9.	22HE6071	Soft Skills – 5(Common)	SEC	2	0	0	2	2	100	0	100
			TOTAL	**20**	**0**	**8**	**24**	**28**	460	440	900

S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER VII											
Theory											
1.	22CH7201	Process Economics and Engineering Management	PCC	3	0	0	3	3	40	60	100
2.	22CH7202	Process Equipment Design	PCC	3	1	0	4	4	40	60	100
3.	22CH73XX	Professional Elective-6	PEC	3	0	0	3	3	40	60	100
4.	22XX74XX	Open Elective – 3*	OEC	3	0	0	3	3	40	60	100
5.	22XX74XX	Open Elective – 4*	OEC	3	0	0	3	3	40	60	100
Practical											
6.	22CH7001	Design and Simulation Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
7.	22CH7701	Internship	SEC	-	-	-	2	2	100	0	100
			TOTAL	**15**	**1**	**4**	**20**	**22**	360	340	700

* - Four weeks internship carries 2 credit and it will be done in before Semester VI summer vacation/placement training and same will be evaluated in Semester VII.

S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER VIII											
EEC Courses (SE/AE)											
1.	22CH8901	Project Work/Granted Patent(Common)	SEC	0	0	20	10		100	0	100
			TOTAL	**0**	**0**	**20**	**10**	**20**	**100**	**0**	**100**

* 1. As per the AICTE guideline, in Semester I, II, III & IV NCC one credit subject is added as Value Added Course with Extra Credit. Further, the students' who enrolled his/her name in HICET NCC and Air Wing are eligible to undergo this subject. The earned extra credits printed in the Consolidated Mark sheet as per the regulation.

2. NCC course level 1 & Level 2 will be added in the list of open elective subjects in the appropriate semester. Further, the students' who have opted NCC subjects in Semester I, II, III & IV are eligible to undergo NCC Open Elective Subjects.

3. The above-mentioned NCC Courses will be offered to theStudents who are going to be admitted in the Academic Year 2021 – 22.

		Instrumentation and Control						
9	22EI6402	Graphical Programming using Virtual Instrumentation	OEC	3	0	0	3	3
10	22AU6401	Fundamentals of Automobile Engineering	OEC	3	0	0	3	3
11	22AU6402	Automotive Vehicle Safety	OEC	3	0	0	3	3
12	22EE6401	Digital Marketing	OEC	3	0	0	3	3
13	22EE6402	Research Methodology	OEC	3	0	0	3	3
14	22FT6401	Traditional Foods	OEC	3	0	0	3	3
15	22AG6401	Urban Agriculture and Organic Farming	OEC	3	0	0	3	3
16	22CH6401	Biomass and Bio refinery	OEC	3	0	0	3	3

Note:Non Circuit Departments can add one Open Elective course in the above list to offer for the circuit branches

OPEN ELECTIVE III (Offered by Chemical Engineering)

Students shall choose any one of the open elective courses such that the course content or title not belongs to their own programme.

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH7401	Waste to Energy Conversion	OEC	3	0	0	3	3

OPENELECTIVE IV

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22LS7401	General studies for competitive examinations	OEC	3	0	0	3	3
2	22LS7402	Human Rights, Women Rights and Gender equity	OEC	3	0	0	3	3
3	22LS7403	Indian ethos and Human values	OEC	3	0	0	3	3
4	22LS7404	Financial independence and management	OEC	3	0	0	3	3
5	22LS7405	Yoga for Human Excellence	OEC	3	0	0	3	3
6	22LS7406	Democracy and Good Governance	OEC	3	0	0	3	3
7	22LS7407	NCC Level - II	OEC	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Petroleum Process Technology	Vertical II Energy Engineering	Vertical III Biochemical Engineering	Vertical IV Environmental and Safety Engineering	Vertical V Computational Chemical Engineering	Vertical VI Chemical Plant Design
Petroleum Chemistry and Refining Fundamentals	Bioenergy	Biochemistry	Air Pollution Engineering	Computational Techniques	Chemical Plant Design
Primary RefiningTechnology	RenewableEnergy Resources	Bioprocess Technology	Waste Water Treatment	Optimization of Chemical Processes	Plant Layout
Secondary Refining Technology	Pinch Technology	Fermentation & Bioprocessing	Solid waste Management	Process Modeling and Simulation	Design Safety
Refinery Advancements and Environmental Regulations	Hydrogen and Fuel Cell Technology	Bio separation & Downstream Processing	Environmental Impact Assessment	Pinch Analysis and Heat Exchange Network Design	Material Selection
Petroleum Equipment Design	Power Plant Engineering	Enzyme Immobilisation Technology	Process Safety Management	Chemical Process Flowsheeting	Statutory Requirements&Customer Care
Petrochemical Technology	Non-Renewable Energy	Bioreactor Design	Risk and HAZOP	Computational Fluid Dynamics	Process Plant Utilities

	Sources		Analysis		
Note: Students are permitted to choose all Professional Electives from a particular vertical					

DETAILS OF VERTICAL I :PETROLEUM PROCESS TECHNOLOGY											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5301	Petroleum Chemistry and Refining Fundamentals	PEC	3	0	0	3	3	40	60	100
2.	22CH5302	PrimaryRefiningTechnology	PEC	3	0	0	3	3	40	60	100
3.	22CH5303	SecondaryRefiningTechnology	PEC	3	0	0	3	3	40	60	100
4.	22CH6301	RefineryAdvancementsandEnvironmentalRegulations	PEC	3	0	0	3	3	40	60	100
5.	22CH6302	PetroleumEquipmentDesign	PEC	3	0	0	3	3	40	60	100
6.	22CH7301	PetrochemicalTechnology	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL II :ENERGY ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5304	Bioenergy	PEC	3	0	0	3	3	40	60	100
2.	22CH5305	Renewable Energy Resources	PEC	3	0	0	3	3	40	60	100
3.	22CH5306	Pinch Technology	PEC	3	0	0	3	3	40	60	100
4.	22CH6303	Hydrogen And Fuel Cell Technology	PEC	3	0	0	3	3	40	60	100
5.	22CH6304	Power Plant Engineering	PEC	3	0	0	3	3	40	60	100
6.	22CH7302	Non-Renewable Energy Sources	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL III :BIOCHEMICAL ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5307	Biochemistry	PEC	3	0	0	3	3	40	60	100
2.	22CH5308	Bioprocess Technology	PEC	3	0	0	3	3	40	60	100
3.	22CH5309	Fermentation & Bioprocessing	PEC	3	0	0	3	3	40	60	100
4.	22CH6305	Bio separation & Downstream Processing	PEC	3	0	0	3	3	40	60	100
5.	22CH6306	Enzyme Immobilization Technology	PEC	3	0	0	3	3	40	60	100
6.	22CH7303	Bioreactor Design	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL IV: ENVIORNMENTAL AND SAFETY ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5310	Biochemistry	PEC	3	0	0	3	3	40	60	100
2.	22CH5311	Bioprocess Technology	PEC	3	0	0	3	3	40	60	100
3.	22CH5312	Fermentation & Bioprocessing	PEC	3	0	0	3	3	40	60	100
4.	22CH6307	Bio separation & Downstream Processing	PEC	3	0	0	3	3	40	60	100
5.	22CH6308	Enzyme Immobilisation Technology	PEC	3	0	0	3	3	40	60	100
6.	22CH7304	Bioreactor Design	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL V: COMPUTATIONAL ENGINEERING											
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
1.	22CH5313	Computational Techniques	PEC	3	0	0	3	3	40	60	100
2.	22CH5314	Optimization of Chemical Processes	PEC	3	0	0	3	3	40	60	100
3.	22CH5315	Process Modeling and Simulation	PEC	3	0	0	3	3	40	60	100
4.	22CH6309	Pinch Analysis and Heat Exchange Network Design	PEC	3	0	0	3	3	40	60	100
5.	22CH6310	Chemical Process Flow sheeting	PEC	3	0	0	3	3	40	60	100
6.	22CH7305	Computational Fluid Dynamics	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL VI :COMPUTATIONAL ENGINEERING											
S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
1.	22CH5316	Chemical Plant Design	PEC	3	0	0	3	3	40	60	100
2.	22CH5317	Plant Layout	PEC	3	0	0	3	3	40	60	100
3.	22CH5318	Design Safety	PEC	3	0	0	3	3	40	60	100
4.	22CH6311	Material Selection	PEC	3	0	0	3	3	40	60	100
5.	22CH6312	Statutory Requirements & Customer Care	PEC	3	0	0	3	3	40	60	100
6.	22CH7306	Process Plant Utilities	PEC	3	0	0	3	3	40	60	100

Enrolment for B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation.

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only. For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes.

(i) B.E. / B.Tech. Honours (specialisation in the same discipline):

a. The student should have earned additionally a minimum of 18 credits from a vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(ii) B.E. / B.Tech. Honours:

a. The students should have earned additional courses (minimum of 18 credits) from more than one vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(iii) B.E. / B.Tech. (Minor in other specialisation):

The student should have earned additionally a minimum of 18 credits in any one of the verticals of other B.E. / B.Tech. programmes or from any one of the following verticals

VERTICAL I: FINTECH AND BLOCK CHAIN

VERTICAL II: ENTREPRENEURSHIP

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY

- Students can earn maximum of 6 credits in online mode (SWAYAM platform), out of these 18 credits as approved by Centre for Academic Courses.

- B.E. / B. Tech. (Honours) Specialisation in the same discipline, B.E / B.Tech. Honours and B.E. / B.Tech. Minor in other specialisation degree will be optional for students.

- For the categories (i) to (ii), the students will be permitted to register the courses from V Semester onwards provided the marks earned by the students until III semester should be of CGPA 7.50 and above and cleared all the courses in the first attempt.

- For the category (iii), the students will be permitted to register the courses from Semester V onwards provided the marks earned by the students until Semester III is CGPA 7.50 and above.

- If a student decides not to opt for Honours, after completing certain number of additional courses, the additional courses studied shall be considered instead of the Professional Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of Professional Elective courses required as per the curriculum, the courses with higher grades shall be considered for the calculation of CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- If a student decides not to opt for Minor, after completing certain number of courses, the additional courses studied shall be considered instead of Open Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of open electives required as per the curriculum, the courses with higher grades shall be considered for calculation of CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- The Head of Department, shall forward the proposal to the Controller of Examinations after getting the approval from Head of the Institution / Dean Academics, before the commencement of the fifth semester of the programme for the students undergo optionally B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation

VERTICALS FOR MINOR DEGREE
CHEMICAL ENGINEERING OFFERING MINOR DEGREE

Minor Specialization in Chemical Process Engineering

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5601	Introduction to Chemical Process	MDC	3	0	0	3	3
2	22CH6601	Fluid Flow Operations in Chemical Engineering	MDC	3	0	0	3	3
3	22CH6602	Fundamentals of Chemical Thermodynamics	MDC	3	0	0	3	3
4	22CH7601	Process Heat and Mass Transfer	MDC	3	1	0	4	4
5	22CH7602	Reaction Engineering	MDC	3	0	0	3	3
6	22CH8601	Unit Operations and Process Laboratory	MDC	0	0	4	4	2

*MDC – Minor Degree Course

In addition to the above the following additional courses for Minor Degree can also be given to the student's common to all the branches.

VERTICAL I: FINTECH AND BLOCK CHAIN								
S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22MBXXX	Financial Management	MDC	3	0	0	3	3
2	22MBXXX	Fundamentals of Investment	MDC	3	0	0	3	3
3	22MBXXX	Banking, Financial Services and Insurance	MDC	3	0	0	3	3
4	22MBXXX	Introduction to Block chain and its Applications	MDC	3	0	0	3	3
5	22MBXXX	Fintech Personal Finance and Payments	MDC	3	0	0	3	3
6	22MBXXX	Introduction to Fintech	MDC	3	0	0	3	3

VERTICAL II: ENTREPRENEURSHIP								
S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22MBXXX	Foundations of Entrepreneurship	MDC	3	0	0	3	3
2	22MBXXX	Team Building & Leadership Management for Business	MDC	3	0	0	3	3
3	22MBXXX	Creativity & Innovation in Entrepreneurship	MDC	3	0	0	3	3
4	22MBXXX	Principles of Marketing Management For Business	MDC	3	0	0	3	3
5	22MBXXX	Human Resource Management for Entrepreneurs	MDC	3	0	0	3	3
6	22MBXXX	Financing New Business Ventures	MDC	3	0	0	3	3

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY								
S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CEXXX	Sustainable infrastructure Development	MDC	3	0	0	3	3
2	22AGXXX	Sustainable Agriculture and Environmental Management	MDC	3	0	0	3	3
3	22BMXXX	Sustainable Bio Materials	MDC	3	0	0	3	3
4	22MEXXX	Materials for Energy Sustainability	MDC	3	0	0	3	3
5	22CEXXX	Green Technology	MDC	3	0	0	3	3
6	22CEXXX	Environmental Quality Monitoring and Analysis	MDC	3	0	0	3	3

VERTICALS FOR B Tech (Hons) and B Tech (Hons) in Chemical Engineering with Specialization

Vertical I Computer Aided Process Engineering	Vertical II Polymer Technology	Vertical III Petroleum Engineering	Vertical IV Instrumental Chemical Analysis
Process Flow Sheeting	Polymer Chemistry	Petroleum Geology	Principles of Mass Spectrometry
Transport Phenomena	Processing Technology	Petroleum Exploration	Advanced Analytical Separation Techniques
Advanced Process Optimization	Rubber Technology	Drilling Technology	Advanced Spectrometry: ICP-MS and LC-MS
Artificial Intelligence in Process Engineering	Polymer Product Design, Blends, and Alloys	Petroleum Production Engineering	Instruments for Morphology and Structural Characterization
Digital Twin and Soft Computing in Process Modelling	Polymer Structure and property relationships	Petroleum Reservoir Engineering	Statistical Analysis and Data Processing (Lab)
Advanced Process Modelling and Simulation	Polymer Compounding Technology	Offshore Engineering	Troubleshooting Analytical Methods and Instruments

B Tech (Hons) Chemical Engineering with Specialization in Computer Aided Process Engineering

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5205	Process Flow Sheeting	MDC	2	0	2	4	3
2	22CH6203	Transport Phenomena	MDC	3	1	0	3	4
3	22CH6204	Advanced Process Optimization	MDC	2	0	2	4	3
4	22CH7203	Artificial Intelligence in Process Engineering	MDC	2	0	2	4	3
5	22CH7204	Digital Twin and Soft Computing in Process Modelling	MDC	2	0	2	4	3
6	22CH8201	Advanced Process Modelling and Simulation	MDC	0	0	4	4	2

B Tech (Hons) Chemical Engineering with Specialization in Polymer Technology

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5206	Polymer Chemistry	MDC	3	0	0	3	3
2	22CH6205	Processing Technology	MDC	3	0	0	3	3
3	22CH6206	Rubber Technology	MDC	3	0	0	3	3
4	22CH7205	Polymer Product Design, Blends, and Alloys	MDC	3	0	0	3	3
5	22CH7206	Polymer Structure and property relationships	MDC	3	0	0	3	3
6	22CH8202	Polymer Compounding Technology	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in Petroleum Engineering

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5207	Petroleum Geology	MDC	3	0	0	3	3
2	22CH6207	Petroleum Exploration	MDC	3	0	0	3	3
3	22CH6208	Drilling Technology	MDC	3	0	0	3	3
4	22CH7207	Petroleum Production Engineering	MDC	3	0	0	3	3
5	22CH7208	Petroleum Reservoir Engineering	MDC	3	0	0	3	3
6	22CH8203	Offshore Engineering	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in Instrumental Chemical Analysis

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5208	Principles of Mass Spectrometry	MDC	3	0	0	3	3
2	22CH6209	Advanced Analytical Separation Techniques	MDC	3	0	0	3	3
3	22CH6210	Advanced Spectrometry: ICP-MS and LC-MS	MDC	3	0	0	3	4
4	22CH7209	Instruments for Morphology and Structural Characterization	MDC	3	0	0	3	3
5	22CH7210	Statistical Analysis and Data Processing (Lab)	MDC	3	0	0	4	2
6	22CH8204	Troubleshooting Analytical Methods and Instruments	MDC	3	0	0	3	3

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COIMBATORE - 641 032.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E/B.TECH	22MA3107	NUMERICAL METHODS (CHEM, FT)	3	1	0	4

Course Objective

The learner should be able to

1. Solve algebraic, transcendental and system of linear equations by using various techniques.
2. Analyze various methods to find the intermediate values for the given data.
3. Explain concepts of numerical differentiation and numerical integration of the unknown functions.
4. Explain single and multi step methods to solve Ordinary differential equations
5. Describe various methods to solve ordinary differential equations and partial differential equations.

Unit	Description	Instructional Hours
I	**SOLUTION OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS** Solution of Algebraic and Transcendental equations: Newton Raphson method . Solution of linear system: Gauss Elimination - Gauss Jordan method -Gauss Seidel method. Matrix inversion by Gauss Jordan method.	12
II	**INTERPOLATION** Interpolation - Newton's forward and backward difference formulae – Newton's divided difference formula and Lagrangian interpolation for unequal intervals.	12
III	**NUMERICAL DIFFERENTIATION AND INTEGRATION** Numerical Differentiation: Newton's forward and backward interpolation formulae for equal intervals –Newton's divided difference formula for unequal intervals. Numerical integration: Trapezoidal and Simpson's 1/3 rule.	12
IV	**INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS** Single step methods for solving first order equations: Taylor's series method – Euler and Modified Euler methods – Fourth order Runge-kutta method -Multi step method: Milne's predictor and corrector method.	12
V	**BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS** Solution of second order ordinary differential equation by Finite difference method – Solution of partial differential equation: one dimensional heat equation by Bender schmidt method – One dimensional Wave equation by Explicit method– Two dimensional heat equation - Laplace Equation and Poisson Equations.	12
	Total Instructional Hours	60

Course Outcome

At the end of the course, the learner will be able to

CO1: Solve the system of linear algebraic equations which extends its applications in the field of engineering

CO2: Apply various methods to find the intermediate values for the given data.

CO3: Identify various methods to perfrom numerical differentiation and integration

CO4: Classify and solve ordinary differential equations by using single and multi step methods.

CO5: Illustrate various methods to find the solution of ordinary and partial differential equations.

TEXT BOOKS:

T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi, 2018.

T2 - Grewal.B.S. " Higher Engineering Mathematics", 44th Edition, Khanna Publications, New Delhi, 2012.

REFERENCE BOOKS :

R1 - M.K.Jain,S.R.K.Iyengar, R.K.Jain "Numerical methods for Scientific and Engineering Computation", Fifth Edition, New Age International publishers 2010.

R2 - Grewal B.S. and Grewal J.S. " Numerical Methods in Engineering and Science ", 6th Edition , Khanna publishers, New Delhi 2015.

R3 - S.K.Gupta, Numerical Methods for Engineers" , New Age International Pvt.Ltd Publishers,2015.

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Course Code &Name : 22MA1101/ MATRICES AND CALCULUS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	-	-	-	-	-	2	2	1
CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO3	3	3	3	2	3	-	-	-	-	-	-	2	2	2
CO4	3	3	3	3	3	-	-	-	-	-	-	2	2	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	1	2
AVG	3	3	3	2.6	2.8	-	-	-	-	-	-	2	1.8	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH3201	CHEMICAL PROCESS CALCULATIONS	3	1	0	4

The student should be able to

Course Objective

1. Formulate material balances to solve for compositions and flow rates of process streams
2. Incorporate single and multiple reactions into unit operations within chemical processes
3. Perform material and energy balance calculations in various systems

Unit	Description	Instructional Hours
I	**BASIC CHEMICAL CALCULATIONS:** Unit Conversion; Mole concept – Concept of normality, molarity, and molality – Density and specific gravity – Methods of expressing the composition of mixtures and solutions – Weight fraction – Mole fraction-Volumetric composition – Ideal gas law – Dalton"s law – Amagat"s law.	9+3
II	**MATERIAL BALANCE WITHOUT CHEMICAL REACTION:** Law of conservation of mass – Process flow sheet – Material balance calculations involving drying, dissolution, distillation, crystallization, evaporation, absorption and extraction.– Humidity and Saturation – Relative and percentage saturation, Wet bulb and dry bulb temperature, Dew point – Use of humidity chart for engineering calculations	9+3
III	**MATERIAL BALANCE WITH CHEMICAL REACTION:** Stoichiometric equation – stoichiometric ratio – limiting reactant – excess reactant – percent excess – conversion – yield.Bypass, Purging, Recycle operations.	9+3
IV	**ENERGY BALANCE:** Standard heat of formation – Standard heat of combustion – Standard heat of reaction – Hess"s law – Determination of heat of reaction at temperatures other than standard temperature using specific heat relationships – Calculation of theoretical flame temperature.	9+3
V	**COMBUSTION CALCULATIONS:** Calorific value of fuels, Flue gas analysis, Orsat analysis, theoretical and excess air requirement for solid, liquid and gaseous fuels.	9+3
	Total Instructional Hours	45+15=60

Course Outcome

CO1	Understand the mole concept and ideal gas equation to express the composition of mixtures
CO2	Apply the method of solving steady state material balances without chemical reactions and usage of psychometric chart
CO3	Estimate the extent of reaction in material balances for systems involving chemical reactions
CO4	Inspect the energy balance and heat capacity calculations.
CO5	Calculate the calorific value of fuels using various methods.

TEXT BOOK:

T1 David M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", 8thEdition, Prentice Hall of India, New Delhi, 2012

T2 Bhatt B.I. and Vora S.M., "Stoichiometry", 2nd Edition, Tata McGraw Hill, New Delhi,2004

T3 Narayanan K.V., Lakshmikutty B, Stoichiometry and Process calculations, Prentice Hall India Limited, New Delhi, 2006.

REFERENCES:

R1 Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, 2nd Edition, CBS publishers, 2004.

R2 Venkatramani. V, Anatharaman. N and Meera Shariffa Begam" Process Calculations" Printice Hall of India, New Delhi, 2nd Edn, 2011.

R3 Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes",3rd Edition, John Wiley & Sons, New York, 2005

R4 Reklaitis G. V., "Introduction to Material and Energy Balances", Wiley, New York, (1983).

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Course Code & Name: 22CH3201-CHEMICAL PROCESS CALCULATIONS

) & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	3		1						2	2	1
CO2	3	3	3	3		1	1		1			2	2	1
CO3	3	3	3	3		1	1		1			2	2	1
CO4	3	3	3	3		1	1		1			2	2	1
CO5	3	3	3	3	1	1						1	1	1
AVG:	3	3	3	3	1	1	1	-	1	-	-	2.2	2.2	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH	22CH3202	FLUID FLOW OPERATIONS	3	0	0	3

Course Objective

The student should be able to

1. Develop an understanding of the fundamental properties of fluids and their behavior in static conditions.
2. Familiarize students with the principles of fluid flow, including laminar and turbulent flow, flow equations, and flow measurement techniques.
3. Enable students to understand various flow metering techniques and their applications in fluid transportation.
4. Introduce students to the principles and selection criteria of hydraulic pumps, compressors, and air motors.

Unit	Description	Instructional Hours
I	**Fluid Properties and Statics:** Nature of fluids - properties of fluids; Types offluids- Newtonian and Non-Newtonian fluids, Compressible and incompressible fluids; Introduction- Hydrostatic equilibrium; Pressure measurement – Manometers.	9
II	**Principles of Fluid Flow**: Types of flow – laminar and turbulent flow in pipes and closed channels;Equation of Continuity; shear stress distribution; friction factors; Bernoulli's equation and applications; Losses in pipes - Introduction - Boundary layer concept. Dimensional analysis: Basics of dimensional analysis: Rayleigh's method and Buckingham's-π method.	9
III	**Flow Past Immersed Bodies**: Drag- types, drag coefficient, friction factor for flow through beds of solids, applications to packed and fluidized beds; packing materials; determination of pressure drop using Ergun equation, Fluidization-types, determination of minimum fluidization velocity and pressure drop; Motion of particles through fluids – calculation of terminal settling velocity. Buoyancy, Condition of Equilibrium for Submerged and Floating Bodies, Centre of Buoyancy, Metacentre–Determination of Metacentric Height.	9
IV	**Metering of Fluids:** Classification and selection of flow meters; variable head and variable area meters: venturi, orifice and rotameters; determination of discharge and discharge coefficient; Pitot tube; Anemometer; Introduction to notches, weirs, turbine, Vortex and Magnetic flow meters.	9
V	**Transportation of Fluids:** Classification of fluid moving machinery; Centrifugal pump-characteristics and applications; elementary principles of Reciprocating, gear, air lift, diaphragm and submersible pumps; Introduction to valves and pipe fittings. performance of multistage pumps - Cavitation - methods of prevention.	9
	Total Instructional Hours	45

Course Outcome

CO1	Demonstrate a comprehensive understanding of the properties and behavior of fluids in static conditions.
CO2	Analyze different types of flow, including laminar and turbulent flow, and apply the equation of continuity and Bernoulli's equation to solve flow-related problems.
CO3	Determine drag coefficients and pressure drops in fluidized and packed beds using appropriate equations and correlations.
CO4	Select and utilize different flow metering techniques for accurately measuring fluid flow rates.
CO5	Understand the principles and characteristics of hydraulic pumps, compressors, and air motors, and apply them in practical applications.

TEXT BOOK:

T1 McCabe W.L., Smith J.C. and Harriot P., — "Unit Operations in Chemical Engineering", 7 th Edition, McGraw Hill International Edition, New York, 2006.

T2 Bansal R.K., "Fluid Mechanics & Hydraulic Machines", Laxmi Publications, 2015.

REFERENCES:

R1 Cengel, Yunus and Cimbala John M, — "Fluid Mechanics Fundamentals and Applications", 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2006.

R2 Munson B.R., Young D.F., Okiishi T.H. and Huebsch W.W., — "Fundamentals of Fluid Mechanics", 6th Edition, Wiley India, New Delhi, 2010.

R3 Noel de Nevers, "Fluid Mechanics for Chemical Engineers", 3rd Edition, McGrawHill, New York, 2004.

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Course Code & Name: 22CH3202-FLUID MECHANICS FOR CHEMICAL ENGINEERS

PO & PSO →	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	2	2	2	2	-	1	-	1	1	-	3	2
CO2	3	2	2	2	1	2	-	1	1	1	-	1	1	1
CO3	3	2	2	2	1	1	-	1	-	1	1	1	3	1
CO4	3	2	3	2	2	2	-	1	-	1	1	2	3	1
CO5	3	2	3	2	2	2	-	1	-	1	2	2	3	1
AVG.	**3**	**2.2**	**2.2**	**2**	**1.6**	**1.8**	**-**	**1**	**1**	**1**	**1.25**	**1.5**	**2.6**	**1.2**

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21CH3203	CHEMICAL ENGINEERING THERMODYNAMICS - I	3	0	0	3

Course Objective

The student should be able to

1. Calculate and analyse the P-V-T behaviour of the gases using various equation of states and compressibility charts.
2. Determine the first and second law of thermodynamics and will learn to apply these to the solution of chemical engineering problems
3. Assess thermodynamic potential and the concept of Internal energy and enthalpy

Unit	Description	Instructional Hours
I	**SCOPE OF THERMODYNAMICS**: Definition of system, control volume, state and path function, equilibrium, reversibility, energy, work and heat. Zeroth law; temperature scales. Joule's experiment, internal energy, first law, energy balance for closed systems, mass and energy balance for open systems.	9
II	**PVT BEHAVIOUR OF FLUIDS**: Mathematical representation of PVT behaviour; generalized compressibility factor correlation; generalized equations of state. Heat effect accompanying chemical reaction.	9
III	**SECOND LAW OF THERMODYNAMICS** : Statements of the second law of thermodynamics, heat engine, heat pump and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, entropy balances for open system, Clausius Inequality second law of thermodynamics for a control volume. Third law of thermodynamics, entropy from a microscopic point of view.	9
IV	**THERMODYNAMIC POTENTIALS** – Internal energy, Enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations - partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams. Fugacity and activity	9
V	**COMPRESSIBLE FLUID FLOW& STEAM ENGINES**: Duct flow of compressible fluids, Compression and expansion processes, steam power plant, internal combustion engines, Gas-turbine power plant, jet and rocket engines	9
	Total Instructional Hours	**45**

Course Outcome

CO1	Remember the concepts of heat, work and energy.
CO2	Evaluate thermodynamic properties of pure substances with special emphasis on fluids
CO3	Solve the practical thermodynamic problems by applying first law and steady flow energy equation
CO4	Understand the fundamental thermodynamic properties.
CO5	Apply various methods of evaluating state properties to equipment commonly Encountered in chemical engineering processes, such as turbines, pumps, engines, and refrigeration units

TEXT BOOK:

T1 Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", McGraw Hill Publishers, VI edition, 2003.

T2 Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004.

REFERENCES:

R1 Kyle, B.G., "Chemical and Process Thermodynamics III Edition", Prentice Hall of India Pvt. Ltd., 3rd edition, 2004.

R2 Elliott J.R., Lira, C.T., "Introductory Chemical Engineering Thermodynamics", Prentice Hall,Second Edition, 2011.

R3 Rao, Y.V.C., "Chemical Engineering Thermodynamics" Universities Press, 2005.

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Course Code & Name: 22CH3203-CHEMICAL ENGINEERING THERMODYNAMICS-I

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	3	2	3	1	--						1		1	1
CO2	3	2	3	1							1		1	1
CO3	3	2	3	1							1		1	1
CO4	3	2	3	1							1		1	1
CO5	3	2	3	1							1		1	1
AVG	**3**	**2**	**3**	**1**							**1**		**1**	**1**

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH3251	MECHANICAL OPERATIONS	2	0	2	3

Course Objective

The student should be able to

1. Understand the basic information and the systematic diagrams of Unit operations involved in Chemical industries.
2. Apply the concepts of design, operation details and schematic of industrial equipment
3. Choose the right separation technology for easy separation of chemical components

Unit	Description	Instructional Hours
I	**INTRODUCTION TO PARTICULATE SOLIDS:** Particle Shape, Size, Mixed Particle Sizes and Size Analysis – Cumulative and Differential Analysis –Various Mean Diameters – Screen Analysis Standard Screens – Various Industrial Screens. **Sieve analysis.**	6+3
II	**SIZE REDUCTION:** Principles of Comminution - Energy and Power Requirements in Comminution - Mechanical Efficiency-Laws of Crushing-Size Reduction Equipment – Crushers- Grinders Cutting Machines – Open and Closed Circuit Operation. **Reduction ratio in Jaw Crusher, Ballmill, Drop Weight Crusher.**	6+4
III	**PARTICLE SEPARATION :** Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging: Characteristics of batch Sedimentation, **Separation characteristics of Cyclone separator, Air Elutriator.**	6+4
IV	**FILTRATION:** Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipment - selection, operation and design of filters and optimum cycle of operation, filter aids. **Batch filtration studies using Leaf Filter and Plate and Frame Filter press.**	6+4
V	**MIXING:** Concept of mixing, Homogeneous and Heterogeneous mixtures, importance of mixing, Mixing liquids with liquids, Mixing of gases with liquids, Mixing of solids with liquids, Mixing of viscous and plastic masses, Types of mixers.	6
	Total Instructional Hours	30+15=45

Course Outcome

CO1	Understand the general characteristics of solids, screening and sieve analysis.
CO2	Examine the particle size reduction processes and to operate the size reduction equipment
CO3	Illustrate the methods of particles separation
CO4	Remember the theory of filtration and filtration equipment
CO5	Estimating the particle handling and the power required for mixing.

TEXT BOOK:

T1 McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.

T2 Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 5th Edn., Asian Books Pvt. Ltd., India, 2006.

T3 Patil K.D., Mechanical Operations (Fundamental Principles and Applications), 3rd ed.,Nirali Prakasam, India, 2012

REFERENCES:

R1 Brown G.G., et.al., "Unit Operations", 1st edition., CBS Publisher, New Delhi, 2005.

R2 Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1st Edition, 2002.

R3 Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edn., John Wiley & Sons, 2008.

R4 Narayanan C.M., Bhattacharya B.C., Mechanical Operations for Chemical Engineers, 3rd ed., Khanna Publishers, India, 2011.

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Course Code & Name: 22CH3251-MECHANICAL OPERATIONS

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO 1	PSO 2
CO1	3	3	3	3		1			1			2	2	1
CO2	3	3	3	3	1	1		1				2	2	1
CO3	3	3	3	3		1	1		1	1		1	2	1
CO4	3	3	3	3		1						2	1	1
CO5	3	3	3	3	1	1		1	1			1	2	1
AVG:	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**1**		**1.6**	**1.8**	**1**

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22AC3191	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2	0	0	0

Course Objective

The student should be able to

1. Facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2. Make the students understand the traditional knowledge and analyze it and apply it to their day to day life.
3. Impart basic principles of thought process, Itihas and Dharma Shasta and connecting society and nature
4. Uunderstand the concept of Intellectual and intellectual property rights with special Reference.

Unit	Description	Instructional Hours
I	**Introduction to traditional knowledge:** Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vs indigenous knowledge, traditional knowledge vs western knowledge	6
II	**Protection of traditional knowledge:** The need for protecting traditional knowledge, Significance of TK Protection, value of TK in global economy, Role of Government to harness TK	6
III	**Itihas and Dharma-Shastra** **Itihas:** The Mahabharata - The Puranas - The Ramayana **Dharma-Shastra**: ***Manu Needhi*** - The Tirukkural– ThiruArutpa	6
IV	**Traditional knowledge and intellectual property:** Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge	6
V	**Indian philosophy** Jain – Buddhist – Charvaka – Samkhya - Yoga - Nyaya - Vaisheshika- Saiva*Siddhanta*	6
	Total Instructional Hours	30

Course Outcome

CO1	Identify the concept of Traditional knowledge and its importance.
CO2	Explain the need and importance of protecting traditional knowledge.
CO3	Explain the need and importance of Itihas and Dharma Shastra.
CO4	Interpret the concepts of Intellectual property to protect the traditional knowledge.
CO5	Interpret the concepts of indian philosophy to protect the traditional knowledge.

REFERENCES:

R1 Traditional Knowledge System in India, by AmitJha, 2009

R2 Traditional Knowledge System in India by AmitJha Atlantic publishers, 2002.

R3 Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.

R4 V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, BharatiyaVidya Bhavan, Mumbai, 5th Edition, 2014.

R5 V N Jha (Eng. Trans,), Tarkasangraha of Annam Bhatta, InernationalChinmay Foundation, Velliarnad, Amaku,am.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	22CH3001	**FLUID FLOW OPERATIONS LAB**	**0**	**0**	**4**	**2**

Course Objectives

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

S.No.	DESCRIPTION
1.	Determination of coefficient of discharge of the given Venturimeter
2.	Determination of coefficient of discharge of the given Orifice meter
3.	Find the calibration of V-notch
4.	Find the friction factor for the given straight pipe
5.	Determine the pressure drop through annular pipe
6.	Determine the critical Reynolds number and friction factor of a fluid flowing through spiral coil
7.	Determine the critical Reynolds number and friction factor of a fluid flowing through helical coil
8.	Find the performance characteristics of the given centrifugal pump and find the maximum efficiency of the pump
9.	Find the performance characteristics of the given reciprocating pump and find the maximum efficiency of the pump
10.	Determine the Pressure drop studies in packed bed using Ergun equation
11.	Determine the velocity- pressure drop relation from the given fluidized bed
	Total Practical Hours **45**

Upon completion of the course, students can be able to

CO1:Estimate the friction and measure the frictional losses in fluid flow.
CO2:Analyze the flow behavior of fluid flow in pipelines
CO3: Determine the fluid flow pressure drop in various equipment.
CO4:Examine the efficiency of various instruments
CO5:Understand the properties of fluids in different process

REFERENCE BOOKS:

- McCabe W.L, Smith, J C and Harriot. P "Unit Operations in Chemical Engineering", McGraw Hill, VII Edition, 2005
- White, F.M., "Fluid Mechanics ", McGraw-Hill Inc., VII Edition, 2011.

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Course Code & Name: 22CH3001-FLUID MECHANICS LAB

PO&PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	-	2	1	1	2	-	3	-	-	2	-	2
CO2	3	-	2	1	2	1	2	-	3	-	-	2	-	2
CO3	3	2	-	2	1	1	2	-	2	2	-	2	1	1
CO4	3	2	-	2	1	1	1	-	3	2	-	2	2	1
CO5	3	2	-	2	1	1	1	-	2	1	-	2	2	1
AVG	3	2	-	2	1	1	1.6	-	2.4	1.8	-	2	1.8	1.4

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	22CH3002	TECHNICAL ANALYSIS LAB	0	0	4	2

Course Objectives

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

S.No.	DESCRIPTION
1.	Determine the Viscosity of the Given oil (Saybolt Viscometer)
2.	Determine the Viscosity of the Given oil (Redwood Viscometer)
3.	Estimation of Flash and Fire Point of the Given Sample (Pensky Martens Closed Cup Method)
4.	Estimation of Flash and Fire Point of the Given Sample (Cleveland Open Cup Apparatus)
5.	Estimation of Cloud and Pour Point of the Given Sample
6.	Estimation of Acid Value of Given oil Sample (Analysis of Oil)
7.	Estimate the Proximate Analysis of the Given Sample of Coal
8.	Estimation of Total Fatty Matter Content in the given sample
9.	Determination of calorific value of fuels using bomb calorimeter.
10.	Flue gas Analysis – Orsat Apparatus.
11.	Determination of Aromatic Content in the given oil sample.

Total Instructional Hours 45

Course Outcomes

Upon completion of the course, students can be able to

CO1: Acquire knowledge through carry out experiments about physical and chemical characterization of petrochemical products and apply knowledge in industries.
CO2: Analyze the properties of various petroleum products.
CO3: Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation.
CO4: Understand the importance and quality of various petroleum products.
CO5: Apply the knowledge of Engineering principles in practice.

REFERENCE BOOKS:

1 Text book of quantitative chemical analysis, J.Mendham, Pearson education 2008.
2 Manual of environmental analysis, N.C Aery, Ane books.2010.
3 Text book of quantitative chemical analysis, J.Mendham, Pearson education 2008.
4 Bhaskar Rao, B.K., "A Text on Petrochemicals", Khanna Publishers, 2000.

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Course Code & Name: 22CH3002-TECHNICAL ANALYSIS LAB

PO&PSO ⟶	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2		2	1	1	2		3	2		2	2	2
CO2	3	2		2	1	1	2		2	2		2	2	2
CO3	3	2		2	1	1	2		2	2		2	1	1
CO4	3	2		2	1	1	1		3	2		2	2	1
CO5	3	2		2	1	1	1		2	1		2	2	1
AVG	3	2		2	1	1	1.6		2.4	1.8		2	1.8	1.4

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Programme	Name of the Course	L	T	P	C	TCP
B.E	22ME3253-BASIC MECHANICAL ENGINEERING	2	0	2	3	4

Course Objective

1. To understand the manufacturing process of metal components.
2. To explore the machine tools and its operation.
3. To understand the mechanisms and relative motions.
4. To learn the thermodynamic process, gas power cycles and Applications.
5. To learn the basic operations and working principles of Hydraulic and pneumatic systems.

Unit	Description	Instructional Hours
I	**Manufacturing Processes** Casting - Sand Mould – Type of patterns - Pattern Materials – Pattern allowances -Moulding machines. Metal Forming Processes: Hot working and cold working of metals - Forging processes. Welding: Basic types and its principles - Sheet Metal Forming Processes-characteristics and operations.	6
II	**Machine Tools** Lathe: Types, Operations, Working Principle; Nomenclature of Cutting Tool – Milling Machines - Types and Working Principle; Drilling machine: Operations and Working Principle - Grinding Machine - Operations, CNC Machines. ***Machining operation using lathe and milling machines.***	6+3
III	**Theory of Machines** Links - Pairs - Chain - Mechanism - Machine structure - Degrees of freedom - Four bar chain. Inversion of mechanisms - Four bar, single slider crank and double slider crank mechanisms. Vibration – Types, Governors and Gyroscopes. ***Understand the concepts on Governors and Gyroscope.***	6+6
IV	**Thermal Engineering** Gas Power Cycles: Otto and Diesel cycles: Internal Combustion Engines: Classification, Components and working principle. Boilers: Classification and working principle; Refrigeration: Vapour Compression and Vapour Absorption system: Types and Applications. ***Performance Test on four stroke Diesel Engine and compressors.***	6+6
V	**Hydraulics & Pneumatics** Fluid power and its Applications - Fluid power systems - Properties and selection of fluids -Accessories and controls. Pneumatics: Properties of air – Fans and Blowers - Compressors – Accessories and controls.	6
	Total Instructional Hours	**30+15=45**

Course Outcome

Upon completion of this course, the students will be able to,

CO1: Understand various manufacturing process.

CO2: Gain knowledge in various machine tools and machining process.

CO3: Classify mechanisms and inversions and determine mobility of a mechanism.

CO4: Learn the basics of thermal power cycles and its Applications.

CO5: understand the basics of Hydraulic and Pneumatic tools and Equipment.

TEXT BOOKS:

T1 - Hajra Choudhary S.K and Hajra Choudhury. AK, "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 1997.

T2 -Ratan.S.S, "Theory of Machines", Tata McGraw Hill Publishing company Ltd., 2nd Edition, 2005.

T3 -Rajput. R. K., "Thermal Engineering" S.Chand Publishers, 2000 Third edition, 2015.

REFERENCE BOOKS:

R1 -Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2004.

R2- Anthony Esposito, "Fluid Power with Applications", Pearson Education 2000.

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Programme/sem	Course Code	Name of the Course	L	T	P	C
B.Tech	22MA4151	PROBABILITY, STATISTICS WITH R PROGRAMMING (COMMON TO AERO, CHEM)	2	0	1	3

Course Objective

1. To construct a well-defined knowledge of Probability.
2. To interpret measures of central tendency, dispersion, and association.
3. To introduce Correlation concepts to understand the relation between two random variables.
4. To describe some basic concepts of statistical methods for testing the hypothesis.
5. To educate the design of experiment techniques to solve various engineering problems.

Unit	Description	Instructional Hours
I	**PROBABILITY** Definition – Axioms of Probability – Conditional Probability – Total Probability – Baye's Theorem (without proof). **Introduction to R Studio Programming**	6 +3
II	**DESCRIPTIVE STATISTICS** Measures of Central Tendency - Mean – Median –Mode, Measures of Dispersion - Range – Quartile Deviation – Standard Deviation – Coefficient of Variation. **R Lab: Mean Median Mode, Standard Deviation & Variance**	6 + 3
III	**CORRELATION AND REGRESSION** Correlation – Karl Pearson's correlation coefficient – Spearman's Rank Correlation – Regression lines (problems based on Raw data only). **R Lab: Correlation & Regression**	6 + 3
IV	**HYPOTHESIS TESTING** Large sample test - Test of significance for single mean and difference of means - Small sample test – t test for single mean and difference of mean - F test for variance, Chi – Square test for independence of attributes – Goodness of fit. **R Lab: t - Test, F - Test & Chi Square Test**	6 + 3
V	**ANALYSIS OF VARIANCE** Introduction- Assumptions of Analysis of Variance- Completely Randomized Design- Randomized Block Design - Latin Square Design. **R Lab: Analysis of Variance**	6 + 3
	Total Instructional Hours	**45 + 15=60**

Course Outcome

CO1: Understand the concepts of probability.
CO2: Understand the concepts of Descriptive Statistics
CO3: Compute correlation and predict unknown values using regression.
CO4: Acquire the knowledge of statistical methods for testing the hypothesis.
CO5: Apply Design of Experiment techniques to solve various engineering problems.

TEXT BOOKS:

T1Veerarajan, T., Probability, Statistics and Random Processes, Tata McGraw-Hill, 2nd Edition, New Delhi, April 19, 2017.
T2 Gupta S C and kapoor V.K, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2016.
T3 Medhi J," Stochastic Processes", New Age International Publishers, New Delhi, 2014.

REFERENCE BOOKS :

R1- O.C. Ibe, "Fundamentals of Applied Probability and Random Processes", Elsevier, First Indian Reprint, 2010.
R2 - Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 10th Edition, Pearson Education, Asia, 2011.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	22CH4201	**MASS TRANSFER OPERATIONS- I**	3	0	0	3

Course Objectives

i. To Understand the classification of mass transfer operations.
ii. To Apply mass transfer theories to calculate coefficients in various flow conditions.
iii. To Analyze psychrometric charts for designing humidification processes.
iv. To Apply material and energy balance for analyzing drying processes.
v. To Apply crystallization kinetics principles to design batch and continuous crystallizers.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**UNIT - I: Introduction to Mass Transfer Operations** **Introduction:** Scope of Mass Transfer Operations - Classification of Mass Transfer Operations - Choice of Separation method - Methods of conducting Mass Transfer Operations. **Diffusion in Fluids:** Molecular diffusion - The equation of continuity - Steady state molecular diffusion of Fluids at rest and in laminar flow - Diffusivity of gases and liquids - Applications of molecular diffusion.	9
II	**UNIT - II: Mass Transfer Coefficients** Inter Phase Mass Transfer: Equilibrium – Overall mass transfer coefficients – gas phase & liquid phase controlled situations. Eddy Diffusion - Mass transfer coefficients - Mass transfer coefficients in laminar flow and turbulent flow - mass transfer theories - Mass, Heat and Momentum Transfer Analogies. Equipment for gas-liquid contact – Description of continuous and stage wise contact equipment – packing for packed columns liquid distribution – NTU and NTP concepts – comparison of plate and packed columns.	9
III	**UNIT – III: Humidification** Humidification Operations: Vapor - liquid Equilibrium and Enthalpy for a pure substance - vapor gas mixtures, Air-water system - Adiabatic saturation curves, wet bulb temperature – Psychrometric charts – humidification and dehumidification – Operating lines and design of packed humidifiers, dehumidifiers - cooling towers - spray chamber – Evaporative cooling.	9
IV	**UNIT - IV: Drying** Drying– Equilibrium; classification of dryers; batch drying – Mechanism and time of cross through circulation drying, continuous dryers – material and energy balance; determination of length of rotary dryer using rate concept.	9
V	**UNIT-V: Crystallisation** Crystallization - Equilibrium, classification of crystallizers, mass and energy balance; kinetics of crystallization – nucleation and growth; design of batch crystallizers; population balance model and design of continuous crystallizers.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1: Categorize mass transfer operations based on fundamental principles, enhancing their understanding.
CO2: Calculate coefficients in both laminar and turbulent flows, applying mass transfer theories.
CO3: Design packed humidifiers using psychrometric charts, considering adiabatic saturation curves.
CO4: Determine rotary dryer length using rate concepts in continuous drying operations.
CO5: Design continuous crystallizers using the population balance model, incorporating kinetics and balance principles.

TEXT BOOKS:

1. Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill,1981.
2. G.K. Roy, Fundamentals of Heat and Mass Transfer, Khanna Publishers, Sixth Edition, 2017.
3. Mass Transfer: Theory and Practice. By N. Anantharaman, K. M. Meera Sheriffa Begu, PHI Learning Pvt. Ltd., 2017.

REFERENCE BOOKS:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II,4th Edition, Asian Books Pvt. Ltd., India,1998.
2. Foust A.S, "Principles of Unit Operations", 2nd Edition, John Wiley,2008.
3. Seader J.D & Henley E.J, "Separation Process Principles", 2nd Edition, John Wiley,2006.
4. Geankoplis, C.J., "Transport Processes and Separation Process Principles Includes Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey,2003.
5. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7thEdition., McGraw-Hill,2005.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1			1		1				3	
CO2	3	3	3	1			1		1				3	
CO3	3	3	2	1			1		2		1		3	1
CO4	3	3	3	1			1		1				3	
CO5	3	3	2	1			1		2		1		3	1

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B.Tech **22CH4202 CHEMICAL ENGINEERING THERMODYNAMICS - II 3 0 0 3**

Course Objectives

- Enable the students to understand the terminologies such as chemical potential, fugacity, fugacity coefficient, activity and activity coefficient
- To apply equations of state and activity coefficient models to describe VLE.
- Students will be able to calculations and develop relations to phase equilibrium
- To familiarize students with methods used to describe and predict the chemical reaction equilibrium.
- To acquire knowledge of methods of refrigeration, performance of vapour compression refrigeration system

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**PROPERTIES OF SOLUTIONS** Partial molar properties - ideal and non-ideal solutions - standard states definition and choice – Chemical Potential - fugacity in solution - Henrys law & Dilute solution- activity in solution - Gibbs-Duhem equation - excess properties of mixtures-	9
II	**PHASE EQUILIBRIA** Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity - application of phase rule – duhem's theorem - Consistency test for VLE data - vapour-liquid equilibrium, phase diagrams for homogeneous systems and for systems with a miscibility gap - effect of temperature and pressure on azeotrope composition - liquid-liquid equilibrium - ternary liquid-liquid.	9
III	**CORRELATION AND PREDICTION OF PHASE EQUILIBRIA** Activity coefficient - composition models - thermodynamic consistency of phase equilibria - application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.	9
IV	**CHEMICAL REACTIONEQUILIBRIA** Reaction Stoichiometry - Standard free energy change and reaction equilibrium constant - evaluation of reaction equilibrium constant - effect of temperature on equilibrium constant - Vant Hoff equation- prediction of free energy data - equilibria in chemical reactors - calculation of equilibrium compositions for homogeneous chemical reactors - thermodynamic analysis of simultaneous reactions.	9
V	**REFRIGERATION** Principles of refrigeration- methods of producing refrigeration, Air refrigeration cycle, Cascade refrigeration system - liquefaction process - Claude and Linde Process - co-efficient of performance - evaluation of the performance of vapour compression and gas refrigeration cycles.	9
	Total Instructional Hours	**45**

Upon completion of the course, students can be able to

Course Outcomes

CO1: Examine the terminologies such as chemical potential, fugacity, fugacity coefficient, activity and activity coefficient
CO2: Apply the equations of state and activity coefficient models to describe VLE
CO3: Illustrate and develop the relations to phase equilibrium and to solve chemical engineering problems
CO4: Calculate the equilibrium constants and predict the effects of temperature, pressure, and composition on equilibrium conversion
CO5: Understand and solve mass, energy and entropy balances to flow processes

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		1	1			2	1	1	1	1	
CO2	3	2	2	1							1		1	1
CO3	3	3	2	2							1		3	
CO4	3	3	2	1	1				1	2	1		3	1
CO5	3	2	1	1	1	1			1	2	2	2	2	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH4203	PROCESS HEAT TRANSFER	3	0	0	3

Course Objective

The student should be able to

1. Learn various heat transfer methods involved in chemical processes.
2. Study the mechanism of heat transfer in unit operations such as evaporation, drying etc.
3. Apply heat transfer concepts in real industry scenario
4. Understand the concept of radiation and evaporation.
5. Calculate the various dimensionless numbers in heat exchangers.

Unit	Description	Instructional Hours
I	**CONDUCTION**: Importance of heat transfer in Chemical Engineering operations – Modes of heat transfer – Fourier's law of heat conduction – one dimensional steady state heat conduction equation for flat plate, hollow cylinder and sphere – Heat conduction through a series of resistances – Thermal conductivity measurement; effect of temperature on thermal conductivity; Heat transfer in extended surfaces-Optimum and economic thickness of insulation.	9
II	**CONVECTION**: Concepts of heat transfer by convection – Natural and forced convection, analogies between transfer of momentum and heat – Reynold's analogy, Prandtl and Coulburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate, flow through packed beds.	9
III	**HEAT TRANSFER WITH PHASE CHANGE:** Heat transfer to fluids with phase change – heat transfer from condensing vapours, drop wise and film wise condensation, Derivation of Nusselt equation for vertical and horizontal tubes, condensation of superheated vapors, Heat transfer to boiling liquids – mechanism of boiling, nucleate boiling and film boiling.	9
IV	**RADIATION** : Radiation heat transfer – Thermal radiation – Laws of radiation – Black body concepts– Emissive power – Radiation shape factor – Gray bodies – Radiation shields. EVAPORATION: Introduction – Types of Evaporators – Capacity – Steam economy – Boiling point elevation (Duhring rule); Material and energy balance of single effect evaporator; Theory of multiple effect evaporators; Design of single and multiple effect evaporators, Vapor recompression method.	9
V	**HEAT EXCHANGERS:** Heat exchangers – Types and practical application – Concept of LMTD & Overall heat transfer coefficient; Effectiveness – NTU method for heat exchanger design; Fouling factor and estimation of Overall heat transfer coefficient; Special type of heat exchangers.	9
	Total Instructional Hours	45

Course Outcome

CO1	Ability to understand and solve conduction problems.
CO2	Ability to analyze and solve problems on convection.
CO3	Ability to apply analogies and correlations to solve industrial problems.
CO4	Ability to analyze and solve problems on radiation and Evaporation.
CO5	Ability to design and analyze the performance of heat exchangers.

TEXT BOOK:

T1 Binay. K Dutta, "Heat Transfer: Principles and Applications", PHI Learning private limited

T2 Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol.I, VI Edition, Asian Books Pvt. Ltd., India, 2006

T3 McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", XII Edition., McGraw-Hill, 2017

REFERENCES:

R1 Kern, D.Q., "Process Heat Transfer", McGraw-Hill, 2001

R2 Holman, J. P., 'Heat Transfer', X Edition., McGraw Hill, 2009.

R3 Ozisik, M. N., "Heat Transfer: A Basic Approach", McGraw-Hill, 1984

R4 Frank Kreith, Raj M Manglik, Principles of Heat Transfer, 8 th ed., Cengage Learning, USA, 2016.

R5 Analysis of heat and mass transfer by Eckert and Drake, McGraw-Hill

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1			1		1				3	
CO2	3	3	3	1			1		1				3	
CO3	3	3	2	1			1		1		1		3	1
CO4	3	3	3	1			1		1				3	1
CO5	3	3	2	1			1		1		2		3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	22CH4204	CHEMICAL PROCESS INDUSTRIES	2	0	0	2

Course Objectives

- Identify Industrial Processes for Sulfur, Sulfuric Acid, and Cement.
- Explain the Ecological Aspects of Nitrogen-Based Fertilizer Production.
- Apply Knowledge to Optimize Paper Production Methods.
- Identify Components of Crude Petroleum.
- Explain the Applications of Industries in Hydrogen Production.

UNIT	DESCRIPTION	HOURS
I	**SULFUR, SULFURIC ACID AND CEMENT:** Sulfur, Raw materials Sources, Mining and Production of Sulfur – Sulfuric acid, Methods of Production of Sulfuric acid – Contact process – Chamber process. Cement – Properties of Cement – Methods of production – Overall factors for Cement industry.	9
II	**FERTILIZER AND ELECTROCHEMICAL INDUSTRIES :** Major Components of Fertilizer Industries –Nitrogen Industries - Ammonia, Nitric acid, Urea – Phosphorus Industries - Phosphorus, Phosphoric acid, Super Phosphate. Electrochemical Industries-Electrolytic Process, Fuel Cells, Arc Process.	9
III	**PULP, PAPER, SUGAR AND STARCH INDUSTRIES:** Pulp – Methods of Production – Comparison of Pulping Processes. Paper – Types of Paper Products, Raw materials, Methods of Production. Sugar – Methods of Production – by Products of the Sugar industry – Starch – Methods of Production, Starch Derivations.	9
IV	**PETROCHEMICAL INDUSTRIES:** Petroleum – Chemical Composition, Classification of Crude Petroleum, Petroleum Refinery Products – Petroleum Conversion Processes – Pyrolysis and Cracking, Reforming Polymerization, Isomerization and Alkylation – Petrochemicals – Methanol, Chloro Methanol, Acetylene and Ethylene.	9
V	**HYDROGEN PRODUCTION INDUSTRIES**: Fundamentals of Hydrogen , Advanced Technologies, Exploration of Emerging Technologies Such as Electrolysis, Steam Methane Reforming and Biomass Conversion for Efficient Hydrogen Production, Practical Applications of Hydrogen in Various Industries and Implementing Safety Protocols for Handling and Storing Hydrogen	9
	Total Instructional Hours	**45**

Course Outcomes:

CO1: List the Applications of Sulfuric Acid in Various Industries.
CO2: Explain the Role of Phosphorus in Fertilizer Production.
CO3: Discuss the Significance of Raw Materials in Paper Production.
CO4: List Common Products Derived from Crude Petroleum.
CO5: Illustrate the Applications of Industries in Hydrogen Production.

TEXT BOOKS:

1.Dryden's Outline of Chemical Technology by M.Gopala Rao Marshall Sittig
2. Shreve's Chemical Process Industries by George T. Austin and Randolph Norris Shreve McGraw-Hill Education
3. Chemical Process Technology and Simulation by S. Pushpavanam.

REFERENCE BOOKS:

1. Chemical Technology: Volume 1 by Anil Kumar & M. Gopala Rao
2. Industrial Chemistry by B. K. Sharma
3. Unit Operations of Chemical Engineering by Warren L. McCabe, Ernest Thiele, Warren L. McCabe
4. Chemical Engineering Design and Analysis: An Introduction by T. Michael Duncan and Jeffrey A. Reimer
5. Chemical Process Equipment: Selection and Design" by James R. Couper, W. Roy Penney, James R. Fair

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1			1		1				3		
CO2	3	3	3	1			1		1				3		2
CO3	3	3	2	1			1		2		1		3	1	3
CO4	3	3	3	1			1		1				3		2
CO5	3	3	2	1			1		2		1		3	1	3

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1			1		1				3	
CO2	3	3	3	1			1		1				3	
CO3	3	3	2	1			1		2		1		3	1
CO4	3	3	3	1			1		1				3	
CO5	3	3	2	1			1		2		1		3	1

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
B.E. / IV	22EE4205	**BASICSOF ELECTRICAL AND ELECTRONICS ENGINEERING (Chemical Engineering)**	2	0	0	2

Course Objective

1. To introduce the basics of electrical quantities.
2. To impart knowledge in the basics of AC fundamentals and circuits
3. To impart knowledge in the Electrical Instrumentation
4. To introduce the basics of power supply and wiring.
5. To impart knowledge in the basics of Electrical Machines.

Unit	Description	Instructional Hours
I	**DC CIRCUITS**–Electrical Quantities-Circuit Components-Types of Electrical Networks - Energy Sources-Electrical Power–Energy -Ohm's Law - Kirchhoff's Laws - Resistors in Series Parallel Circuit – Source Transformation	9
II	**AC CIRCUITS** – Introduction to AC Circuits- Phasor Representation – Relationship Between Voltage And Current in Resistor - Inductor and Capacitor – Simple AC Series &Parallel Circuit circuits – Power – Power factor	9
III	**BASIC ELECTRICAL INSTRUMENTATION**–Introduction - Classification of Instruments - Operating principles - Moving coil - Permanent Magnet (PMMC) Instruments Voltmeter and Ammeter- Moving Iron Ammeters and Voltmeters - Energy meter – Wattmeter.	9
IV	**BASICS OF POWER SUPPLY AND ELECTRICAL WIRING** Introduction to Power supply circuits: Half wave, Full wave Rectifier – SMPS, UPS (online & offline). Wiring types and applications. - Brief discussion on concealed conduit wiring. One way and two way control.	9
V	**ELECTRICAL MACHINES** Squirrel Cage & Slip Ring three phase induction motor (Construction & Working Principles) - Single phase induction motors – types – Capacitor Start & Run – Universal Motor - AC Motor Starters - DOL & Star Delta -. Selection of Motors for Chemical Industries	9
	Total Instructional Hours	**45**

At the end of the course, the learner will be able to

Course Outcome

CO1: Analyze basic DC electric circuits.
CO2:Classify the AC circuits waveforms and its quantities
CO3:Familiarize on fundamentals of electrical measurementation
CO4:Ability to analyze basics of power supply and wiring
CO5: Understand the operations of Electrical Machines.

TEXT BOOKS:

T1 - D P Kothari and I J Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
T2 - D C Kulshreshtha, "Basic Electrical Engineering", Tata McGraw Hill, 2010..
T3 - Wayne Tomasi and Neil Storey, A Textbook On Basic Communication and Information Engineering, Pearson, 2010.

REFERENCE BOOKS:

R1 - . Del Toro V, "Electrical Engineering Fundamentals", Pearson Education.
R2 - T. K. Nagsarkar, M. S. Sukhija, "Basic Electrical Engineering", Oxford Higher Education
R3 - A. Bruce Carlson, Paul B. Crilly, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, Tata McGraw Hill, 5th Edition.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	22CH4251	CHEMICAL REACTION ENGINEERING - I	2	0	2	3

Course Objectives

- Impart the knowledge of calculus, differential equations, thermodynamics, general chemistry, and material and energy balances to solve reactor design problems.
- Simulate several types of reactors in order to choose the most appropriate reactor for a given need
- Examine the problems related to multiple reactions and evaluate the selectivity, reactivity and yield
- Apply the effect of temperature in reactor design
- Analyze the non-ideal flow and evaluate the conversion in real reactors

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**FUNDAMENTAL CONCEPTS AND DEFINITIONS:** Rate equation, Classification of reactions at equilibrium, theories of reaction rate and prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis. Method of half-life; Analysis of data for Reversible and Irreversible Reactions **Kinetic studies in CSTR (Equimolar)**	6+3
II	**CHEMICAL KINETICS:** Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, Equal sized CSTRs in series and parallel, Equal sized PFRs in series and parallel, size comparison of reactors, Semi batch reactor - Recycle reactor .**Kinetic studies CSTR in series**	6+3
III	**DESIGN FOR MULTIPLE REACTIONS:** Design of reactors for multiple reactions - consecutive, parallel and mixed reactions- factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield. **Kinetic studies in MFR followed by PFR**	6+3
IV	**NON-ISOTHERMAL REACTORS:** Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression. **Effect of temperature on reaction rate constant and conversion**	6+3
V	**NON IDEAL REACTORS:** The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; Relationship between C, E and F curves basic models for non-ideal flow; conversion in non-ideal reactors. **RTD Studies in MFR**	6+3
	Total Instructional Hours	**30+15**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the concept of rate equation and batch reactors.
CO2- Evaluate the choice of right reactor among single, multiple, recycle reactor, etc. with or without multiple reaction
CO3- Analyze the design and working of multiple reactors.
CO4- Determine the non-isothermal effect on reactors.
CO5- Estimate the concept of RTD in analyzing reactor performances.

TEXT BOOKS:

1. Levenspiel O, "Chemical Reaction Engineering", Wiley Eastern Ltd., II Edition, 2000
2. Fogler H.S., Elements of Chemical Reaction Engineering, 5th ed., Prentice Hall India Pvt. Ltd., India, 2016
3. Scott Fogler, H., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India.2009

REFERENCES BOOKS:

1. Froment. G.F. & K.B.Bischoff, "Chemical Reactor Analysis and Design", John Wiley and Sons, 1979.
2. Smith J.M., Chemical Engineering Kinetics, 8th ed., McGraw-Hill, USA, 2008
3. Lanny D. Schmidth The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2005
4. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press ,2014

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1						1	1			3	3
CO2	3	3	3	1					1	1			2	3
CO3	2	3	2	1					1	1				3
CO4	2	2	3	1					2	1			2	2
CO5	3	2	2	1					2	1				3

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	22CH4001	**HEAT TRANSFER LAB**	0	0	3	2

Course Objectives

- To enable the students to develop a sound working knowledge on different types of heat transfer equipment.

S.No.	DESCRIPTION
1.	Heat Transfer in Agitated Vessel and Helical Coil
2.	Heat transfer through natural convection
3.	Heat transfer through forced convection
4.	Heat transfer in a shell and tube heat exchanger
5.	Heat transfer in a double pipe heat exchanger
6.	Heat transfer in a bare and finned tube heat exchanger
7.	Heat transfer in helical coils
8.	Heat transfer through packed bed
9.	Heat transfer in agitated vessels
10.	Heat transfer in a Vertical Condenser
11.	Heat transfer in a Horizontal Condenser
12.	Heat transfer in Open Pan Evaporator
13.	Stefan Boltzmann experiment
14.	Emissivity measurement

Total Instructional Hours **45**

Course Outcomes

Upon completion of the course, students can be able to

- Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipment's
- Estimate the heat transfer rate and heat transfer co-efficient
- Evaluate the performance/calculate the parameters in heat transfer equipments.
- Understand the applications of heat transfer equipment in various operating process plants.
- Evaluate the performance/calculate the parameters in heat transfer equipments.

REFERENCE BOOKS:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.
2. Holman, J. P., 'Heat Transfer ', 8th Edn., Tata McGraw Hill, 1997.
3. Y.A. Cengel and A.J. Ghajar. Heat and Mass Transfer: Fundamentals and Applications. McGraw-Hill, 4/e, 2011.
4. Bergman, Theodore L., Adrienne S. Lavine, Frank P. Incropera, et al. *Introduction to Heat Transfer*. Wiley, 2011
5. Lienhard, John H., and John H. Lienhard. *A Heat Transfer Textbook*. Dover Publications, 2011

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1				1	2		1	3	1
CO2	3	2	2	3	1	2			2	3			3	1
CO3	3	3	3	3	1				2				3	2
CO4	3	3	3	2		2			2	2		1	3	2
CO5	3	3	2	1					1				3	1

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	22HE4071	Soft Skills and Aptitude III	0	0	0	1

Course Objectives:

1. Solve Logical Reasoning questions of easy to intermediate level
2. Solve Quantitative Aptitude questions of easy to intermediate level
3. Solve Verbal Ability questions of easy to intermediate level
4. Display good writing skills while dealing with essays

Unit	Description	Instructional Hours
	Logical Reasoning	
I	Clocks - Calendars - Direction Sense - Cubes - Data Interpretation: Tables, Pie Chart, Bar Graph - Data Sufficiency - Syllogism	10
	Quantitative Aptitude	
II	Time and work: Work with different efficiencies, Pipes and cisterns, Work equivalence, Division of wages - Time, Speed and Distance: Basics of time, speed and distance, Relative speed, Problems based on trains, Problems based on boats and streams, Problems based on races - Profit and loss, Partnerships and averages: Basic terminologies in profit and loss - Partnership - Averages - Weighted average Permutation, Combination: Fundamental Counting Principle, Permutation and Combination, Computation of Permutation, Circular Permutations, Computation of Combination - Probability	12
	Verbal Ability	
III	Sentence Correction: Subject-Verb Agreement, Modifiers, Parallelism, Pronoun-Antecedent Agreement, Verb Time Sequences, Comparisons, - Sentence Completion and Para-jumbles- Critical Reasoning: Argument – Identifying the Different Parts (Premise, assumption, conclusion), Strengthening statement, Weakening statement, Mimic the pattern	6
	Recruitment Essentials	
IV	Cracking interviews - demonstration through a few mocks - Sample mock interviews to demonstrate how to crack the: HR interview, MR interview, Technical interview - Cracking other kinds of interviews: Skype/ Telephonic interviews, Panel interviews, Stress interviews - Resume building – workshop: A workshop to make students write an accurate resume- Essay Writing	2
	Total Instructional Hours	30

Course Outcome:

CO1: Students will avoid the various fallacies that can arise through the misuse of logic.

CO2: Students would opt for alternate methods to solve the problems rather than conventional methods.

CO3: Students will heighten their awareness of correct usage of English grammar in writing and speaking

CO4: Students will be concise and clear, using professional language for placements.

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DEPARTMENT OF CHEMICAL ENGINEERING
REGULATION-2022
B.TECH. CHEMICAL ENGINEERING
I TO VIII SEMESTERS CURRICULUM

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER I											
Theory											
1.	**22MA1101**	Matrices and Calculus	BSC	3	1	0	4	4	40	60	100
2.	22ME1201	Engineering Drawing	ESC	1	4	0	3	5	40	60	100
Theory with Lab Component											
3.	22HE1151	English for Engineers	HSC	2	0	2	3	4	50	50	100
4.	22PH1151	Physics of Materials	BSC	2	0	2	3	4	50	50	100
5.	22IT1151	Python Programming and Practices	ESC	2	0	2	3	4	50	50	100
EEC Courses (SE/AE)											
6.	**22HE1071**	Universal Human Values	AEC	2	0	0	2	2	40	60	100
7.	**22HE1072**	Entrepreneurship & Innovation	AEC	1	0	0	1	1	100	0	100
Mandatory Courses											
8.	**22MC1091/ 22MC1092**	□□□□□□□□□□□□□	MC	2	0	0	0	2	0	0	0
			TOTAL	**15**	**5**	**6**	**19**	**27**	**370**	**330**	**700**
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER II											
1	**22MA2104**	Fourier Analysis and Laplace Transforms	BSC	3	1	0	4	4	40	60	100
2	**22PH2101**	Basics of Material Science	BSC	2	0	0	2	2	40	60	100
3	**22CY2101**	Environmental Studies	ESC	2	0	0	2	2	40	60	100
4	22CH2201	Introduction to Chemical Engineering	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5	**22CY2151**	Chemistry for Engineers	BSC	2	0	2	3	4	50	50	100
6	**22HE2151**	Effective Technical Communication	HSC	2	0	2	3	4	50	50	100
Practical											
7.	**22ME2001**	Engineering Practices	ESC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
8.	**22HE2071**	Design Thinking	AEC	1	0	2	2	3	100	0	100
9.	**22HE2072**	Soft Skills and Aptitude-I	SEC	1	0	0	1	1	100	0	100
Mandatory Courses											
10.	**22MC2093**	NCC */NSS / YRC / Sports / Clubs / Society Service - Enrollment	MC	All students shall enroll, on admission, in anyone of the personality and character development programmes and undergo training for about 100 hours							
11.	**22MC2091/ 22MC2092**	□□□□□□□□□□/ Heritage of Tamil	MC	2	0	0	0	2	0	0	0
			TOTAL	**18**	**1**	**10**	**22**	**29**	**520**	**380**	**900**
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER III											
Theory											
1.	**22MA3107**	Numerical Methods	BSC	3	1	0	4	4	40	60	100
2.	22CH3201	Chemical Process Calculations	PCC	3	1	0	4	3	40	60	100

3.	22CH3202	Fluid Flow Operations	PCC	3	0	0	3	3	40	60	100
4.	22CH3203	Chemical Engineering Thermodynamics – I	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5.	22CH3251	Mechanical Operations	PCC	2	0	2	3	4	50	50	100
6.	22ME3253	Basic Mechanical Engineering	ESC	2	0	2	3	4	50	50	100
Practical											
7.	22CH3001	Fluid Flow Operations Lab	AEC	0	0	4	2	4	60	40	100
8.	22CH3002	Technical Analysis Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
9.	22HE3071	Soft Skills -2	SEC	1	0	0	1	1	100	0	100
Mandatory Course											
10	22MC3091	Essence of Indian Traditional Knowledge	AC	2	0	0	0	2	100	0	100
			TOTAL	**17**	**2**	**12**	**25**	**30**	480	420	900
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER IV											
Theory											
1.	22HE4101	IPR and Start-ups(Common)	HSC	2	0	0	2	2	40	60	100
2.	22CH4201	Mass Transfer Operations - I	PCC	3	0	0	3	3	40	60	100
3.	22CH4202	Chemical Engineering Thermodynamics – II	PCC	3	0	0	3	3	40	60	100
4.	22CH4203	Process Heat Transfer	PCC	3	0	0	3	3	40	60	100
5.	22CH4204	Chemical Process Industries	PCC	2	0	0	2	2	40	60	100
Theory with Lab Component											
6.	**22EE4251**	Basics of Electrical &Electronics Engineering	ESC	1	0	2	2	3	50	50	100
7.	22CH4251	Chemical Reaction Engineering - I	PCC	2	0	2	3	4	50	50	100
8.	**22MA4151**	Probability and statistics with R programming	BSC	2	0	2	3	4	50	50	100
Practical											
9.	22CH4001	Heat Transfer Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
10.	22HE4071	Soft Skills -3(Common)	SEC3	1	0	0	1	1	100	0	100
Mandatory Courses											
11	22MC4091	Indian Constitution	AC	2	0	0	0	2	100	0	100
			TOTAL	**21**	**0**	**10**	**24**	**31**	510	490	1000
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER V											
Theory											
1.	22CH5201	Mass Transfer Operations - II	PCC	3	0	0	3	3	40	60	100
2.	22CH5202	Process Instrumentation Dynamics and Control	PCC	3	0	0	3	3	40	60	100
3.	22CH53XX	Professional Elective-1	PEC	3	0	0	3	3	40	60	100
4.	22CH53XX	Professional Elective-2	PEC	3	0	0	3	3	40	60	100
5.	22CH53XX	Professional Elective-3	PEC	3	0	0	3	3	40	60	100
Theory with Lab Component											
6.	22CH5251	Chemical Reaction Engineering - II	PCC	2	0	2	3	4	50	50	100
Practical											
7.	22CH5001	Mass Transfer Operations Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
8.	22HE5071	Soft Skills -4/Foreign languages	SEC	1	0	0	1	1	100	0	100
			TOTAL	**17**	**1**	**6**	**21**	**24**	410	390	800

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER VI											
Theory											
1.	22CH6201	Transport Phenomena	PCC	3	0	0	3	3	40	60	100
2.	22CH6202	Instrumental Method of Analysis	PCC	3	0	0	3	3	40	60	100
3.	22HE6101	Professional Ethics (Common)	HSC	3	0	0	3	3	40	60	100
4.	22CH63XX	Professional Elective-4	PEC	3	0	0	3	3	40	60	100
5.	22CH63XX	Professional Elective-5	PEC	3	0	0	3	3	40	60	100
6.	22XX64XX	Open Elective – 1*	OEC	3	0	0	3	3	40	60	100
Practical											
7.	22CH6001	Process Control Lab	PCC	0	0	4	2	4	60	40	100
8.	22CH6002	Computational Chemical Engineering Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
9.	22HE6071	Soft Skills – 5(Common)	SEC	2	0	0	2	2	100	0	100
			TOTAL	**20**	**0**	**8**	**24**	**28**	460	440	900

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER VII											
Theory											
1.	22CH7201	Process Economics and Engineering Management	PCC	3	0	0	3	3	40	60	100
2.	22CH7202	Process Equipment Design	PCC	3	1	0	4	4	40	60	100
3.	22CH7203	Bio Chemical Engineering	PCC	3	0	0	3	3	40	60	100
4.	22CH73XX	Professional Elective-6	PEC	3	0	0	3	3	40	60	100
5.	22XX74XX	Open Elective – 2*	OEC	3	0	0	3	3	40	60	100
Practical											
6.	22CH7001	Design and Simulation Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses (SE/AE)											
7.	22CH7701	Internship	SEC	-	-	-	2	2	100	0	100
			TOTAL	**15**	**1**	**4**	**20**	**22**	360	340	700

* - Four weeks internship carries 2 credit and it will be done in before Semester VI summer vacation/placement training and same will be evaluated in Semester VII.

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER VIII											
EEC Courses (SE/AE)											
1.	22CH8901	Project Work/Granted Patent(Common)	SEC	0	0	20	10		100	0	100
			TOTAL	**0**	**0**	**20**	**10**	**20**	**100**	**0**	**100**

* 1. As per the AICTE guideline, in Semester I, II, III & IV NCC one credit subject is added as Value Added Course with Extra Credit. Further, the students' who enrolled his/her name in HICET NCC and Air Wing are eligible to undergo this subject. The earned extra credits printed in the Consolidated Mark sheet as per the regulation.

2. NCC course level 1 & Level 2 will be added in the list of open elective subjects in the appropriate semester. Further, the students' who have opted NCC subjects in Semester I, II, III & IV are eligible to undergo NCC Open Elective Subjects.

3. The above-mentioned NCC Courses will be offered to theStudents who are going to be admitted in the Academic Year 2021 – 22.

SEMESTER WISE CREDIT DISTRIBUTION

B.E. / B.TECH.PROGRAMMES									
S.No.	Course Area	Credits per Semester							TotalCredits
		I	II	III	IV	V	VI	VII	VIII	
1	HSC	3	3	-	2	-	3	-	-	**11**
2	BSC	7	9	4	3	-	-	-	-	**23**
3	ESC	6	4	3	2	-	-	-	-	**15**
4	PCC	-	3	15	16	11	10	12	-	**67**
5	PEC	-	-	-	-	9	6	3	-	**18**
6	OEC	-	-	-	-	-	3	3	-	**6**
7	EEC	3	3	3	1	1	2	2	10	**25**
8	MC	✓	✓							
	Total	**19**	**22**	**25**	**24**	**21**	**24**	**20**	**10**	**165**

OPEN ELECTIVE I AND II (EMERGING TECHNOLOGIES)

To be offered for the students other than CSE, IT, AI&ML, ECE & BIOMEDICAL

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22AI6451	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2	22CS6451	Blockchain Technology	OEC	2	0	2	4	3
3	22EC6451	Cyber security	OEC	2	0	2	4	3
4	22EC6452	IoT Concepts and Applications	OEC	2	0	2	4	3
5	22IT6451	Data Science and Analytics	OEC	2	0	2	4	3
6	22BM6451	Augmented andVirtual Reality	OEC	2	0	2	4	3

OPENELECTIVE I AND II

To be offered for the students other than AUTO, AERO, AGRI, MECH, MCTS, CIVIL, EEE, CHEMICAL, FOOD TECH, E&I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	22AE6401	Space Science	OEC	3	0	0	3	3
2	22MT6401	Introduction to Industrial Engineering	OEC	3	0	0	3	3
3	22MT6402	Industrial Safety and Environment	OEC	3	0	0	3	3
4	22CE6401	Climate Change and its Impact	OEC	3	0	0	3	3
5	22CE6402	Environment and Social Impact Assessment	OEC	3	0	0	3	3

6	22ME6401	Renewable Energy System	OEC	3	0	0	3	3
7	22ME6402	Additive Manufacturing systems	OEC	3	0	0	3	3
8	22EI6401	Introduction to Industrial Instrumentation and Control	OEC	3	0	0	3	3
9	22EI6402	Graphical Programming using Virtual Instrumentation	OEC	3	0	0	3	3
10	22AU6401	Fundamentals of Automobile Engineering	OEC	3	0	0	3	3
11	22AU6402	Automotive Vehicle Safety	OEC	3	0	0	3	3
12	22EE6401	Digital Marketing	OEC	3	0	0	3	3
13	22EE6402	Research Methodology	OEC	3	0	0	3	3
14	22FT6401	Traditional Foods	OEC	3	0	0	3	3
15	22AG6401	Urban Agriculture and Organic Farming	OEC	3	0	0	3	3
16	22CH6401	Biomass and Bio refinery	OEC	3	0	0	3	3

Note:Non Circuit Departments can add one Open Elective course in the above list to offer for the circuit branches

OPEN ELECTIVE III (Offered by Chemical Engineering)

Students shall choose any one of the open elective courses such that the course content or title not belongs to their own programme.

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH7401	Waste to Energy Conversion	OEC	3	0	0	3	3

OPENELECTIVE IV

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22LS7401	General studies for competitive examinations	OEC	3	0	0	3	3
2	22LS7402	Human Rights, Women Rights and Gender equity	OEC	3	0	0	3	3
3	22LS7403	Indian ethos and Human values	OEC	3	0	0	3	3
4	22LS7404	Financial independence and management	OEC	3	0	0	3	3
5	22LS7405	Yoga for Human Excellence	OEC	3	0	0	3	3
6	22LS7406	Democracy and Good Governance	OEC	3	0	0	3	3
7	22LS7407	NCC Level - II	OEC	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Petroleum Process Technology	Vertical II Energy Engineering	Vertical III Biochemical Engineering	Vertical IV Environmental and Safety Engineering	Vertical V Computational Chemical Engineering	Vertical VI Chemical Plant Design
Petroleum Chemistry and Refining Fundamentals	Bioenergy	Biochemistry	Membrane Separation Process	Computational Techniques	Chemical Plant Design
Primary RefiningTechnology	RenewableEnergy Resources	Bioprocess Technology	Waste Water Treatment	Optimization of Chemical Processes	Plant Layout
Secondary Refining Technology	Pinch Technology	Fermentation & Bioprocessing	Solid waste Management	Process Modeling and Simulation	Design Safety
Refinery Advancements and Environmental Regulations	Hydrogen and Fuel Cell Technology	Bio separation & Downstream Processing	Environmental Impact Assessment	Pinch Analysis and Heat Exchange Network Design	Material Selection
Petroleum Equipment Design	Power Plant Engineering	Enzyme Immobilisation Technology	Process Safety Management	Chemical Process Flowsheeting	Statutory Requirements&Customer Care
Petrochemical Technology	Non-Renewable Energy Sources	Bioreactor Design	Risk and HAZOP Analysis	Computational Fluid Dynamics	Process Plant Utilities

Note: Students are permitted to choose all Professional Electives from a particular vertical

DETAILS OF VERTICAL I :PETROLEUM PROCESS TECHNOLOGY

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
1.	22CH5301	Petroleum Chemistry and Refining Fundamentals	PEC	3	0	0	3	3	40	60	100
2.	22CH5302	Primary Refining Technology	PEC	3	0	0	3	3	40	60	100
3.	22CH5303	Secondary Refining Technology	PEC	3	0	0	3	3	40	60	100
4.	22CH5310	Refinery Advancements and Environmental Regulations	PEC	3	0	0	3	3	40	60	100
5.	22CH5311	Petroleum Equipment Design	PEC	3	0	0	3	3	40	60	100
6.	22CH5312	Petrochemical Technology	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL II :ENERGY ENGINEERING

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
1.	22CH5304	Bioenergy	PEC	3	0	0	3	3	40	60	100
2.	22CH5305	Renewable Energy Resources	PEC	3	0	0	3	3	40	60	100
3.	22CH5306	Pinch Technology	PEC	3	0	0	3	3	40	60	100
4.	22CH5313	Hydrogen And Fuel Cell Technology	PEC	3	0	0	3	3	40	60	100
5.	22CH5314	Power Plant Engineering	PEC	3	0	0	3	3	40	60	100
6.	22CH5315	Non-Renewable Energy Sources	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL III :BIOCHEMICAL ENGINEERING

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
1.	22CH5307	Biochemistry	PEC	3	0	0	3	3	40	60	100
2.	22CH5308	Bioprocess Technology	PEC	3	0	0	3	3	40	60	100
3.	22CH5309	Fermentation & Bioprocessing	PEC	3	0	0	3	3	40	60	100
4.	22CH5316	Bio separation & Downstream Processing	PEC	3	0	0	3	3	40	60	100
5.	22CH5317	Enzyme Immobilization Technology	PEC	3	0	0	3	3	40	60	100
6.	22CH5318	Bioreactor Design	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL IV: ENVIORNMENTAL AND SAFETY ENGINEERING											
S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
1.	22CH6301	Membrane Separation Process	PEC	3	0	0	3	3	40	60	100
2.	22CH6302	Waste Water Treatment	PEC	3	0	0	3	3	40	60	100
3.	22CH6303	Solid waste Management	PEC	3	0	0	3	3	40	60	100
4.	22CH6304	Environmental Impact Assessment	PEC	3	0	0	3	3	40	60	100
5.	22CH6305	Process Safety Management	PEC	3	0	0	3	3	40	60	100
6.	22CH6306	Risk and HAZOP Analysis	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL V: COMPUTATIONAL ENGINEERING											
S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
1.	22CH6307	Computational Techniques	PEC	3	0	0	3	3	40	60	100
2.	22CH6308	Optimization of Chemical Processes	PEC	3	0	0	3	3	40	60	100
3.	22CH6309	Process Modeling and Simulation	PEC	3	0	0	3	3	40	60	100
4.	22CH6310	Pinch Analysis and Heat Exchange Network Design	PEC	3	0	0	3	3	40	60	100
5.	22CH6311	Chemical Process Flow sheeting	PEC	3	0	0	3	3	40	60	100
6.	22CH6312	Computational Fluid Dynamics	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL VI :COMPUTATIONAL ENGINEERING											
S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
1.	22CH7301	Chemical Plant Design	PEC	3	0	0	3	3	40	60	100
2.	22CH7302	Plant Layout	PEC	3	0	0	3	3	40	60	100
3.	22CH7303	Design Safety	PEC	3	0	0	3	3	40	60	100
4.	22CH7304	Material Selection	PEC	3	0	0	3	3	40	60	100
5.	22CH7305	Statutory Requirements & Customer Care	PEC	3	0	0	3	3	40	60	100
6.	22CH7306	Process Plant Utilities	PEC	3	0	0	3	3	40	60	100

Enrolment for B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation.

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only. For minor degree, a student

shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes.

(i) B.E. / B.Tech. Honours (specialisation in the same discipline):

a. The student should have earned additionally a minimum of 18 credits from a vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(ii) B.E. / B.Tech. Honours:

a. The students should have earned additional courses (minimum of 18 credits) from more than one vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(iii) B.E. / B.Tech. (Minor in other specialisation):

The student should have earned additionally a minimum of 18 credits in any one of the verticals of other B.E. / B.Tech. programmes or from any one of the following verticals

VERTICAL I: FINTECH AND BLOCK CHAIN

VERTICAL II: ENTREPRENEURSHIP

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY

- Students can earn maximum of 6 credits in online mode (SWAYAM platform), out of these 18 credits as approved by Centre for Academic Courses.

- B.E. / B. Tech. (Honours) Specialisation in the same discipline, B.E / B.Tech. Honours and B.E. / B.Tech. Minor in other specialisation degree will be optional for students.

- For the categories (i) to (ii), the students will be permitted to register the courses from V Semester onwards provided the marks earned by the students until III semester should be of CGPA 7.50 and above and cleared all the courses in the first attempt.

- For the category (iii), the students will be permitted to register the courses from Semester V onwards provided the marks earned by the students until Semester III is CGPA 7.50 and above.

- If a student decides not to opt for Honours, after completing certain number of additional courses, the additional courses studied shall be considered instead of the Professional Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of Professional Elective courses required as per the curriculum, the courses with higher grades shall be considered for the calculation of CGPA. Remaining

courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- If a student decides not to opt for Minor, after completing certain number of courses, the additional courses studied shall be considered instead of Open Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of open electives required as per the curriculum, the courses with higher grades shall be considered for calculation of CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- The Head of Department, shall forward the proposal to the Controller of Examinations after getting the approval from Head of the Institution / Dean Academics, before the commencement of the fifth semester of the programme for the students undergo optionally B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation

VERTICALS FOR MINOR DEGREE
CHEMICAL ENGINEERING OFFERING MINOR DEGREE

Minor Specialization in Chemical Process Engineering

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5471	Introduction to Chemical Process	MDC	3	0	0	3	3
2	22CH6471	Fluid Flow Operations in Chemical Engineering	MDC	3	0	0	3	3
3	22CH6472	Fundamentals of Chemical Thermodynamics	MDC	3	0	0	3	3
4	22CH7471	Process Heat and Mass Transfer	MDC	3	1	0	4	4
5	22CH7472	Reaction Engineering	MDC	3	0	0	3	3
6	22CH8471	Unit Operations and Process Laboratory	MDC	0	0	4	4	2

*MDC – Minor Degree Course

In addition to the above the following additional courses for Minor Degree can also be given to the student's common to all the branches.

VERTICAL I: FINTECH AND BLOCK CHAIN								
S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22MB5231	Financial Management	MDC	3	0	0	3	3
2	22MB6231	Fundamentals of Investment	MDC	3	0	0	3	3
3	22MB6232	Banking, Financial Services and Insurance	MDC	3	0	0	3	3
4	22MB7231	Introduction to Block chain and its Applications	MDC	3	0	0	3	3
5	22MB7232	Fintech Personal Finance and Payments	MDC	3	0	0	3	3
6	22MB8231	Introduction to Fintech	MDC	3	0	0	3	3

VERTICAL II: ENTREPRENEURSHIP								
S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22MB5232	Foundations of Entrepreneurship	MDC	3	0	0	3	3
2	22MB6233	Team Building & Leadership Management for Business	MDC	3	0	0	3	3
3	22MB6234	Creativity & Innovation in Entrepreneurship	MDC	3	0	0	3	3
4	22MB7233	Principles of Marketing Management For Business	MDC	3	0	0	3	3
5	22MB7234	Human Resource Management for Entrepreneurs	MDC	3	0	0	3	3
6	22MB8232	Financing New Business Ventures	MDC	3	0	0	3	3

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY								
S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CE5232	Sustainable infrastructure Development	MDC	3	0	0	3	3
2	22AG6233	Sustainable Agriculture and Environmental Management	MDC	3	0	0	3	3
3	22BM6233	Sustainable Bio Materials	MDC	3	0	0	3	3
4	22ME7233	Materials for Energy Sustainability	MDC	3	0	0	3	3
5	22CE7233	Green Technology	MDC	3	0	0	3	3
6	22CE8232	Environmental Quality Monitoring and Analysis	MDC	3	0	0	3	3

VERTICALS FOR B Tech (Hons) and B Tech (Hons) in Chemical Engineering with Specialization

Vertical I Computer Aided Process Engineering	Vertical II Polymer Technology	Vertical III Petroleum Engineering	Vertical IV ANALYTICAL INSTRUMENTATION
Process Flow Sheeting	Polymer Chemistry	Petroleum Geology	Principles of Mass Spectrometry
Transport Phenomena	Processing Technology	Petroleum Exploration	Advanced Analytical Separation Techniques
Advanced Process Optimization	Rubber Technology	Drilling Technology	Advanced Spectrometry: ICP-MS and LC-MS
Artificial Intelligence in Process Engineering	Polymer Product Design, Blends, and Alloys	Petroleum Production Engineering	Instruments for Morphology and Structural Characterization
Digital Twin and Soft Computing in Process Modelling	Polymer Structure and property relationships	Petroleum Reservoir Engineering	Statistical Analysis and Data Processing (Lab)
Advanced Process Modelling and Simulation	Polymer Compounding Technology	Offshore Engineering	Troubleshooting Analytical Methods and Instruments

B Tech (Hons) Chemical Engineering with Specialization in Computer Aided Process Engineering

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5371	Process Flow Sheeting	MDC	2	0	2	4	3
2	22CH6371	Transport Phenomena	MDC	3	1	0	3	4
3	22CH6372	Advanced Process Optimization	MDC	2	0	2	4	3
4	22CH7371	Artificial Intelligence in Process Engineering	MDC	2	0	2	4	3
5	22CH7372	Digital Twin and Soft Computing in Process Modelling	MDC	2	0	2	4	3
6	22CH8371	Advanced Process Modelling and Simulation	MDC	0	0	4	4	2

B Tech (Hons) Chemical Engineering with Specialization in Polymer Technology

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5372	Polymer Chemistry	MDC	3	0	0	3	3
2	22CH6373	Processing Technology	MDC	3	0	0	3	3
3	22CH6374	Rubber Technology	MDC	3	0	0	3	3
4	22CH7373	Polymer Product Design, Blends, and Alloys	MDC	3	0	0	3	3
5	22CH7374	Polymer Structure and property relationships	MDC	3	0	0	3	3
6	22CH8372	Polymer Compounding Technology	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in Petroleum Engineering

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	22CH5373	Petroleum Geology	MDC	3	0	0	3	3
2	22CH6375	Petroleum Exploration	MDC	3	0	0	3	3
3	22CH6376	Drilling Technology	MDC	3	0	0	3	3
4	22CH7375	Petroleum Production Engineering	MDC	3	0	0	3	3
5	22CH7376	Petroleum Reservoir Engineering	MDC	3	0	0	3	3
6	22CH8373	Offshore Engineering	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in ANALYTICAL INSTRUMENTATION

S No	Course Code	Course Title	Category	Periods Per week	Total Contact	Credits

				L	T	P	Periods	
1	22CH5374	Principles of Mass Spectrometry	MDC	3	0	0	3	3
2	22CH6377	Advanced Analytical Separation Techniques	MDC	3	0	0	3	3
3	22CH6378	Advanced Spectrometry: ICP-MS and LC-MS	MDC	3	0	0	3	4
4	22CH7377	Instruments for Morphology and Structural Characterization	MDC	3	0	0	3	3
5	22CH7378	Statistical Analysis and Data Processing (Lab)	MDC	3	0	0	4	2
6	22CH8374	Troubleshooting Analytical Methods and Instruments	MDC	3	0	0	3	3

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5201	MASS TRANSFER OPERATIONS- II	3	0	0	3

Course Objective

The student should be able to

1. Examine the physical and thermodynamic principles of mass transfer with an emphasis on how these principles affect the design of equipment and result in specific requirements for quality and capacity.
2. Illustrate the process aspects and equipment used in the operations like ion exchange, extraction and leaching.
3. Analyze the separation of chemical components in distillation columns and adsorbers.

Unit	Description	Instructional Hours
I	**ABSORPTION:** Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations.	9
II	**DISTILLATION:** Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation.	9
III	**LIQUID-LIQUID EXTRACTION:** Liquid - liquid extraction - solvent characteristics- equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors- Supercritical extraction.	9
IV	**LEACHING:** Solid-liquid equilibria- leaching equipment for batch and continuous operations- calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), equipments for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.	9
V	**ADSORPTION AND ION EXCHANGE & MEMBRANE SEPARATION PROCESS:** Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.	9
	Total Instructional Hours	**45**

Course Outcome

CO1	Evaluate the theoretical stages, number of transfer units and height requirements for a gas absorption process
CO2	Apply the number of trays for stage wise contact and determine the height of the packed tower.
CO3	Illustrate the equilibrium stages and understand the working of extractor.
CO4	Evaluate the number of stages and the working of leaching equipment.
CO5	Understand the concept of adsorption, ion exchange & membrane separation processes.

TEXT BOOK:

T1 Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill, 1981.

T2 Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.

T3 Geankoplis C.J., "Transport Processes and Separation Process Principles", 4 th Edition, Prentice-Hall of India, New Delhi, 2005.

REFERENCES:

R1 McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.

R2 Seader, J.D. and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley,2006.

R3 King,C.J.,"SeparationProcesses",2ndEdn.,TataMcGraw-Hill1980.

R4 Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1						1	1			3	3	1
CO2	3	3	3	1					1	1			2	3	
CO3	2	3	2	1					1	1				3	2
CO4	2	2	3	1					2	1			2	2	3
CO5	3	2	2	1					2	1				3	3

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1						1	1			3	3
CO2	3	3	3	1					1	1			2	3
CO3	2	3	2	1					1	1				3
CO4	2	2	3	1					2	1			2	2
CO5	3	2	2	1					2	1				3

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5202	PROCESS INSTRUMENTATION DYNAMICS AND CONTROL	3	0	0	3

Course Objective

The student should be able to

1. Learn the principles and measurement of Instrumentations and its elements.
2. To introduce open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation.
3. Apply the knowledge of process control in chemical process industries.

Unit	Description	Instructional Hours
I	**PRINCIPLES OF MEASUREMENT:** Introduction to measurement and its hardware element - Transducer function and types – Static and Dynamic characteristics of measuring device - Types and principles of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases transmitter.	9
II	**OPEN LOOP SYSTEMS:** Laplace transformation and its application in process control. Transform of standard functions - derivatives and integrals - inversion theorems - Open loop system - Transfer functions - Forcing functions - step, pulse, impulse and sinusoidal- First order systems, and their transient response for standard input functions, first order systems in series, linearization, and its application in process control, second order systems and their dynamics; transportation lag.	9
III	**CLOSED LOOP SYSTEMS:** Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability- OFFSET calculation.	9
IV	**FREQUENCY RESPONSE:** Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, bode diagram, stability criterion, Process reaction curve, tuning of controllers Z-N tuning rules, C-C tuning rules, IMC tuning.	9
V	**ADVANCED CONTROL SCHEMES**: Feedback control of systems with dead time and inverse response. Control systems with multiple loops. Advanced Control Schemes a) Feed forward b) ratio control c) Cascade control d) Adaptive control. Control of Reactor, distillation towers and heat exchangers.	9
	Total Instructional Hours	**45**

Course Outcome

CO1	Understand the classification of various process instruments.
CO2	Examine the open loop systems in process control.
CO3	Illustrate the closed loop systems in process control.
CO4	Determine the frequency response of control systems and tune the PID controllers
CO5	Execute the advanced control schemes and to control the equipment in chemical industries

TEXT BOOK:

T1 Coughnowr, D., " Process Systems Analysis and Control ", 3rd Edn., McGraw Hill, New York, 2008.

T2 Stephanopoulos, G., "Chemical Process Control", Prentice Hall of India, 2003.

REFERENCES:

R1 Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp , Process dynamics and control I - 2nd ed. John Wiley & Sons, Inc.

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R2 Marlin, T. E., " Process Control ". 2nd Edn, McGraw Hill, New York, 2000.

R3 Ogunnaike, B. A., & Ray, W. H. (1994). Process dynamics, modeling, and control (Vol. 1). New York: Oxford University Press.

R4 Seborg, D. E., Mellichamp, D. A., Edgar, T. F., & Doyle III, F. J. (2010). Process dynamics and control. John Wiley & Sons.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	-	-	-	-	-	-	-	-	3	1
CO2	3	3	1	1	-	-	-	-	-	-	-	-	3	1
CO3	3	3	2	2	-	-	-	-	-	-	-	-	3	1
CO4	3	3	2	2	-	-	-	-	-	-	-	-	3	1
CO5	3	3	2	1	2	-	-	-	-	-	-	-	3	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5251	CHEMICAL REACTION ENGINEERING– II	2	0	2	3

Course Objective

The student should be able to

1. Design and characterize catalyst surface properties for better activation of the catalyst
2. Understand the heterogeneous reaction systems and design the reactors for fluid-solid systems
3. To enable the students to learn the gas-solid catalytic reactors.
4. Analyze the mechanism of non-catalytic solid-fluid reactions
5. Construct and apply a general problem solving approach to design heterogeneous and multiphase reactors

Unit	Description	Instructional Hours
I	**CATALYSTS:** General definition of catalysts, Solid catalysts, Components of catalyst, Industrial catalysts, Preparation of solid catalysts, Precipitation and co-precipitation methods, Sol gel method, Supported catalysts. Nature of catalysts, surface area and pore-volume distribution. **Kinetic studies in batch reactor**	6+3
II	**HETEROGENEOUS REACTORS:** Rate equations for heterogeneous reactions, adsorption isotherms, rates of adsorption and desorption, surface reaction analysis of rate equation and rate controlling steps. **Kinetic studies in a PFR (Equimolar)**	6+3
III	**GAS-SOLID CATALYTIC REACTORS:** Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets, effectiveness factor, Thiele Modulus, fixed bed reactors. **RTD Studies in PFR**	6+3
IV	**GAS-SOLID NON-CATALYTIC REACTORS:** Shrinking core model – Gas film controlling – Ash layer controlling controlling – Shrinking spherical particles – Fluidized bed reactor – Chemical reaction volume and surface models; controlling resistances and rate controlling steps; **Kinetic Studies CSTR (Non-Equimolar)**	6+3
V	**GAS-LIQUID REACTORS:** Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants; application of film, penetration and surface renewal theories; Hatta number and enhancement factor for first order reaction, tower reactor design. **Kinetics of straight tube PFR (Equimolar)**	6+3
	Total Instructional Hours	**30+15=45**

Course Outcome

Upon completion of the course, students can be able to

CO1 Understand the nature, preparation and required properties of catalyst.

CO2 Apply the rate and isotherms studies of heterogeneous reactors.

CO3 Analyze the heat and mass transfer in gas-solid catalytic reactors.

CO4 Evaluate the rate kinetics and controlling steps in gas-solid non-catalytic reactors.

CO5 Understand the mass transfer effects on gas-liquid reactors.

TEXT BOOK:

T1 Levenspiel O, "Chemical Reaction Engineering", Wiley Eastern Ltd., II Edition,2000.

T2 Smith, J.M, "Chemical Engineering Kinetics", McGraw Hill, III Edition,1981.

REFERENCES:

R1 Froment. G.F. & K.B.Bischoff, "Chemical Reactor Analysis and Design", John Wiley and Sons, 1979.

R2 Fogler H.S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Ltd., 3rd Edition,2000.

R3 Lanny D. Schmidth The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2005

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1						1	1			3	3
CO2	3	3	3	1					1	1			2	3
CO3	2	3	2	1					1	1				3
CO4	2	2	3	1					2	1			2	2
CO5	3	2	2	1					2	1				3

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B.Tech	22CH5001	MASS TRANSFER OPERATIONS LAB	0	0	3	2

Course Objectives

- Develop sound practical knowledge for students on different types of mass transfer equipment's

S.No.	DESCRIPTION
1	Separation of binary mixture using Simple distillation
2	Separation of binary mixture using Steam distillation
3	Separation of binary mixture using Packed column distillation
4	Drying characteristics of Rotary dryer
5	Water purification using ion exchange columns
6	Mass transfer characteristics of Rotating disc contactor
7	Estimation of mass/heat transfer coefficient for cooling tower
8	Adsorption studies
9	Liquid-liquid extraction
10	Leaching studies
11	Gas – Liquid absorption Column
12	Vapor liquid equilibrium
13	Mass transfer characteristics of Bollman Extractor

Total Practical Hours **45**

Course Outcomes

On the completion of the course students are expected to

CO1: Determine the diffusivity practically and compare the results with the empirical correlations.
CO2: Estimate the mass transfer rate and mass transfer co-efficient
CO3: Evaluate the performance/calculate the parameters in different distillation processes
CO4: Evaluate the performance/calculate the parameters in leaching and extraction operations
CO5: Estimate the drying characteristics

REFERENCE BOOKS:

- McCabe W.L, Smith, J C and Harriot. P "Unit Operations in Chemical Engineering", McGraw Hill, VII Edition, 2005
- White, F.M., "Fluid Mechanics ", McGraw-Hill Inc., VII Edition, 2011.

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Course Code & Name: 22CH3001-FLUID MECHANICS LAB

PO&PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	-	2	1	1	2	-	3	-	-	2	-	2
CO2	3	-	2	1	2	1	2	-	3	-	-	2	-	2
CO3	3	2	-	2	1	1	2	-	2	2	-	2	1	1
CO4	3	2	-	2	1	1	1	-	3	2	-	2	2	1
CO5	3	2	-	2	1	1	1	-	2	1	-	2	2	1
AVG	3	2	-	2	1	1	1.6	-	2.4	1.8	-	2	1.8	1.4

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5301	PETROLEUM CHEMISTRY AND REFINING FUNDAMENTALS	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Learn the fundamental and methodologies in the petroleum refining processes.
	2.	Express the objectives of petroleum refining and classify the processes used in petroleum refining
	3.	Analyze how physical and chemical principles are applied to achieve the objectives of each refinery process

Unit	Description	Instructional Hours
I	**CRUDE CHEMISTRY AND PRODUCTS:** Origin, Formation and Evaluation of Crude Oil -Indian petroleum industries- types of Hydrocarbon -composition of crude oil (PONA,S,N2 etc) -Thermo-physical and physical properties of crude oil petroleum standards- chemical analysis data- Testing methods of petroleum products-Chemical quality of products-Types of crude-Crude assay- selection of crude based on product yield.	9
II	**BASICS FOR REFINING:** Properties of gas-Ideal gas laws-partial pressure-specific gravity-density-Properties of liquid viscosity and index-boiling point-pressure of fluid at rest-flow resistance-static/induced pressure specific/latent heat/condensation-modes of heat transfer-diffusion mass transfer-properties of solid	9
III	**PETROLEUM THERMODYNAMICS AND CALCULATION:** First/second law-behavior of gas and liquid – PVT relationship- equation of state-VLE- equilibrium constant-Multi component liquid vapor composition calculation-specific gravity calculation-TBP distillation-ASTM-conversion to pseudo-components-Molecular weight calculation-pseudo-critical properties-calculation of enthalpy of petroleum fractions-Generalized equation for thermo physical properties of petroleum.	9
IV	**REFINERY UNIT OPERATIONSAND CALCULATION:** Distillation-types-column internals-multi component distillation-relative volatility- azeotropic mixture- absorption-desorption- adsorption- refrigeration - extraction- drying curve-humfidication principle-crystallization-stripping operation-.boiling curve- application of all operation in refinery and its basic design calculations.	9
V	**REFINERY PROCESSES AND CATALYST FUNDAMENTAL:** Treating processes petroleum products- Thermal/catalytic/hydo cracking-reforming/ isomerization /alkylation principles and reactions- Catalyst phenomenon and theory- surface area/void volume/porosit catalyst classification and preparation/selectivity/yield/reactivity heterogeneous reaction catalytic reactor types (packed bed/moving bed/fluidized bed)- residence time-space velocit Catalyst loading techniques	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the classification, composition and testing methods of crude petroleum and its products.
	CO2	Illustrate the insights of primary treatment processes to produce the precursors.
	CO3	Apply the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products
	CO4	Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.
	CO5	Analyze the societal impact of petrochemicals and learn their manufacturing processes and Learn the importance of optimization of process parameters for the high yield of petroleum products.

TEXT BOOK:

T1	Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology
T2	The Chemistry and technology of Petroleum, James G. Speight, CRC Press, taylor& Francis Group
T3	Jean vidal, Thermodynamics Application in chemical Engineering and the petroleum industry, Institute Francaisbu petrolepublications,France 2003.

REFERENCES:

R1	W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969.
R2	R.N. Watkin, "Petroleum Refinery Distillation", Gulf Publishing Co, Houstan, Texas, USA, 2nd edition, 1981
R3	McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7thEdition, McGraw-Hill,2005.
R4	Wayne C. Edmister, "Applied Hydrocarbon Thermodynamics", Gulf Publishing Co., 2nd edition, 1988

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5302	PRIMARY REFINING TECHNOLOGY	3	0	0	3

Course Objective	**The student should be able to**	
	1.	learn the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing..
	2.	Examine how each refinery process works.
	3.	Apply each operating variables are applied to achieve the objectives of each refinery process

Unit	Description	Instructional Hours
I	**FEED PREPARATION:** Pipelines from port to tank farm -safety and regulations -storage techniques in crude oil-impurities removal- measuring by dipping -spiking techniques -types of salts in crude - desalting process – electric desalter- preheating train and design- furnace and its operation.	9
II	**ATMOSPHERIC DISTILLATION:** Operation and process description of ADU-design characteristics of ADU tower-cutpoints-degree of fractionation-over flash-column pressure and overhead temperature- Preflash system overhead system-side streams-intermediate pump around and reflux systems- Refinery off gas – LPG treatment-Naphtha stabilizer and splitter-side stripping sections-operating variables	9
III	**VACUUM DISTILLATION:** Operation of VDU- Need of vacuum- ejectors and its types/principle- Overhead ejector system flash zone- draw off temperature- internal flow in VDU- light/middle/heavy cuts- routing to secondary units- lube based treatments-packing section tower loading of VDU.	9
IV	**LUBE OIL BASE STOCKS:** Viscosity index calculation and pour point - LOBS processing by solvent treatment and hydro treatment- solvent selection-solvent extraction by NMP,furfural,- MEK solvent dewaxing/- refrigerating and filtration -hydro finishing- types of LOBS based on VI- types or groups of lube processing-spindle/LN/IN/HN/BN processing and blending.	9
V	**ASPHALT AND WAX TECHNOLOGY:** Vacuum residue properties- propane deasphalting asphalt processing and types-chemical structure-air blowing of bitumen- slack wax processing wax and types/properties- wax deoiling unit operations in wax plants- refrigerating and filtration/ hydro treating of wax- molding and storage.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.
	CO2	Illustrate how each refinery process works
	CO3	Learn the operating variables which are applied to achieve the objectives of each refinery process
	CO4	Analyze the methodologies of processing and blending .
	CO5	Apply the concepts in asphalt processing and wax treatment technology.

TEXT BOOK:

T1	Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Publishinng Co. Pvt. Ltd.
T2	Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000.
T3	J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007.

REFERENCES:

R1	J.G. Speight and B. Ozum, "Petroleum Refining Processes", Marcel Dekker Inc, New York, 2002 .
R2	David.S.J."STAN"Jones and Peter R.Pujado "Handbook of Petroleum Processing,Springer,2006.
R3	Smalheer, C.V and R.Kennedy Smith Lubricant Additives. The Lezius – Hill Company, Cleveland, Ohio. USA, 1987 .
R4	Wayne C. Edmister, "Applied Hydrocarbon Thermodynamics", Gulf Publishing Co., 2nd edition, 1988

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5303	SECONDARY REFINING TECHNOLOGY	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Learn the methodologies in the secondary petroleum refining or upgrading processes like thermal cracking, coking, catalytic cracking, hydro cracking ,hydro treating, reforming, isomerization, alkylation and sulfur finishing processes
	2.	Examine refinery operation on FCC, Vis breaker, DCU, Reformer, etc. and operation on utilities like steam, cooling water, instrument air, H2, N2 etc..
	3.	Apply each operating variables are applied to achieve the objectives of each refinery process

Unit	Description	Instructional Hours
I	**THERMAL CRACKING AND COKING :** Resid up gradation technologies- cracking-thermal cracking-mechanism/principle/reactions process variables- Visbreaking- soaker process- coil visbreaker-Disadvantages-Coking thermodynamics and mechanism of coking-delayed coking-operation-fluid coking-flexicoking types of coke and properties- yield patter of cracking and coking.	9
II	**CATALYTIC CRACKING :** Principles of catalytic cracking-mechanisms- FCC- main reaction of FCC- role of FCC in refinery Fluidization- feedstocks/products/yield pattern-Kinetics and thermodynamics of FCC reactions FCC catalyst and licensor technologies-reaction/regeneration/fractionation sections-slide valves and its importance- riser/cyclone separator/reactor internals-RFCC/MSCC/Petro FCC	9
III	**HYDROGEN AND HYDROCONVERSION :** H2 requirements-steam reforming and shift conversion-operation and thermodynamics of reformer and NI catalyst-Hydro treatment processes- catalyst and reaction chemistry Naphtha/Diesel/lube/wax/gasoline hydro treatment-Hydrocracking process.	9
IV	**REFORMING/ISOMERISATION/ALKYLATION :** thermodynamics of Pt catalyst reactions-Operation in Straight Run and Continuous Run mode yield calculation-Isomerization techniques- reactions and kinetics.	9
V	**FINISHING PROCESSES AND UTILITIES :** Sources of sulfur in refinery-types of sulf compounds in crude-sweetening processes- various sulfur treatment process in products-H2S properties and removal by physical and chemical process- Cryogenic distillation of air to N2 and O2 production- Instrument air operation.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Acquires knowledge on different methodologies in the secondary petroleum refining processes like thermal cracking, coking, catalytic cracking, hydro cracking .
	CO2	Understand the operation on FCC, Vis breaker, DCU, Reformer.
	CO3	Illustrate the operation on utilities like steam, cooling water, instrument air, H2, N2
	CO4	Analyze the isomerisation, alkylation and reforming process.
	CO5	Apply the concepts of finishing processes and their operations in refining industries.

TEXT BOOK:	
T1	Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Publishinng Co. Pvt. Ltd.
T2	Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000.
T3	J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007.
REFERENCES:	
R1	J.G. Speight and B. Ozum, "Petroleum Refining Processes", Marcel Dekker Inc, New York, 2002 .
R2	David.S.J."STAN"Jones and Peter R.Pujado "Handbook of Petroleum Processing,Springer,2006.
R3	Smalheer, C.V and R.Kennedy Smith Lubricant Additives. The Lezius – Hill Company, Cleveland, Ohio. USA, 1987 .
R4	Wayne C. Edmister, "Applied Hydrocarbon Thermodynamics", Gulf Publishing Co., 2nd edition, 1988

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5304	BIO ENERGY	3	0	0	3

Course Objective	The student should be able to
	1. Learn the Biomass characteristics & preparation.
	2. Examine Feedstock for producing biogas
	3. Apply the Pyrolysis,Gasfication and Combustion of biomass.

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

On completion of the course, the students will be able to

Course Outcome		
	CO1	Understand the fundamental knowledge on classification, characterization and sources of biomass
	CO2	Learn the production of biogas.
	CO3	Gather knowledge on the operations of incineration, pyrolysis
	CO4	Illustrate the process in gasification of biomass
	CO5	Analyze the types of combustion of biomass.

TEXT BOOK:

T1	Anju Dahiya, Bioenergy: Biomass to biofuels First Edition, Academic Press, 2014
T2	Li, Yebo, and Samir Kumar Khanal. Bioenergy: principles and applications. John Wiley & Sons, 2016.
T3	Biomass for Renewable Energy, Fuels, and Chemicals,Donald L. Klass,1998

REFERENCES:

R1	Vaughn C Nelson, Kenneth L. Starcher. Introduction to bioenergy. CRC Press, 2017
R2	Wall, Judy D., Caroline S. Harwood, and Arnold Demain. "Bioenergy." Bioenergy.. ASM Press, 2008.
R3	Biomass to Biofuels,Alain Vertes, Nasib Qureshi, Hideaki Yukawa, Hans P. Blaschek,Wiley, 15 Dec 2009
R4	Biomass Combustion Science, Technology and Engineering,Lasse Rosendahl,Elsevier, 4 Apr 2013.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5305	RENEWABLE ENERGY RESOURCES	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Learn the fundamental of today's energy and its history.
	2.	Express the objectives of Solar, Bio and Geothermal energy.
	3.	Illustrate the applications of Wind and Tidal energy.

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

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the fundamental knowledge on history, consumption of energy.
	CO2	Learn the production of solar energy.
	CO3	Apply the knowledge on the geothermal and bio energy.
	CO4	Appreciate the production of wind energy and their utilization .
	CO5	Analyze the production and utilization of tidal energy .

TEXT BOOK:

T1	Mukherjee, D., and S. Chakrabarti. *Fundamentals of renewable energy systems*. New Age International, 2004.
T2	Jenkins, Nicholas, and Janaka Ekanayake. *Renewable energy engineering*. Cambridge University Press, 2017.
T3	Jean vidal, Thermodynamics Application in chemical Engineering and the petroleum industry, Institute Francaisbu petrolepublications,France 2003.

REFERENCES:

R1	Kishore, V. V. N., ed. *Renewable energy engineering and technology: principles and practice*. The Energy and Resources Institute (TERI), 2010.
R2	Tiwari, Gopal Nath, and Rajeev Kumar Mishra. *Advanced renewable energy sources*. Royal Society of Chemistry, 2012.
R3	Renewable Energy Resources, John Twidell, Tony Weir, Routledge, 26 Jan 2015.
R4	Introduction to Renewable Energy, Vaughn C. Nelson, CRC Press, 14 Jun 2011.

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CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5311	WASTE WATER TREATMENT	3	0	0	3

Course Objective	The student should be able to	
	1.	Focus on the wastewater transport system
	2.	Express the theory and design technique for the wastewater treatment process
	3.	Illustrate the applications of advanced waste water treatment.

Unit	Description	Instructional Hours
I	**WASTE WATER TREATMENT AN OVERVIEW:** Terminology – Regulations – Health and Environment Concerns in waste water management – Constituents in waste water; inorganic, Organic and heavy metal constituents.	9
II	**CHEMICAL UNIT PROCESSES:** Role of unit processes in waste water treatment- Principles of Chemical treatment – Coagulation - flocculation– Precipitation–flotation – solidification and stabilization –disinfection.	9
III	**BIOLOGICAL TREATMENT :** Objectives of biological treatment – significance – Principles of aerobic and anaerobic treatment - kinetics of biological growth – Factors affecting growth – attached and suspended growth - Determination of Kinetic coefficients for organics removal .	9
IV	**TREATMENT METHODS :** Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters- RBC-Moving Bed Reactors-fluidized bed reactors, aerated lagoons, waste stabilization ponds- Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal	9
V	**ADVANCED WASTE WATER TREATMENT:** Technologies used in advanced treatment – Classification of technologies- Removal of Colloids and suspended particles– Membrane Filtration – Ion Exchange – Advanced oxidation process – Zero liquid Discharge. - Software Applications	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the Physical and chemical Characteristics of wastewater and their measurement.
	CO2	Illustrate the various pollutant treatment techniques.
	CO3	Apply the concepts using biological treatment methods
	CO4	Analyze the reactors used for various treatment techniques.
	CO5	Understand the membrane based electrochemical process for pollutant treatment..

TEXT BOOK:

T1	Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FI Biston, 2002.
T2	Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
T3	S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.

REFERENCES:

R1	Casey, T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, 2006
R2	Metcalf & Eddy, Inc. Wastewater Engineering - Treatment, Disposal, and Reuse, Fourth Edition, Tata McGraw-Hill, 1995..
R3	Spellman, R.F., Handbook of water and wastewater treatment plant operations, CRC Press/Taylor & Francis Publications, 2009
R4	C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5312	SOLID WASTE MANAGEMENT	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Conversant with the types, sources, generation of MSW.
	2.	Express the storage, collection, transport, processing and disposal of municipal solid waste.
	3.	Illustrate the applications of advanced disposal of MSW.

Unit	Description	Instructional Hours
I	**SOURCES AND CHARACTERISTICS :** Sources and types of municipal solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics. Elements of Municipal Solid Waste Management Plan.	9
II	**SOURCE REDUCTION, WASTE STORAGE AND RECYCLING :** Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste – On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage	9
III	**COLLECTION AND TRANSFER OF WASTES :** Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations –location, operation and maintenance; options under Indian conditions	9
IV	**PROCESSING OF WASTES:** Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio meth nation; Thermal processing options – case studies under Indian conditions.	9
V	**WASTE DISPOSAL:** 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.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	State solid waste characteristics and its sources.
	CO2	Identify and analyze different methods of treatment of solid waste..
	CO3	Illustrate Industrial practices in solid waste management.
	CO4	Discuss the significance of recycling reuse and reclamation of solid wastes.
	CO5	Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air.

TEXT BOOK:

T1	William A. Worrell, P. AarneVesilind (2012) Solid Waste Engineering, Cengage Learning, 2012.
T2	John Pitchel (2014), Waste Management Practices-Municipal, Hazardous and industrial – CRC Press, Taylor and Francis, New York..
T3	Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", Prentice Hall, Inc., 1981

REFERENCES:

R1	Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.
R2	Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996...
R3	Spellman, R.F., Handbook of water and wastewater treatment plant operations, CRC Press/Taylor & Francis Publications, 2009
R4	Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". McGraw Hill, New York, 1993.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5313	COMPUTATIONAL TECHNIQUES	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Understand the Principles of Numerical Methods and Analysis.
	2.	Develop Proficiency in Algorithmic Problem Solving
	3.	Master Programming Languages and Tools for Computation

Unit	Description	Instructional Hours
I	**NUMERICAL METHODS FOR SYSTEM OF LINEAR ALGEBRAIC EQUATIONS:** Gauss elimination, LU decomposition, matrix inversion, Tri-diagonal matrix algorithm, Gauss-Seidel method, Chemical Engineering problems involving solution of linear algebraic equations	9
II	**NUMERICAL METHODS FOR NON LINEAR ALGEBRAIC EQUATIONS :** Introduction, Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, System of Non-linear Equations, Chemical Engineering problems involving solution of non-linear equations	9
III	**INTERPOLATION AND NUMERICAL INTEGRATIO:** Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression, Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration.	9
IV	**NUMERICAL METHODS FOR ODES:** Euler method – explicit and implicit, Runge-Kutta method – 2 nd and 4 th order, Boundary value problems – shooting method, Chemical engineering problems involving single and system of ODEs.	9
V	**NUMERICAL METHODS FOR PDES:** Euler method – explicit and implicit, Runge-Kut method – 2 nd and 4 th order, Boundary value problems – shooting method, Chemical engineerir problems involving single and system of ODEs.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the numerical methods for linear algebraic equations
	CO2	Identify numerical methods for non linear algebraic equations
	CO3	Identify different methods for interpolation and numerical integration.
	CO4	Illustrate the numerical methods for ordinary differential equations
	CO5	Assess the basic methods for partial differential equations

TEXT BOOK:

T1	Chapra. S. C. & Canale, R. P., "Numerical Methods for Engineers", Eighth Edition, McGraw Hill, 2021.
T2	Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.
T3	Ahuja, P., "Introduction to Numerical methods in Chemical Engineering" 2nd Edition, PHI learning Private Ltd, 2019.

REFERENCES:

R1	R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
R2	Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.
R3	Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5314	OPTIMIZATION OF CHEMICAL PROCESSES	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Understanding Optimization Theory and Techniques
	2.	Integration of Computational Tools and Software for Process Optimization
	3.	Application of Optimization Techniques to Chemical Processes

Unit	Description	Instructional Hours
I	**PROBLEM FORMULATION & CLASSIFCATION:** Introduction; formulation of objective functions; fitting models to data; classification of functions; necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods.	9
II	**LINEAR PROGRAMMING:** Review on basic concepts of LP formulations; Simplex methods; Big-M method, two phase method and Duality in linear programming.	9
III	**NON-LINEAR PROGRAMMING:** The Lagrange multiplier method, Integer, quadratic, geometric and dynamic programming	9
IV	**NUMERICAL METHODS:** Unimodal functions; Newton, quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant method.	9
V	**APPLICATIONS:** Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale systems.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the basic problem formulation and optimization
	CO2	Identify mathematical characteristics of Linear programming.
	CO3	Identify computational solution techniques for nonlinear unconstrained optimization. .
	CO4	Illustrate various techniques used in constrained optimization.
	CO5	Apply the optimal and dynamic optimization.

TEXT BOOK:

T1	Edgar T.F., Himmelblau D.M., Lasdon,L.S., Optimization of Chemical Processes, Second Edition, McGraw-Hill, New York, 2001.
T2	Rao, S. S., Engineering Optimization: Theory and Practice, Fifth Edition, Wiley, New York, 2019.
T3	Ahuja, P., "Introduction to Numerical methods in Chemical Engineering" 2nd Edition, PHI learning Private Ltd, 2019.

REFERENCES:

R1	R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
R2	Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.
R3	Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5315	PROCESS MODELING AND SIMULATION	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Develop Proficiency in Process Modeling Techniques
	2.	Master Simulation Software for Process Analysis and Design
	3.	Understand the Role of Process Simulation in Engineering Decision Making

Unit	Description	Instructional Hours
I	**INTRODUCTION AND FIRST PRINCIPLES:** Definition, Uses of Mathematical Models - Principles of formulation, Classification of Process Models, Fundamental laws: Total Continuity equation- Macroscopic and Microscopic Examples, Component Continuity Equation – Macroscopic and Microscopic Examples, Energy equation, Equations of motion, Transport equations, Equations of State, Equilibrium and Chemical Kinetics. Simple Examples. .	9
II	**LUMPED SYSTEMS:** Simple Hydraulic Tank, Variable flow hydraulic tank, Enclosed tank, Adiabatic compression in gas space, Mixing vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, Continuous flow boiling system	9
III	**STAGED OPERATIONS AND DISTRIBUTED SYSTEMS:** Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat exchanger, Membrane separation process, tubular reactor and evaporators.	9
IV	**FITTING MODEL TO DATA:** Fitting Linear Model, Multi-Linear Models, Matrix representation of Multi Linear Model, Fitting Quadratic Model, Cubic Model and Polynomial model using Regression, Power Law models. Performance Criteria to check quality of model, Co-efficient of Determination (R2)	9
V	**SIMULATION OF BASIC MODELS:** MATLAB/Simulink - Introduction, Basic component Operational Blocks, Examples - Gravity flow tank, Three CSTR's in series, Numerical solution of model using RK4, Euler's explicit and implicit techniques, Introduction to ODE 45 solver, Dynamic simulation of simple tank, variable flow tank, enclosed tank with isothermal compression, mixing vessel, mixing vessel with reaction using ODE 45 solver.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics
	CO2	Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods
	CO3	Create the mathematical models for different unit operations equipments.
	CO4	Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems
	CO5	Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions.

TEXT BOOK:

T1	Bequette, B. W., Process Dynamics: Modeling, Analysis, and Simulation. Prentice-Hall, 2002.
T2	Babu, B V., Process Plant Simulation, Oxford University Press, 2004 .
T3	Jana, A. K., Chemical Process Modeling and Computer Simulation, Second Edition, Prentice Hall India Pvt. Ltd, 2011.

REFERENCES:

R1	Luyben, W.L.: Process Modeling, Simulatio5n and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.
R2	Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.
R3	Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.

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CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5316	CHEMICAL PLANT DESIGN	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Understanding the Fundamentals of Chemical Process Design
	2.	Mastering the Design and Integration of Unit Operations
	3.	Applying Engineering Economics and Risk Assessment in Plant Design

Unit	Description	Instructional Hours
I	**ROTARY EQUIPMENT : Pumps: Various types:** Centrifugal, Reciprocating& Other Positive displacement types – Plunger, Piston, Diaphragm, Gear, Screw, Lobe, Vane, etc.; **Compressors: Various types:** Axial, Centrifugal, Reciprocating, and other positive displacement type such as Rotary Screw, Scroll, etc. Further, compressors are classified into two namely Oil free and Oil flooded lubricated; **Fans: Various types:** Axial fans (including Propeller, Tube-axial, and Vane-axial) and Centrifugal fans. Further fans are classified as Induced draft and Forced draft types.	9
II	**STATIC EQUIPMENT - HEAT TRANSFER EQUIPMENT : Heat Exchangers**– Shell and Tube, Double Pipe, Plate &Frame type, Tube in tube Scraped surface, and Fin tube, Coolers, Condensers, Fin Fan Coolers; **Fired Heaters& Boilers**– With or without air preheaters, Balanced draft or simply natural draft or even only forced draft, With and without waste heat generation.	9
III	**STATIC EQUIPMENT - MASS TRANSFER : Mass Transfer Operations**: Multi Component Distillation columns, Extractive distillation, Reactive Distillation, Azeotropic distillation, Divided wall columns, Dryers, Adsorption Isotherm, Pressure Swing Adsorption, Importance of recycles and Optimization needs, Absorption processes & operating variables, Liquid – Liquid Solvent Extraction ; **Humidification** & dehumidification, Evaporation, Precipitation, Crystallizers, Membrane filtration.	9
IV	**EQUIPMENT ANCILLARIES : Special equipment**– Static Mixer, Agitators, Jet Mixing, Ejectors, Educators, Structured Packing, Grid Packing and Random Packing, Demisters, Vortex Breaker, Calming Baffles, Schoepentoeter, Vapor horn device, Cyclone separators; **Package units** – Inert gas generators, Feed stream filters (Mechanical, Chemical), Scrubbers, Spray Nozzles, Guard beds, Flare stack, Ground Flare, Flame arrestors, Strainers, Spring supports, Expansion joints, Electrostatic Precipitators	9
V	**STATIC EQUIPMENT - PRESSURE VESSELS, INTERNALS &SAFETY VALVES : Pressure Vessels** – Vertical / Horizontal, Knock Out Drums, Steam and Blow down drum, Cold & Hot Separators, Surge drum, Deaerators, Water Seal Pot, Molecular seals, Shock Absorbers, **Internals** –Column internals such as Trays (Sieve, Valve, Bubble Cap, Baffle, Dual flow, Multi down comer, Chimney tray etc.), **Safety Valves**: Normal, balanced bellows, pilot operated, etc., Rupture Discs, and Design codes governing Safety valve design, .	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the basic on designing chemical process unit for rotary equipment
	CO2	Learn the operations of boilers, heat exchangers, refrigeration and air conditioners.
	CO3	Illustrate the operations of reactors, humidifiers and mass transfer operations
	CO4	Analyze the different types of equipments in process industries.
	CO5	Apply the knowledge on usage of different valves such as pressure, safety and internal.

TEXT BOOK:

T1	Robert H. Perry; Don W. Green and James O. Maloney, Chemical Engineering Handbook
T2	James R. Couper, W. Roy Penney, James R. Fair, Stanley M. Walas, Chemical Process Equipment: Selection and Design (Third Edition) .
T3	Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz - "Analysis, Synthesis and Design of Chemical Processes" (5th Edition).

REFERENCES:

R1	Gavin P. Towler, R.K. Sinnott - "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design" Second Edition, 1996.
R2	Max S. Peters, Klaus D. Timmerhaus, Ronald E. West - "Plant Design and Economics for Chemical Engineers, Second Edition, 1997.
R3	Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5317	PLANT LAYOUT	3	0	0	3

Course Objective	The student should be able to	
	1.	Understand the importance of plant layout in mitigating risk on people, plant
	2.	Apply knowledge in placing equipment for ease of operability & maintainability
	3.	Analyze the risk assessment and Engineering package.

Unit	Description	Instructional Hours
I	**STANDARDS FOR AREA CLASSIFICATION :** Standards for area classification– Electrical Area classifications, OSHA (Occupational Safety and Health Administration) regulations, National Fire Protection Association (NFPA), Petroleum Hazards Classification, IP15 Petroleum classification based on flash point, OISD standards (Oil Industry Safety Directorate), API Codes (American Petroleum Institute), PESO (Petroleum and Explosives Safety Organization) guidelines, Investigations Reports & Best practices data Chemical Safety Board, USA	9
II	**INTER UNIT DISTANCES :** Distance between plants, substation, centralized control room, utilities sections / captive power plants; Inter-distance between adjacent Columns, Storage tanks, Tank dykes; Flare stack location (based on Prevailing up-wind direction), Design to keep it smokeless, Sterile zone/area – Governing API /OISD Standards, Field cabins. Access to firefighting facilities, Fire tank capacity, Foam need assessment, Design to tackle simultaneous fire incidents, Protection of fire network and ensuring availability on demand.	9
III	**STORAGE TANKS :** Fixed or Floating roof, Mounded Bullet tanks, Cryogenic storage tanks & their special design requirements, Special designs along with breather systems, Lightening arrestors, Earth pits, other appurtenances –Manways for roofs or tank sidewalls, Catwalks, Roof vents, Roof hatches, Nozzles, Roofs (flat-style, knuckle-style, or pitched), Aluminium geodesic domes, Ladders, etc. Comfort factors Vs Inventory carrying cost, Safe operation of floating roof travel, breather sizing, steam coils design.	9
IV	**RISK SYSTEMS AND EQUIPMENT :** Fuel gas systems, Fuel oil network, Hydrogen gas for generator cooling in power plants; Plant battery systems, Ammonia systems, Solid handling of coal and coke dust, Sulphur yard, Toxic gas loss of containment, etc, MSDS of every stream being handled / processed, Spent catalyst safe disposal ;Safe at Risk Assessment: Overall risk assessment using credible scenario along with preventive measures &systems to be in place to eliminate / minimize loss of containment.	9
V	**ENGINEERING DESIGN PACKAGE :** First document to be prepared and approved between Process Engineering Team and Owner's representative. It shall cover not limited to – Site Conditions (weather, wind rose, seismic activity, water table, etc.); System of measurement (in FPS or MKS for flow of gas / liquid / steam, temperature, pressure, heat duty, inferential properties, etc.), Design considerations and margins, Design philosophies such as Operating & Control philosophy, Vent & Drain philosophy.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the importance of plant layout in mitigating risk on people,
	CO2	Apply the placing equipment for ease of operability & maintainability
	CO3	Illustrate the storage tanks operation and usage at safety level.
	CO4	Analyze the usage of equipment at safety levels and their risk assessment.
	CO5	Apply the basic engineering design package.

TEXT BOOK:

T1	Richard Muther - "Facility Layout and Location: An Analytical Approach" (4th Edition, 2015).
T2	James M. Moore, John A. White - "Introduction to Facility Layout and Location: From Design to Realization" (1st Edition, 2011).
T3	Jack Greene, Charles Petrie, Joseph Ballard - "Facility Layout and Location: An Analytical and System Approach" (1st Edition, 1991).

REFERENCES:

R1	Alberto Garcia-Diaz - "Plant Layout and Material Handling" (1st Edition, 2018).
R2	Sunderesh S. Heragu - "Facilities Design" (4th Edition, 2010).
R3	Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5318	DESIGN SAFETY	3	0	0	3

Course Objective	**The student should be able to**
	1. Understand the process safety systems both to prevent incident & to minimize loss
	2. Apply the principles 'safe at risk' to assess likely unsafe conditions in unit operation.
	3. Analyze the risk mitigation measures.

Unit	Description	Instructional Hours
I	**SAFETY SYSTEMS :** Safety systems: Deployment of sensors (Toxic, HC and Thermal) at critical locations, Fire network including elevated fire monitors, Egress system, Escape route and Assembly point, Water curtain, eye wash requirement, Clean and cooler water supply ;Dovetail Early Event Detections system to forecast and forewarn on 'unsafe' conditions emerging in process units, Cause & Effect diagram, Alarm rationalization, Partial or Total Plant Trips review.	9
II	**ELECTRICAL SYSTEMS :** Power systems – KV level, 3 phase and single phase, LT, HT generation and distribution network systems, MCC / PCC (motor control centre and power control centre) substations, Electrical Energy Audits, Exergy analysis, Cogen design aspects ; Emergency Power needs based on process criticalities (including power back up for fire water and plant safe shut down), Load shedding, Essential and Non- essential power load ;Uninterrupted Power System (UPS), Load assessment for UPS, Battery bank ;Earth pit design and maintenance aspects.	9
III	**FLARE SYSTEM:** LP, HP, LLP and H2S flares, Types – Single Point Flares (Sonic & Subsonic), Multi Point Flares,Coanda Flares, Vent Tips, Enclosed Flares and Air Assisted Gas Flares ;Pilot gas system, Electronic ignition, Flare tip design, Flare noise reduction, Fire Ball prevention, Smokeless flare at worst weather conditions, Radiation impact zone, Flare release scenarios (fire, blocked mode, partial and total power failure), Nitrogen purge, flare header network design; Safety margins in design, Assessing flare loss in a multi units complex where metering individual headers is near impossible ;Flare gas recovery and Zero Flare release.	9
IV	**RISK MITIGATION MEASURES :** HAZOP (Hazard and Operability Study), HAZID (Hazard identification), HAZAN (Hazard Analysis), EERA (Emergency escape route analysis), SIL (Safety Integrity levels) study, QRA (Quantitative Risk Assessment)and Dispersion studies ;Trip reset (Field and Control Room) and MSDS (Material Safety Data Sheet) for all streams being handled, Bow Tie Analysis, Risk Evaluation using 8 x 8 Matrix, FMEA (Failure Modes And Effects Analysis),Insurance premium assessment and measures to minimize ;Best practices – Updated documentation, SOPs (Standard Operating Procedures)	9
V	**PROCESS CONTROL & INSTRUMENTATION:** Graphic design & grouping to minimize user latency in process control ;Designed for safety through redundancy right from dedicated impulse lines to card level, PLC (Programmable Logic Controls), Cascaded Control, Process Historian, Online reporting by exception, Inferential predictions ;Use of AI / ML in controlling plant within best operating zone,	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the safety systems both to prevent incident & to minimize loss.
	CO2	Apply the safety in electrical systems.
	CO3	Illustrate the flare systems and their safety.
	CO4	Analyze the risk analysis and mitigation.
	CO5	Apply the control systems and their safety usage in different process industries.

TEXT BOOK:

T1	Trevor A. Kletz - "Process Plants: A Handbook for Inherently Safer Design, Second Edition" (1998).
T2	Daniel A. Crowl and Joseph F. Louvar - "Chemical Process Safety: Fundamentals with Applications, Fourth Edition" (2019).
T3	Ulrich Hauptmanns - "Safety Design for Space Systems" (2009).

REFERENCES:

R1	Dennis P. Nolan - "Handbook of Fire and Explosion Protection Engineering Principles: for Oil, Gas, Chemical and Related Facilities" - 2nd Edition (2011).
R2	Frank P. Lees - "Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control" - 3rd Edition (2005).
R3	CCPS (Center for Chemical Process Safety) - "Guidelines for Engineering Design for Process Safety" - 4th Edition (2012).

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DEPARTMENT OF CHEMICAL ENGINEERING
R-2022
REVISION COURSES

SL.NO	COURSE CODE	NAME OF THE COURSE	EXISTING SYLLABUS	SUGGESTIONS AND COMMENTS GIVEN BY EXPERTS	ACTION TAKEN	% OF CHANGE
1.	22CH5251 Batch admitted from 2022 – 2023 onwards	Chemical Reaction Engineering – I	UNIT-I- catalyst preparation. Nature of catalysts, surface area and pore-volume distribution. **Kinetic studies in batch reactor**. UNIT-IV-Models for explaining kinetics; Chemical reaction volume and surface models; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes, fluidized and static reactors	Recommended to incorporate the following, UNIT-I- General definition of catalysts, Solid catalysts, Components of catalyst, Industrial catalysts, Preparation of solid catalysts, Precipitation and co-precipitation methods, Sol gel method, Supported catalysts. UNIT-IV- Shrinking core model – Gas film controlling – Ash layer controlling controlling – Shrinking spherical particles – Fluidized bed reactor	Incorporated	20
2	22CH5001 Batch admitted from 2022 – 2023 onwards	Mass Transfer Operations Lab	Separation of binary mixture using Steam distillation Separation of binary mixture using Packed column distillation Measurement of diffusivity Drying characteristics of Tray dryer Drying characteristics of Rotary dryer Water purification using ion exchange columns Mass transfer characteristics of Rotating disc contactor Evaporation studies (Single effect) Evaporation studies (Multiple effect)	Recommended to incorporate the following, • Separation of binary mixture using Simple distillation • Mass transfer characteristics of Bollman Extractor	Incorporated	20
3	22CH5203 Batch admitted from 2022	Process Instrumentation Dynamics	UNIT-I- INSTRUMENTATION Types and principles of measurement of temperature, pressure, fluid flow, liquid weight	Recommended to incorporate the following, UNIT-I- **PRINCIPLES OF**	Incorporated	20

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	– 2023 onwards	and Control	and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases. UNIT-II- Laplace transformation and its application in process control. Transform of standard functions - derivatives and integrals - inversion theorems - Open loop system - First order systems, and their transient response for standard input functions, first order systems in series, linearization, and its application in process control, second order systems and their dynamics; transportation lag. UNIT-III–Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability UNIT-IV- Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules	**MEASUREMENT:** Introduction to measurement and its hardware element - Transducer function and types – Static and Dynamic characteristics of measuring device - Principles of measurements and classification of process instruments, transmitter.. UNIT-II- Transform of standard functions - derivatives and integrals - inversion theorems - Open loop system - Transfer functions - Forcing functions - step, pulse, impulse and sinusoidal UNIT-III- OFFSET calculation UNIT-IV- Process reaction curve, IMC tuning.		

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Department of Chemical Engineering
R-2022
NEW COURSES INTRODUCED

S. No.	Course code	Name of the Course
1	22CH5207	Petroleum Geology
2	22CH5306	Pinch Technology
3	22CH5307	Biochemistry
4	22CH5308	Bioprocess Technology
5	22CH5309	Fermentation & Bioprocessing

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NEW COURSES

Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5306	PINCH TECHNOLOGY	3	0	0	3

Course Objective	The student should be able to	
	1.	Learn the Concept and fundamentals of Pinch process.
	2.	Examine how each Pinch methodology works.
	3.	Apply each resource analysis of various processes.

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Thermodynamic review of the process, Pinch Concept, significance of pinch, pinch in grid representation, Threshold problems, capital cost implication of the pinch.	9
II	**TARGETING**: Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, and continuous targeting.	9
III	**PINCH METHODOLOGY**: Problem representation, temperature enthalpy diagram, simple match matrix. Heat content diagram, Temperature interval diagram.	9
IV	**PINCH DESIGN AND OPTIMIZATION:** Networks for maximum energy recovery, Pinch design method, Flexibility criteria of the pinch, CP table, heuristics, optimization of heat exchanger network: optimality for a minimum area network.	9
V	**ENERGY AND RESOURCE ANALYSIS OF VARIOUS PROCESSES:** Batch process, distillation process, evaporation process, reaction process, process using mass separating agent	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the pinch concept and process thermodynamics.
	CO2	Identify minimum energy targets.
	CO3	Classify different choices and constraint during heat exchange networking.
	CO4	Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes
	CO5	Analyze the concepts in various chemical processes.

TEXT BOOK:

T1	V. Uday Shenoy" Heat Exchanger network synthesis" Gulf Publishing Co, USA, 1995..
T2	Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000.
T3	J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007.

REFERENCES:

R1	D.W. Linnhoff et al., "User Guide on Process Integration for the efficient use of Energy".Institution of Chemical Engineers, U.K., 1994.
R2	James M. Douglas "Conceptual Design of Chemical Process", McGraw Hill, New York, 1988.
R3	Anil Kumar, "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill New Delhi, 1977..
R4	Wayne C. Edmister, "Applied Hydrocarbon Thermodynamics", Gulf Publishing Co., 2nd edition, 1988

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5307	BIOCHEMISTRY	3	0	0	3

Course Objective	The student should be able to	
	1.	Learn the fundamentals of Biochemical Processes and Biomolecules.
	2.	Examine the Structure and properties of Important Biomolecules.
	3.	Illustrate the Functions of Proteins, Enzymes, introduction to biocatalysts, metabolic pathways.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BIOMOLECULES - CARBOHYDRATES:** Basic principles of organic chemistry, role of carbon, types of functional groups, chemical, nature of water, pH and biological buffers, bio molecules structure and properties of Carbohydrates (mono, di, oligo & polysaccharides) Proteoglycans, glucosaminoglycans. mutarotation, glycosidic bond, reactions of monosaccharides, reducing sugars.	9
II	**STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES :** Structure and properties of Important Biomolecules. **Lipids:** fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins. **Protein:** Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determine of primary structure.	9
III	**METABOLISM CONCEPTS AND CARBOHYDRATE METABOLISM :** Functions of Proteins, Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Interconnection of pathways and metabolic regulation. Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt & glyoxalate shunt.	9
IV	**INTERMEDIARY METABOLISM AND REGULATION :** Fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.	9
V	**PROTEIN TRANSPORT AND DEGRADATION :** Protein targeting, signal sequence, secretion; Folding, Chaperone and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Acquires knowledge on basic concepts on carbohydrates .
	CO2	Understand the concepts of proteins .
	CO3	Illustrate the knowledge on importance of nucleic acids.
	CO4	Analyze the knowledge on lipids.
	CO5	Apply the concepts on intermediary metabolism and their pathways.

TEXT BOOK:

T1	Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H.Freeman and Company 2017
T2	Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006. .
T3	Rastogi, S.C. "Biochemistry" 2 nd Edition, Tata McGraw-Hill, 2003.

REFERENCES:

R1	Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.
R2	Berg, Jeremy M. et al. "Biochemsitry", 6th Edition, W.H. Freeman & Co., 2006.
R3	Murray, R.K., etal "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
R4	Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc.,2010.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5308	BIOPROCESS TECHNOLOGY	3	0	0	3

Course Objective	The student should be able to	
	1.	Understand the fundamentals of bioprocesses
	2.	Examine the production process of biomolecules
	3.	Apply the strong foundation in bioreactors

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BIOPROCESS :** Biologists and Engineers, comparison of chemical and biochemical processing overview of biological basics, About cells and its growth, the stoichiometry of microbial growth and product Bioprocesses: Regulatory Constraints	9
II	**MEDIA FORMULATION AND DEVELOPMENT :** Media formulation, Media Sterilization: Methods of heat sterilization of media, thermal death kinetics, design criteria, batch and continuous sterilization. Air Sterilization: Methods of air sterilization, mechanism of air sterilization, solid and liquid handling. Industrially fermented broth	9
III	**UNDERSTANDING BIOREACTORS :** Purpose and importance of bioreactors, Classification of bioreactors, bioreactors for animal cells, bioreactors for plant cells, bioreactors for immobilized cells, operations of bioreactors, stirred tank reactor, plug flow reactor (PFR), fluidized bed reactor, bubble column, airlift reactor, Agitation, and Aeration: Mechanical agitation, power consumption in agitation, bubble aeration, bioreactors for waste management	9
IV	**TRANSPORT PROCESSES:** Diffusivity and mechanism of mass transfer - derivation of the equations of mass transport by diffusion-stationary and unsteady mass transport by diffusion, mass transfer coefficient, macroscopic balances for mass transport. Mechanisms and applications of heat transfer-mode of heat transfer-conduction, convection and radiation	9
V	**BIOETHICS AND BIOSAFETY:** Introduction to Bioethics. Social and ethical issues, the process of biotechnology involved in generating new forms of life for informed decision making, Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release into the environment.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the fundamental knowledge on bioprocess technology
	CO2	Learn the the production process of biomolecules.
	CO3	Gather knowledge on the operations of bioreactors and their purposes
	CO4	Illustrate the transportation processes in reactors and their behaviors
	CO5	Apply knowledge on the biosafety and information on bioethics.

TEXT BOOK:

T1	Bailey, J. E., and D. F. Ollis. Biochemical Engineering Fundamentals. 2nd ed. New York, McGraw-Hill, 1986.
T2	H. W. Blanch and D. S. Clark, Biochemical Engineering, Marcel, Dekker Inc., 1996.
T3	Pauline M. Doran. Bioprocess Engineering Principles. 2nd ed. Elsevier Science & Technology Books. 1995

REFERENCES:

R1	Transport Phenomena, by Bird R.B., Steward W.E., and Lightfoot E.N., John Wiley & sons, Inc., New York, 2002
R2	C J Geankoplis, Transport Processes and Separation Processes Principles, 4th Edition, New Jersey, PHI Publishers, 2010
R3	Murray, R.K., etal "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
R4	Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc.,2010.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5309	FERMENTATION AND BIOPROCESSING	3	0	0	3

Course Objective	The student should be able to	
	1.	Understand the fermentation and its kinetics.
	2.	Examine the structural, functional properties of microbes.
	3.	Design fermenter with auxiliaries.

Unit	Description	Instructional Hours
I	**FERMENTATION PROCESSES:** Importance of fermentation, Fermentation and redox potential, solid-liquid fermentation, solid state fermentation, Kinetics of fermentations, Biosensors for fermentations, Production processes in fermentation.	9
II	**MICROBIAL GROWTH KINETICS:** Diversity of patterns of microbial growth in situ and ex situ, Microbial growth under homogeneous conditions, Heterogeneous microbial growth, Growth kinetics, Derivation of mathematical models, and identification	9
III	**DESIGN OF FERMENTERS:** Fermentation processes and microorganisms, Kinetics and stoichiometry, Mass balances and design for batch, continuous and fed-batch reactors, Comparison of batch, continuous and fed-batch reactors, Heat generation and heat balances, examples of industrial fermentation processes	9
IV	**INSTRUMENTATION AND CONTROL:** Common Instruments for Process Automation – Temperature, Gas Flowrate, Liquid Flowrate, Off Gas Analysis, pH, Dissolved Oxygen, Pressure, Foam Level, Stirring , Redox Potential, Advanced Instrumentation for Bioprocess Control and Automation	9
V	**FERMENTATION AND COMMODITY PRODUCTS:** Engineering of Secretory Pathways, production of heterologous proteins, fungal, yeast fermentation of industrial products.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the structural, functional properties of microbes.
	CO2	Learn the the growth kinetics of microorganisms.
	CO3	Gather knowledge on the operations of bioreactors and their purposes
	CO4	Apply knowledge on the operation of control systems in fermentation and bioprocess industry.
	CO5	Acquire knowledge on the commodity, fermentation production and their production pathways

TEXT BOOK:

T1	Essentials in Fermentation Technology, Aydin Berenjian, Springer ,2019.
T2	Principles of Fermentation Technology (Second Edition), Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Pergamon, 1995.
T3	Pauline M. Doran. Bioprocess Engineering Principles. 2nd ed. Elsevier Science & Technology Books. 1995

REFERENCES:

R1	Fermentation and Biochemical Engineering Handbook; Editors-in-Chief: Henry C. Vogel and Celeste M. Todaro, Third Edition, Elsevier, 2014
R2	Fermentation Biotechnology: Principles, Processes, and Products (Prentice Hall advanced references series), Owen P. Ward, Prentice Hall, 1989
R3	Anil Kumar, "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill New Delhi, 1977..
R4	Wayne C. Edmister, "Applied Hydrocarbon Thermodynamics", Gulf Publishing Co., 2nd edition, 1988

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5310	AIR POLLUTION ENGINEERING	3	0	0	3

Course Objective	The student should be able to
	1. Learn about Air Pollution, effects of air pollution, Global effects.
	2. Examine the Sampling of pollutants, Meteorology and air pollution, Atmospheric stability
	3. Analyze the dispersion and Prediction of air quality.

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Introduction to Air Quality, An Overview of the Clean Air Act Amendments; Air Pollution Regulatory Framework - Regulatory System Laws and Regulations – Clean air Act –. Ambient Air Quality Standards in India; Properties of Air Pollutants; Sources and effects of air pollution.	9
II	**PARTICULATE AIR POLLUTION:** Particle Collection mechanisms- Fluid particle Dynamics – Particle size Distribution – Efficiency –Gravity Settling chambers Cyclones-Electrostatic precipitators and Bag houses.	9
III	**EFFECTS OF AIR POLLUTION:** Effects of Air Pollution on human beings, plants and animals and Properties. Global Effects-Green house effect, Ozone depletion, heat island, dust storms, Automobile pollution sources and control, Photochemical smog, Future engines and fuels	9
IV	**AIR POLLUTION CONTROL:** Air Pollution control- at source-equipments for control of air pollution-For particulate matter-Settling chambers-Fabric filters-Scrubbers-Cyclones Electrostatic precipitators, For Gaseous pollutants-control by absorption-adsorption scrubbers-secondary combustion after burners, Working principles advantages and disadvantages.	9
V	**AIR QUALITY SAMPLING AND MONITORING:** Stack sampling, instrumentation and methods of analysis of SO2, CO etc, legislation for control of air pollution and automobile pollution.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome		
	CO1	Understand the nature and characteristics of air pollutants, and basic concepts of air quality standards.
	CO2	Identify, formulate and solve air pollution problems using air pollution control devices to meet applicable standards.
	CO3	Gather knowledge on the Effects of Air Pollution on human beings, plants and animals and Properties.
	CO4	Control the air pollution in industries using various equipments.
	CO5	Acquire knowledge on the Stack sampling, instrumentation and methods of analysis

TEXT BOOK:

T1	H.S. Peavy, D.R. Row & G. Tchobanoglous, Environmental Engineering, Mc Graw Hill International Edition
T2	Anjaneyulu, Y., Air Pollution and Control Technologies, Allied Publishers (P) Ltd., India, 2002.
T3	Wang, L.K., Parelra, N.C., Hung, Y.T., Air Pollution Control Engineering, Tokyo, 2004.

REFERENCES:

R1	David, H.F., Liu, Bela G., Liptak Air Pollution, Lweis Publishers, 2000.
R2	Stern, A.C., Air Pollution (Vol.I – Vol.VIII), Academic Press, 2006.
R3	Heck, R.M., and Farrauto, R.J., Catalytic Air Pollution Control: Commercial Technology, 2nd Edition John Wiley Sons, 2012
R4	Pierce, J.J., Environmental pollution and control, Butterworth-Heinemann, 4th edn, 1997.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6201	TRANSPORT PHENOMENA	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Understand the mass, momentum and energy transport at molecular, microscopic and macroscopic level
	2.	Express their knowledge to determine velocity, temperature and concentration profiles.
	3.	Illustrate the idea about equations of change and their applications.

Unit	Description	Instructional Hours
I	**MOMENTUM TRANSPORT :** Viscosity, temperature and pressure effect on viscosity of gases and liquids, Newton's law, mechanism of momentum transport, shell momentum balance method, Shear stress and velocity distributions in falling film, circular tube.	9
II	**ENERGY TRANSPORT :** Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanism of energy transport, shell energy balance method, Energy flux and temperature distribution in solids, heat conduction through composite walls, cylinders, spheres.	9
III	**MASS TRANSPORT :** Diffusivity, temperature and pressure effect on diffusivity, Fick's law, mechanism of mass transport, shell mass balance method, Mass flux and concentration distribution in solids and in laminar flow.	9
IV	**EQUATIONS OF CHANGE AND THEIR APPLICATIONS:** Momentum: Equations of continuity, motion and mechanical energy (Isothermal), Energy: Equation of energy (non-isothermal). Mass: Equations of change (multi-component), equations of continuity for each species, equation of energy (multi-component).	9
V	**TRANSPORT IN TURBULENT FLOWS AND ANALOGIES:** Comparison of laminar and turbulent flows, time-smoothed equations of change, empirical expressions. Comparison of laminar and turbulent hydrodynamics.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.
	CO2	Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels.
	CO3	Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes
	CO4	Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems
	CO5	Apply the concepts of dimensional analysis and scale factors for equation of change for different coordinate systems.

TEXT BOOK:

T1	Bird, R. B., Stewart, W. E. and Lighfoot, E. W., "Transport Phenomena", 2nd Edn., John Wiley, 2006
T2	Brodkey, R. S., and Hershey, H. C., "Transport Phenomena", McGraw-Hill, 1987.

REFERENCES:

R1	Welty, J. R., Wilson, R. W., and Wicks, C. W., "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition. John Wiley, New York, 2008.
R2	Slattery, J. S., "Advanced Transport Phenomena", Cambridge University Press, London, 1999.
R3	C. J. Geankopolis, "Transport Processes in Chemical Operations", 3rd Edn., Prentice Hall of India, New Delhi, 1993.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	3	3
CO2	3	3	3	2	2	-	-	-	1	-	-	1	3	3
CO3	3	3	3	1	1	-	-	-	1	-	-	1	3	3
CO4	3	3	3	2	1	-	-	-	1	-	-	1	3	3
CO5	3	3	3	2	1	-	-	-	1	-	-	1	3	3

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech.	22CH6202	INSTRUMENTAL METHOD OF ANALYSIS	3	0	0	3

Course Objective	**The student should be able to**	
	1.	List the basic components of a UV-Vis spectrophotometer and describe their functions.
	2.	Explain the working principles and theoretical foundations of techniques such as spectroscopy, chromatography, and electrochemical analysis.
	3.	Use appropriate instrumental techniques to analyze unknown samples and interpret the results accurately.

Unit	Description	Instructional Hours
I	**Introduction:** Introduction to classical qualitative and quantitative analysis, classification of instrumental methods, Errors, precision and accuracy of instruments, statistical methods of data handling.	9
II	**Spectroscopy:** Beer"s Law, deviation of Beer"s Law, instrumentation of UV and IR spectroscopy: Monochromatic Source, grating systems and types of detectors, different sampling techniques and application of UV & IR Spectroscopy. Principles, Application of Atomic Spectroscopy, Mass Spectrometry (MS).	9
III	**Gravimetric analysis:** Principle of Thermo gravimetric analyzer (TGA), construction of TGA, principle of bomb Calorimeter (BC), principle of Differential scanning calorimeter (DSC), Instrumentation of TGA and BC, Application of TGA	9
IV	**Gas chromatography:** Introduction, Principle, carrier gas, stationary phase, instrumentation, column detectors (TCD, FID, ECD), qualitative and quantitative analysis.	9
V	**High performance liquid chromatography:** Principle, instrumentation, types of columns, sample injection, detectors used like (absorbance, refractive index, and electrochemical measurements), criteria for mobile phase selection and application of HPLC.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the components of a sample using classical qualitative analysis.
	CO2	Comprehend the Instrumentation of UV and IR Spectrometers
	CO3	Apply DSC to study phase transitions, material stability, and heat-induced changes in various materials.
	CO4	Interpret chromatograms to assess the purity and concentration of compounds in a sample.
	CO5	Conduct qualitative and quantitative analysis using HPLC to determine the presence and concentration of substances in complex samples.

TEXT BOOK:

T1	Instrumental Methods of Chemical Analysis; Gurudeep R. Chatwal and Sham K. Anand, Himalaya Publishing House.
T2	Douglas A. Skoog, F. James Holler, Stanley R. Crouch., "Principles of Instrumental Analysis", 6th Edition, published by Thomson Brooks/Cole,2007.

REFERENCES:

R1	Lloyd R. Snyder, Joseph J. Kirkland, John W. Dolan., "Introduction to Modern Liquid Chromatography"., 3rd Edition, Wiley-Blackwell, scholarly publishing.
R2	H.H. Willard, L.L. Merritt, J.N. Dean and F.A. Settle, "Instrumental methods of analysis"., I.B.H. Publishing House, New Delhi.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	-	1	1	1	1	1	1	2	3	2
CO2	2	1	1	1	2	1	1	1	1	1	2	2	3	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	3	2
CO4	1	2	2	2	1	1	2	2	2	1	2	1	3	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22HE6101	PROFESSIONAL ETHICS	3	0	0	3

Course Objective	The student should be able to	
	1.	Foster ethical behavior and life skills for holistic development.
	2.	Illustrate the value of Engineering Ethics
	3.	Inculcate the social responsibility of an engineer.
	4.	Impart knowledge on issues related to safety, responsibility and rights
	5.	Educate on professional practice on global issues

Unit	Description	Instructional Hours
I	**VALUE EDUCATION** Moral values and Right understanding- Holistic development and the Role of Value Education- Understanding Value Education-. Self-exploration as the process for value Education- Integrity -Work Ethics- Empathy- Spirituality	9
II	**ENGINEERING ETHICS** 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.	9
III	**ENGINEERING AS SOCIAL EXPERIMENTATION:** Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.	9
IV	**SAFETY, RESPONSIBILITIES AND RIGHTS** Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest -- Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.	9
V	**GLOBAL ISSUES** Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the importance of various components of human values
	CO2	Apply ethics in society
	CO3	Discuss the ethical issues related to engineering and
	CO4	Realize the responsibilities and rights in the society
	CO5	Apply professional ethics in solving global issues

TEXT BOOK:

T1	Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
T2	Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
T3	Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.

REFERENCES:

R1	Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
R2	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
R3	John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.

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CO1	3	3	2	2	-	2	2	2	-	-	-	-2	3	3
CO2	-	3	2	3	3	2	2	2	2	-	-	-	3	3
CO3	2	3	3	2	3	2	2	2	2	2	-	-	3	3
CO4	2	2	2	2	2	3	3	2	2		2	-	3	3
CO5	2	2	2	2	2	-	-	-	3	3	2	-	3	3

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6001	PROCESS CONTROL LAB	0	0	4	2
Course Objective	The student should be able to					
	1.	Hands-on experience in designing, implementing, and analyzing control systems for industrial processes.				
	2.	Express their knowledge in the field of process control instrumentation and software for real-time monitoring and control of dynamic systems.				
	LIST OF EXPERIMENTS					
1.	Response of first order system					
2.	Response of second order system					
3.	Response of Non-Interacting level system					
4.	Response of Interacting level system					
5.	Open loop study on a thermal system					
6.	Closed loop study on a level system					
7.	Closed loop study on a flow system					
8.	Closed loop study on a thermal system					
9.	Tuning of a level system					
10.	Tuning of a pressure system					
11.	Tuning of a thermal system					
12.	Flow co-efficient of control valves					
13.	Characteristics of different types of control valves					
14.	Closed loop study on a pressure system					
15.	Closed loop response of cascade control system					
		Total Instructional Hours	45			
On completion of the course, the students will be able to						
Course Outcome	CO1	Design and implement PID controllers for various industrial processes and evaluate their performance.				
	CO2	Demonstrate proficiency in using software tools like MATLAB, Simulink, or LabVIEW for simulating process control systems.				
	CO3	Analyze and interpret data from process control experiments, improving decision-making in control system design and tuning.				
REFERENCES:						
R1	Coughnowr, D., " Process Systems Analysis and Control ", 3rd Edn., McGraw Hill, New York, 2008.					

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	3	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	22CH6002	COMPUTATIONAL CHEMICAL ENGINEERING LAB	0	0	4	2

The student should be able to

Course Objectives

1. **Develop** the ability to interpret and create isometric and orthographic projections for various engineering components.
2. **Equip** students with practical skills in 3D modeling of mechanical systems, such as boilers, valves, and pipe fittings.
3. **Provide** hands-on experience in conducting and analyzing heat transfer experiments, including steady-state, unsteady-state, convection, and radiation processes.

S.No.	LIST OF EXPERIMENTS
1	Draw the isometric view from orthographic projection.
2	Draw the orthographic projection from isometric view.
3	Construct a 3D diagram of boiler with valves and pipe fittings.
4	Construct a 3D diagram of helical oil.
5	Steady state heat transfer through a composite rectangular slab
6	Unsteady state heat conduction in a rectangular slab
7	Radiation heat transfer between two vertical parallel plates
8	Natural convection heat transfer from a vertical plate
9	Forced convection heat transfer across a horizontal cylinder
10	Flow through pipe at different Reynolds numbers
	Total Practical Hours 45

Course Outcomes

Upon completion of the course, students can be able to

1. **Draw** isometric and orthographic projections accurately for engineering components based on given specifications.
2. **Construct** 3D models of systems such as boilers with valves, pipe fittings, and helical coils using CAD tools.
3. **Perform** experiments to observe heat transfer processes, including steady-state conduction, convection, and radiation, and analyze the results for different setups such as slabs, plates, and pipes.

REFERENCE BOOKS:

- Hoffmann, K. A. and Chiang, S. T., —Computational Fluid Dynamics for Engineersl, 4th Edition, Engineering Education Systems (2000)
- Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	3	-	3	3	-	-
CO2	3	3	3	3	3	-	-	-	3	-	3	3	3	2
CO3	3	3	3	3	3	-	-	-	3	-	3	3	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6301	MEMBRANE SEPARATION PROCESS	3	0	0	3

Course Objective	The student should be able to	
	1.	Understand the principle and technical concept of advanced separation processes.
	2.	Describe the process of Reverse Osmosis, Nanofiltration.
	3.	Summarize the Types and choice of Adsorbents.

Unit	Description	Instructional Hours
I	**BASICS OF SEPARATION PROCESS** : Overview and membrane materials, Material properties and preparation of phase-inversion membranes, Review of Conventional Processes, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid, Dual functional Filter.	9
II	**MEMBRANE SEPARATIONS:** Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane , Porous and non-porous membrane transport and Osmosis concepts , Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Preparation of composite, inorganic membranes , MF and UF characterization and membrane transport , Problems and solutions based on RO, MF.	9
III	**SEPARATION BY ADSORPTION:** Types and choice of Adsorbents, Affinity Chromatography, Ion Exchange Chromatography and Immuno Chromatography, Recent Trends in Adsorption.	9
IV	**INORGANIC SEPARATIONS:** Electrophoresis, Dielectrophoresis, , Electro dialysis, Evaporation, Problems and solutions based on ED, PV, Facilitated Transport, Membrane contactors and other membrane processes.	9
V	**OTHER TECHNIQUES:** Separation involving Lyophilisation. Liquid Membranes. Gas separation, Membrane Distillation, zone melting, Adductive Crystallization, Supercritical fluid Extraction.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the Concept of Separation Process.
	CO2	Analyze key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, limiting cases, efficiency and mass transport effects.
	CO3	Illustrate the concept of adsorption and its application.
	CO4	Acquire Knowledge in inorganic separations for the reaction.
	CO5	Differentiate and determine various processes by performing the specific tests.

TEXT BOOK:	
T1	Schoen, H.M., "New Chemical Engineering Separation Techniques", Interscience Publishers,1972.
T2	Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., 1980.
T3	B. K. Dutta, Mass Transfer and Separation Processes, PHI,2007.
REFERENCES:	
R1	King, C. J., "Separation Processes", Tata McGraw Hill, 1982.
R2	M. H. Mulder, Basic Principles of Membrane Technology,Springer, 2004
R3	Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987
R4	Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar, 1992.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6301	MEMBRANE SEPARATION PROCESS	3	0	0	3

Course Objective	The student should be able to	
	1.	Understand the principle and technical concept of advanced separation processes.
	2.	Describe the process of Reverse Osmosis, Nanofiltration.
	3.	Summarize the Types and choice of Adsorbents.

Unit	Description	Instructional Hours
I	**BASICS OF SEPARATION PROCESS** : Overview and membrane materials, Material properties and preparation of phase-inversion membranes, Review of Conventional Processes, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid, Dual functional Filter.	9
II	**MEMBRANE SEPARATIONS:** Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane , Porous and non-porous membrane transport and Osmosis concepts , Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Preparation of composite, inorganic membranes , MF and UF characterization and membrane transport , Problems and solutions based on RO, MF.	9
III	**SEPARATION BY ADSORPTION:** Types and choice of Adsorbents, Affinity Chromatography, Ion Exchange Chromatography and Immuno Chromatography, Recent Trends in Adsorption.	9
IV	**INORGANIC SEPARATIONS:** Electrophoresis, Dielectrophoresis, , Electro dialysis, Evaporation, Problems and solutions based on ED, PV, Facilitated Transport, Membrane contactors and other membrane processes.	9
V	**OTHER TECHNIQUES:** Separation involving Lyophilisation. Liquid Membranes. Gas separation, Membrane Distillation, zone melting, Adductive Crystallization, Supercritical fluid Extraction.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the Concept of Separation Process.
	CO2	Analyze key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, limiting cases, efficiency and mass transport effects.
	CO3	Illustrate the concept of adsorption and its application.
	CO4	Acquire Knowledge in inorganic separations for the reaction.
	CO5	Differentiate and determine various processes by performing the specific tests.

TEXT BOOK:	
T1	Schoen, H.M., "New Chemical Engineering Separation Techniques", Interscience Publishers,1972.
T2	Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., 1980.
T3	B. K. Dutta, Mass Transfer and Separation Processes, PHI,2007.
REFERENCES:	
R1	King, C. J., "Separation Processes", Tata McGraw Hill, 1982.
R2	M. H. Mulder, Basic Principles of Membrane Technology,Springer, 2004
R3	Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987
R4	Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar, 1992.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6302	WASTE WATER TREATMENT	3	0	0	3

Course Objective	The student should be able to	
	1.	Focus on the wastewater transport system
	2.	Express the theory and design technique for the wastewater treatment process
	3.	Illustrate the applications of advanced waste water treatment.

Unit	Description	Instructional Hours
I	**WASTE WATER TREATMENT AN OVERVIEW:** Terminology – Regulations – Health and Environment Concerns in waste water management – Constituents in waste water; inorganic, Organic and heavy metal constituents.	9
II	**CHEMICAL UNIT PROCESSES:** Role of unit processes in waste water treatment- Principles of Chemical treatment – Coagulation - flocculation– Precipitation–flotation – solidification and stabilization –disinfection.	9
III	**BIOLOGICAL TREATMENT:** Objectives of biological treatment – significance – Principles of aerobic and anaerobic treatment - kinetics of biological growth – Factors affecting growth – attached and suspended growth - Determination of Kinetic coefficients for organics removal.	9
IV	**TREATMENT METHODS** : Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters- RBC-Moving Bed Reactors- fluidized bed reactors, aerated lagoons, waste stabilization ponds- Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal	9
V	**ADVANCED WASTE WATER TREATMENT**: Technologies used in advanced treatment – Classification of technologies- Removal of Colloids and suspended particles– Membrane Filtration – Ion Exchange – Advanced oxidation process – Zero liquid Discharge. - Software Applications	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the Physical and chemical Characteristics of wastewater and their measurement.
	CO2	Illustrate the various pollutant treatment techniques.
	CO3	Apply the concepts using biological treatment methods
	CO4	Analyze the reactors used for various treatment techniques.
	CO5	Understand the membrane based electrochemical process for pollutant treatment..

TEXT BOOK:

T1	Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous. FI Biston, 2002.
T2	Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
T3	S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.

REFERENCES:

R1	Casey, T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, 2006
R2	Metcalf & Eddy, Inc. Wastewater Engineering - Treatment, Disposal, and Reuse, Fourth Edition, Tata McGraw-Hill, 1995..
R3	Spellman, R.F., Handbook of water and wastewater treatment plant operations, CRC Press/Taylor & Francis Publications, 2009
R4	C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6303	SOLID WASTE MANAGEMENT	3	0	0	3

Course Objective	The student should be able to	
	1.	Conversant with the types, sources, generation of MSW.
	2.	Express the storage, collection, transport, processing and disposal of municipal solid waste.
	3.	Illustrate the applications of advanced disposal of MSW.

Unit	Description	Instructional Hours
I	**SOURCES AND CHARACTERISTICS** : Sources and types of municipal solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics. Elements of Municipal Solid Waste Management Plan.	9
II	**SOURCE REDUCTION, WASTE STORAGE AND RECYCLING :** Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste – On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage	9
III	**COLLECTION AND TRANSFER OF WASTES** : Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations –location, operation and maintenance; options under Indian conditions	9
IV	**PROCESSING OF WASTES:** Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio meth nation; Thermal processing options – case studies under Indian conditions.	9
V	**WASTE DISPOSAL:** 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.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	State solid waste characteristics and its sources.
	CO2	Identify and analyze different methods of treatment of solid waste..
	CO3	Illustrate Industrial practices in solid waste management.
	CO4	Discuss the significance of recycling reuse and reclamation of solid wastes.
	CO5	Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air.

TEXT BOOK:

T1	William A. Worrell, P. AarneVesilind (2012) Solid Waste Engineering, Cengage Learning, 2012.
T2	John Pitchel (2014), Waste Management Practices-Municipal, Hazardous and industrial – CRC Press, Taylor and Francis, New York..
T3	Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", Prentice Hall, Inc., 1981

REFERENCES:

R1	Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.
R2	Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996...
R3	Spellman, R.F., Handbook of water and wastewater treatment plant operations, CRC Press/Taylor & Francis Publications, 2009
R4	Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". McGraw Hill, New York, 1993.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6304	ENVIRONMENTAL IMPACT ASSESSMENT	3	0	0	3

Course Objective	The student should be able to	
	1.	To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects.
	2.	Implement appropriate methodologies for assessing environmental impacts in a specific project context.
	3.	Examine the potential environmental, social, and economic impacts of the proposed project, categorizing them into direct and indirect effects.

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Impacts of Development on Environment – Rio Principles of Sustainable Development Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework.	9
II	**ENVIRONMENTAL ASSESSMENT:** Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction.	9
III	**ENVIRONMENTAL MANAGEMENT PLAN**: Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Public Hearing-Environmental Clearance	9
IV	**SOCIO ECONOMIC ASSESSMENT:** Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis	9
V	**MONITORING STUDIES AND APPLICATIONS:** Environmental monitoring - guidelines - policies - planning of monitoring programmes: Environmental Management Plan- Post project audit.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the concept of environmental Impact assessment.
	CO2	Identify the various components and assessment techniques of EIA.
	CO3	Illustrate Environmental management plan.
	CO4	Illustrate socio economic assessment plans
	CO5	Gain knowledge about EIA monitoring studies through various industrial exposure .

TEXT BOOK:	
T1	Canter, L. W., Environmental Impact Assessment, McGraw Hill, New York, 1996
T2	Petts, J., Handbook of Environmental Impact Assessment Vol. I and II, Blackwell Science, London, 2009.
T3	Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent Problems, Wiley-Interscience, New Jersey, 2003.
REFERENCES:	
R1	Anjaneyulu, Y., and Manickam, V., Environmental Impact Assessment, Methodologies, 2nd Edition, BS Publications, 2007
R2	Becker H. A., Frank Vanclay, "The International handbook of social impact assessment" conceptual and methodological advances, Edward Elgar Publishing,2003.
R3	Barry Sadler and Mary McCabe, "Environmental Impact Assessment Training Resource Manual", United Nations Environment Programme,2002.
R4	Judith Petts, "Handbook of Environmental Impact Assessment Vol. I and II", Blackwell Science New York, 1998.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6305	PROCESS SAFETY MANAGEMENT	3	0	0	3

Course Objective	The student should be able to	
	1.	Develop, evaluate, and implement effective Process Safety Management (PSM) strategies by understanding regulatory requirements.
	2.	Identifying hazards, analyzing potential risks.
	3.	Applying preventive measures to ensure operational safety.

Unit	Description	Instructional Hours
I	**PROCESS SAFETY INFORMATION:** Safety vs Process Safety, Importance of Process Safety, Elements of Process safety - Overview ; Process Safety Information (PSI) – Importance of Process Safety Information , Types of PSI, Collection of PSI, familiarization of formats for capturing PSI, Challenges	9
II	**SAFETY PROGRAMMES AND PROCEDURES:** Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling-Implementation of safety procedures – periodic inspection and replacement.	9
III	**ACCIDENT ANALYSIS:** Accidents – identification and prevention, promotion of industrial safety. Process Safety Incident reporting and Investigation – Element overview, reporting and its importance; Process safety incident classification, Root cause analysis, making recommendations.	9
IV	**PROCESS HAZARD ANALYSIS:** Hazard identification- safety audits, checklist, what if analysis, vulnerability models- event tree analysis- fault tree analysis. Asset Integrity Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes).	9
V	**SAFETY MANAGEMENT**: Employee Participation – Overview, Benefits of Employee participation. Various modes of engaging workforce in PSM, Challenges; Management of Change – Types of Changes, Managing Changes in PSM Perspective, Framework, evaluating changes.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the chemical process safety, safety codes.
	CO2	Identify the safe handling of chemicals and plant inspection
	CO3	Illustrate the different analysis to overcome the accidents in process industry.
	CO4	Illustrate the hazard analysis in process industry.
	CO5	Gain knowledge about safety management in different process industry.

TEXT BOOK:	
T1	Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
T2	Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965
T3	Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.
REFERENCES:	
R1	Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969
R2	Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGrawHill Book Co., 1980
R3	Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994
R4	Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis. Dyadem Press, 2004

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6306	RISK AND HAZOP ANALYSIS	3	0	0	3

Course Objective	The student should be able to	
	1.	Conduct, evaluate, and apply Hazard and Operability (HAZOP) analysis techniques
	2.	Identify, assess, and mitigate risks in industrial processes
	3.	Analyzing potential hazards, and creating effective solutions to ensure safety and compliance.

Unit	Description	Instructional Hours
I	**RISK ANALYSIS:** Risk analysis introduction, quantitative risk assessment, rapid risk analysis –comprehensive risk analysis – identification, evaluation and control of risk.	9
II	**RISK ASSESSMENT:** Risk assessment – introduction and available methodologies, Risk assessment steps- Quantitative risk analysis-event tree, fault tree, consequence analysis and layer of protection analysis- Bow tie analysis	9
III	**EMERGENCY PLANNING:** Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies-marketing terminal, gas processing complex ; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.	9
IV	**HAZARD:** Hazard - Hazard identification – methods: Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)	9
V	**HAZOP:** Introduction to HAZOP-Significance of HAZOP -HAZOP procedure – HAZOP Analysis -Computer usage in HAZOP- softwares employed - Limitations of HAZOP – case studies	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the knowledge of types of risks arising in working environment.
	CO2	Identify the Risk Assurance and Assessment
	CO3	Design Risk management systems and planning.
	CO4	Analyze the effect of process hazard.
	CO5	Gain knowledge about hazop and its consequences and to create hazard free working premises

TEXT BOOK:

T1	Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990. .
T2	Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965
T3	Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.

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R1	Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969
R2	Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGrawHill Book Co., 1980.
R3	Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994
R4	Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6307	COMPUTATIONAL TECHNIQUES	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Apply, analyze, and create computational techniques to solve engineering and scientific problems
	2.	Understand the algorithms, and evaluating numerical methods.
	3.	Developing solutions using computational tools.

Unit	Description	Instructional Hours
I	**NUMERICAL METHODS FOR SYSTEM OF LINEAR ALGEBRAIC EQUATIONS:** Gauss elimination, LU decomposition, matrix inversion, Tri-diagonal matrix algorithm, Gauss-Seidel method, Chemical Engineering problems involving solution of linear algebraic equations.	9
II	**NUMERICAL METHODS FOR NON LINEAR ALGEBRAIC EQUATIONS:** Introduction, Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, System of Non-linear Equations, Chemical Engineering problems involving solution of non-linear equations.	9
III	**INTERPOLATION AND NUMERICAL INTEGRATION:** Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression, Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments.	9
IV	**NUMERICAL METHODS FOR ODES**: Euler method – explicit and implicit, Runge-Kutta method – 2nd and 4th order. Boundary value problems – shooting method, Chemical engineering problems involving single and system of ODEs.	9
V	**NUMERICAL METHODS FOR PDES:** Introduction to Partial Differential Equations: Characterization of PDEs, parabolic, elliptic and first order hyperbolic equations, explicit and implicit methods, Chemical engineering problems involving the three types of PDEs.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the numerical methods for linear algebraic equations
	CO2	Identify numerical methods for non linear algebraic equations
	CO3	Identify different methods for interpolation and numerical integration
	CO4	Illustrate on the numerical methods for ordinary differential equations.
	CO5	Apply the basic methods for partial differential equations.

TEXT BOOK:

T1	Chapra. S. C. & Canale, R. P., "Numerical Methods for Engineers", Eighth Edition, McGraw Hill, 2021.
T2	Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.
T3	Ahuja, P., "Introduction to Numerical methods in Chemical Engineering" 2nd Edition, PHI learning Private Ltd, 2019.

REFERENCES:

R1	R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
R2	Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.
R3	Luyben, W.L.: Process Modeling, Simulatio5n and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.
R4	Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.

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

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HINDUSTHAN COLLEGE OF ENGG & TECH

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6308	OPTIMIZATION OF CHEMICAL PROCESSES	3	0	0	3

Course Objective	The student should be able to	
	1.	Apply, analyze, and optimize chemical processes by understanding optimization techniques
	2.	Evaluating process performance, and designing improvements to enhance efficiency, safety, and sustainability.
	3.	List common optimization techniques and recall key parameters involved in chemical process optimization.

Unit	Description	Instructional Hours
I	**PROBLEM FORMULATION & CLASSIFCATION:** Introduction; formulation of objective functions; fitting models to data; classification of functions; necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods.	9
II	**LINEAR PROGRAMMING:** Review on basic concepts of LP formulations; Simplex methods; Big-M method, two phase method and Duality in linear programming.	9
III	**NON-LINEAR PROGRAMMING:** The Lagrange multiplier method, Integer, quadratic, geometric and dynamic programming.	9
IV	**NUMERICAL METHODS:** Unimodal functions; Newton, quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant method	9
V	**APPLICATIONS:** Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation: large scale systems.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the basic problem formulation and optimization.
	CO2	Identify mathematical characteristics of Linear programming
	CO3	Identify computational solution techniques for nonlinear unconstrained optimization.
	CO4	Illustrate various techniques used in constrained optimization.
	CO5	Apply the optimal and dynamic optimization..

TEXT BOOK:	
T1	Edgar T.F., Himmelblau D.M., Lasdon,L.S., Optimization of Chemical Processes, Second Edition, McGraw-Hill, New York, 2001
T2	Rao, S. S., Engineering Optimization: Theory and Practice, Fifth Edition, Wiley, New York,2019.
T3	Ahuja, P., "Introduction to Numerical methods in Chemical Engineering" 2nd Edition, PHI learning Private Ltd, 2019.

REFERENCES:	
R1	R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
R2	Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.
R3	Luyben, W.L.: Process Modeling, Simulatio5n and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.
R4	Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6309	PROCESS MODELING AND SIMULATION	3	0	0	3

Course Objective	The student should be able to	
	1.	Develop, analyze, and apply process models and simulations by understanding key modeling techniques
	2.	Evaluating and simulating the dynamic systems.
	3.	Optimizing process operations for improved efficiency and accuracy.

Unit	Description	Instructional Hours
I	**INTRODUCTION AND FIRST PRINCIPLES:** Definition, Uses of mathematical Models - Principles of formulation, Classification of Process Models, Fundamental laws: Total Continuity equation- Macroscopic and Microscopic Examples, Component Continuity Equation – Macroscopic and Microscopic Examples, Energy equation, Equations of motion, Transport equations, Equations of State, Equilibrium and Chemical Kinetics. Simple Examples.	9
II	**LUMPED SYSTEMS:** Simple Hydraulic Tank, Variable flow hydraulic tank, Enclosed tank, Adiabatic compression in gas space, Mixing vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, Continuous flow boiling system.	9
III	**STAGED OPERATIONS AND DISTRIBUTED SYSTEMS:** Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat exchanger, Membrane separation process, tubular reactor and evaporators.	9
IV	**FITTING MODEL TO DATA:** Fitting Linear Model, Multi-Linear Models, Matrix representation of Multi Linear Model, Fitting Quadratic Model, Cubic Model and Polynomial model using Regression, Power Law models. Performance Criteria to check quality of model, Co-efficient of Determination (R2)	9
V	**SIMULATION OF BASIC MODELS:** MATLAB/Simulink - Introduction, Basic components, Operational Blocks, Examples - Gravity flow tank, Three CSTR's in series, Numerical solution of model using RK4, Euler's explicit and implicit techniques, Introduction to ODE 45 solver.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics
	CO2	Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods.
	CO3	Create the mathematical models for different unit operations equipments.
	CO4	Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems.
	CO5	Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions.

TEXT BOOK:

T1	Bequette, B. W., Process Dynamics: Modeling, Analysis, and Simulation. Prentice-Hall, 2002.
T2	Babu, B V., Process Plant Simulation, Oxford University Press, 2004.
T3	Jana, A. K., Chemical Process Modeling and Computer Simulation, Second Edition, Prentice Hall India Pvt. Ltd, 2011.

REFERENCES:

R1	Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.
R2	Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.
R3	Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.
R4	Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6310	PINCH ANALYSIS AND HEAT EXCHANGER NETWORK DESIGN	3	0	0	3

Course Objective	**The student should be able to**	
	1.	Identify key concepts of pinch analysis, including hot and cold streams, minimum temperature difference, and pinch point.
	2.	Describe the process of identifying energy inefficiencies in a process using pinch analysis.
	3.	Summarize how pinch analysis impacts the design and operation of heat exchanger networks.

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Pinch analysis, process synthesis, pinch point, composite curves, energy targeting: problem table algorithm, shifted composite curve, capital cost, total cost targeting, process modification.	9
II	**TARGETING:** Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, and continuous targeting.	9
III	**PINCH ANALYSIS:** Identification of streams, temperature, enthalpy diagram, minimum temperature difference, construction of composite curves, energy cost target, optimum target, design of heat exchanger network..	9
IV	**PINCH DESIGN AND OPTIMIZATION:** Networks for maximum energy recovery, Pinch design method, flexibility criteria of the pinch, optimization of heat exchanger network, optimality for a minimum area network, Sensitivity analysis.	9
V	**ENERGY AND RESOURCE ANALYSIS OF VARIOUS PROCESSES:** Batch process, flexible process, distillation process, evaporation process, reaction process, process using mass separating agent, heat pipes and heat pumps	9
	Total Instructional Hours	45

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the pinch concept and process thermodynamics.
	CO2	Identify minimum energy targets.
	CO3	Illustrate the knowledge of diagrams and energy cost target
	CO4	Identify different choices and constraint during heat exchange networking.
	CO5	Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes.

TEXT BOOK:

T1	Kemp, I. C., Pinch Analysis and Process Integration, Second edition, Elsevier, 2006
T2	Shenoy, V. U., Heat Exchanger network synthesis, Gulf Publishing, 1995
T3	Jana, A. K., Chemical Process Modeling and Computer Simulation, Second Edition, Prentice Hall India Pvt. Ltd, 2011.

REFERENCES:

R1	Douglas, J. M., Conceptual Design of Chemical Process, McGraw Hill, 1988.
R2	Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.
R3	Luyben, W.L.: Process Modeling, Simulatio5n and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.
R4	Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6311	CHEMICAL PROCESS FLOW SHEETING	3	0	0	3

Course Objective	The student should be able to	
	1.	Identify the basic symbols, conventions, and components used in chemical process flow diagrams (PFDs).
	2.	Describe how material and energy balances are integrated into process flow sheets.
	3.	Summarize the information conveyed by a typical chemical process flow sheet.

Unit	Description	Instructional Hours
I	**FLOWSHEETING:** Introduction, symbols, flowsheet presentation with examples, manual flow sheet calculation, flow sheeting approaches.	9
II	**DECOMPOSITION OF NETWORKS:** Partitioning and tearing a flowsheet, tearing algorithms based on signal flow graph, algorithms based on reduced graph, comparing various tearing algorithms.	9
III	**SEQUENTIAL MODULAR APPROACH TO FLOWSHEETING**: Principle of method, convergence of flowsheet using different methods - Newton's method, direct substitution, Wegstein's method, dominant Eigenvalue method, quasi Newton method, criteria for acceleration	9
IV	**FLOWSHEETING BY EQUATION SOLVING METHODS:** Precedence ordering, disjoining, tearing a system of equations, SWS algorithm, maintaining sparsity, solution of system of equations using Newton's method	9
V	**CASE STUDIES:** Simulation of process flowsheets involving mass recycle, energy recycle, tear stream and design specification, demonstration of open source flows heeting software	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the basic concept in preparation of flow sheet.
	CO2	Identify the preparing networks
	CO3	Illustrate the different approach in flow sheeting.
	CO4	Identify flow sheet preparation by equation solving methods.
	CO5	Evaluate the case studies using flow sheeting software.

TEXT BOOK:	
T1	Babu, B V., Process Plant Simulation, Oxford University Press, 2004
T2	Shenoy, V. U., Heat Exchanger network synthesis, Gulf Publishing, 1995
T3	Jana, A. K., Chemical Process Modeling and Computer Simulation, Second Edition, Prentice Hall India Pvt. Ltd, 2011.

REFERENCES:	
R1	Douglas, J. M., Conceptual Design of Chemical Process, McGraw Hill, 1988.
R2	Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.
R3	Luyben, W.L.: Process Modeling, Simulatio5n and Control for Chemical Engineers. McGraw Hill, International Student Edition, Second Edition, 1996.
R4	Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6312	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3

Course Objective	The student should be able to	
	1.	Identify the basic principles and governing equations (e.g., Navier-Stokes equations) used in CFD.
	2.	Describe the process of discretization and its role in solving fluid flow equations computationally.
	3.	Summarize the advantages and limitations of CFD compared to experimental fluid dynamics.

Unit	Description	Instructional Hours
I	**GOVERNING EQUATIONS:** Governing equations of fluid flow and heat transfer - Navier-Stokes equations for a Newtonian fluid, Classification of physical behaviour, Classification of fluid flow equations, Auxiliary conditions for viscous fluid flow equations.	9
II	**TURBULENCE AND ITS MODELLING:** Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, free turbulent flows, flat plate boundary layer and pipe flow, Turbulence models, mixing length model	9
III	**FINITE VOLUME METHOD FOR DIFFUSION PROBLEMS:** Introduction to finite volume method, one-dimensional steady state diffusion, two-dimensional diffusion, discretised equations for diffusion problems	9
IV	**FINITE VOLUME METHOD FOR CONVECTION-DIFFUSION PROBLEMS :** Steady one-dimensional convection and diffusion, the central differencing scheme, properties of discretisation schemes - conservativeness, boundedness, transportiveness, Assessment of the central differencing scheme for convection-diffusion problems	9
V	**FINITE VOLUME METHOD FOR UNSTEADY FLOWS:** One-dimensional unsteady heat conduction, transient convection-diffusion equation, solution procedure for unsteady flow calculations. Implementation of inlet, outlet and wall boundary conditions, constant pressure boundary condition.	9
	Total Instructional Hours	45

On completion of the course, the students will be able to		
Course Outcome	CO1	Understand the basics of CFD and governing equations for conservation of mass momentum and energy.
	CO2	Identify the mathematical characteristics of partial differential equations.
	CO3	Illustrate the computational solution techniques for time integration of ordinary differential equations
	CO4	Identify various discreitization techniques used in CFD.
	CO5	Evaluate the flow field computation techniques for steady and unsteady flows.

TEXT BOOK:	
T1	Versteeg H. K. and Malalasekera, W., An introduction to computational fluid dynamics: the finite volume method, Second edition, Pearson, 2008.
T2	Anderson, J. D. Computational fluid dynamics: The Basics with Applications, McGraw-Hill, 1995.
T3	Jana, A. K., Chemical Process Modeling and Computer Simulation, Second Edition, Prentice Hall India Pvt. Ltd, 2011.

REFERENCES:	
R1	Ranade, V. V., Computational flow modeling for Chemical Reactor Engineering, Academic Press, 2002. .
R2	Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.
R3	Luyben, W.L.: Process Modeling, Simulatio5n and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.
R4	Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH6401	WASTE TO ENERGY CONVERSION	3	0	0	3

Course Objective	The student should be able to	
	1.	Learn about production of energy from different types of wastes through thermal, biological and chemical routes
	2.	Express their knowledge in the field of the utilization of different types of wastes for energy production.
	3.	Illustrate the idea about incineration and Pyrolysis.

Unit	Description	Instructional Hours
I	**INTRODUCTION**: Introduction to waste to energy conversion, characterization of wastes, Energy production form wastes through incineration, energy production through gasification of wastes.	9
II	**PYROLYSIS:** Energy production through pyrolysis and gasification of wastes, syngas utilization. Incineration: Basics of waste incineration, process flow, types of incinerators (grate, fluidized bed, rotary kiln), energy recovery from incineration.	9
III	**DENSIFICATION OF BIOMASS AND WASTE PLASTIC BLENDS:** Densification of solids, efficiency improvement of power plant and energy production from waste plastics, Energy production form wastes Plastic, gas cleanup.	9
IV	**ENERGY PRODUCTION FROM WASTE:** Energy production from organic wastes through anaerobic digestion and fermentation, introduction to microbial fuel cells	9
V	**CULTIVATION OF MICROALGAE FOR BIOFUEL PRODUCTION:** Energy production from wastes through fermentation and transesterification. Cultivation of algal biomass from wastewater and energy production from algae.	9
	Total Instructional Hours	**45**

On completion of the course, the students will be able to

Course Outcome	CO1	Understand the basic principles of waste management, including waste classification
	CO2	Evaluate various thermal conversion technologies, such as incineration, pyrolysis, gasification.
	CO3	Assess the principles and applications of densification of biomass.
	CO4	Analyze the Energy production from organic wastes through anaerobic digestion and fermentation
	CO5	Apply chemical conversion techniques, such as transesterification for biodiesel production

TEXT BOOK:

T1	Ashok K. Rathoure. Zero Waste: Management Practices for Environmental Sustainability, CRC Press, 2019, 1st Edition.
T2	M. Habibur Rahman, Abdullah Al-Muyeed, Solid and Hazardous Waste Management, ITN-BUET, 2010
T3	S. Vander Gheynst, S.C. Capareda., Introduction to Biomass Energy Conversion, CRC Press,2013

REFERENCES:

R1	A.V. Bridgwate, Thermochemical Processing of Biomass: Conversion into Fuels, Chemicals, and Power, Wiley-Blackwell, 2010
R2	Samir K. Khanal, A Anaerobic Biotechnology for Bioenergy Production: Principles and Applications, Wiley-Blackwell, 2008.
R3	Nickolas J. Themelis, Energy from Waste: A Practical Guide, Springer, 2011
R4	James G. Speight, Gasification of Unconventional Feedstocks, Elsiever, 2014.

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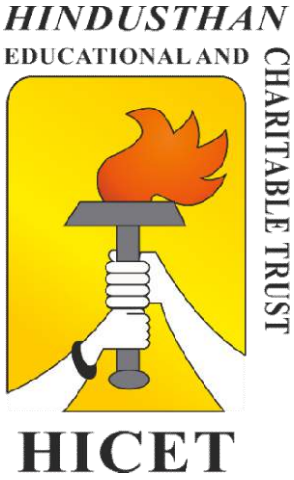

HINDUSTHAN

COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution)

Coimbatore – 641032

DEPARTMENT OF CHEMICAL ENGINEERING

Revised Curriculum and Syllabus for the Batch 2021-2025

(Academic Council Meeting Held on 03.03.2023)

2019 REGULATIONS WITH AMENDMENT

HindusthanCollegeofEngineering andTechnology

(AnAutonomousInstitution, Affiliatedto AnnaUniversity,Chennai
ApprovedbyAICTE,NewDelhi&AccreditedbyNAACwith'A'Grade)
ValleyCampus,PollachiHighways,Coimbatore,Tamilnadu.

DETAILS OF CHANGES CARRIED OUT IN CURRICULUM & SYLLABUS

CBCS PATTERN

UNDERGRADUATE PROGRAMMES

B.TECH. CHEMICAL ENGINEERING (UG)

REGULATION-2019 WITH AMENDMENT

(For the students admitted during the academic year 2021-2025 and onwards)

SEMESTER I

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21HE1101	Technical English	HS	2	1	0	3	40	60	100
2	21MA1102	Calculus and Linear Algebra	BS	3	1	0	4	40	60	100
THEORY WITH LAB COMPONENT										
3	21PH1151	Applied Physics	BS	2	0	2	3	50	50	100
4	21CY1151	Chemistry for Engineers	BS	2	0	2	3	50	50	100
5	21CS1151	Python Programming and Practices	ES	2	0	2	3	50	50	100
6	21ME1152	Engineering Drawing	ES	1	0	4	3	50	50	100
PRACTICAL										
7	21HE1001	Language Competency Enhancement Course-I	HS	0	0	2	1	100	0	100
MANDATORY COURSES										
8	21HE1072	**Career Guidance Level** – I Personality, Aptitude and Career Development	EEC	2	0	0	0	100	0	100
			Total :	**14**	**2**	**12**	**20**	**480**	**320**	**800**

SEMESTER II

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21HE2101	Business English for Engineers	HS	2	1	0	3	40	60	100
2	21MA2101	Differential Equations and Complex Variables	BS	3	1	0	4	40	60	100
3	21EE2103	Basics of Electrical and Electronics Engineering	ES	3	0	0	3	40	60	100
4	21CH2101	Principles of Chemical Engineering	ES	3	0	0	3	40	60	100
THEORY WITH LAB COMPONENT										
5	21PH2151	Material Science	BS	2	0	2	3	50	50	100
6	21CY2151	Environmental Studies	BS	2	0	2	3	50	50	100
PRACTICAL										
7	21ME2001	Engineering Practices	ES	0	0	4	2	60	40	100
8	21HE2001	Language Competency Enhancement Course-II	HS	0	0	2	1	100	0	100
MANDATORY COURSES										
9	21HE2072	**Career Guidance Level – II** Personality, Aptitude and Career Development	EEC	2	0	0	0	100	0	100
10	21HE2073	Entrepreneurship & Innovation	EEC	1	0	0	0	100	0	100
			Total :	**18**	**2**	**10**	**22**	**620**	**380**	**1000**

SEMESTER III

S.No	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21MA3103	Fourier Analysis and Numerical Methods	BS	3	1	0	4	40	60	100
2	21CH3201	Chemical Process Calculations	PC	3	1	0	4	40	60	100
3	21CH3202	Fluid Mechanics for Chemical Engineers	PC	3	0	0	3	40	60	100
4	21CH3203	Chemical Engineering Thermodynamics – I	PC	3	0	0	3	40	60	100
THEORY WITH LAB COMPONENT										
5	21CH3251	Analytical Instruments for Analysis	PC	2	0	2	3	50	50	100
PRACTICAL										
6	21CH3001	Fluid Mechanics Lab	PC	0	0	3	1.5	60	40	100
7	21CH3002	Chemical Analysis Lab	PC	0	0	3	1.5	60	40	100
MANDATORY COURSES										
8	21AC3191	Indian Constitution	AC	2	0	0	0	100	0	100
9	21HE3072	**Career Guidance Level – III** Personality, Aptitude and Career Development	EEC	2	0	0	0	100	0	100
10	21HE3073	Leadership Management Skills	EEC	1	0	0	0	100	0	100
			Total	**19**	**2**	**8**	**20**	**630**	**370**	**1000**

SEMESTER IV

S.No	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21CH4201	Process Heat Transfer	PC	3	1	0	4	40	60	100
2	21CH4202	Mass Transfer – I	PC	3	0	0	3	40	60	100
3	21CH4203	Chemical Engineering Thermodynamics - II	PC	3	0	0	3	40	60	100
THEORY WITH LAB COMPONENT										
4	21CH4251	Mechanical Operations	PC	3	0	2	4	50	50	100
5	21MA4153	Applied Probability Statistics	BS	3	0	2	4	50	50	100
PRACTICAL										
6	21CH4001	Heat Transfer Lab	PC	0	0	3	1.5	60	40	100
7	21CH4002	Petrochemical Analysis Lab	PC	0	0	3	1.5	60	40	100
MANDATORY COURSES										
8	21AC4191	Essence of Indian tradition knowledge/Value Education	AC	2	0	0	0	100	0	100
9	21HE4072	**Career Guidance Level – IV** Personality, Aptitude and Career Development	EEC	2	0	0	0	100	-	100
10	21HE4073	Ideation Skills	EEC	2	0	0	0	100	-	100
			Total	**21**	**1**	**10**	**21**	**640**	**360**	**1000**

SEMESTER V

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21CH5201	Chemical Reaction Engineering – I	PC	3	1	0	4	40	60	100
2	21CH5202	Mass Transfer – II	PC	3	1	0	4	40	60	100
3	21CH5203	Process Instrumentation Dynamics and Control	PC	3	1	0	4	40	60	100
4	21CH5204	Safety in Chemical Industries	PC	3	0	0	3	40	60	100
5	21CH53XX	**Professional Elective -I**	PE	3	0	0	3	40	60	100
THEORY WITH LAB COMPONENT										
6	21CH5251	Water Treatment and Solid Waste Management	PC	2	0	2	3	50	50	100
PRACTICALS										
7	21CH5001	Mass Transfer Lab	PC	0	0	3	1.5	60	40	100
8	21CH5002	Process Control Lab	PC	0	0	3	1.5	60	40	100
MANDATORY COURSES										
9	21HE5071	Soft Skills - I	EEC	1	0	0	1	100	0	100
10	21HE5072	Design Thinking	EEC	1	0	0	1	100	0	100
			Total	**19**	**3**	**8**	**26**	**570**	**430**	**1000**

SEMESTER VI

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21CH6201	Chemical Reaction Engineering– II	PC	3	1	0	4	40	60	100
2	21CH6202	Chemical Process Industries	PC	3	0	0	3	40	60	100
3	21CH6181	Professional Ethics in Engineering	HS	3	0	0	3	40	60	100
4	21CH63XX	**Professional Elective - II**	PE	3	0	0	3	40	60	100
5	21XX64XX	**Open Elective– I**	OE	3	0	0	3	40	60	100
THEORY WITH LAB COMPONENTS										
6	21CH6251	Fluidization Engineering	PC	2	0	2	3	50	50	100
PRACTICALS										
7	21CH6001	Chemical Reaction Engineering Lab	PC	0	0	4	2	60	40	100
MANDATORY COURSES										
8	21CH6701	Internship/Industrial Training/Skill Development Course (Minimum 3 weeks)	EEC	-	-	-	1	100	0	100
9	21HE6071	Soft Skills - II	EEC	1	0	0	1	100	0	100
10	21HE6072	Intellectual Property Rights (IPR)	EEC	1	0	0	1	100	0	100
			Total	**19**	**1**	**6**	**24**	**610**	**390**	**1000**

SEMESTER VII

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21CH7201	Process Economics and Engineering Management	PC	3	0	0	3	40	60	100
2	21CH7202	Process Equipment Design	PC	3	1	0	4	40	60	100
3	21CH73XX	**Professional Elective-III**	PE	3	0	0	3	40	60	100
4	21XX74XX	**Open Elective – II**	OE	3	0	0	3	40	60	100
PRACTICALS										
5	21CH7001	Design and Simulation Lab	PC	0	0	3	1.5	60	40	100
6	21CH7002	Computational Fluid Dynamics Lab	PC	0	0	3	1.5	60	40	100
PROJECT WORK										
7	21CH7901	Project Work – Phase I	EEC	0	0	4	2	50	50	100
			Total	**12**	**1**	**10**	**18**	**330**	**370**	**700**

SEMESTER VIII

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21CH83XX	**Professional Elective –IV**	PE	3	0	0	3	40	60	100
2	21CH83XX	**Professional Elective- V**	PE	3	0	0	3	40	60	100
PROJECT WORK										
3	21CH8901	Project Work – Phase II	EEC	0	0	16	8	100	100	200
			Total	**6**	**0**	**16**	**14**	**180**	**220**	**400**

TOTAL NO OF CREDITS: 165

LIST OF PROFESSIONAL ELECTIVES

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
PROFESSIONAL ELECTIVE I										
1	21CH5301	Energy Technology	PE	3	0	0	3	40	60	100
2	21CH5302	Petroleum Formation Evaluation	PE	3	0	0	3	40	60	100
3	21CH5303	Electrochemical Engineering	PE	3	0	0	3	40	60	100
4	21CH5304	Polymer Technology	PE	3	0	0	3	40	60	100
5	21CH5305	Food Technology	PE	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE II										
1	21CH6301	Petroleum Exploration and Exploitation Techniques	PE	3	0	0	3	40	60	100
2	21CH6302	Enzyme Engineering	PE	3	0	0	3	40	60	100
3	21CH6303	Fundamentals of Nano science	PE	3	0	0	3	40	60	100
4	21CH6304	Corrosion Science and Engineering	PE	3	0	0	3	40	60	100
5	21CH6305	Piping and Instrumentation	PE	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE III										
1	21CH7301	Natural Gas Engineering	PE	3	0	0	3	40	60	100
2	21CH7302	Pulp and Paper Technology	PE	3	0	0	3	40	60	100
3	21CH7303	Transport Phenomena	PE	3	0	0	3	40	60	100
4	21CH7304	Multicomponent Distillation	PE	3	0	0	3	40	60	100
5	21CH7305	Chemical Process Optimization	PE	3	0	0	3	40	60	100
6	21CH7306	Blue Economy Entrepreneurship	PE	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE IV										
1	21CH8301	Industrial Management	PE	3	0	0	3	40	60	100
2	21CH8302	Process Plant Utilities	PE	3	0	0	3	40	60	100
3	21CH8303	Total Quality Management	PE	3	0	0	3	40	60	100
4	21CH8304	Foundation Skills in Integrated Product Development	PE	3	0	0	3	40	60	100
5	21CH8305	Supply Chain Management	PE	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE V										
1	21CH8306	Fermentation Technology	PE	3	0	0	3	40	60	100
2	21CH8307	Frontiers of Chemical Technology	PE	3	0	0	3	40	60	100
3	21CH8308	Industrial Nanotechnology	PE	3	0	0	3	40	60	100
4	21CH8309	Drugs and Pharmaceutical Technology	PE	3	0	0	3	40	60	100
5	21CH8310	Membrane Separation Process	PE	3	0	0	3	40	60	100

LIST OF OPEN ELECTIVES										
CHEMICAL ENGINEERING										
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**TOTAL**
1	21CH6401	Waste to Energy Conversion	OE	3	0	0	3	40	60	100
2	21CH7401	Biomass Conversion and Biorefinery	OE	3	0	0	3	40	60	100
LIFE SKILL COURSES										
3	21LSZ401	General Studies for Competitive Examinations	OE	3	0	0	3	40	60	100
4	21LSZ402	Human Rights, Women's Rights and Gender Equality	OE	3	0	0	3	40	60	100
5	21LSZ403	Indian Ethos and Human Values	OE	3	0	0	3	40	60	100
6	21LSZ404	Indian Constitution and Political System	OE	3	0	0	3	40	60	100
7	21LSZ405	Yoga for Human Excellence	OE	3	0	0	3	40	60	100
NCC COURSES (Only forthe students' who have opted NCC subjects in Semester I, II, III & IV are eligible)										
8	21HEZ401	NCC course level 1	OE	3	0	0	3	40	60	100
9	21HEZ402	NCC course level 2	OE	3	0	0	3	40	60	100

(Note: Z Stands for semester, students can't choose twice the course)

ADDITIONAL CREDIT COURSE FOR CHEMICAL ENGINEERING						
S.No	**Course Code**	**Course Title**	**Category**	**Duration**	**Assessment**	**Credit**
1.	21VACH01	Industrial Automation	VA	30 hrs	Internal	1
2.	21VACH02	Bulk Solid Handling for Chemical Engineers	VA	30 hrs	Internal	1
3.	21VACH03	Fundamentals of AI and it's Chemometric Applications	VA	30 hrs	Internal	1
4.	21VACH04	Introduction to Chemical Engineering MATLAB	VA	30 hrs	Internal	1
5.	21VACH05	IOT- Basics and Application in Unit Operations	VA	30 hrs	Internal	1

CREDIT DISTRIBUTION

B.E. / B.TECH.PROGRAMMES										
S.No.	**Course Area**	**Credits per Semester**								**Total Credits**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
1	HSC	4	4	-	-	-	3	-	-	**11**
2	BSC	10	10	4	4	-	-	-	-	**28**
3	ESC	6	8	-	-	-	-	-	-	**14**
4	PCC	-	-	16	17	21	12	10	-	**76**
5	PEC	-	-	-	-	3	3	3	6	**15**
6	OEC	-	-	-	-	-	3	3	-	**6**
7	EEC	-	-	-	-	2	3	2	8	**15**
8	MC	-	-	-	-	-	-	-	-	-
Total		**20**	**22**	**20**	**21**	**26**	**24**	**18**	**14**	**165**

Enrolment for B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation.

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only. For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes.

(i) B.E. / B.Tech. Honours (specialisation in the same discipline):

a. The student should have earned additionally a minimum of 18 credits from a vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(ii) B.E. / B.Tech. Honours:

a. The students should have earned additional courses (minimum of 18 credits) from more than one vertical of the same programme.

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(iii) B.E. / B.Tech. (Minor in other specialisation):

The student should have earned additionally a minimum of 18 credits in any one of the verticals of other B.E. / B.Tech. programmes or from any one of the following verticals

VERTICAL I: FINTECH AND BLOCK CHAIN

VERTICAL II: ENTREPRENEURSHIP

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY

- Students can earn maximum of 6 credits in online mode (SWAYAM platform), out of these 18 credits as approved by Centre for Academic Courses.

- B.E. / B. Tech. (Honours) Specialisation in the same discipline, B.E / B.Tech. Honours and B.E. / B.Tech. Minor in other specialisation degree will be optional for students.

- For the categories (i) to (ii), the students will be permitted to register the courses from V Semester onwards provided the marks earned by the students until III semester should be of CGPA 7.50 and above and cleared all the courses in the first attempt.

- For the category (iii), the students will be permitted to register the courses from Semester V onwards provided the marks earned by the students until Semester III is CGPA 7.50 and above.

- If a student decides not to opt for Honours, after completing certain number of additional courses, the additional courses studied shall be considered instead of the Professional Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of Professional Elective courses required as per the curriculum, the courses with higher grades shall be considered for the calculation of CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- If a student decides not to opt for Minor, after completing certain number of courses, the additional courses studied shall be considered instead of Open Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of open electives required as per the curriculum, the courses with higher grades shall be considered for calculation of CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

- The Head of Department, shall forward the proposal to the Controller of Examinations after getting the approval from Head of the Institution / Dean Academics, before the commencement of the fifth semester of the programme for the students undergo optionally B.E. / B. Tech. Honours (Specialisation in the same discipline) / B.E. / B. Tech. Honours and B.E. / B. Tech. Minor Degree in other specialisation

VERTICALS FOR MINOR DEGREE
CHEMICAL ENGINEERING OFFERING MINOR DEGREE

Minor Specialization in Chemical Process Engineering

SL. NO.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	21CH5231	Introduction to Chemical Process	MDC	3	0	0	3	3
2	21CH6231	Fluid Flow Operations in Chemical Engineering	MDC	3	0	0	3	3
3	21CH6232	Fundamentals of Chemical Thermodynamics	MDC	3	0	0	3	3
4	21CH7231	Process Heat and Mass Transfer	MDC	3	1	0	4	4
5	21CH7232	Reaction Engineering	MDC	3	0	0	3	3
6	21CH8231	Unit Operations and Process Laboratory	MDC	0	0	4	4	2

*MDC – Minor Degree Course

In addition to the above the following additional courses for Minor Degree can also be given to the student's common to all the branches.

VERTICAL I: FINTECH AND BLOCK CHAIN								
S No	**Course Code**	**Course Title**	**Category**	**Periods Per week**			**Total Contact Periods**	**Credits**
				L	**T**	**P**		
1	21MB5231	Financial Management	MDC	3	0	0	3	3
2	21MB6231	Fundamentals of Investment	MDC	3	0	0	3	3
3	21MB6232	Banking, Financial Services and Insurance	MDC	3	0	0	3	3
4	21MB7231	Introduction to Block chain and its Applications	MDC	3	0	0	3	3
5	21MB7232	Fintech Personal Finance and Payments	MDC	3	0	0	3	3
6	21MB8231	Introduction to Fintech	MDC	3	0	0	3	3

VERTICAL II: ENTREPRENEURSHIP								
S No	**Course Code**	**Course Title**	**Category**	**Periods Per week**			**Total Contact Periods**	**Credits**
				L	**T**	**P**		
1	21MB5232	Foundations of Entrepreneurship	MDC	3	0	0	3	3
2	21MB6233	Team Building & Leadership Management for Business	MDC	3	0	0	3	3
3	21MB6234	Creativity & Innovation in Entrepreneurship	MDC	3	0	0	3	3
4	21MB7233	Principles of Marketing Management For Business	MDC	3	0	0	3	3
5	21MB7234	Human Resource Management for Entrepreneurs	MDC	3	0	0	3	3
6	21MB8232	Financing New Business Ventures	MDC	3	0	0	3	3

VERTICAL III: ENVIRONMENT AND SUSTAINABILITY								
S No	**Course Code**	**Course Title**	**Category**	**Periods Per week**			**Total Contact Periods**	**Credits**
				L	**T**	**P**		
1	21CE5232	Sustainable infrastructure Development	MDC	3	0	0	3	3
2	21AG6233	Sustainable Agriculture and Environmental Management	MDC	3	0	0	3	3
3	21BM6233	Sustainable Bio Materials	MDC	3	0	0	3	3
4	21ME7233	Materials for Energy Sustainability	MDC	3	0	0	3	3
5	21CE7233	Green Technology	MDC	3	0	0	3	3
6	21CE8232	Environmental Quality Monitoring and Analysis	MDC	3	0	0	3	3

VERTICALS FOR B Tech (Hons) and B Tech (Hons) in Chemical Engineering with Specialization

Vertical I Computer Aided Process Engineering	Vertical II Polymer Technology	Vertical III Petroleum Engineering	Vertical IV Instrumental Chemical Analysis
Process Flow Sheeting	Polymer Chemistry	Petroleum Geology	Principles of Mass Spectrometry
Transport Phenomena	Processing Technology	Petroleum Exploration	Advanced Analytical Separation Techniques
Advanced Process Optimization	Rubber Technology	Drilling Technology	Advanced Spectrometry: ICP-MS and LC-MS
Artificial Intelligence in Process Engineering	Polymer Product Design, Blends, and Alloys	Petroleum Production Engineering	Instruments for Morphology and Structural Characterization
Digital Twin and Soft Computing in Process Modelling	Polymer Structure and property relationships	Petroleum Reservoir Engineering	Statistical Analysis and Data Processing (Lab)
Advanced Process Modelling and Simulation	Polymer Compounding Technology	Offshore Engineering	Troubleshooting Analytical Methods and Instruments

B Tech (Hons) Chemical Engineering with Specialization in Computer Aided Process Engineering

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	21CH5203	Process Flow Sheeting	MDC	2	0	2	4	3
2	21CH6202	Transport Phenomena	MDC	3	1	0	3	4
3	21CH6203	Advanced Process Optimization	MDC	2	0	2	4	3
4	21CH7203	Artificial Intelligence in Process Engineering	MDC	2	0	2	4	3
5	21CH7204	Digital Twin and Soft Computing in Process Modelling	MDC	2	0	2	4	3
6	21CH8201	Advanced Process Modelling and Simulation	MDC	0	0	4	4	2

B Tech (Hons) Chemical Engineering with Specialization in Polymer Technology

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	21CH5204	Polymer Chemistry	MDC	3	0	0	3	3
2	21CH6204	Processing Technology	MDC	3	0	0	3	3
3	21CH6205	Rubber Technology	MDC	3	0	0	3	3
4	21CH7205	Polymer Product Design, Blends, and Alloys	MDC	3	0	0	3	3
5	21CH7206	Polymer Structure and property relationships	MDC	3	0	0	3	3
6	21CH8202	Polymer Compounding Technology	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in Petroleum Engineering

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	21CH5205	Petroleum Geology	MDC	3	0	0	3	3
2	21CH6206	Petroleum Exploration	MDC	3	0	0	3	3
3	21CH6207	Drilling Technology	MDC	3	0	0	3	3
4	21CH7205	Petroleum Production Engineering	MDC	3	0	0	3	3
5	21CH7206	Petroleum Reservoir Engineering	MDC	3	0	0	3	3
6	21CH8203	Offshore Engineering	MDC	3	0	0	3	3

B Tech (Hons) Chemical Engineering with Specialization in Instrumental Chemical Analysis

S No	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1	21CH5206	Principles of Mass Spectrometry	MDC	3	0	0	3	3
2	21CH6208	Advanced Analytical Separation Techniques	MDC	3	0	0	3	3
3	21CH6209	Advanced Spectrometry: ICP-MS and LC-MS	MDC	3	0	0	3	4
4	21CH7207	Instruments for Morphology and Structural Characterization	MDC	3	0	0	3	3
5	21CH7208	Statistical Analysis and Data Processing (Lab)	MDC	3	0	0	4	2
6	21CH8204	Troubleshooting Analytical Methods and Instruments	MDC	3	0	0	3	3

Chairman, Board of Studies
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CHE - HiCET

Dean (Academics)
Dean (Academics)
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Principal
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COIMBATORE - 641 032.

HINDUSTHAN ACADEMIC COUNCIL
Chairman
HINDUSTHAN COLLEGE OF ENGG & TECH

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH7201	PROCESS ECONOMICS AND ENGINEERING MANAGEMENT	3	0	0	3

Course Objectives

- To enable the students to understand the various concepts of economics, process development, design consideration and cost estimation in chemical industry.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTEREST AND PLANT COST:** Time value of money - equivalence, Depreciation, Depletion, estimation of capital cost, Capital requirement for complete plant, cost indices, capital recovery.	9
II	**PROJECT PROFITABILTY AND FINANCIAL RATIOS:** Estimation of project profitability, Investment alternatives, income statement and financial ratios, balance sheet preparation- problems.	9
III	**ECONOMIC BALANCE IN EQUIPMENTS:** Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipments.	9
IV	**PRINCIPLES OF MANAGEMENT:** Principles of management, planning, organizing, staffing, coordinating, directing, controlling and communicating. Types of organizations, Management information systems (MIS).	9
V	**PRODUCTION PLANNING CONTROL:** Work measurement techniques, motion study, principles of time study, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory and control, role of control charts in production and quality control.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Calculate the capital cost and the value of money for the complete plant
CO2- Illustrate the profitability of the project and balance sheet preparation
CO3- Estimate the economic operation of the equipment
CO4- Identify the planning and management
CO5- Examine the production planning, control chart preparation and quality control

TEXT BOOKS:

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, 2004.
2. Schweyer. H.E, "Process Engineering Economics", Mc Graw Hill, 1969.

REFERENCE BOOKS:

1. F.C. Jelen and J.H. Black, "Cost and Optimization Engineering", McGraw Hill, 3rd Edn., 1992
2. Ahuja K.K, Industrial management, Khanna publishers, New Delhi, 1985.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	-	2.0	-	-	-	-	-	2.0	-	3.0	3.0	-
CO2	3.0	3.0	-	2.0	-	-	-	-	-	-	-	3.0	3.0	2.0
CO3	3.0	3.0	-	2.0	2.0	-	-	-	-	-	-	3.0	3.0	-
CO4	3.0	3.0	-	2.0	2.0	-	-	-	-	-	-	3.0	3.0	-
CO5	3.0	3.0	-	2.0	2.0	-	-	-	-	2.0	-	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**-**	**2.0**	**2.0**	**-**	**-**	**-**	**-**	**2.0**	**-**	**3.0**	**3.0**	**2.0**

Chairman - BoS
CHE - HiCET

Chairman

Dean (Academics)
HiCET

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH7202	PROCESS EQUIPMENT DESIGN	3	1	0	4

Course Objectives

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

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**DESIGN OF HEAT EXCHANGERS:** Design of double pipe heat exchangers, Shell and tube heat exchangers ,Condensers	12
II	**DESIGN OF EVAPORATORS,COOLING TOWERS AND DRYERS**: Design of single-effect evaporator, Cooling Tower, Dryers	12
III	**DESIGN OF MASS TRANSFER EQUIMENT-:** Distillation Column, Absorption column, Extraction Column., Adsorption column.,	12
IV	**DESIGN OF REACTORS**: CSTR,PFR Reactors, Pressure Vessel, Storage Vessel.	12
V	**DESIGN OF PLANT LAYOUT:** Pipe Lines and Pipe Layouts, Schematics and Presentation Materials of Construction and Selection of process equipments.	12
	Total Instructional Hours	**60**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the principles and apply design procedures for thermal equipment such as heat exchangers, condensers, and evaporators.
CO2- Analyze and design mechanical and thermal aspects of cooling towers and industrial dryers

CO3- Evaluate and design mass transfer equipment including absorption, distillation, extraction, and adsorption columns.
CO4- Design pressure vessels, packed bed reactors, and storage vessels considering safety, mechanical integrity, and process requirements.
CO5- Develop comprehensive plant layouts including pipelines and piping systems, and prepare schematic presentations with appropriate selection of materials of construction.

TEXT BOOKS:

1. Green D. W., "Perry's Chemical Engineer's Handbook", 8th Edition McGraw Hill, 2007
2. Coulsion and Richardson's., "Chemical Engineering Design - Volume 6", Pergamon; 2nd edition, 1993.

REFERENCE BOOKS:

1. R. K. Sinnott, "Coulson & Richardson's Chemical Engineering", Vol. 6, Butterworth Heinermann, Oxford, 1996.
2. Green D. W., "Perry's Chemical Engineer's Handbook", 8th Edition McGraw Hill, 2007.
3. Dawande, S. D., "Process Design of Equiment", 4th Edition, Central Techno Publications, Nagpure, 2005.
4. Baranan, C.R., "Rules of Thumb for Chemical Engineers", Gulf Publishing Co, Texas, 1996.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	2.0	1.0	-	-	-	-	-	-	-	-	-	3.0	2.0
CO2	3.0	3.0	3.0	2.0	2.0	-	-	-	-	-	-	-	3.0	2.0
CO3	3.0	2.0	3.0	2.0	1.0	-	-	-	-	-	-	-	3.0	2.0
CO4	3.0	3.0	3.0	2.0	2.0	-	-	-	-	-	-	-	3.0	2.0
CO5	3.0	3.0	3.0	3.0	2.0	2.0	1.0	1.0	-	1.0	-	3.0	3.0	-
Avg	**3.0**	**2.6**	**2.6**	**2.25**	**1.75**	**2.0**	**1.0**	**1.0**	**-**	**1.0**	**-**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH7001	DESIGN AND SIMULATION LAB	0	0	3	1.5

Course Objectives

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

S.No.	DESCRIPTION
1.	Equations of state using Newton's method.
2.	Regression for parameter estimation using a set of data points.
3.	Equilibrium flash distillation (Multicomponent Ideal).
4.	Batch Reactor.
5.	CSTR in Series Stage wise contacting equipment.
6.	Solving a simple flow sheet by simultaneous approach.
7.	Simulation of batch Distillation (binary ideal).
8.	Gravity Flow Tank.
9.	Heat Exchanger.
10.	Plug Flow Reactor.
11.	Absorber.
12.	Drag coefficient of solid particle

Total Practical Hours 45

Course Outcomes

Upon completion of the course, students can be able to

- Solve equations of state using Newton's method for accurate thermodynamic calculations.
- Perform regression analysis to estimate model parameters from experimental data.
- Model batch reactors, CSTRs in series, and plug flow reactors for optimal performance
- Calculate equilibrium and simulate flash distillation and gas absorption for multicomponent systems.
- Simulate heat exchangers and gravity flow tanks for efficient energy and fluid dynamics control

REFERENCE BOOKS:

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
CO2	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
CO4	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
CO5	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
Avg	**3.0**	**3.0**	**3.0**	**2.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH7002	COMPUTATIONAL FLUID DYNAMICS LAB	0	0	3	1.5

Course Objectives

- The lab involved the numerical solution of some common problems of chemical engineering and aim to visualize the effect of various factors on the flow of heat and mass transfer.

S.No.	DESCRIPTION
1.	Study of fluid flow and heat transfer in mixing tee.
2.	Study of flow mal distribution in different shapes of headers.
3.	Velocity boundary layer analysis of flow of fluid over a flat plate in laminar flow.
4.	Study of laminar and turbulent flow in pipe line.
5.	Modeling of forced convection in pipe line flows.
6.	Study of flow of fluid over air foil and effect of angle of attack.
7.	Modeling steady flow past cylinder and other geometries.
8.	Study of fluid flow and heat transfer in mixing elbow.
9.	Study the effect of roughness in turbulent flow through pipe line.
10.	Study of flow of fluid through a nozzle.
11.	Study of fluid flow in a rotating disk.
12.	Modeling motion of sphere in cylinder falling under gravity.

Total Practical Hours 45

Course Outcomes

Upon completion of the course, students can be able to

- Analyze fluid flow and heat transfer in mixing tees and elbows for process efficiency
- Evaluate flow distribution in various header shapes and assess velocity boundary layers in laminar flow.
- Distinguish between laminar and turbulent flow in pipelines and assess the impact of surface roughness.
- Model forced convection, fluid flow over airfoils, and steady flow past cylinders and complex geometries.
- Examine flow behavior in nozzles, rotating disks, and the motion of spheres in cylindrical systems

REFERENCE BOOKS:

1. P.S. Ghosdastidar, Computer Simulation of Flow and Heat Transfer, Tata McGraw-Hill (1998).
2. Muralidhar, K.,andSundararajan,T. Computational Fluid Flow and Heat Transfer, Narosa Publishing. House (1995).
3. Ranade, V.V., Computational flow modeling for chemical reactor engineering, Academic Press (2002).
4. Finlayson, B. A., Introduction to Chemical Engineering Computing, John Wiley & Sons, New Jersey, 2006.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
CO2	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
CO4	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
CO5	3.0	3.0	3.0	2.0	2.0	1.0	-	-	-	-	-	-	3.0	2.0
Avg	**3.0**	**3.0**	**3.0**	**2.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH5301	ENERGY TECHNOLOGY	3	0	0	3

Course Objectives

- Students will gain knowledge about different energy sources

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

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about the energy and its classification

CO2- Illustrate about the conventional energy resources and its production

CO3- Examine about non-conventional energy resources and its production

CO4- Explain about production of biomass energy

CO5- Understand about the energy conservation and management

TEXT BOOKS:

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Energy Management, Paul W.O'Callaghan McGraw – Hill, 1993

REFERENCE BOOKS:

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH5302	PETROLEUM TECHNOLOGY	3	0	0	3

Course Objectives

- To make the students understand petroleum engineering principles, their application to petroleum and natural gas manufacturing problems.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Refinery products – Refinery Feeds – Crude distillation – Coking and thermal process.	9
II	**CATALYTIC CRACKING:** Catalytic Cracking - Catalytical hydro cracking – Hydroprocessing and Reused processing hydro treating.	9
III	**CATALYTICAL:** Reforming and isomerization alkylation and polymerization – Product blending – Supporting processes.	9
IV	**LUBRICIATING:** Lubriciating oil blending stocks petrochemical feedstocks.	9
V	**COST EVALUATION:** Cost Evaluation – Economic evaluation of petroleum reused and refineries.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the basic refinery products by unit operation and process

CO2- Examine about the process of catalytic cracking and hydro treating for the production of petroleum products

CO3- Illustrate about the catalytical process of petroleum products production

CO4- Determine the lubrication of petroleum feed stock

CO5- Understand the cost evaluation process in petroleum refineries

TEXT BOOKS:

1. Petroleum Refining: Technology and economics CRC Press V Edition 2007 J.CH Garry, Hardward G.E and M.J.Kaiser.
2. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edition., McGraw Hill, New York,1985.

REFERENCE BOOKS:

1. Modern Petroleum Technology Upstream Vol I A.G. Lucas Hurley Edition 2002.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons,1986.
3. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edition, Khanna Publishers, New Delhi, 1987.
4. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH5303	ELECTROCHEMICAL ENGINEERING	3	0	0	3

Course Objectives

- Students will gain knowledge about electrochemical process and its application.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**REVIEW BASICS OF ELECTROCHEMISTRY:** Faraday's law - Nernst potential –Galvanic cells – Polarography, The electrical double layer: 94It's role in electrochemical processes –Electrocapillary curve – Helmoltz layer – Guoy – Steven's layer – fields at the interface.	9
II	**MASS TRANSFER IN ELECTROCHEMICAL SYSTEMS:** Diffusion controlled electrochemical reaction – the importance of convention and the concept of limiting current. over potential, primary-secondary current distribution – rotating disc electrode.	9
III	**INTRODUCTION TO CORROSION:** Series, corrosion theories derivation of potential-current relations of activities controlled and diffusion controlled corrosion process. Potential-pH diagram, Forms of corrosion- definition, factors and control methods of various forms of corrosion-corrosion control measures- industrial boiler water corrosion control – protective coatings –Vapor phase inhibitors – cathodic protection, sacrificial anodes – Paint removers.	9
IV	**ELECTRO DEPOSITION** : electro refining – electroforming – electro polishing – anodizing – Selective solar coatings, Primary and secondary batteries – types of batteries, Fuel cells.	9
V	**ELECTRODES USED IN DIFFERENT ELECTROCHEMICAL INDUSTRIES:** Metals-Graphite – Lead dioxide – Titanium substrate insoluble electrodes – Iron oxide – semi conducting type etc. Metal finishing-cell design. types of electrochemical reactors, batch cell, fluidized bed electrochemical reactor, filter press cell, Swiss roll cell, plug flow cell, design equation, figures of merits of different type of electrochemical reactors.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the basic electrochemistry

CO2- Understand the diffusion transfer in electrochemical systems

CO3- Understand the corrosion formation and control measures

CO4- Understand the process of electro plating and fuel cells

CO5- Understand the various types of electrodes in electrochemical industries

TEXT BOOKS:

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

REFERENCE BOOKS:

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH5304	POLYMER TECHNOLOGY	3	0	0	3

Course Objectives

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

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** History of Macromolecules – structure of natural products like cellulose, rubber,proteins – concepts of macro molecules – Staudinger's theory of macromolecules – difference between simple organic molecules and macromolecules.	9
II	**ADDITION POLYMERIZATION:** Chemistry of Olefins and Dienes – double bonds – Chemistry of free radicals – monomers – functionality – Polymerization: Initiation – types of initiation – free radical polymerization – cationic polymerization – anionic polymerization – coordination polymerization	9
III	**CONDENSATION POLYMERIZATION:** Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity – polycondensation – kinetics of polycondensation- Carother's equation – Linear polymers by polycondensation – Interfacial polymerization – crosslinked polymers by condensation – gel point.	9
IV	**MOLECULAR WEIGHTS OF POLYMERS:** Difference in molecular weights between simple molecules and polymers – number average and weight average molecular weights – Degree of polymerization and molecular weight – molecular weight distribution – Polydispersity – molecular weight determination.	9
V	**TRANSITIONS IN POLYMERS:** First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures – crystallinity in polymers – effect of crystallization – in polymers – factors affecting.	9
	Total Instructional Hours	45

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about the various macromolecules and its difference with organic molecules

CO2- Understand about the initiation of addition polymerization and its types

CO3- Understand about condensation polymerization reaction for polymer synthesis

CO4- Understand the molecular distribution and the methods of determination

CO5- Understand the transition in polymers and crystallization process

TEXT BOOKS:

1. Billmeyer.F.W.,Jr, Text Book of Polymer Science, Ed. Wiley-Interscience, 1984.
2. Gowariker.V.T., Viswanathan.N.V., and Sreedar.J., Polymer Science, Wiley Eastern Ltd., 1988.

REFERENCE BOOKS:

1. Joel,R.F; Polymer Science and Technology, Eastern Economy Edition, 1999.
2. Rodriguez, F., Cohen.C., Oberic.K and Arches, L.A., Principles of Polymer Systems, 5th edition, Taylor and Francis.
3. Vishu Shah, Hand book of Plastics Testing and Failure Analysis, 3rd Edition, John-Willey &Sons, New York, 2007.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH5305	FOOD TECHNOLOGY	3	0	0	3

Course Objectives

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

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**AN OVERVIEW:** General aspects of food industry; world food needs and Indian situation.	9
II	**FOOD CONSTITUENTS, QUALITY AND DERIVATIVE:** Constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their control.	9
III	**GENERAL ENGINEERING ASPECTS AND PROCESSING:** Preliminary processing methods; conversion and preservation operations.	9
IV	**FOOD PRESERVATION METHODS:** Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurization; fermentation and pickling; packing methods.	9
V	**PRODUCTION AND UTILISATION OF FOOD PRODUCTS:** 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.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the basic and general aspects of food industry
CO2-Examine the quality standards and control of food constituents
CO3- Illustrate the preliminary and general methods of food processing
CO4- Categorize about the different food preservation methods
CO5- Understand about the production of different food products and utilization

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Heldman D.R., Food Process Engineering, The AVI publishing co., 1975.
2. Charm S.E., The Fundamentals of Foods Engineering, The AVI Publishing Co., Westport, 1963.
3. Chakraverty, Amalendu, and Dhiren Sankar De. "Post harvest technology of cereals and pulses.1981.
4. Fellows, Peter John. Food processing technology: principles and practice. Elsevier, 2009.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH6301	PETROLEUM EXPLORATION AND EXPLOITATION TECHNIQUES	3	0	0	3

Course Objectives

- To make the students understand the stages of oil and gas formation, exploration and production

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**ORIGIN AND OCCURRENCE OF PETROLEUM AND SEDIMENTRARY ENVIRONMENT:** Origin of oil – Rock cycle - Important factors that control petroleum occurrence – Source, cap and reservoir rocks - Oil bearing rocks - Migration and accumulation - Continental environment – Transitional environment – Marine environment.	9
II	**EXPLORATION METHODS, WELL PROGNOSIS AND ECONOMIC:** Geological exploration methods – Geophysical exploration methods – Geochemical methods - Prognostication – Classification of drilling locations – Economic analysis – Well programme – Geotechnical order.	9
III	**GEOLOGICAL STRUCTURE AND GEOLOGGING:** Various traps and faults – Core Collection Techniques – Sample logging, Drilling time logging, Mud/Gas/Oil logging – Formation Evaluation Techniques using wire line well logging include – Spontaneous pontential logging, Natural Gamma Ray Logging, Caliber Logging, Formation Density Logging, Neutron Porosity logging, Sonic velocity Logging, Electrical Resistance Logging, etc.	9
IV	**DRILLING FLUIDS AND WORK COMPLETION:** Drilling Technology - Drilling Fluids: Function, composition, and classification – Packer fluid – Casing packs – Cementing – Various well completion methods – Various stimulation methods.	9
V	**OFF – SHORE TECHNOLOGY:** Seismic technology – Sniffer survey – Drilling technology – Off-shore rigs – Primary, secondary and enhanced oil recovery techniques and methods – Major well complication and Remedies.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the origin and occurrence of petroleum

CO2- Understand the various exploration methods and economic analysis of exploration

CO3- Understand the process of various logging based on various geological structure

CO4- Understand the process of drilling for well completion and different stimulation methods

CO5- Understand the process various off-shore technology oil recovery techniques

TEXT BOOKS:

1. Bhagwan Sahay "Petroleum Exploration and Exploitation Practices" Allied Publishers Ltd., Chennai, 1994.
2. Richard Dawe, "Modern Petroleum Technology", Vol.I, Upstream, 6th Edition, John and Wiley Sons Ltd, 2000.

REFERENCE BOOKS:

1. Howard B. Bradley, "Petroleum Engineering Handbook", Society of Petroleum Engineers, 1987.
2. Norman J. Hyne., "Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production", 2nd Edition, Pennwell Books, 2001.
3. Shay B., "Wellsite Geological Techniques for Petroleum Exploration" Allied Publishers Ltd., 1991.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH6302	ENZYME ENGINEERING	3	0	0	3

Course Objectives	
	• To develop skills of the students in the area of Enzyme Engineering with emphasis on reactor operation and design.

UNIT		DESCRIPTION	INSTRUCTIONAL HOURS			
I	**TYPES OF MICROORGANISM:** Structure and function of microbial cells. Fundamentals of microbial growth, batch and continuous culture. Isolation and purification of enzymes from cells. Cell and Enzyme Immobilization.			9		
II	**FERMENTATION**: Types of mechanisms, Continuous fermentation – aeration and agitation, kinetics of fermentation – Processes			9		
III	**INTRODUCTION OF BIOREACTOR DESIGN:** Continuously stirred aerated tank bioreactors. Mixing power correlation. Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power.			9		
IV	Introduction to Biochemistry, Function and applications. Nature and function of enzyme. Coenzyme / Cofactor. Classification of enzymes. Assay methods and units. Examples of applications of enzymes in industry, analytical technique medicine and Pharmaceuticals.			9		
V	Industrial Bioreactors Utilizing Isolated enzymes and biosensors development and applications. Designs of reactor, Batch and continue type; analysis for immobilized enzyme reactors. Sterile and non sterile operations; reactors in series with and without recycle.			9		
		Total Instructional Hours		**45**		

Course Outcomes	
	Upon completion of the course, students can be able to
	CO1- Understand the types and structure of different microbial cells, its isolation, purification of enzymes and immobilizing both
	CO2- Understand the fermentation operation and its kinetics
	CO3- Understand the mixing, oxygen transfer methodology into the cells and power requirement for the design of bioreactor
	CO4- Understand the basic biochemistry related to enzymes, its assay techniques and enzyme applications
	CO5- Understand the design of bioreactors under batch, continuous mode by the use of isolated enzymes

TEXT BOOKS:

1. Technological Applications of Bio-catalysts, BIOTOL series, Butter worth, 1995.
2. Cornish. A -Bowden, Analysis of Enzyme Kinetic Data, Oxford University Press, 1996.

REFERENCE BOOKS:

1. Wiseman. A and Blakeborough N and Dunnill P, Enzymic and nonenzymic catalysis, Ex. Vol.5 Ellis and Harwood, U.K. (1981).
2. Wiseman A (Ed.), Topics in enzyme and fermentation Bio-technology, Ellis and Harwood, U.K. Vol-5.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH6303	**FUNDAMENTALS OF NANO SCIENCE**	**3**	**0**	**0**	**3**

Course Objectives

- To learn about basis of nanomaterial science, preparation method, types and application

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classifications of nanostructured materials- nano particles- quantum dots, nanowires- ultra-thinfilms- multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).	9
II	**GENERAL METHODS OF PREPARATION:** Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes,Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.	9
III	**NANOMATERIALS:** Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2,	9
IV	**CHARACTERIZATION TECHNIQUES:** X-ray diffraction technique, Scanning Electron Microscopy- environmental techniques,Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.	9
V	**APPLICATIONS:** NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the concept of nanoscience, implications of science and mathematics and the fundamental properties

CO2- Understand the process of nanoparticle preparation methods in general

CO3- Understand about the various nanomaterials preparation, its properties and applications

CO4- Understand about the various characterization techniques for the identification of nano size and structure

CO5- Understand the application of nanotechnology in various fields

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, "Nanoscale Charecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCE BOOKS:

1. G Timp, "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia,"The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH6304	Corrosion Science and Engineering	3	0	0	3

Course Objectives

- To provide an understanding of the corrosion principles and engineering methods used to minimize and prevent the corrosion. Basic concepts: Definition and importance, Electrochemical nature and forms of corrosion, Corrosion rate and its determination.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**CORROSION:** Corrosion - Definition, classification, forms of corrosion, expressions for corrosion rate, emf and galvanic series , merits and demerits, Pourbaix diagram for iron, magnesium and aluminium - Forms of corrosion, Uniform, pitting, intergranular, stress corrosion - Corrosion fatigue - Dezincification - Erosion corrosion - Crevice corrosion - Cause and remedial measures, Pilling Bedworth ratio, High temperature oxidation.	9
II	**BOILERS:** Boiler water corrosion by carbon dioxide and unstable salts - Corrosion prevention methods by treatment cooling water, specification, types of scales and causes, use of antiscalant - Water treatments - Maintenance of boilers - Protection of boilers during off loading, high temperature, corrosion, turbine corrosion - Corrosion inhibitors, principles and practice, inhibitors for acidic neutral and other media - Corrosion failure - Inspection and analysis of corrosion damage.	9
III	**CORROSION TESTING:** Purpose of corrosion testing, classification, susceptibility tests for intergranular corrosion, stress corrosion test, salt spray test, humidity and porosity tests, accelerated weathering tests - ASTM standards for corrosion testing.	9
IV	**POLARIZATION:** Polarization - Exchange current density, Activation polarization, Tafel Equation ,Passivating metals and nonpassivating metals, Effect of oxidizing agents.	9
V	**ELECTROLESS PLATING AND ANODISING:** Electroless plating and Anodizing - Cathodic protection, metallic, organic and inorganic coatings, corrosion inhibitors - Special surfacing processes - CVD and PVD processes,sputter coating - Laser and ion implantation, arc spray, plasma spray, flame spray, HVOF.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about corrosion and its forms
CO2- Understand about Protect boiler against corrosion
CO3- Understand various corrosion test and its ASTM standards
CO4- Understand the Polarization and Effect of oxidizing agents on corrosion
CO5- Understand the Corrosion prevention methods and its applications.

TEXT BOOKS:

1. Fontana and Greene., Corrosion Engineering, McGraw Hill Book Co, New York, 1983
2. Raj Narayan ., An Introduction to Metallic Corrosion and its prevention, Oxford and IBH, New Delhi, 1983.

REFERENCE BOOKS:

1. Budinski, K.G., Surface Engineering for Wear Resistance, Prentice Hall Inc., Engelwood Cliff, New Jersey, USA, 1988
2. Uhlig, H.H ., Corrosion and Corrosion Control , John Wiley and Sons, New York, USA, 1985.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH6305	PIPING AND INSTRUMENTATION	3	0	0	3

Course Objectives

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

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**FUNDAMENTALS OF PIPING ENGINEERING:** Definitions, Piping Components their introduction, applications. Piping MOC, Budget Codes and Standards, Fabrication and Installations of piping.	9
II	**PIPE HYDRAULICS AND SIZING:** Pipe sizing based on velocity and pressure drop consideration cost, least annual cost approach, pipe drawing basics, development of piping general arrangement drawing, dimensions and drawing of piping.	9
III	**PLOT PLAN:** Development of plot plan for different types of fluid storage, equipment layout, process piping layout, utility piping layout. Stress analysis - Different types of stresses and its impact on piping, methods of calculation, dynamic analysis, flexibility analysis.	9
IV	**PIPING SUPPORT:** Different types of support based on requirement and its calculation.	9
V	**INSTRUMENTATION:** Final Control Elements; measuring devices, instrumentation symbols introduction to process flow diagram (PFD) and piping & instrumentation diagram (P&ID).	9
	Total Instructional Hours	45

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about the basic piping engineering, its standards and installations

CO2- Understand the drawing, sizing and hydraulics study of pipe

CO3- Understand about the development of pipe layout, plot plan and equipment layout and its dynamic analysis

CO4- Understand about the different types of piping support for various requirements

CO5- Understand about the process and instrumentation diagram and cost elements

TEXT BOOKS:

1. Piping Handbook, 6 th edition, M.L. Nayyar, P.E., Mc Graw-Hill, Inc.
2. Piping Design Handbook edited by Johan J McKetta, CRC Press, 1992.

REFERENCE BOOKS:

1. Luyben, W. L.," Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill, 1990.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH7301	NATURAL GAS ENGINEERING	3	0	0	3

Course Objectives

- Enable the students to learn the basic concept and applications of Natural Gas Engineering.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**NATURAL GAS TECHNOLOGY AND EARTH SCIENCE:** Branches of petroleum Industry. Sources of Information for natural gas engineering and its applications. Geology and earth sciences: Earth sciences-Historical geology, Sedimentation process, Petroleum reservoirs, Origin of petroleum. Earth temperatures & pressure, Earth temperatures, Earth pressure. Petroleum: Natural gas, LP gas, Condensate, & Crude oil.	9
II	**PROPERTIES OF NATURAL GASES:** Typical compositions. Equations of state: general cubic equations, specific high accuracy equations. Use of equation of state to find residual energy properties, gas measurement gas hydrates, condensate stabilization, acid gas treating, gas dehydrations, compressors, process control deliverability test, gathering and transmission, and natural gas liquefaction.	9
III	**GAS COMPRESSION:** Positive displacement and centrifugal compressors; fans. Calculation of poser requirements. Compressible Flow in Pipes: Fundamental equations of flow: continuity, momentum, elegy equations.	9
IV	**ISOTHERMAL FLOW IN PIPES:** The Weymouth equation. Static and flowing bottom-hole pressures in wells. Fundamentals of Gas flow in porous media: Steady state flow equations. Definition of pseudo-pressure function. Gas flow in cylindrical reservoirs: general equation for radial flow of gases in symmetrical homogeneous reservoirs.	9
V	**NON-DIMENSIONAL FORMS OF THE EQUATION:** Derivation of coefficients relation dimensionless to real variables. Infinite reservoir solution: Pseudo-steady-state solution. Gas Well Deliverability Tests: Flow-after-flow tests: prediction of IPR curve and AOF for the well. Isochronal tests. Draw down tests: need for data at two flow rates.	9
	Total Instructional Hours	45

Course Outcomes

Upon completion of the course, students can be able to

CO1: Understand about the various sources of information for natural gas engineering and its applications

CO2: Understand about the composition and various properties of natural gases

CO3: Understand about the compression equipment and its analysis

CO4: Understand about the fundamentals of gas flow in various conduits under constant thermodynamic property

CO5: Understand about the non-dimentional forms of the equation for gas deliverability

TEXT BOOKS:

1. Katz D.L.et al., Natural Gas Engineering (Production & storage), McGraw-Hill, Singapore.

REFERENCE BOOKS:

1. Standard Handbook of Petroleum and Natural Gas Engineering. 2nd Edition. William C Lyons, Gary C Plisga. Gulf Professional Publishing.
2. Modern Petroleum Technology Upstream Vol I A.G. Lucas Hurley Edition 2002.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH7302	PULP AND PAPER TECHNOLOGY	3	0	0	3

Course Objectives

- Focused on papermaking science and technology and is intended to be especially valuable to students majoring in programs leading to careers in corporate or government positions which would interface with the paper related industries.

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

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the basic pulp and paper technology
CO2- Understand about the mechanical and chemical pulping processes
CO3- Understand about the wet and dry machines and operations for paper production
CO4- Understand about the production of paper and paperboard
CO5- Understand about the various properties and quality testing of pulp and paper and pollution control

TEXT BOOKS:

1. Pulp and paper chemistry and Technology Monica ER Monica, Goran Gellerstcdt Gunnar Hennksson De Gneyter 2009.
2. Paper and Pulp Technology, K.P Rao, Oxford and Ibh Publishers 2003

REFERENCE BOOKS:

1. Modern Technology of Pulp, Paper and Paper Conversion Industries [NI104] by NIIR Board of Consultants and Engineers
2. Pulp & Paper - Chemistry & Chemical Technology, Second Edition Revised & Enlarged - Volumes I-iii, Casey, James P**.,** Interscience Publishers, New York (1960)
3. Handbook of Pulp and Paper Technology, Second Edition Revised and Enlarged, Kenneth W. Britt, Van Nostrand Reinhold Co.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH7303	TRANSPORT PHENOMENA	3	0	0	3

Course Objectives

- To develop a fundamental knowledge of the physical principles that govern the transport of momentum, energy and mass, with emphasis on the mathematical formulation of the conservation principles.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**TRANSPORT PHENOMENA BY MOLECULAR MOTION:** Vectors/Tensors, Newton's law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick's law of diffusion, Temperature,pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.	9
II	**ONE DIMENSIONAL MOMENTUM TRANSPORT:** Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems.	9
III	**ONE DIMENSIONAL HEAT TRANSPORT:** Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations of change (non- isothermal), equation of motion for forced and free convection, equation of energy (non-isothermal).	9
IV	**ONE DIMENSIONAL MASS TRANSPORT:** Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalyst and the effectiveness factor, equation of continuity for binary mixtures, equation of change to set up diffusion problems for simultaneous heat and mass transfer.	9
V	**TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW:** Turbulence phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface. Introduction to macroscopic balances for isothermal flow systems, non-isothermal systems and multicomponent systems.	9
	Total Instructional Hours	45

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about the fluid flow and molecular transfer mechanism

CO2- Understand about the one dimensional momentum transport, its boundary condition and velocity profile

CO3- Understand about the one dimensional heat transport, its boundary conditions and temperature profiles

CO4- Understand about the one dimensional mass transport, its boundary conditions, concentration profiles

CO5- Understand about the transport in turbulent and boundary layer flow

TEXT BOOKS:

1. R. B. Bird, W.E. Stewart, E.W. Lightfoot, Transport Phenomena, 2nd Revised Edition, John Wiley, 2007.
2. Brodkey, R. S., and Hershey, H. C., "Transport Phenomena", McGraw-Hill, 1988.

REFERENCE BOOKS:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles, Prentice- Hall Inc., 4th Edition 2003.
2. Slattery, J. S., "Advanced Transport Phenomena", Cambridge University Press, London, 1999.
3. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc- Graw Hill, 1983.
4. R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition, John Wiley, New York, 2007.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	T	P	C
B.Tech	21CH7304	MULTICOMPONENT DISTILLATION	0	0	3

Course Objectives

To understand the concepts of Multi component distillation systems.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**THERMODYNAMIC PRINCIPLES:** Fundamental Thermodynamic principles involved in the calculation of vapor – liquid equilibria and enthalpies of multi component mixtures – Use of multiple equation of state for the calculation of K values – Estimation of the fugacity coefficients for the vapor phase of polar gas mixtures – calculation of liquid – phase activity coefficients.	9
II	**THERMODYNAMIC PROPERTY EVALUATION:** Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.	9
III	**MINIMUM REFLUX RATIO FOR MCD SYSTEM:** General considerations in the design of columns – Column sequencing – Heuristics for column sequencing – Key components – Distributed components – Non-Distributed components – Adjacent keys. Definition of minimum reflux ratio – calculation of Rm for multi component distillation Underwood method – Colburn method.	9
IV	**VARIOUS METHODS OF MCD COLUMN DESIGN:** Theta method of convergence – Kb method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method – Stage and reflux requirements – Short cut methods and Simplified graphical procedures.	9
V	**VARIOUS TYPES OF MCD COLUMNS:** Design of sieve, bubble cap, valve trays and structured packing columns for multi component distillation – computation of plate efficiencies.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Remember and apply the important thermodynamic principles in multi component mixtures

CO2- Understand about the fundamental principles involved in the separation of multi component mixtures

CO3- Understand about Underwood method – Colburn method for the calculation of minimum reflux ratio

CO4- Understand about Theta method to complex columns and to system of columns – Lewis Matheson method for MCD column design

CO5- Understand about the design procedure of sieve, bubble cap, valve tray and packed columns

TEXT BOOKS:

1. Holland, C.D., "Fundamentals of Multi Component Distillation", McGraw Hill Book Company, 1981.
2. Van Winkle, "Distillation Operations", McGraw Hill Publications, 1987.

REFERENCE BOOKS:

1. King, C.J., "Separation Process Principles", Mc Graw Publications, 1986.
2. Treybal, R.E., "Mass Ttransfer Operations", 5th Edition, Mc Graw Hill publications. 1996.
3. Mc Cabe and Smith, J.C., Harriot, "Unit Operation of Chemical Engineering", 6th Edition, McGraw Hill, 2001.
4. Seader, J.D. and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley,2006.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**								**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH7305	**CHEMICAL PROCESS OPTIMIZATION**	**3**	**0**	**0**	**3**

Course Objectives

- Students will gain knowledge about process modeling and optimization

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Introduction to optimization; applications of optimization in chemical engineering; classification of optimization problems.	9
II	**SINGLE VARIABLE OPTIMIZATION:** Necessary and sufficient conditions for optimum; region elimination methods; interpolation methods; direct root methods.	9
III	**MULTIVARIABLE OPTIMIZATION WITHOUT AND WITH CONSTRAINTS:** Necessary and sufficient conditions for optimum; direct search methods; indirect search methods.	9
IV	**OTHER OPTIMIZATION METHODS:** Introduction to geometric, dynamic and integer programming and genetic algorithms.	9
V	**APPLICATIONS OF OPTIMIZATION:** Formulation of objective functions; fitting models to data; applications in fluid mechanics, heat transfer, mass transfer, reaction engineering, equipment design, resource allocation and inventory control.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the various classification of optimization process in chemical engineering

CO2- Understand the procedure for the determination of necessary and sufficient conditions for optimum

CO3- Understand the process multivariable optimization without and with constraints

CO4- Understand the basic concepts about geometric, dynamic and integer programming and genetic algorithms.

CO5- Understand the optimization application in fluid mechanics, heat transfer, mass transfer, reaction engineering, equipment design, resource allocation and inventory control

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimisation ", John Wiley, New York, 1980.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8301	**INDUSTRIAL MANAGEMENT**	**3**	**0**	**0**	**3**

Course Objectives

- To provide an opportunity to learn basic management concepts essential for business.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Management - Definition – Functions – Evolution of Modern Management – Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization – Individual Ownership – Partnership	**9**
II	**FUNCTIONS OF MANAGEMENT:** Planning – Nature and Purpose – Objectives – Strategies – Policies and Planning Premises – Decision Making – Organizing – Nature and Process – Premises – Departmentalization – Line and staff – Decentralization – Organizational culture, Staffing - selection and training – Placement – Performance appraisal – Career Strategy – Organizational Development. Leading – Managing human factor.	**9**
III	**ORGANIZATIONAL BEHAVIOUR:** Definition – Organization – Managerial Role and functions – Organizational approaches, Individual behaviour – causes – Environmental Effect – Behavior and Performance, Perception – Organizational Implications. Personality – Contributing factors - Dimension – Need Theories – Process Theories – Job Satisfaction, Learning and Behavior – Learning Curves,Work Design and approaches.	**9**
IV	**GROUP DYNAMICS:** Group Behavior – Groups – Contributing factors – Group Norms, Communication – Process – Barriers to communication – Effective communication, leadership – formal and informal characteristics – Managerial Grid – Leadership styles – Group Decision Making – Leadership Role in Group Decision, Group Conflicts – Types – Causes.	**9**
V	**MODERN CONCEPTS:** Management by Objectives (MBO), Management by Exception (MBE), Strategic Management - Planning for Future direction – SWOT Analysis – Information technology in management – Decisions support system – Business Process Re-engineering (BPR) – Enterprises Resource Planning (ERP) – Supply Chain Management (SCM) – Activity Based Management (ABM).	**9**
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the definition for management, partnership, ownership, etc
CO2- Remember the functions of management
CO3- Understand the behavioral characteristics in the industry
CO4- Understand the dynamic conflicts and its solution in a group
CO5- Understand the various modern industrial management concepts

TEXT BOOKS:

1. Herald Knottz and Heinz Weihrich, "Essentials of Management", Tata McGraw Hill Education Pvt. Ltd., 2010.
2. Stephen P. Robbins, "Organization Behaviour", Pearson Education Inc., 13 edition, 2010.

REFERENCE BOOKS:

1. Ties, AF, Stoner and R.Edward Freeman, "Management" Prentice Hall of India Pvt. Ltd. New Delhi 110 011, 1992.
2. Joseph J, Massie, "Essentials of Management" Prentice Hall of India Pvt. Ltd. 1985.
3. Tripathi. P.C. & P.N. Reddy, "Principles of Management", Tata McGraw Hill, 2006.
4. Ahuja K.K, Industrial management, Khanna publishers, New Delhi, 1985.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8302	SUGAR TECHNOLOGY	3	0	0	3

Course Objectives

To educate individuals in the scientific principles and practical techniques involved in the processing of sugarcane and sugar beet into refined sugar and related products.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** 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. Analytical methods used in Sugar Industry.	9
II	**PURIFICATION:**Chemical technology of the purification processes. Fundamental reactions and physical chemistry aspects of clarification. Liming, sulphitation and carbonation processes. Filtration of sugar juice.	9
III	**EVAPORATION:**Evaporation of sugar juice. Heat transfer in evaporators. Evaporation equipment and auxiliaries. Methods of obtaining steam and quality of steam. Steam economy. Chemistry of the evaporation process. Scale formation and cleaning of evaporators.	9
IV	**CRYSTALLIZATION:** 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.	9
V	**CENTRIFUGATION:** 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.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about the sugar industries and analytical methods
CO2- Examine the purification methods
CO3- Determine the evaporation technique in sugar juice processing
CO4- Illustrate the crystallization technique in sugar juice processing
CO5- Remember the centrifugation technique in sugar juice processing

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

REFERENCE BOOKS:

1. Payne J.H., Sugarcane factory Analytical control, Fifth Edition, Elsevier Publisher, London, 1968.

2. Jenkins G.H., Introduction to Sugarcane technology, Elsevier Publisher, London, 1966

3. Hoing P., Principle of Sugar Cane Technology, Elsevier Publisher, London.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8303	TOTAL QUALITY MANAGEMENT	3	0	0	3

Course Objectives

- To facilitate the understanding of Quality Management principles and process.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.	9
II	**TQM PRINCIPLES:** Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.	9
III	**TQM TOOLS AND TECHNIQUES I:** The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.	9
IV	**TQM TOOLS AND TECHNIQUES II:** Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.	9
V	**QUALITY MANAGEMENT SYSTEM:** Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation— Documentation—Internal Audits—Registration-- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001— Benefits of EMS.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about quality management towards Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention

CO2- Illustrate about Quality Statements and principles in detail

CO3-Examine about the traditional tools like six sigma in TQM

CO4- Determine about the Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function

CO5- Understand about the quality management system

TEXT BOOKS:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

REFERENCE BOOKS:

1. Joel.E. Ross, "Total Quality Management – Text and Cases",Routledge.,2017.
2. Kiran.D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006 .

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8304	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	3	0	0	3

Course Objectives

- To get an idea about the global trends and the requirement of skills for integrated product development

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**FUNDAMENTALS OF PRODUCT DEVELOPMENT:** Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services	9
II	**REQUIREMENTS AND SYSTEM DESIGN:** Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.	9
III	**DESIGN AND TESTING:** Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design	9
IV	**SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT :** Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal.	9
V	**BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY:** The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1: Understand the global trends and development methodologies of various types of products and services

CO2:Examine the system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics

CO3: Illustrate the requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification

CO4: Examine the process of documentation, test specifications and coordinate with various teams

CO5: Understand the process of conceptualize, prototype and develop product management plan for a new product.

TEXT BOOKS:

1. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.

REFERENCE BOOKS:

1. Hiriyappa B, "Corporate Strategy – Managing the Business", Author House, 2013.
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning – Concepts", Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8305	SUPPLY CHAIN MANAGEMENT	3	0	0	3

Course Objectives

- To provide an insight on the fundamentals of supply chain networks, tools and techniques.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.	9
II	**SUPPLY CHAIN NETWORK DESIGN:** Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions.	9
III	**LOGISTICS IN SUPPLY CHAIN:** Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation.	9
IV	**SOURCING AND COORDINATION IN SUPPLY CHAIN:** Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.	9
V	**SUPPLY CHAIN AND INFORMATION TECHNOLOGY:** The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain - E-Business in supply chain.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about the role, scope, importance and evolution of supply chain
CO2- Understand about the supply chain network design for network decisions
CO3- Determine about the logistics in supply chain
CO4- Examine about the sourcing and coordination in supply chain
CO5- Understand about the information technology in supply chain management and future

TEXT BOOKS:

1. Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and operation", Pearson Education, 2010.
2. Srinivasan G.S, "Quantitative models in Operations and Supply Chain Management", PHI, 2010.

REFERENCE BOOKS:

1. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, "Logistics", PHI 2002.
2. James B.Ayers, "Handbook of Supply chain management", St.Lucle press, 2000.
3. Jeremy F.Shapiro, "Modeling the supply chain", Thomson Duxbury, 2002.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO2	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO3	3.0	2.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO4	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
CO5	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
Avg	**3.0**	**2.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**2.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8306	PROCESS PLANT UTILITIES	3	0	0	3

Course Objectives

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

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**IMPORTANT OF UTILITIES:** Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.	9
II	**STEAM AND STEAM GENERATION:** Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.	9
III	**REFRIGERATION:** Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.	9
IV	**COMPRESSED AIR:** Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air – Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.	9
V	**FUEL AND WASTE DISPOSAL:** Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. Internal Combustion Engine, Petrol and Diesel Engine. Waste Disposal.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the importance of various utility operations such as Chemical Softening and Demineralization, Water Softening and Reverse Osmosis etc.,

CO2-Illustrate the importance of steam and its generation, properties and steam production equipment

CO3- Examine about the various Refrigeration Cycles, different methods of Refrigeration used in Industry

CO4- Determine about the air compression, equipment used for Humidification, Dehumidification and Cooling Towers in the industries

CO5- Understand about the types of Fuel used in Chemical Process Industries and the proper disposal of fuel waste

TEXT BOOKS:

1. Industrial Chemistry by Shashi Chawla, Dhanpat Rai and Sons Publication.
2. P. L. Ballaney, "Thermal Engineering", Khanna Publisher New Delhi, 1986.
3. Heat Transfer by D.S. Kumar.
4. Fuel Furances and Refractories by O.P. Gupta, Khanna Publishers.

REFERENCE BOOKS:

1. Perry R. H. Green D. W. "Perry's chemical Engineer's Handbook", McGraw Hill, New York, 2007.
2. P. N. Ananthanarayan, "Basic Refrigeration & Air conditioning", Tata McGraw Hill, New Delhi, 2007.
3. Plant Utilities by D.B. Dhone, NiraliPrakshan Publication.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	2.0	3.0	2.0	-	2.0	3.0	-	-	-	-	3.0	3.0	3.0
CO2	3.0	3.0	3.0	2.0	-	2.0	2.0	-	-	-	-	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	-	2.0	3.0	-	2.0	-	-	3.0	3.0	2.0
CO4	3.0	2.0	3.0	2.0	-	2.0	3.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	2.0	3.0	2.0	-	2.0	3.0	-	-	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**2.4**	**3.0**	**2.0**	**-**	**2.0**	**2.8**	**-**	**2.0**	**-**	**3.0**	**3.0**	**3.0**	**2.2**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8307	FERMENTATION TECHNOLOGY	3	0	0	3

Course Objectives

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

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION TO FERMENTATION PROCESSES:** Microbial biomass – Microbial Enzymes – Microbial metabolites – Recombinant products – Transformation Process – Microbial growth binetus – Isolation and preservation and improvement of industrially important micro organism.	9
II	**INSTRUMENTATION AND CONTROL:** 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 termentation technology.	9
III	**RECOVERY AND PURIFICATION OF FERMENTATION PRODUCTS :** Removal of Microbial cells – Foam Separation – Precipitation Filtration – Different Filtration process - Centifugation – Different centrifuge cell description Different methods – Solvent recovery – Superfluid extraction – Chromatography Membrane processes – Drying – Crystallization – Whole growth processing.	9
IV	**EFFLUENT TREATMENT:** Strength of fermentation effluent – Treatment and disposal – Treatment Processes – Physical, chemical and biological – Aerobic process – Anareobic treatment.	9
V	**FERMENTATION ECONOMICS:** Introduction – Isolation of micro organisms of industrial interest – Strain improvement – Market potential – Plant and equipment – Media – Air sterilization – Heating and cooling – Recovery costs.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the basic fundamental of microbial cells, enzymes and recombinant technology in fermentation processes

CO2- Illustrate about the various instrumental control techniques in fermentation operations

CO3- Illustrate about the various downstream operations in the fermentation process

CO4- Determine the treatment of fermentation effluent use of physical, chemical and biological methods and its strength

CO5- Understand the economic production of fermented products and operation starts from upstream to downstream

TEXT BOOKS:

1. Fermentation and Biochemical Engineering Handbook – C.C Haber. William Andrew II Edition 2007.
2. Principles of fermentation Technology P.Stanbury Buttuworth Hanman – 1999.

REFERENCE BOOKS:

1. Bioprocess Engineering Hydersen B.K Nancy A.delaK.L.Nelsen Wiley Interscience,1994.
2. Bioprocess engineering principles, Pauline M. Doran, Academic Press.
3. Biochemical Engineering, H.W. Blanch and D.S. Clark, Marcel Dekker, 1997.
4. Shigeo Katoh, Jun-ichiHoriuchi and Fumitake Yoshida, "Biochemical Engineering", Wiley, 2015.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO2	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO3	3.0	2.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO4	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
CO5	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
Avg	**3.0**	**2.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**2.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8308	FRONTIERS OF CHEMICAL TECHNOLOGY	3	0	0	3

Course Objectives

- Students will know the latest trends to be followed in the process industries

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**PROCESS INTENSIFICATION:** Novel reactor configurations; combination of reaction and separation; use of different energy fields, lab on a chip.	9
II	**CHEMICAL PRODUCT DESIGN:** Scope and importance; identification of needs and specifications; sources of ideas and screening ideas; selection of product idea; process development for product manufacture; specialty chemical manufacture; economic aspects.	9
III	**RENEWABLE ENERGY:** Hydrogen production, Hydrogen economy, Fuel Cell Technology, biofuel cells and bio-hydrogen, solar energy	9
IV	**MATERIALS ENGINEERING:** Polymers and composites, ceramics and glasses, colloidal dispersions and nanoparticles, thin films and electronic materials	9
V	**BIOENGINEERING:** Biomechanics, biotransport and biomaterials, biomolecular and cellular engineering, drug discovery and development.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about the application of various unit operations, unit processes, chemical reaction principles for the design of advanced reactors and lab

CO2- Remember the fundamentals and chemical engineering principle for the design of chemical products with economic aspects

CO3- Remember and apply the chemical technologies in the field of renewable energy production

CO4- Understand about the various materials in the advancement of chemical engineering

CO5- Understand about the various development in bioengineering

REFERENCE BOOKS:

1. Keil, F. J., Modeling of Process Intensification Wiley-VCH Verlag GmbH & Co. KGaA2007.
2. Cussler, E.l. and Moggridge, G.D., "Chemical product design" Cambridge University Press, Cambridge, 2001.
3. Hoffmann,P, Tomorrow's energy: hydrogen, fuel cells, and the prospects for a cleaner planet, MIT Press, Sabon, 2002.
4. Mitchell, B.S., An introduction to materials engineering and science for chemical and materials engineers, John Wiley and Sons Inc., New Jersey, 2004.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8309	INDUSTRIAL NANOTECHNOLOGY	3	0	0	3

Course Objectives

- To elucidate on advantages of nanotechnology based applications in each industry
- To provide instances of contemporary industrial applications of nanotechnology
- To provide an overview of future technological advancements and increasing role of nanotechnology in each industry

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**NANO ELECTRONICS:** Advantages of nano electrical and electronic devices – Electronic circuit chips – Lasers - Micro and NanoElectromechanical systems – Sensors, Actuators, Optical switches, Bio-MEMS –Diodes and Nano-wire Transistors - Data memory –Lighting and Displays – Filters (IR blocking) – Quantum optical devices.	9
II	**BIONANOTECHNOLOGY:** Nanoparticles in bone substitutes and dentistry – Implants and Prosthesis - Reconstructive Intervention and Surgery – Nanorobotics in Surgery – Photodynamic Therapy - Nanosensors in Diagnosis– Neuro-electronic Interfaces – Protein Engineering – Drug delivery – Therapeutic applications.	9
III	**NANOTECHNOLOGY IN CHEMICAL INDUSTRY :** Nanocatalyts – Smart materials – Heterogenous nanostructures and composites – Nanostructures for Molecular recognition (Quantum dots, Nanorods, Nanotubes) – Molecular Encapsulation and its applications – Nanoporous zeolites – Self-assembled Nanoreactors - Organic electroluminescent displays.	9
IV	**NANOTECHNOLOGY IN AGRICULTURE AND FOOD TECHNOLOGY** : Nanotechnology in Agriculture -Precision farming, Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers - Nanotechnology in Food industry - Packaging, Food processing - Food safety and biosecurity – Contaminant detection – Smart packaging.	9
V	**NANOTECHNOLOGY IN TEXTILES AND COSMETICS:** Nanofibre production - Electrospinning – Controlling morphologies of nanofibers – Tissue engineering application– Polymer nanofibers - Nylon-6 nanocomposites from polymerization - Nano-filled polypropylene fibers - Bionics– Swim-suits with shark-skin-effect,Soil repellence.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about nanotechnology in electronic industries and various products
CO2- Determine about nanotechnology in biotechnology sectors and applications
CO3- Examine about nanotechnology in chemical industries and various applications
CO4- Illustrate about nanotechnology in agriculture and food technology sectors and various applications
CO5- Understand about nanotechnology in textiles and cosmetics sectors and various applications

REFERENCE BOOKS:

1. Neelina H. Malsch (Ed.),Biomedical Nanotechnology, CRC Press (2005).
2. Udo H. Brinker, Jean-Luc Mieusset (Eds.), Molecular Encapsulation: Organic Reactions in Constrained Systems,Wiley Publishers (2010).
3. Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, (2006).
4. Lynn J. Frewer, WillehmNorde, R. H. Fischer and W. H. Kampers, Nanotechnology in the Agri- food sector, Wiley-VCH Verlag, (2011).

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO2	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO3	3.0	2.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO4	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
CO5	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
Avg	**3.0**	**2.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**2.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH8310	DRUGS AND PHARMACEUTICAL TECHNOLOGY	3	0	0	3

Course Objectives

- To give the students an understanding of the polytechnical nature of engineering and drug discovery in the pharmaceutical industry involving Chemical Engineering.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Development of drugs and pharmaceutical industry; organic therapeutic agents uses and economics.	9
II	**DRUG METABOLISM AND PHARMACO KINETICS & MICROBIOLOGICAL AND ANIMAL PRODUCTS:** Drug metabolism;physico chemical principles; pharma kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones.	9
III	**IMPORTANT UNIT PROCESSES AND THEIR APPLICATION :** Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.	9
IV	**MANUFACTURING PRINCIPLES & PACKING AND QUALITY CONTROL**: 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.	9
V	**PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS:** Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others. Analytical methods and tests for various drugs and pharmaceuticals – spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pH metry.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand in general about development of drugs and pharmaceutical industry

CO2- Determine the drug metabolism and pharmaco kinetics & microbiological and animal products in general

CO3- Examine about important unit processes and their application in drug manufacturing

CO4- Illustrate about the various drug manufacturing principles & packing and quality control

CO5- Understand about the various pharmaceutical products and its analysis

TEXT BOOKS:

1. Rawlines, E.A.; " Bentleys Text book of Pharmaceutics ", III Edition, Bailliere Tindall, London, 1977.
2. Shayne Cox Gad. Pharmaceutical Manufacturing Handbook, Published by John Wiley & Sons, Inc., 2008.

REFERENCES BOOKS:

1. Yalkonsky, S.H.; Swarbick. J.; " Drug and Pharamaceutical Sciences ", Vol. I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. "Remingtons Pharmaceutical Sciences ", Mack Publishing Co., 1975.
3. Bernd Meibohm. Pharmacokinetics and Pharmacodynamics of biotech drugs, Published by Wiley-VCH, 2006.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO2	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO3	3.0	3.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	3.0	3.0	2.0
CO4	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
CO5	3.0	3.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	3.0	3.0	2.0
Avg	**3.0**	**3.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**3.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21CH8311	MEMBRANE SEPARATION PROCESS	3	0	0	3

Course Objective

The student should be able to

1. Understand the principle and technical concept of advanced separation processes.
2. Describe the process of Reverse Osmosis, Nanofiltration.
3. Summarize the Types and choice of Adsorbents.

Unit	Description	Instructional Hours
I	**BASICS OF SEPARATION PROCESS :** Overview and membrane materials, Material properties and preparation of phase-inversion membranes, Review of Conventional Processes, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid, Dual functional Filter.	9
II	**MEMBRANE SEPARATIONS:** Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane , Porous and non-porous membrane transport and Osmosis concepts , Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Preparation of composite, inorganic membranes , MF and UF characterization and membrane transport , Problems and solutions based on RO, MF.	9
III	**SEPARATION BY ADSORPTION:** Types and choice of Adsorbents, Affinity Chromatography, Ion Exchange Chromatography and Immuno Chromatography, Recent Trends in Adsorption.	9
IV	**INORGANIC SEPARATIONS:** Electrophoresis, Dielectrophoresis, , Electro dialysis, Evaporation, Problems and solutions based on ED, PV, Facilitated Transport, Membrane contactors and other membrane processes.	9
V	**OTHER TECHNIQUES:** Separation involving Lyophilisation, Liquid Membranes, Gas separation, Membrane Distillation, zone melting, Adductive Crystallization, Supercritical fluid Extraction.	9
	Total Instructional Hours	**45**

Course Outcome

On completion of the course, the students will be able to

CO1	Understand the Concept of Separation Process.
CO2	Analyze key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, limiting cases, efficiency and mass transport effects.
CO3	Illustrate the concept of adsorption and its application.
CO4	Acquire Knowledge in inorganic separations for the reaction.
CO5	Differentiate and determine various processes by performing the specific tests.

TEXT BOOK:

T1 Schoen, H.M., "New Chemical Engineering Separation Techniques", Interscience Publishers,1972.

T2 Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., 1980.

T3 B. K. Dutta, Mass Transfer and Separation Processes, PHI,2007.

REFERENCES:

R1 King, C. J., "Separation Processes", Tata McGraw Hill, 1982.

R2 M. H. Mulder, Basic Principles of Membrane Technology,Springer, 2004

R3 Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987

R4 Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar, 1992.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO2	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO3	3.0	2.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO4	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
CO5	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
Avg	**3.0**	**2.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**2.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH6401	WASTE TO ENERGY CONVERSION	3	0	0	3

Course Objectives

To provide students with the production of energy from different types of wastes through thermal, biological and chemical routes. It is intended to help the young scientific professionals to keep their knowledge upgraded with the current thoughts and newer technology options along with their advances in the field of the utilization of different types of wastes for energy production.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**Introduction:** Introduction to waste to energy conversion, characterization of wastes, Energy production form wastes through incineration, energy production through gasification of wastes	9
II	**Pyrolysis:** Energy production through pyrolysis and gasification of wastes, syngas utilization.	9
III	**Densification of biomass and waste plastic blends**: Densification of solids, efficiency improvement of power plant and energy production from waste plastics, Energy production form wastes Plastic, gas cleanup.	9
IV	**Energy production from waste:** Energy production from organic wastes through anaerobic digestion and fermentation, introduction to microbial fuel cells	9
V	**Cultivation of microalgae for biofuel production:** Energy production from wastes through fermentation and trans esterification, Cultivation of algal biomass from wastewater and energy production from algae.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand to characterize the waste

CO2- Understand about the pyrolysis and gasification process for energy production.

CO3- Understand about the process of energy production from plastics

CO4- Understand about the energy production from organic waste

CO5- Understand about the Energy production from wastes through fermentation and trans esterification

TEXT BOOKS:

1. Ashok K. Rathoure, Zero Waste: Management Practices for Environmental Sustainability, CRC Press, 2019, 1st Edition.
2. M. Habibur Rahman, Abdullah Al-Muyeed, Solid and Hazardous Waste Management, ITN-BUET, 2010

REFERENCES BOOKS:

1. George Tchobanoglous , Frank Kreith Handbook of Solid Waste Management, McGRAW-HILL, 2002.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO2	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO3	3.0	2.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO4	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
CO5	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
Avg	**3.0**	**2.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**2.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	21CH7401	BIOMASS CONVERSION AND BIO-REFINERY	3	0	0	3

Course Objectives

- This course will provide an insight to the basics of biomass, various conversion technologies and the different types of products that can be obtained upon successful conversion.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**Introduction:** World energy scenario, consumption pattern, fossil fuel depletion and environmental issues. Availability and abundance of biomass, photosynthesis, composition and energy potential, virgin biomass production and selection, waste biomass availability, abundance and potential, biomass as energy resources, short rotation woody crops, oil crops and their bio refinery potential, microalgae.	9
II	**Biomass Pretreatment:** Barriers in lignocellulosic biomass conversion, pretreatment technologies. Physical and Thermal Conversion Processes, Microbial Conversion Process: Types, fundamentals, equipment's and applications; thermal conversion products.	9
III	**Production of biofuels:** Diesel from vegetable oils, microalgae and syngas; trans esterification; FT process, catalysts; biodiesel purification, fuel properties. Factors affecting bio oil, bio chars production, fuel properties, bio oil up gradation. Corn ethanol, lignocellulosie ethanol, microorganisms for fermentation, current industrial ethanol production technology.	9
IV	**Hydrogen, Methane and Methanol:** Bio-hydrogen generation, metabolic basics, feedstock's, dark fermentation by strict anaerobes, facultative anaerobes, thermophilic microorganisms, integration of bio hydrogen with fuel cell; fundamentals of biogas technology, fermenter designs, biogas purification, methanol production and utilization.	9
V	**Organic Commodity Chemicals from Biomass, Integrated Biorefinery** Biomass as feedstock for synthetic organic chemicals, lactic acid, polylactic acid, succinic acid, propionic acid, acetic acid, butyric acid, 1,3-propanediol, 2,3-butanedioil, PHA. Concept of biorefinery, corn/soybean/sugarcane Biorefinery.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand about the Biomass and Biorefinary
CO2- Examine about the various various pretreatment and conservation process
CO3- Understand about the various production of biofuels
CO4- Illustrate about the biomass feedstock's
CO5- Understand about the process of Integrated Biorefinery

TEXT BOOKS:

1. Shibu Jose, Thallada Bhaskar, Biomass and Biofuels:Advanced Biorefineries for Sustainable Production and Distribution, 2015, CRC Press.
2. Donald L. Klass, Biomass for Renewable Energy, Fuels, and Chemicals, Academic Press, Elsevier, 2006

REFERENCES BOOKS:

1. Thallada Bhaskar Ashok Pandey S.Venkata Mohan Duu-Jong Lee Samir Kumar Khanal, Waste Biorefinery, 2018, Elsevier, 2018.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO2	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO3	3.0	2.0	3.0	2.0	2.0	-	2.0	-	2.0	-	2.0	2.0	3.0	2.0
CO4	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
CO5	3.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	-	3.0	2.0	3.0	2.0
Avg	**3.0**	**2.0**	**2.2**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.0**	**-**	**2.4**	**2.0**	**3.0**	**2.0**

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech.	21LSZ401	**General Studies for Competitive Examinations**	3	0	0	3

Course Objectives

1. To provide awareness to the students about higher education entrance exams and various types of jobs offered both in the Central and State Government.(CAT, GMAT, GRE, IBPS, IELTS, UPSC, SSC, RRB, TNPSC, GATE, IES, TNEB, AFCAT, DRDO, ISRO, INCOME TAX,LIC...)
2. To help the students to choose the area where they are interested.
3. To develop competitive skills through various types of objective tests.
4. To train them by conducting aptitude test based on verbal and quantitative skills.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**NUMERICAL ABILITY** Simplification and Approximation – Algebra – Number System- Averages – Ratio and Proportion – Partnership – Allegation or Mixture – Problem on Ages - Percentages - Profit and Loss – Time and Work – Pipes and Cisterns – Time, Speed and Distance – Problems on Trains ,Boats and Streams - Permutation and Combination- Probability- Data Interpretation- Simple Interest and Compound Interest – Geometry , Trigonometry and Mensuration – Progressions.	18
II	**REASONING ABILITY** Alphanumeric series - Reasoning Analogies – Coding-Decoding – Blood Relations - Directions – Calendars –Clocks – Data Sufficiency – Deductive Reasoning - Input-Output – Order & Ranking – Seating Arrangements –Visual Reasoning – Cubes and cuboids - Critical Reasoning – Syllogism – Venn Diagram – Puzzles.	10
III	**LANGUAGE COMPETENCY** Reading Comprehensions – Cloze Test – Sentence Completion – Match the Columns – Error Detection – Jumbled word/Paragraphs – Vocabulary & Grammar – One Word Substitution – Idioms and Phrases – Antonyms and Synonyms – Sentence Correction – Misfit/Out of Context sentence.	10
IV	**COMPUTER ACQUAINTANCESHIP** Internet – Memory – Keyboard Shortcuts – Computer Abbreviation – Microsoft Office – Computer Hardware – Computer Software – Operating System – Networking – Computer Fundamentals /Terminologies.	3
V	**GENERAL AWARENESS** Geography – Culture – History – Economic Science – Scientific Research – General Policy – Awards and Honours – Books and Authors – Static GK - Current Affairs	4
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1: Thinking critically and applying basic mathematics skills to interpret data, draw conclusions, and solve problems; developing proficiency in numerical reasoning; Application of quantitative reasoning in aptitude tests.

CO2: The ability to identify and define problems/issues, recognizing their complexity, and considering alternative viewpoints and solutions to use the critical skills of observation, analysis, evaluation.

CO3: Understanding and reasoning using concepts framed in words; Critical verbal reasoning; Reading Comprehension; Application of verbal reasoning in aptitude tests.

CO4: Students will possess the basic understanding of computer hardware and software, utilizing web technologies, basic understanding of network principles, Keyboard Shortcuts and various Operating System.

CO5: Students will be updated with awareness and knowledge regarding the occurrences around the world.

REFERENCES BOOKS:

R1: Quantitative Aptitude for Competitive Examinations – Abhijith Guptha

R2: The Pearson Guide to Quantitative Aptitude - Dinesh Khattar

R3: Analytical Reasoning and Logical Reasoning- Peeyush Bharadwaj R4: A New Approach to Reasoning - B.S. Sijwali & S. Sijwali Arihant R5: Word Power made easy - Norman Lewis

R6: Verbal Ability & Reading Comprehension for the CAT – Arun Sharma, Meenakshi Upadhyay - Mcgraw-hill Education

R7: Computer Awareness - Arihant Publication

R8: General Knowledge and General Awareness - Arihant Manhar Pandey

Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech.	21LSZ402	**Human rights, Women rights and Gender equality**	3	0	0	3

COURSE OBJECTIVES

- To sensitize the Engineering students to various aspects of Human Rights
- To make them understand the world level perspective related to Human Rights
- To identify the constitutional rights of women
- To understand the various political rights and laws related to women
- To understand the gender equality concepts

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**Introduction** Human Rights – Evolution of the concept of Human Rights - Meaning, origin and Development. Notion and Classification of Rights – Natural, Moral and Legal Rights, Civil and Political rights. Economic, Social and Cultural Rights - Theories of Human Rights - Philosophical foundations of Human Rights	9
II	**Human Rights national and international perspective** Human Rights in India – Constitutional Provisions / Guarantees – Redressal Mechanisms at National and International levels – Constitutional Remedies and Directions of state policy - Geneva Convention of 1864. Universal declaration of Human Rights, 1948. UN agencies to monitor and compliance – UNHRC (United Nations Human Rights Commission)	9
III	**CONSTITUTIONAL RIGHTS OF WOMEN IN INDIA** Indian constitution relating to women - Fundamental rights - Directive principles of state policy - right to equality - rights against exploitation, the right to constitutional remedy - University Declaration of Human Rights - Enforcement of Human Rights for Women and Children - Role of Cells and Counseling Centers - Legal AID cells, Help line, State and National level Commission	9
IV	**POLITICAL RIGHTS OF WOMEN IN INDIA AND LAWS** Political Rights of Women in India - Electoral process - women as voters - candidates and leader - pressure group, Representation of women in local self government – women in Rural and urban local bodies – Reservation of women – Laws against violence & Sexual crimes: eve teasing – rape - indecent representation of women - immoral trafficking	9
V	**GENDER EQUALITY** Gender roles: Biological vs cultural determinism – Private vs public dichotomy – Gender division of labour and asymmetric role structure Gender role socialization and formation of identity –Occupational segregation and wage discrimination – Gender stereotyping in work place – Human development indicators and gender disparity	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1: Engineering students will have the basic knowledge of human rights
CO2: Initiates the students to know the various national and international perspectives of human rights
CO3: Gives an orientation on the various rights of women
CO4: Makes them to understand the role of women in politics
CO5: Provides a direction on gender equalities

TEXT BOOKS

1. Kapoor S.K, "Human Rights under International Law and Indian Laws", Central Agency, Allahabad 2014
2. ArunaGoel. (2004). "Violence and Protective Measures for Women Development and Empowerment". Deep & Deep, New Delhi.

REFERENCES BOOKS:

1. Chandra U "Human Rights" Allahabad Law Agency, Allahabad 2014
2. Upandra Baxi "The Future of Human Rights, Oxford Univeristy Press, New Delhi
3. Menonnivedita (2004). "Recovering Subversion: Feminist Politics beyond the Law". Permanent Black, Delhi.
4. Cornick, J.C. and Meyers, M.K. (2009) *Gender Equality: Transforming Family Divisions of Labor*. New York: Verso.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech.	21LSZ403	**Indian Ethos and Human Values**	3	0	0	3

COURSE OBJECTIVES

1. To learn about Indian ethos and its importance today
2. To know about business concepts and philosophies from various perspectives.
3. To know the Indian philosophical system of knowing oneself.
4. To understand values and its significance.
5. To know ethics from western and Indian perspective.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INDIAN ETHOS** Indian Ethos – Models of management in Indian socio-political environment. Indian work ethos and principles of Indian Management – Goals of Life- Teachings of important Indian Spiritual leaders..	9
II	**BUSINESS CONCEPTS AND PHILOSOPHIES** Economics of giving - Western economic system. Developing and implementing gross national happiness - Sabbath economics - Islamic economics and Banking	9
III	**CONSTITUTIONAL RIGHTS OF WOMEN IN INDIA** Indian constitution relating to women - Fundamental rights - Directive principles of state policy - right to equality - rights against exploitation, the right to constitutional remedy - University Declaration of Human Rights - Enforcement of Human Rights for Women and Children - Role of Cells and Counseling Centers - Legal AID cells, Help line, State and National level Commission	9
IV	**POLITICAL RIGHTS OF WOMEN IN INDIA AND LAWS** Political Rights of Women in India - Electoral process - women as voters - candidates and leader - pressure group, Representation of women in local self government – women in Rural and urban local bodies – Reservation of women – Laws against violence & Sexual crimes: eve teasing – rape - indecent representation of women - immoral trafficking	9
V	**GENDER EQUALITY** Gender roles: Biological vs cultural determinism – Private vs public dichotomy – Gender division of labour and asymmetric role structure Gender role socialization and formation of identity –Occupational segregation and wage discrimination – Gender stereotyping in work place – Human development indicators and gender disparity	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1: To impart knowledge on Indian Ethos for inspirational life
CO2: To apply Business concepts and philosophies for broader perspective in society
CO3: To familiarize students about Indian philosophy system to handle life efficiently
CO4: To apply values in day to day functioning for better standard of life.
CO5: To conceptualize ethics from western and Indian perspective

TEXT BOOKS

T1- Nandagopal.R and Ajith Sankar R.N. Indian Ethos and Values in Management, ISBN – 978-0-07-106779-9. Tata McGraw Hill Education Private Ltd, 2011.

T2-Khandelwal.N.M, Indian Ethos and Values for Managers, ISBN 978-93-5024-452-4, 3rd Edition, Himalaya Publishing House, 2011.

REFERENCES BOOKS:

R1-Management Thoughts in Thirukkural by K. Nagarajan – ANMOL Publications PVT Ltd 4374/4B Ansari Road, New Delhi 110 002. 2010

R2-Dr. Radhakrishnan Pillai, Corporate Chanakya, ISBN 978-81-8495-133-2, Jaico Publishing House, 2016

R3-Soham, LEEP (Life Empowerment and Enrichment Program), ISBN 9788175977259 Central Chinmaya Mission Trust, 2017. .

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech.	21LSZ404	**Indian Constitution and Political System**	3	0	0	3

COURSE OBJECTIVES

- Teach history and philosophy of Political Science.
- Describe the Indian Constitution and fundamental rights.
- Summarize powers and functions and Emergency rule of Indian government.
- Explain Local Governance.
- Converse the challenges to Indian Democracy

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION** Meaning, Nature and Scope of Political Science – Significance of Political Science as a Discipline - Approaches to the study of Political Science – Key Concepts: State, Nation and Sovereignty - Political Science as a Science or an Art .	9
II	**CONSTITUTION OF INDIA & FUNDAMENTAL RIGHTS** Meaning of the constitution law and constitutionalism – Historical perspective of the constitution of India – salient features and characteristics of the constitution of India. Scheme of the fundamental rights – fundamental duties and its legislative status – The directive principles of state policy –Rights of women and Children - Constitutional Remedies for citizens	9
III	**PARLIAMENTARY FORM OF GOVERNMENT AND EMERGENCY PROVISIONS** The constitution powers and the status of the president in India. – Amendment of the constitutional powers and procedures – Emergency provisions: National emergency, President rule, Financial emergency.	9
IV	**LOCAL GOVERNANCE** Panchayati Raj and Municipal Government; Structure, Power & Functions; Significance of 73rd and 74th Amendments; Changes in Rural Power structure and empowerment of the marginalized groups such as SCs/STs and Women	9
V	**CHALLENGES TO INDIAN DEMOCRACY** Caste, class, ethnicity and gender in Indian politics; Criminalization and corruption, politics of regionalism, communalism, backward class and Dalit movements, Tribal people movements, struggle for gender justice	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1: Understand the history of Indian Constitution

CO2: Understand fundamental rights and fundamental duties.

CO3: Understand the Parliamentary form of Government and Challenges to Indian Demorcracy

TEXT BOOKS

T1 - Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi, 1997.

T2 - Agarwal R C., "Indian Political System", S.Chand and Company, New Delhi, 1997.

T3 - Johari,J.C. Principles of Modern Political Science. New Delhi: Sterling, 1989.

T4 - Sharma K L., "Social Stratification in India: Issues and Themes", Jawaharlal Nehru University, New Delhi, 1997.

REFERENCES BOOKS:

R1 - Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.

R2 - Gahai U R., "Indian Political System ", New Academic Publishing House, Jalaendhar.

R3 - Sharma R N., "Indian Social Problems ", Media Promoters and Publishers Pvt. Ltd.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech.	21LSZ405	**Yoga for Human Excellence**	2	0	2	3

COURSE OBJECTIVES

Understanding of
(1) Structure and functions of Human Body,
(2) Importance of Physical Exercises and various Medical systems
(3) Life force and Philosophy of Kaya Kalpa
(4) Mind and its functions and Meditation Practices.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**PHYSICAL STRUCTURE** • Purpose of life - life - yoga - modern life style - importance of physical health • Physical structure - combination of five elements - three forms of body. • Blood circulation system - Respiratory system. • Nervous system - Digesting system.	9
II	**FUNCTIONS OF PHYSICAL BODY** Three circulations - disease, pain and death - causes for disease. • Limit and method in five aspects - food, work, sleep, sensual pleasure and thought. • Importance of physical exercises - Simplified Physical Exercises - Rules and regulations. • Food and Medicine - yogic food habits - natural food - naturopathy - Medical systems: Allopathy, Siddha, Ayurvedha, Unani and Homeopathy.	9
III	**REJUVENATION OF LIFE-FORCE** Philosophy of Kaya kalpa - Physical body - Sexual vital fluid - Life force - Bio-Magnetism - Mind. • Anti-ageing and postponing death - Kayakalpa Practical - benefits. • Sex and spirituality - value of sexual vital fluid - married life - chastity. • Functional Relationships of body, life force and mind.	9
IV	**MIND** Bio-magnetic wave - Mind - imprinting and magnifying - Eight essential factors of living beings. • Mental Frequency - functions of mind - five layers. • Ten stages of mind Benefits of meditation - habitual imprints - understandable imprints. • Importance of meditation - benefits of meditation.	9
V	**MEDITATION** Simplified Kundalini Yoga - greatness of guru - types of meditation • Agna meditation - explanation - benefits. • Santhi meditation - explanation - benefits - clearance of spinal cord - benefits. • Thuriam meditation - explanation - benefits - Thuriyatheetham meditation - explanation - benefits.	9
	Total Instructional Hours	**45**

TEXT BOOKS

T1 - Yogic Life - VISION, Vethathiri Publications.

REFERENCES BOOKS:

R1 - Vethathiri Maharishi, Yoga for Modern age, 2017, Vethathiri Publications, Erode.
R2. Vethathiri Maharishi, Mind, 2017, Vethathiri Publications, Erode.
R3. Dr.Mathuram Sekar, Medicine and Health, Narmadha Publications.
R4. Vethathiri Maharishi, Simplified Physical Exercises, 2013, Vethathiri Publications, Erode.
R5. WCSC-VISION for Wisdom, Yogasanas, 2012, Vethathiri Publications, Erode.

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	21HE1074	NCC General and National Integration	1	0	0	1

Course Objectives:

1. Know about the history of NCC, its organization and incentives of NCC cadets for their career prospects.
2. Understand the concept of national integration and its importance.
3. Understand the practices of health and hygiene and importance.
4. Be motivated to serve the nation by joining Armed forces .
5. Appreciate grace and dignity in the performance of foot drill.

Unit	Description	Instructional Hours
I	**ORGANIZATION OF NCC** NCC General - Aims and Objectives - Motto of NCC - Organization - training and NCC song - History of NCC - Incentives of NCC - Duties of NCC cadets.	3
II	**NATIONAL INTEGRATION** Introduction to National Integration - Major religions in India - Importance and Necessity of National integration - Unity in diversity - Factors affecting National integration - Threats to national security - Benefits of National Integration.	3
III	**HEALTH AND HYGIENE** Structure and function of a human body - health and sanitization - Infectious and contagious diseases and its prevention.	3
IV	**ARMED FORCES AND GENERAL SERVICE KNOWLEDGE** Basic Organization of Armed Forces - Army, Navy and Airforce - Equivalent Ranks in Defence services - History of the Armed Forces - modes of entry in Indian Armed forces.	3
V	**FOOT DRILL** Basics of drill - File formation -Basics of foot drill - word of command - Savdhan - Vishram - Aram se - Thahine mud - Baye mud - piche mud - Thej chal - Tham - kadham thal.	3

Course Outcome:

CO1: Imbibe the conduct of NCC cadets. And exposure of NCC organization
CO2: Respect the diversity of different Indian culture.
CO3: Provide good health by hygiene living.
CO4: Understand about Indian Armed forces and effective contribution.
CO5: Provide and follow the different word of command

Reference :

1. UGC and AICTE circulated syllabus.

Text Books :

1. NCC cadet Guide (SD/SW) Army
2. NCC cadet Guide (SD/SW) Airforce.
3. ANOs Guide (SD/SW) by DG NCC, Ministry of Defence, New Delhi
4. Digital Forum App 1.0 & 2.0, by DG NCC DG NCC, Ministry of Defence, New Delhi

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	21HE2074	Social services and community development	1	0	0	1

Course Objectives:

1. Acquire the knowledge and active participate in social service and community development activities.
2. Understand the concept of disaster management and role of NCC cadets in disaster management..
3. Understand the concept thinking and reasoning process..
4. Understand about maps and use of bearing and service protector
5. Know about the principles of flight and Aerofoil structure and ATC procedures.

Unit	Description	Instructional Hours
	SOCIAL SERVICES AND COMMUNITY DEVELOPMENT	
I	Basics of social services and its need - Rural development programs - Contribution of youth towards social welfare - NGOs in social services Swach bharath Abhiyan - Social evils - Mission Indra danush - Beti bacho Beti pado - Digital awareness - Constitution day.	3
	DISASTER MANAGEMENT	
II	Organization of Disaster management -Types of emergencies - Natural and manmade disasters - fire service and fire fighting - prevention of fire.	3
	PERSONALITY DEVELOPMENT	
III	Introduction to personality development - public speaking Intra and Inter personal skills -self awareness - critical thinking - Decision making and problem solving.	3
	MAP READING	
IV	Types of maps - conventional signs - scales and Grid system - relief and contour gradient - cardinal points - Types of North - types of bearing and use of service protector - Prismatic compass and its uses - setting of map - finding North and own position.	3
	PRINCIPLES OF FLIGHT AND AIRMANSHIP	
V	Introduction to principle of flight - Forces acting on the aircraft - Angle of attack - Angle of incidence - Newton's - law of motion - Bernauli's theorem and Venturi effect - Aerofoil - Airfield layout - ATC (Air Traffic Control) - circuit procedures - Aviation medicine.	3

Course Outcome:

CO1: Perform the social services on various occasions for better community and social life
CO2: Appreciate the need and requirement for disaster management and NCC role in disaster management activities.
CO3: Define thinking, reasoning, critical thinking and creative thinking
CO4: Use of bearing and service protector and locate the places and objects on the ground.
CO5: Understand the principles of flight and Aerofoil structure.

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	21HE3074	Leadership Qualities and camp activities	1	0	0	1

Course Objectives:

1. Identify the leadership traits.
2. Understand importance of Environmental awareness and conservation.
3. Acquiring awareness about the basic obstacles and weapon system in training
4. Use of terrain effectively for concealment , camouflage, indicate landmarks and give field signals.
5. Obtain Knowledge about Airframes, types of wings and instruments for flying.

Unit	Description	Instructional Hours
	LEADERSHIP DEVELOPMENT	
I	Introduction to Leadership - Leadership traits - indicators - motivation - ethics and Moral values - Honor code - Basics of OLQ (Officer like Qualities).	3
	ENVIRONMENTAL AWARENESS	
II	Water conservation - Sources of water - water cleaning management - Pollution - Types of pollution - Energy sources - Solar, wind, Tidal - Renewable and none renewable energy conversion - waste management - Tree plantation	3
	OBSTACLES AND WEAPON TRAINING	
III	Introduction to weapons - Types of rifles - SLR, .22, INSAS etc., - Firing - Types of Firing position - short range firing - Principles of firing - Holding, Aiming and Triggering. Understanding about obstacle training - Analysis and Process of obstacle training. Precautions carrying on training	3
	FIELD CRAFT AND BATTLE CRAFT	
IV	Introduction to FCBC- Observation, camouflage and concealment. Judging distance - Description of ground - Recognition, description and indication of land mark and target	3
	AIR FRAMES AND INSTRUMENTS	
V	Aircraft control surfaces - Types of Air frames - Types of wings and plane. Landing gear - Basic Flight Instruments - Air speed Indicator (ASI) - Altimeter -Artificial Horizon (AH).	3

Course Outcome:

CO1: Imbibe leadership qualities.
CO2: Contribute in environmental awareness and conservation activities.
CO3: Understand and execute obstacles course and uses of weapons.
CO4: Observe surroundings in better way.
CO5: Understand the design of Aircraft, control surfaces and Airspeed indicator.

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	21HE4074	General awareness, communication and Aero engines	1	0	0	1

Course Objectives:

1. Understand importance of General Awareness.
2. Show Arm drill and ceremonial drill sequences.
3. Get Acquainted with the procedure to treat the wounds and fractures during emergencies.
4. Understand and knowledge about communications networks and Infantry weapons and supporting Arms.
5. Obtain Knowledge about Aero engine, Aero modeling and flying basics.

Unit	Description	Instructional Hours
	GENERAL AWARENESS	
I	Constitution of India - Current affairs - logical reasoning - Types of awards - Indian history and geographical structure - Indian culture - know your country - freedom fighters.	3
	ARM DRILL AND CEREMONIAL DRILL	
II	Arm Drill - Rifle ke sath savdhan, Vishram aur Aram se - Rifle ke saath Parade par aur Saj, Rifle ke saath visarjan, Line Tod - Bhumi Shastra aur Uthao Shastra, Bagal Shastra aur Baju Shastra. Salami sasthra - Squad Drill with Arms – Salute - General Salute - National Salute - ceremonial Drill - Guard of Honour - Gurad mounting.	3
	FIRST AID AND WELLBEING OF HUMAN BODY	
III	First Aid common medical Emergencies - treatment of wounds - Introduction to yoga and daily exercise - Types of Asanas - benefits of yoga and exercises - Balanced Diet food - Health monitors - Immunity development - fight against spread of diseases.	3
	COMMUNICATION , INFANTRY WEAPONS AND SUPPORTING ARMS	
IV	Types of communications - characteristics of wireless communication - Characteristics of 7.65 m SLR - Ammunition - fire power - Stripping, Assebling and Aiming - Supporting Arms - INSAS, Rocket Launcher, Tanks - Army Defence system.	3
	AERO ENGINES, AERO MODELING AND FLYING	
V	Introduction to Aero Engine - types of Aero Engines - Piston and Jet Engines - Principles and working of Aero Engines - history of Aero modeling - types of Aero models - Building and flying of Aero models - Pre flight checking - Start up, taxi and take off - forced landing techniques.	3

Course Outcome:

CO1: Keep abreast of current affairs and general awareness.
CO2: Observe and practice Arm drill with rifle and General salute.
CO3: Follow healthy personal hygiene practices and provide first aid in emergencies.
CO4: Observe and characteristics of Radar communication, SLR characteristics and functioning of tanks.
CO5: Understand principle and working of piston engine and jet engine. Aero modeling procedures and flying controls.

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Course Code	Course Name	Course Duration
21VACH01	Industrial Automation	30 Hrs.

Course Objective:

- To make the students program PLC module using ladder logic method through powerful software package and enhance the student knowledge on integrated industrial automation using PLC

Module No	Heading	Subheading	Hours
Module 1	**Introduction to PLC, CPU and Programming**	• Introduction to PLC, PLC size and Application • CPU Block diagram & Memory • PLC Programming Language • Installation and wiring guidelines	4
Module 2	**Hardware, Logic and Control Instructions**	• Addressing & Hardware configuration • NO/NC Concept • Bit Logic Instructions • Control Instructions	5
Module 3	**Various Operations**	• Comparison operation • Conversion Operations • Math Instructions	3
Module 4	**Tools**	• Timers • Counters	4
Module 5	**Programming with PLC**	• For the Lamp Circuit • For Actuating Single Acting Cylinder • For Water Level Control of Two Different Water Tanks • For Material Handling System • For Stamping System • For Spray Painting System • For Bottle Filling System	14
		Total Contact Hours	30 Hours

Course Outcomes:

At the end of the course the students will able to

- Interface the hardware component in real time environment
- Program, Simulate and run the various industrial applications through PLC module

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Course Code	Course Name	Course Duration
21VACH02	Bulk Solid Handling for Chemical Engineers	30 Hrs.

Course Objective:

- To study about detailed design, safety and environment aspects, commissioning of value chain and equipment procurement to handle bulk solids. And also, the persons who involved to solve and prevent the flow problems.

Module No	Heading	Subheading	Hours
Module 1	**Introduction on bulk solid and handling of bulk solids**	• Concepts and role of unit operation in process industries, Introduction on bulk solid and handling of bulk solid. • Explanation in coal industry.	3
Module 2	**Classification and Flow ability**	• Particle shape, particle size, classification of bulk solids, comparison of solids and liquids in flow ability of solids. • Explanation of Iron and Steel Industries	3
Module 3	**Bulk solid flow**	• Hourglass flow, flow through model deflector, flow patterns, bulk solid flow differ from fluid flow, wall friction, compressibility, permeability. • Other properties affect the flow of solids through various types of feeders, blenders, chutes, bins, and hoppers.	6
Module 4	**Mixing**	• Reduction of segregation, sampling, size reduction, energy requirement and product size distribution, mixing and agitation - mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers**.**	3
Module 5	**Blending and Segregation**	• Blending- convection, diffusion, blend quality, segregation testing of powders and solids-fluidization, shifting, vibration. • Explanation of mining industry	3
Module 6	**Bulk Solid handling Fertilizer Plants**	• Process Flow diagram, equipment specification process, parameters, control the process and case study. • Explanation of fertilizer industry for bulk handling	3
Module 7	**Solid bulk material handling in Refineries & Petrochemical plant**	• Practical Application and role of chemical engineers in Solid bulk material handling in Refineries & Petrochemical plant, Equipment's used in refineries. • Explanation of Refinery Industries	3
Module 8	**Case study, Group Discussion & Assessment**	• Transfer Chute Plugging Solved at Iron Ore Export Terminal • Gypsum Flow Problems Solved at Lafarge Cement • *Coal Feeding: Pressure-Sealing Solids Pump Improves Feed*	6
		Total Contact Hours	30 Hours

Course Outcomes:

- To Understand how to specify and select hardware recommended for bulk solid flow problems and objectives; also, to remodel of equipment to correct the flow problems.
- To Understand the handling of solid materials in fertilizer industry, Refinery Industry and the equipment's used in varying configurations in order to meet their specific needs
- To Understand and solve flow problems which involve production lost, extra labor, unreliable equipment, poor quality control, downtime of plant and waste material

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Course Code	Course Name	Course Duration
21VACH03	Fundamentals of AI and it's Chemometric Applications	30 Hrs.

Course Objective:

- This course will provide an insight to Apply AI into Chemical Engineering.

Module No	Heading	Subheading	Hours
Module 1	**Introduction to AI**	• Definition, types of tasks (classification, regression, etc.), supervised vs unsupervised learning, major AI techniques & applications, basic terminology (data, label, machine learning vs deep learning, etc.)	5
Module 2	**Workflow**	• Data collection, exploratory data analysis (EDA), pre-processing, model selection, model evaluation, deployment	5
Module 3	**Exploratory data analysis**	• Wine quality dataset background, physico-chemical data (input variables) explanation, basic metrics (count, mean, quartiles, etc), graphical visualization (histogram, box plot, scatter plot, correlation matrix, etc), dimensionality reduction (PCA, LDA, LLE, etc).	5
Module 4	**Data pre-processing**	• Standardization, normalization, scaling.	5
Module 5	**Model selection, training & evaluation**	• Train/dev/test sets, commonly used models - linear regression, logistic regression, SVM, kNN, random forest, neural networks. Evaluation metrics (loss functions), model selection criteria's (resampling methods - train-test split, cross-validation).	5
Module 6	**Improving ML models.**	• Bias & variance, hyper parameter tuning (orthogonalization strategy), overfitting & underfitting, regularization, training final model	5
		Total Contact Hours	30 Hours

Course Outcomes:

- To Understand about the AI techniques & and its applications.
- To Understand about the data collection, evaluation and data analysis.
- To Understand about data processing and normalization.
- To Understand about the model selection and evaluation.
- To Understand about regularization and final model

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Course Code	Course Name	Course Duration
21VACH04	Introduction to Chemical Engineering MATLAB	30 Hrs.

Course Objective:

- **To enable the students to carry out mathematical modelling related to process design, control and optimization by using MATLAB.**

Module No	Heading	Subheading	Hours
Module 1	**Introduction to MATLAB Programming**	• Basics of MATLAB programming • Array operations in MATLAB • Basic notations in MATLAB	7
Module 2	**MATLAB Components**	• Loops and execution control • Working with files: Scripts and Functions • Plotting and program output	7
Module 3	**Ordinary Differential Equations (ODE) in MATLAB**	• Introduction to ODEs • MATLAB ode45 algorithm in single variable • MATLAB ode45 algorithm in multiple variables	4
Module 4	**Simu Link Basics**	•Introduction to Simulink • Components of Simulink	4
Module 5	**Final Project**	•In this Module, you will do a project based on what you have learned so far, for example: - • **Iso-Thermal Batch Reactor** • **Dynamic Simulation of Two tank Interacting system.** • **Simulation of Double pipe Heat Exchanger using Simulink.**	8
		Total Contact Hours	30 Hours

Course Outcomes:

- To understand the mathematical operation using MATLAB programming.
- To understand the components of MATLAB programming and its executions.
- To understand the simulation and optimization of Chemical Engineering Unit Operation system using Simulink.

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Course Code	Course Name	Course Duration
21VACH05	IoT- Basics and Application in unit operations.	30 Hrs.

Course Objective:

- To develop the ability to apply the IoT tools and its components in the field of various Unit Operations.

Module No	Heading	Subheading	Hours
Module 1	Introduction to IoT	• IoT definition ad Characteristics • IoT Complete Architectural Stack • IoT enabling Technologies • IoT Challenges	6
Module 2	Sensors and Hardware for IoT	• Hardware Platforms – Arduino, Raspberry Pi, Node MCU.	6
Module 3	Protocols for IoT	• Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols.	5
Module 4	Lab Practice	• A Case study with any one of the boards and data acquisition from sensors. • A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions. • IoT based performance monitoring and control in counter flow double pipe heat exchanger. • IOT-based monitoring of lab scale constitutive landfill model of food waste.	6 7
Module 5	Final Project		
	Total Contact Hours		30 Hours

Course Outcomes:

- To Understand the definition and significance of the Internet of Things.
- To Understand the characteristics of IoT components and its Tools.
- To Understand the Design and development of IoT based sensor systems.
- To Understand the need for IoT Trust and variants of IoT

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