HINDUSTHAN

COLLEGE OF ENGINEERING ANDTECHNOLOGY

(An Autonomous Institution)

Coimbatore– 641032

DEPARTMENT OF CHEMICAL ENGINEERING

CURRICULUM

(UNDER REGULATIONS 2022)

(Academic Council Meeting held on 03.03.2023)

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

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**	அறிவியல்தமிழ்/Indian Constitution	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**	**தமிழர்மரபு**/ 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
			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											
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.

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

		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	22CH5231	Introduction to Chemical Process	MDC	3	0	0	3	3
2	22CH6231	Fluid Flow Operations in Chemical Engineering	MDC	3	0	0	3	3
3	22CH6232	Fundamentals of Chemical Thermodynamics	MDC	3	0	0	3	3
4	22CH7231	Process Heat and Mass Transfer	MDC	3	1	0	4	4
5	22CH7232	Reaction Engineering	MDC	3	0	0	3	3
6	22CH8231	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	22CH5203	Process Flow Sheeting	MDC	2	0	2	4	3
2	22CH6202	Transport Phenomena	MDC	3	1	0	3	4
3	22CH6203	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	22CHXXXX	Polymer Chemistry	MDC	3	0	0	3	3
2	22CHXXXX	Processing Technology	MDC	3	0	0	3	3
3	22CHXXXX	Rubber Technology	MDC	3	0	0	3	3
4	22CHXXXX	Polymer Product Design, Blends, and Alloys	MDC	3	0	0	3	3
5	22CHXXXX	Polymer Structure and property relationships	MDC	3	0	0	3	3
6	22CHXXXX	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	22CHXXXX	Petroleum Geology	MDC	3	0	0	3	3
2	22CHXXXX	Petroleum Exploration	MDC	3	0	0	3	3
3	22CHXXXX	Drilling Technology	MDC	3	0	0	3	3
4	22CHXXXX	Petroleum Production Engineering	MDC	3	0	0	3	3
5	22CHXXXX	Petroleum Reservoir Engineering	MDC	3	0	0	3	3
6	22CHXXXX	Offshore Engineering	MDC	3	0	0	3	3

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

Course Objective

1. Construct the characteristic polynomial of a matrix and use it to identify eigenvalues and Eigenvectors
2. To impart the knowledge of sequences and series.
3. Analyseanddiscussthemaximaandminimaofthefunctionsofseveralvariables.
4. Evaluate the multiple integrals and apply in solving problems.
5. Apply 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, Jacobian, Maxima, minima and saddle points; Method of Lagrange 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; 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: Compute partial derivatives of function of several variables and write Taylor's series for functions with two variables.
CO4: Evaluate multiple integral and its applications in finding area, volume.
CO5: Apply the concept of vector calculus in two and three dimensional spaces.

TEXTBOOKS:

T1:G.B.ThomasandR.L.Finney,"CalculusandAnalyticalGeometry",9thEdition Addison Wesley Publishing company,2016.
T2:Erwin Kreyszig,"Advanced Engineering Mathematics",JohnWiley&Sons,2019.
T3:K.P.UmaandS.Padma,"Engineering MathematicsI(MatricesandCalculus) ",PearsonLtd,2022.

REFERENCEBOOKS:

R1-JerroldE.Marsden,AnthonyTromba,"VectorCalculus",W.H.Freeman,2003
R2-StraussM.J,G.L.Bradley and K.J.Smith,"Multivariable calculus",PrenticeHall,2002.
R3-VeerarajanT,"Engineering Mathematics",McGraw Hill Education(India)PvtLtd,NewDelhi,2016.

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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/sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/I	22HE1151	ENGLISH FOR ENGINEERS- (Common to all Branches)	2	0	2	3

Course Objective

1. To improve the communicative proficiency of learners
2. To help learners use language effectively in professional writing
3. To advance the skill of maintaining the suitable one of communication.
4. To introduce the professional life skills.
5. To impart official communication etiquette.

Unit	Description	Instructional Hours
I	**Language Proficiency:** Types of Sentences, Functional Units, Framing question. **Writing:** process description, Writing Checklist. **Vocabulary** – words on environment. **Practical Component: Listening**- Watching short videos and answer the questions, **Speaking-** Self introduction, formal & semi-formal	7+2
II	**Language Proficiency**: Tenses, Adjectives and adverbs. **Writing:** Formal letters (letters conveying positive and negative news), Formal and informal email writing (using emoticons, abbreviations& acronyms), reading comprehension. **Vocabulary**– words on entertainment. **Practical Component: Listening-**Comprehensions based on TED talks **Speaking-** Narrating a short story or an eventh appened in their life	7+2
III	**Language Proficiency:** Prepositions, phrasal verbs. **Writing:** Formal thanks giving, Congratulating, warning and apologizing letters, cloze test. **Vocabulary** – words on tools.**PracticalComponent:Listening**-Listentosongsandanswerthequestions **Speaking-** Justaminute	5+4
IV	**Language Proficiency:** Subject verb concord, Prefixes & suffixes. **Writing:** Preparing agenda &minutes, writing an event report. **Vocabulary**– words on engineering process. **Practical Component: Listening-** Comprehensions based on Talk of orators or interview shows **Speaking-**Presentation on a general topic with ppt.	5+4
V	**Language Proficiency:** Modal Auxiliaries, Active & passive voice, **Writing:** Project report (proposal&progress), 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.	6+3
	TotalInstructionalHours	**45**

Course Outcome

CO1:To communicate in a professional forum
CO2:To speak or write a content in the proficient language
CO3:To maintain and use appropriate tone of the communication.
CO4:To read,write and present in a professional way.
CO5:To follow the etiquettes in formal communication.

TEXTBOOKS:

T1- Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press.2016.T2-Raymond Murphy, "Essential English Grammar", Cambridge UniversityPress,2019.

REFERENCEBOOKS:

R1- Meenakshi Raman and Sangeetha Sharma. "Technical Communication- Principles and Practice", OxfordUniversityPress, 2009.

R2-RaymondMurphy, "EnglishGrammarinUse"-4theditionCambridgeUniversityPress,2004.

R3-KamaleshSadanan"AFoundationCoursefortheSpeakersofTamil-Part-I&II",OrientBlackswan,2010.

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Course Code & Name : 22ME1201/ ENGINEERING DRAWING

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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	3	1	2	1	1	-	1	-	2	2	-	1
CO5	2	3	3	2	2	1	1	-	1	-	1	2	-	-
Avg	2	2.6	2.6	1.4	1.4	1	1	-	1	-	1.2	2	-	1

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Programme/sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/I	22PH1151	PHYSICS FOR NON- CIRCUIT EGINEERING	2	0	2	3

Course Objective

The student should be able to

1. Gain knowledge about laser, their applications and Conversant with principles of optical fiber, types and applications of optical fiber
2. Enhance the fundamental knowledge in properties of matter
3. Extend the knowledge about wave optics
4. Gain knowledge about magnetic materials.
5. Acquire fundamental knowledge of nano materials which is related to the engineering program

Unit	Description	Instructional Hours
I	**LASER AND FIBRE OPTICS**	6
	Spontaneous emission and stimulated emission –Type of lasers – Nd:YAG laser - Laser Applications – Holography – Construction and reconstruction of images. Principle and propagation of light through optical fibers – Derivation of numerical aperture and acceptance angle – Classification of optical fibers (based on refractive index and modes) – Fiber optical communication link.	3
	Determination of Wavelength and particle size using Laser	
II	**PROPERTIES OF MATTER**	
	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	6
	Determination of Young's modulus by uniform bending method	3
	Determination of Rigidity modulus – Torsion pendulum	3
III	**WAVE OPTICS**	6
	Interference of light – air wedge –Thickness of thin paper - 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	3
	Determination of thickness of a thin wire – Air wedge method	3
IV	**QUANTUM PHYSICS**	6
	Black body radiation –Compton effect: theory and experimental verification – wave particle duality –concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box .	
V	**THERMAL PHYSICS**	6
	Transfer of heat energy –thermal conduction, convection and radiation – thermal conductivity - Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – applications: solar water heaters.	
	Total Instructional Hours	45

Course Outcome

After completion of the course the learner will be able to

CO1: Understand the advanced technology of LASER and optical communication in the field of Engineering
CO2: Illustrate the fundamentalproperties of matter
CO3: Discuss the Oscillatory motions of particles
CO4: Understand the advanced technology of magnetic materials in the field of Engineering
CO5: Develop the technology of smart materials and Nano materials in engineering field

TEXT BOOKS:

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, DhanpatRai Publications (P) Ltd., New Delhi, 2015.

REFERENCE BOOKS:

R1 - M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., New Delhi2016
R2 -Dr. G. Senthilkumar "Engineering Physics – I" VRB publishers Pvt Ltd., 2021

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Course Code & Name : 22PH1151/PHYSICS OF MATERIALS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	1	1	-	1	-	2	3	3	2
CO2	3	3	2	2	1	1	1	-	1	-	2	2	3	1
CO3	3	3	2	2	2	1	1	-	1	-	1	2	2	2
CO4	3	2	3	1	3	1	1	-	1	-	1	2	2	1
CO5	3	2	3	1	2	1	1	-	1	-	2	2	2	1
Avg	3	2.6	2.6	1.6	2.2	1	1	-	1	-	1.6	2.2	2.4	1.4

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Programme/sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/I	22IT1151	PYTHON PROGRAMMING AND PRACTICES	2	0	2	3

Course Objective

The learner should be able to

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

Unit	Description	Instructional Hours
I	**ALGORITHMIC PROBLEM SOLVING**	
	Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).	5
	Illustrative problems: To find the Greatest Common Divisor (GCD)oftwo numbers, Fahrenheit to Celsius, Perform Matrix addition.	4
II	**DATA, STATEMENTS,CONTROL FLOW**	
	Data Types, Operators and precedence of operators, expressions, statements, comments; Conditionals: Boolean values and operators, conditional (if), alternative (if -else), chained conditional (if –elif-else); Iteration: state, while, for, break, continue, pass;	5
	Simple algorithms and programs: Area of the circle, check the given year is Leap year or not, Factorial of a Number.	4
III	**FUNCTIONS, STRINGS**	
	Functions, parameters and arguments; Fruitful functions: return values, local and global scope, function composition, recursive functions. Strings: string slices, immutability, string functions and methods, string module.	5
	Illustrative programs: Perform Linear Search, Selection sort, Sum of all elements in a List, Pattern Programs	4
IV	**LISTS, TUPLES, DICTIONARIES**	5
	Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, listparameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations andmethods; advanced list processing - list comprehension.	
	Illustrative programs: List Manipulation, Finding Maximum in a List, String processing.	4
V	**FILES, MODULES, PACKAGES**	
	Files and exception: text files, reading and writing files, errors and exceptions, handling exceptions, modules, packages	9
	Illustrative programs: Reading writing in a file, word count, Handling Exceptions	
	Total Instructional Hours	45

Course Outcome

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

CO1: Develop algorithmic solutions to simple computational problems

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

CO3: Structure simple Python programs for solving problems and Decompose a Pythonprogram into functions

CO4: Represent compound data using Python lists, tuples, dictionaries

CO5: Read and write data from/to files in Python Programs.

TEXT BOOKS:

T1: Guido van Rossum and Fred L. Drake Jr. An Introduction to Python – Revised and updated for Python 3.6.2. Shroff Publishers. First edition (2017).

T2:S. Annadurai. S.Shankar. I.Jasmine. M.Revathi. Fundamentals of Python Programming. Mc-Graw Hill Education (India) Private Ltd. 2019

REFERENCE BOOKS:

R1:CharlesDierbach, —Introduction to Computer Science using Python: A Computational Problem- Solving Focus, Wiley India Edition, 2013.
R2:Timothy A. Budd, —Exploring Python!, Mc-Graw Hill Education (India) Private Ltd., 2015
R3:Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016

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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	2	3	3	-	2	-	-	-	-	-	-	2	1	1
CO2	2	3	3	-	2	-	-	-	2	-	-	2	1	1
CO3	2	3	3	-	2	-	-	-	2	-	-	2	1	1
CO4	2	3	3	-	2	-	-	-	2	-	-	2	1	1
CO5	2	3	3	-	2	-	-	-	2	-	-	2	1	1
AVG.	2	3	3	-	2	-	-	-	2	-	-	2	1	1

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Programme/ sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech /I	22HE1071	UNIVERSAL HUMAN VALUES	2	0	0	2

(COMMON TO ALL BRANCHES)

Course Objective

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. TohighlightplausibleimplicationsofsuchaHolisticunderstandingintermsofethicalhuman conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Unit	Description	Instructional Hours
	Introduction to Value Education	
I	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
II6	**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	
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 RightEvaluation Understanding Harmony in the Society	6
IV	**Harmony in the Nature / Existence** Understanding Harmony in the Nature.Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature- Understanding Existence as Co-existence of mutually interacting units in allpervasive spaceRealizing Existence as Co-existence at All LevelsThe 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 ValuesDefinitiveness 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 CaseStudiesStrategies for Transition towards Value-based Life and Profession	6
	Total Instructional Hours	30

Course Outcome

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'Manualfor*AFoundationCourseinHumanValuesandProfessionalEthics*,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, JeevanVidyaPrakashan, Amarkantak,1999.

R4.Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi,2004.

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Course Code & Name : 22HE1071 / UNIVERSAL HUMAN VALUES

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/I	22MC1091	INDIAN CONSTITUTION	2	0	0	0

CourseObjective

1. Sensitizationofstudenttowardsself,family(relationship),societyand nature
2. Understanding(ordevelopingclarity)ofnature,societyandlargersystems,onthebasisofhumanr elationshipsandresolvedindividuals
3. Strengtheningof self-reflection
4. Development of commitment and courage to act

Unit	Description	Instructional Hours
	BASICFEATURESANDFUNDAMENTALPRINCIPLES	
I	Meaningoftheconstitutionlawandconstitutionalism– Historicalperspectiveoftheconstitutionofl ndia– salient features and characteristics of the constitution of India.	6
	FUNDAMENTALRIGHTS	
II	Scheme of the fundamental rights–fundamental duties and its legislative status–The directive principles of state policy–its importance and implementation-Federal structure and distribution Of legislative and financial powers between the union and states.	6
III	**PARLIAMENTARYFORMOFGOVERNMENT** The constitution powers and the status of the president in India.–Amendment of the constitutional Powers and procedures–The historical perspective of the constitutional amendment of India–Emergency provisions: National emergency, President rule. Financial emergency.	6
	LOCALGOVERNANCE	
IV	Local self-government-Rural Local Government-Panchayath Raj, Elections of Panchayat-State Election Commission-Urban Local Government-Amendment Act,Urban Local Government Structures in India	6
	INDIANSOCIETY	
V	Constitutional Remedies for citizens–Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.	6
	Total Instructional Hours	30

Course Outcome

Upon completion of the course, students will be able to
CO1: Understand the functions of the Indian government.
CO2:Understandand abide the rules of the Indian constitution

TEXTBOOKS:

T1-DurgaDasBasu."Introduction to the Constitution of India",PrenticeHall of India, New Delhi.1997.T2-AgarwalRC.,"Indian Political System", S.Chand and Company, New Delni,1997.
T3-Macive r and Page,"Society:An Introduction Analysis",MacMilan IndiaLtd.,NewDelhi.
T4-SharmaKL., "Social Stratification in India: Issues and Themes", Jawah arlal NehruUniversity, NewDelhi,1997.

REFERENCEBOOKS:

R1-Sharma. Brij Kishore,"Introduction to the Constitution of India:,Prentice Hall of India, NewDelhi.R2-GahaiUR.,"Indian Political System",New Academic Publishing House, Jalaendhar.
R3-Sharma RN.,"Indian Social Problems",Media Promoters and Publishers Pvt.Ltd.

Chairman, Board of Studies

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Programme/sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/I	22HE1072	ENTREPRENEURSHIP & INNOVATION	1	0	0	1

1. To acquiretheknowledgeandskillsneededtomanagethedevelopmentofinnovation.
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 the seplans.
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**

Course Outcome

CO1: Understand the nature of business opportunities, resources, and industries incritical and creative 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 lforanewventure,includingcustomerneed,competitors,andindustryattractiveness..
CO5:Develop a business model for a new venture, including revenue. Margins, operations, Working capital, and investment

TEXTBOOKS

T1:AryaKumar"Entrepreneurship–Creating and leading an Entrepreneurial Organization",Pearson, Second Edition(2012).
T2:EmrahYayici"Design Thinking Methodology", Artbiztech,First Edition(2016).

REFERENCEBOOKS

R1: Christopher Golis "Enterprise & Venture Capital", Allen &Unwin Publication, Fourth Edition (2007).
R2:Thomas Lock Wood & EdgerPapke"Innovation by Design",Career Press.com,SecondEdition(2017).
R3:JonathanWilson "Essentials of Business Research", Sage Publication, First Edition(2010).

WEBRESOURCES

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

Chairman, Board of Studies

Principal / Dean (Academics)

HINDUSTHAN
EDUCATIONAL AND CHARITABLE TRUST

HICET

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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ACADEMIC COUNCIL * HINDUSTHAN COLLEGE OF ENGG & TECH * Chairman

DEAN ACADEMICS
Dean (Academics)
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Coimbatore – 641 032

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.	[illegible]	[illegible]	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	தமிழர் மரபு/ 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	[illegible]	[illegible]	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	[illegible]	[illegible]	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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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

Course Objective

The student should be able to

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:** [redacted]	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; [redacted] - 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. [redacted]	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. [redacted]	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	PO10	PO11	PO12	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

The student should be able to

Course Objective

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. [redacted]	9
III	**SECOND LAW OF THERMODYNAMICS** : Statements of the second law of thermodynamics, heat engine, [redacted] and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, [redacted] 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. [redacted]	9
V	**COMPRESSIBLE FLUID FLOW& STEAM ENGINES**: Duct flow of compressible fluids, Compression and expansion processes, steam power plant, internal combustion engines, [redacted] 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:** [redacted] -Various Mean Diameters – Screen Analysis Standard Screens – Various Industrial Screens. **Sieve analysis.**	6+3
II	**SIZE REDUCTION:** [redacted] -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), 3 rd 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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Program me	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	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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	Course Code	Name of the Course	L	T	P	C
Programme 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-	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-	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	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 R	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 types and properties-Paraffin, microcrystalline, synthetic waxes.- wax deoiling-solvent deoiling, centrifugal separation, refrigerated crystallization. -Wax Refining:hydro treating of wax, filtration and bleaching- molding and storage	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Describe 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	Identify 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. 6th edition 2017

T2 Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2022 Edition.

T3 J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 6th Edition, 2020.

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,2nd edition, 2015

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5303 R	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. Solvent Deasphalting (SDA), Advanced Carbon Rejection Processes.	9
II	**CATALYTIC CRACKING** : Principles of catalytic cracking-mechanisms- FCC- main reaction of FCC- role of FCC in refinery Fluidization- feedstocks/products/yield pattern-Specialized FCC Technologies.	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-Hydro cracking process. Advanced Hydro cracking: Single-stage vs. Two-stage Systems, Zeolite-based Catalysts	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. Digital Twin Application in Process Optimization and Control.	9
V	**FINISHING PROCESSES AND UTILITIES :** Sources of sulfur in refinery-types of sulfu compounds in crude-sweetening processes- Cryogenic distillation of air to N2 and O2 production- Instrument air operation.Cryogenic Air Separation for High-purity Gases (O_2 , N_2 , Ar). Instrument Air Systems with Smart Monitoring.Utility Integration: Steam and Power Optimization, Energy Recovery Systems	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Analyze the principles, mechanisms, and operational variables involved in thermal 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	2	2	1	1	2	2	2	2	2	1	2	1	3	2
CO2	1	2	1	2	2	2	2	1	1	2	2	2	3	1
CO3	2	1	1	2	2	2	1	2	2	2	2	1	3	2
CO4	1	2	1	1	2	1	1	2	1	2	2	1	3	2
CO5	1	1	1	1	2	2	1	1	2	1	1	2	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5304 R	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. Types of storage.	9
II	**BIOGAS TECHNOLOGY:** Feedstock for producing biogas; Microbial and biochemical aspects and operating parameters for biogas production, Kinetics and mechanism. Effect of Feedstock and Process Variables. 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:** Basic Principles of Gasification. Thermo chemical principles: Effect of pressure, temperature and introducing steam and oxygen. Design and operation of Fixed and Fluidized Bed Gasifies, Safety aspects. Scaling up of emerging technologies.	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. Environmental Regulations and Emission Standards.	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	3	2	-	-	-	-	2	-	-	-	-	1	-	-
CO2	3	2	2	-	1	1	2	-	-	-	-	1	-	2
CO3	3	2	2	1	1	-	2	-	-	-	-	1	3	3
CO4	3	2	2	2	1	-	3	-	-	-	-	1	-	-
CO5	3	3	2	2	2	-	3	-	-	-	-	1	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5305 R	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, Global and Indian energy scenario, Government policies and incentives for renewable energy in India.	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. Biofuels: biodiesel and ethanol production and applications, Geothermal Resources, Geothermal Technologies.	9
IV	**WIND ENERGY:** Wind Resources. Wind Turbines. Environmental Impact. Data and energy estimation. Conversion. Wind mill Performance and applications. Wind Energy Conversion Systems. Layout of wind farms.	9
V	**TIDAL ENERGY:** Design and Operation of Tidal Plants .Ocean Energy Potential against Wir and Solar. Wave Characteristics and Statistics. Wave Energy Devices. Tide Energy Technologie 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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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	-	2	-	2	-	-	2	3	3
CO2	3	3	3	2	3	-	2	-	2	-	-	2	3	3
CO3	3	3	3	2	3	-	2	-	2	-	-	2	3	3
CO4	3	3	3	2	3	-	2	-	2	-	-	2	3	3
CO5	3	3	3	2	3	-	2	-	2	-	-	2	3	3

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5306 R	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:** Definition, Basics & Objectives of Pinch Technology. Thermodynamic review of the process, Pinch Concept, significance of pinch, pinch in grid representation, Threshold problems, capital cost implication of the pinch. Areas of applications of Pinch Technology	9
II	**TARGETING**: Minimum Utility Usage, Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, and continuous targeting.	9
III	**PINCH METHODOLOGY**: Fundamental principles of process integration. 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. Pinch Design Methods, Heat Exchanger Network (HEN).	9
V	**ENERGY AND RESOURCE ANALYSIS OF VARIOUS PROCESSES:** Basic objective, The plus-minus principle, appropriate placement applied to unit operations, Batch process, distillation process, evaporation process, reaction process, process usin 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 Ian C. Kemp., "Pinch Analysis and Process Integration" Elsevier, UK, 2006

T3 Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000.

T4 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

R5 De Gruyter., Pinch Technology., De Gruyter 2022

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

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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, pl 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	2	-	-	-	-	1	2	1	2	2	1	1	3	2
CO2	2	-	-	-	-	1	2	1	2	2	1	1	3	1
CO3	2	-	-	1	1	1	2	1	2	2	1	1	2	2
CO4	2	-	-	1	1	1	2	1	2	2	1	1	2	2
CO5	2	1	1	1	2	1	2	1	2	2	2	2	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5308 R	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 chemic and biochemical processing overview of biological basics, About cells and its growth, th stoichiometry of microbial growth and product Bioprocesses: Cultivation of microorganisms i bioreactors, Downstream Processing and 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, Non-Newtonian behavior in viscous broths.	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, Scale-Up and Scale-Down of Bioreactors	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, Dimensional Analysis and Transport Analogies.	9
V	**BIOETHICS AND BIOSAFETY:** Introduction to Bioethics. Social and ethical issues, th process of biotechnology involved in generating new forms of life for informed decisic making, Definition of Biosafety. Difference between bioethics and biosafety, Biosafety Leve and Laboratory Practices, Biosafety for human health and environment. Social and ethic 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	2	1	1	2	1	1	2	2	1	1	1	2	3	2
CO2	2	2	2	2	1	1	2	2	2	1	1	2	3	1
CO3	2	3	3	2	2	1	2	2	2	1	1	2	3	2
CO4	2	3	3	2	2	1	2	2	2	1	2	2	3	2
CO5	2	1	1	2	2	1	2	3	3	2	2	2	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5309 R	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, Submerged fermentation, solid state fermentation, Kinetics of fermentations, Applications of biosensors in industrial fermentation, 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, Influence of environmental stress on microbial growth dynamics.	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, Scale-up considerations, 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, Bioprocess data acquisition systems, Advanced Instrumentation for Bioprocess Control and Automation.	9
V	**FERMENTATION AND COMMODITY PRODUCTS:** Engineering of Secretory Pathways, production of heterologous proteins, microbial cell factories, fungal, yeast fermentation of industrial products, biosurfactants and biopolymers production.	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	1	1	1	2	2	2	2	1	1	2	3	2
CO2	1	2	1	2	2	2	2	2	2	1	1	2	3	1
CO3	1	2	3	3	3	2	2	2	2	1	2	2	3	2
CO4	2	3	3	2	2	1	2	2	2	1	2	2	3	2
CO5	1	2	2	2	3	2	2	2	2	2	2	2	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5310	REFINERY ADVANCEMENTS AND ENVIRONMENTAL REGULATIONS	3	0	0	3

Course Objective

The student should be able to

1. Learn the advanced techniques, automation, units integration and instrumentation techniques in refinery.
2. Understand the environmental regulations, safety and government policies on refinery
3. Analyze the energy saving techniques and refinery economics.

Unit	Description	Instructional Hours
I	**ENVIRONMENTAL REGULATION AND GOVERNMENT POLICIES :** Classes of petroleum based on flash point- storage tank design- GAS/LIQUID/SOLID wastes form refinery units-environmental standards on air and water pollution and control-Solid waste management	9
II	**CORROSION AND SAFETY:** Corrosion- reaction and types- refinery corrosion tests-controlling parameters- corrosion control in equipment and pipelines-Types of fire- Safety triangle- Firefighting equipment-PPE- HAZOP studies- Petroleum disasters case study-process safety protocol- pressure relief systems	9
III	**ADVANCEMENTS IN REFINERY:** Instrumentation- Flow/pressure/temperature/level transmitter-Control systems and logics – controller types- mode of controllers- cascade, split range, ratio etc. - P/PI/PID controllers and control tuning-process optimization by APC/DMC- DCS/PLC systems	9
IV	**REFINERY UNIT INTEGRATION AND RECENT TRENDS:** Overall modern refinery flow sheet- products routing- naphtha utilization route up and integration-Diesel/gasoline/ATF/kerosene route up to blending header- Blending processes-line blending- Blending of diesel and MS calculation- LP model for blending operation- Recent trends in ADU with pre flash- RFCC-OHCU	9
V	**ENERGY SAVING AND REFINERY ECONOMICS:** Furnace efficiency calculation-steam utilization- plume length- insulation of pipelines- heat tracing-steam traps-Standard Refinery Fuel Tonnage- Fuel and loss- operational cost- margin cost- refining capacity-complexity factor	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Understand the regulations and government policies in refining industries
CO2	Acquire some knowledge on advanced techniques, automation and instrumentation techniques.
CO3	Know the different controllers and automated control systems in refineries.
CO4	Gathers knowledge on unit integrations in refineries.
CO5	Determine the basis on energy saving techniques and refinery economics

TEXT BOOK:

T1 W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969

T2 J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007

T3 Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology

REFERENCES:

R1 Luyben, W. L., Tyréus, B. D., &Luyben, M. L. (1998). Plant wide process control (Vol. 43). New York: McGraw-Hill.

R2 Stephanopoulos, G. (1984). Chemical process control (Vol. 2). New Jersey: Prentice hall.

R3 Instrumentation and Control Systems, K.Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.

R4 Gilbert M. Masters, Introduction to Environmental Engineering and Science, Prentice -Hall India , 2000

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5311 R	HYDROGEN AND FUEL CELL TECHNOLOGY	3	0	0	3

Course Objective

The student should be able to

1. Aware about alternate clean fuel available.
2. Familiar with the concepts and chemistry of fuel cells.
3. Describe the process of discretization and its role in solving fluid flow equations computationally.

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Overview of fuel cells: History, Principle, Classification Fuel cell thermodynamics - heat, work Potentials, prediction of reversible voltage, fuel cell efficiency, Types of fuel cells - Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others	9
II	**FUEL CELL KINETICS:** Fuel cell reaction kinetics - electrode kinetics, overvoltage, Tafel equation, charge transfer reaction, exchange currents, electro catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte.	9
III	**CHARACTERIZATION TECHNIQUES:** Fuel cell characterization - in-situ and ex-situ characterization techniques, i-V curve, frequency response analysis; Fuel cell modeling and system integration: - 1D model – analytical solution and CFD models.	9
IV	**FUEL CELL DESIGN:** Fuel cell components, materials, properties and Processes - membrane, electrode, gas diffusion layer, bi-polar plates - Fuel cell operating conditions: pressure, temperature, flow rates, humidity.	9
V	**APPLICATIONS OF FUEL CELL:** Fuel cell power plants: fuel processor, fuel cell power section (fuel cell stack), power conditioner; automotive applications, portable applications	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Evaluate the thermodynamic parameters and fuel selection criteria to determine the most efficient type of fuel cell for a given application.
CO2	Design an electrode system that minimizes over potentials by applying knowledge of reaction kinetics and mass transport phenomena.
CO3	Develop a diagnostic model using characterization data and CFD tools to predict and improve the performance of fuel cell systems.
CO4	Create a complete design layout of a fuel cell system by selecting appropriate materials, components, and operating conditions for optimized performance.
CO5	Design a comprehensive application plan for fuel cells in either portable electronics or transport systems, with performance and cost optimization.

TEXT BOOK:

T1 Gregor Hoogers, "Fuel Cell Technology Handbook", CRC Press, 2003.

T2 O'Hayre R. P., S. Cha., W. Colella., F. B. Prinz., Fuel Cell Fundamentals, Wiley, NY, 3rd edition, 2016.

T3 A. J.Bard, L. R. Faulkner, "Electrochemical Methods", Wiley, 2004.

REFERENCES:

R1 S. Basu, "Fuel Cell Science and Technology", Springer, 2007.

R2 H. Liu, "Principles of Fuel Cells", Taylor & Francis, 2006.

R3 Karl Kordesch & Gunter R. Simader., Fuel Cells and Their Applications, 1st ed., VCH Publishers, NY, 2001.

R4 Subhash C., Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications, Elsevier Advanced Technology, 2003

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5312	BIO SEPARATION & DOWNSTREAM PROCESSING	3	0	0	3

Course Objective

The student should be able to

1. Identify the various bioseparation techniques such as filtration, centrifugation, chromatography, and precipitation.
2. Design unit operations steps for various downstream purification steps
3. Summarize the challenges associated with the purification of biological molecules such as proteins, enzymes, and antibodies.

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Introduction to By-products and Bioseparation: Range and characteristics of bio products, Characteristics of Fermentation Broth, Selection of unit operation with due consideration of the physical, chemical and biochemical aspects of biomolecules. Stages of Downstream Processing	9
II	**CENTRIFUGATION AND FILTRATION:** Primary Separation: Removal of insoluble and Biomass (and particulate debris) separation techniques, Flocculation and sedimentation, Centrifugation-Ultracentrifugation, Gradient centrifugation, Filtration: Theory of Filtration,	9
III	**ABSORPTION:** Gas Absorption: Solubility of gases in liquids, Effect of temperature and pressure on solubility, Ideal and Non-ideal solutions, Choice of solvent for gas absorption, absorption factor, stripping factor, minimum gas liq ratio, Single stage gas absorption Cross Current, Co- current.	9
IV	**EXTRACTION:** Liquid-Liquid Separation Process: Single Stage Operation, Equipments for liquid-liquid extraction. Types of extraction processes: Reactive extraction, Aqueous two-phase systems, Reverse micellar extraction, solid-liquid extraction.	9
V	**CHROMATOGRAPHY AND MEMBRANE SEPARATION:** Theory of chromatography, Shape and yield of a chromatographic peak, Binary chromatography, Hydrodynamic chromatography. Membrane-based bioseparation - Classification of membrane processes, Ultrafiltration, Microfiltration, Dialysis, Liquid membrane processes, Membrane chromatography, Electrophoresis, Affinity ultrafiltration, Field-flow fractionation	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Understand the basic concept of bioseparation processes
CO2	Acquire knowledge on theory, design, and application of bioprocessing
CO3	Know the basic concepts absorption and their problems in bioprocessing
CO4	Gather knowledge on extraction of bioproducts using different methods
CO5	Gain knowledge on chromatography techniques and their analysis, membrane separation process

TEXT BOOK:

T1 Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.

T2 Roger G. Harrison, Paul Todd, ScottR. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, Oxford University Press

T3 B.Shivshankar, Bioseparations: Principles and Techniques, Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012

REFERENCES:

R1 P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley Interscience Publication, 1988.

R2 R. K. Scopes, Berlin, Protein Purification: Principles and Practice, Springer, 1982.
Scopes Ak, Protein Purification, IRL Press, 1993

R3 Biotechnology: Bioprocessing, Rhem and Reed, Vol. 3, 1993

R4 Separation and purification techniques in biotechnology, Fredreich Dechow, 1989

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5313	**PETROLEUM EQUIPMENT DESIGN**	3	0	0	3

Course Objective

The student should be able to

1. Identify the various types of petroleum equipment, such as pumps, compressors, separators, and storage tanks.
2. Analyze suitable equipment for particular reservoir conditions.
3. Summarize the environmental and safety impacts associated with petroleum equipment design.

Unit	Description	Instructional Hours
I	**WELL DESIGN AND DRILLING EQUIPMENT:** Casing program, casing and tubing design, principles of cementing, completion added skin, well perforating, hydraulic fracturing. DRILL BIT DESIGN.ROLLER CONE BITS.PDC DRILL BITS.NOMENCLATURE AND IADC CODES for drill bits. BHA (Bottom hole assembly). ESP(Electrical submersible pumps). SRP (Sucker rod pumping) unit design.	9
II	**DESIGN OF SURFACE PRODUCTION FACILITIES:** Design of Surface Facilities - Design of production and processing equipment, including separation problems, treating, and transmission systems.	9
III	**CAPSTONE DESIGN:** Capstone design in the areas of geology, reservoir engineering, production, drilling and well completions to practical design problems based on real field data with all of the associated shortcomings and uncertainties. Use of commercial software.	9
IV	**OIL AND GAS TREATMENT AND PROCESSING SYSTEMS**: Oil desalting-horizontal and spherical electrical dehydrators- Natural Gas Dehydration-Horton sphere-Natural Gas Sweetening. Crude & Condensate Stabilization-design of stabilizer- Oil and Gas Treatment. Treating Equipment**.**	9
V	**REFINERY AND PIPELINE DESIGN**: Refinery Equipment Design-atmospheric distillation column Design and construction of on/ offshore pipelines, Fields Problems in pipeline, Hydrates, scaling & wax etc and their mitigation.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Understand the drill bit fundamentals, codes and standards
CO2	Design of production and processing equipment
CO3	Know the Capstone design in reservoir engineering.
CO4	Know the design of Oil and Gas Treatment Equipment
CO5	Gain knowledge on the design of pipe systems

TEXT BOOK:

T1 Petroleum Exploration Hand Book by Moody, G.B.

T2 Wellsite Geological Techniques for petroleum Exploration by Sahay.B et al

T3 Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.

REFERENCES:

R1 Standard Hand Book of Petroleum & Natural Gas Engineering" – 2nd Edition 2005-William C.Lyons& Gary J.Plisga-Gulf professional publishing comp (Elsevier).

R2 P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley Interscience Publication, 1988.

R3 Biotechnology: Bioprocessing, Rhem and Reed, Vol. 3, 1993

R4 Separation and purification techniques in biotechnology, Fredreich Dechow, 1989

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5314 R	POWER PLANT ENGINEERING	3	0	0	3

Course Objective

The student should be able to

1. Identify the different types of power plants, including thermal, hydroelectric, nuclear, and renewable energy plants.
2. Describe the environmental and economic impacts of power generation methods.
3. Summarize the role of power plant engineering in ensuring reliable and sustainable energy supply.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO POWER PLANT ENGINEERING:** Power Plants - Features, Components and Layouts - Working of Power Plants, Power Plant Economics. Smart Grid Integration and Distributed Generation. Plant Automation and Digital Twin Concepts	9
II	**BOILER TECHNOLOGY AND CLASSIFICATION:** Boiler Classification - Boiler Types - Fire Tube & Water Tube Boilers - Fluidized Bed Boilers - Positive Circulation Boilers - Thermal Liquid Heaters & Vaporizers. Modern Boiler Designs: Once-through Boilers, Supercritical & Ultra-supercritical Boilers	9
III	**INTRODUCTION TO STEAM TURBINE:** Steam Turbines: Classification - Features - Working – Performance; Losses in Steam Turbines - Trouble Shooting. Advanced Materials for High-Temperature Operation. Performance Metrics: Heat Rate, Efficiency Enhancements	9
IV	**INTRODUCTION TO GAS TURBINES:** Gas Turbines: Classification and Comparison of Different Types Gas Turbine Power Plants Components - Economics & Future of Combined Cycles.Gas Turbine Components and Modern Material Developments. Combined Cycle Power Plants (CCPP): Configuration and Performance Optimization.	9
V	**ADVANCED POWER GENERATION** TECHNOLOGIES: Integrated Gasification Combined Cycle (IGCC) – Indirect Fired Combined Cycle (IFCC) – Magneto Hydrodynamics (MHD) – Fuel Cells – Micro turbines– RDF based power plants. Indirect Fired Combined Cycle (IFCC) – Applications in Biomass.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Understand the fundamental knowledge on components, layouts and working of power plants
CO2	Learn the types, classification and usage of boilers
CO3	Evaluate the performance of different types of steam turbines.
CO4	Compare different gas turbine power plant configurations and assess their components
CO5	Describe emerging power generation technologies such as IGCC, MHD, and fuel cells.

TEXT BOOK:

T1 Thomas C. Elliott ,"Standard Hand Book of Power Plant Engineering"

T2 Wellsite Geological Techniques for petroleum Exploration by Sahay.B et al

T3 Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 2019

REFERENCES:

R1 E L Wakil, "Power Plant Engineering", McGraw-hill Book Co, N.Y. 2001

R2 Arora and Domkundwar, A course in Power Plant Engineering, Dhanpat Ra, N.Delhi.2022

R3 Nag, P.K., "Power Plant Engineering", 2nd Edition, TMH, 2019

R4 Standard Hand Book of Petroleum & Natural Gas Engineering" – 2nd Edition 2020-William C.Lyons& Gary J.Plisga-Gulf professional publishing comp (Elsevier).

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5315	ENZYME IMMOBILISATION TECHNOLOGY	3	0	0	3

Course Objective

The student should be able to

1. Understand structural, functional properties, and metabolic pathways
2. Learn immobilization procedures, and types.
3. Design enzyme reactors

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Catalysis and biocatalysis, Enzyme classification and nomenclature, enzyme structure, functionality and relationship, enzyme activity, enzyme sources, synthesis, recovery and purification, enzymes as process catalysts.	9
II	**HOMOGENEOUS ENZYME KINETICS:** Hypothesis of enzyme kinetics, rapid equilibrium and steady-state hypothesis, determination of kinetic parameters, various types of kinetic inhibition, reactions with more than one substrate, effect of environmental variables- pH, temperature, and ionic strength.	9
III	**BASICS OF IMMOBILISATION:** Immobilisation – Functional properties, Classification of Immobilisation techniques – Adsorption, matrix entrapment, crosslinking, covalent binding- advantages & disadvantages of each method, selection and characterisation of matrices for immobilisation, effect of physico chemical parameters on immobilised enzymes.	9
IV	**HETEROGENEOUS ENZYME KINETICS:** Mass transfer effects in heterogeneous biocatalysis, partition effects, Immobilised enzyme kinetics - external (film) diffusion, internal (pore) diffusional kinetics, Thiele modulus and Effectiveness factor. Effects of electrostatic potential of the micro environment.	9
V	**ENZYME REACTORS & APPLICATION OF IMMOBILISED ENZYMES:** Design of reactors with immobilised enzymes, Design of advanced immobilized enzyme systems, Application of immobilised enzymes in food industry, textile industry, Pharmaceutical industry & in medicine, in the production of biofuels, detergent industry, production of various bio-products, as biosensors.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Understand the basic knowledge on classification of enzymes and their nomenclature.
CO2	Know about enzymes, homogeneity, and heterogenicity.
CO3	Gain knowledge about structural, functional properties, and metabolic pathways of enzymes.
CO4	Learn immobilization procedures, and their different types.
CO5	Knowledge on designing enzyme reactors.

TEXT BOOK:

T1 "Enzyme Technology" by M.F.Chaplin and C.Bucke, Cambridge University press, 1990. (Website for the book, www:lsbu.ac.uk/biology/enztech/)

T2 "Biocatalysts and Enzyme Technology" by K. Buchholz,V. Kasche and U.T. Bornscheur, Wiley,2005

T3 B.Shivshankar, Bioseparations: Principles and Techniques, Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012

REFERENCES:

R1 "Enzyme Technology", by Shanmugam,S. and Satish Kumar,T.,IK International Pvt. Ltd, New Delhi, 2008

R2 Enzyme Biocatalysis: Principles and Applications' by A.Illanes, Springer,2008

R3 Biotechnology: Bioprocessing, Rhem and Reed, Vol. 3, 1993

R4 Separation and purification techniques in biotechnology, Fredreich Dechow, 1989

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5316	PETROCHEMICAL TECHNOLOGY	3	0	0	3

Course Objective

The student should be able to

1. Learn the operation and methodologies in petrochemical industries
2. Identify the application of petrochemicals in all process fields
3. Learn each product of petrochemical industries and its application with production techniques in detail.

Unit	Description	Instructional Hours
I	**PETROCHEMICALS EVOLUTION:** Petrochemical Industries and their feedstock selection .History, Economics, Growth of petrochemical industry.-structure of Petrochemical complexes- Classification of petrochemicals- Basic building processes- Integration with refinery-flow scheme	9
II	**INTERMEDIATES FOR PETROCHEMICALS INDUSTRIES:** Production Methods - Reforming and cracking of feed stocks; Sources: Chemicals from synthesis gas, olefins and aromatics-Ethylene, Propylene, C4hydrocarbons, higher olefins, Benzene, Toluene, Xylene and their derivatives	9
III	**COMPLEX PETROCHEMICAL PRODUCTS:** Acrylonitrile, Acrylic acid, dimethyl terephthalate, ethanol, ethylene glycol, linear alkyl benzene, methyl tertiary butyl ether, vinyl acetate, vinyl chloride, Maleic and phthalic anhydride, ethyl benzene, Phenol, Cumene, Styrene, Bisphenol, Aniline – Process flow scheme- various technology-advantages-yield pattern-process variables	9
IV	**POLYMERS:** Polymers production: Fibers, Rubbers and Plastics. Acrylonitrile butadiene styrene (ABS), polyethylene-LDPE, HDPE, Polypropylene, PVC, PS, SAN, SBR, PAN, Nylon and Polycarbonates.	9
V	**GLOBAL CHEMICALS:** Petrochemicals-Lubricants, additives, adhesives, agrochemicals, cosmetics raw materials, electronic chemicals, detergents, paint, healthcare and pharmaceuticals, Fertilizers- Ammonia, Urea, NPK etc.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Able to understand the basic knowledge on petrochemical industry and their growth, history.
CO2	Understand the different methods of production in petrochemical products and their derivatives.
CO3	Gather knowledge on the production of complex petrochemical products
CO4	Know the operation of the petrochemical industries and its application with production techniques in polymers.
CO5	Gain knowledge about the application of petrochemicals in all process fields

TEXT BOOK:

T1 Bhaskara Rao,B.K.“ATextonPetrochemicals”,2nd Edition, Khanna Publishers, NewDelhi,1998

T2 H. Steiner, "Introduction to petrochemicals", Pergamon Press, NewYork, 1961.

T3 Wiseman.P.,"Petrochemicals",UMIST Series in Science and Technology, John Wiley &Sons,1986.

REFERENCES:

R1 BrownsteinA.M.'Trends in Petrochemical Technology', Petroleum Publishing Company, 1976.

R2 G.MargaretWells,'HandbookofPetrochemicalsandProcesses'2nd Revised Edition, Gower Publishing

R3 Groogins, “Unit Process in Organic Synthesis”, McGraw Hill Book Company, New York

R4 Robert A. Meyers, “Handbook of Petrochemicals Production Processes”, McGraw-Hill Education: New York, 2 nd edition, 2019 (ISBN: 9781259643132)

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH5317 R	NON-RENEWABLE ENERGY SOURCES	3	0	0	3

Course Objective

The student should be able to

1. Identify different types of non-renewable energy sources, including coal, oil, natural gas, and nuclear energy.
2. Describe the environmental impacts of utilizing non-renewable energy, such as greenhouse gas emissions and habitat destruction.
3. Summarize the economic implications of relying on non-renewable energy sources for global energy needs.

Unit	Description	Instructional Hours
I	**PETROLEUM SCIENCE AND REFINING:** Origin of Petroleum, Composition, Extraction of Petroleum. Products of Petroleum refining: Diesel; Gasoline; LPG; Fuel oil; Tar; and Bitumen. Environmental Issues associated with petroleum resources. Focus on improving yield and environmental performance.	9
II	**COAL SCIENCE AND UTILIZATION:** Types of coal; Composition of coal; Oxygen content, Proximate and Ultimate Analysis of coal; Carbonization, Coal for generation of electricity, coal liquefaction, coal blending. Environmental Issues associated with usage of coal. Integrated Gasification Combined Cycle	9
III	**NATURAL GAS RESOURCES AND UTILIZATION:** Resources of for Natural Gas, Properties and classification of natural gas, transportation of natural gas, products from natural gas, liquefied natural gas, chemicals from natural gas, shale gas; Environmental Issues associated with usage of coal. Exploration of frozen methane beneath ocean floors and permafrost.	9
IV	**NUCLEAR PHYSICS AND FUEL TECHNOLOGY:** Nuclear models, binding energy, Radio activity, half-life, mechanism of nuclear fission and fusion, decay chains, neutron reactions. Thorium Fuel Cycle Development	9
V	**NUCLEAR REACTOR DESIGN AND SAFETY:** Nuclear reactors and classification, boiling water reactors (BWR), pressurized heavy water reactor (PHWR), fast breeder reactor (FBR), basics of nuclear fusion reactor. Nuclear Power Plant -Waste Management and Safety. Generation IV Nuclear Reactor Technologies. assive Safety Systems in Modern Reactors	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Understand the fundamental knowledge on petroleum and its products
CO2	Learn the usage of coal, types and its composition
CO3	Gather knowledge on the properties, classification and products of natural gas
CO4	Know the fundamentals of nuclear engineering
CO5	Knowledge on the usage of nuclear reactors, nuclear waste management and safety usage

TEXT BOOK:

T1 Breeze, Paul. Nuclear power. Academic Press, 2022.

T2 Viswanathan, Balasubramanian. Energy sources: fundamentals of chemical conversion processes and applications. Newnes, 2022.

T3 Rao, S., and B. B. Parulekar. "Energy Technology: Non-conventional, Renewable and Conventional. " Khanna Publication, 3rd (2020).

REFERENCES:

R1 E L Wakil, “Power Plant Engineering”, McGraw-hill Book Co, N.Y. 2020

R2 Arora and Domkundwar, A course in Power Plant Engineering, Dhanpat Ra, N.Delhi.2019

R3 Nag, P.K., “Power Plant Engineering”, 5th Edition, TMH, 2019

R4 Standard Hand Book of Petroleum & Natural Gas Engineering” – 2nd Edition 2020-William C.Lyons& Gary J.Plisga-Gulf professional publishing comp (Elsevier).

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

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

Course Objective

The student should be able to

1. Understand the fundamentals of bioreactor design
2. Design single and multiple bioreactors
3. Summarize the design of bioprocess system.

Unit	Description	Instructional Hours
I	**BIOREACTOR DESIGN & MEDIA REQUIREMENTS:** Microbial growth and product formation kinetics, Bioreactor Selection, Reactor operational mode and selection.	9
II	**DESIGN EQUATIONS FOR BIOREACTORS:** Basic Design Equations/ Mole Balances: Batch, Fed-Batch and Repetitive Batch Reactors, Continuous: Stirred tank and tubular flow reactors, Microbial death kinetics, Design criterion for sterilization, Batch and continuous sterilization of medium, Multiple reactions-series, parallel and mixed-mode, Air sterilization	9
III	**BIOREACTOR REQUIREMENTS:** Process-General requirements; Basic design and construction of bioreactors and their ancillaries; Material of construction, Vessel geometry, Bearing Assemblies, Motor drives, Aseptic seals; Flow measuring devices, Valves, Agitator and Sparger Design, Sensors, Non-isothermal homogeneous reactor systems. Adiabatic reactors, batch and continuous reactors, optimum temperature progression	9
IV	**DESIGN OF BIOREACTORS:** Process and mechanical design of Bioreactors, volume, sparger, agitator-type, size and motor power, heat transfer calculations for coil and jacket, sterilization system, scale-up, scale down, bioinstrumentation and control.	9
V	**NOVEL BIOREACTORS DESIGN:** Design of Immobilized enzyme packed bed Reactor. Fluidized bed reactors, Slurry Reactors, Airlift & Loop reactors, Packed bed and Hollow fiber membrane bioreactors, Bioreactors for waste treatment processes; SSF bioreactors. bioreactor design considerations for plant and animal cell cultures.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Compare kinetics and reaction rates for various bioreactor designs, based on operational mode and type of substrate.
CO2	Differentiate and estimate productivity in commercial bioreactors- packed bed, fed batch reactors
CO3	Helps to understand various requirements such as material of construction, valves, agitator, sensors etc
CO4	Understand the mechanical design and heat transfer calculations for various type of bioreactor
CO5	Analyze immobilization techniques in reactors and use it for various applications

TEXT BOOK:

T1 Bioprocess Engineering -Kinetics, Mass Transport, Reactors and Gene Expression Wolf R. Vieth A Wiley-Interscience Publication 1994

T2 Chemical Kinetic Methods: Principles of relaxation techniques Kalidas C New Age International 1996

T3 Chemical Reactor Analysis and Design Forment G F and Bischoff K B John Wiley 1990

REFERENCES:

R1 Bioprocess Engineering -Kinetics, Biosystems, sustainability and reactor Design, Shijie Liu, Elsevier Publication 2013.

R2 G.MargaretWells,'HandbookofPetrochemicalsandProcesses'2nd Revised Edition, Gower Publishing

R3 Groogins, "Unit Process in Organic Synthesis", McGraw Hill Book Company, New York

R4 Robert A. Meyers, "Handbook of Petrochemicals Production Processes", McGraw-Hill Education: New York, 2 nd edition, 2019 (ISBN: 9781259643132)

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7201	PROCESS ECONOMICS AND ENGINEERING MANAGEMENT	3	0	0	3

Course Objective

The student should be able to

1. Understand the process design development, plant location and layout, cost accounting and estimation, capital investments, taxes and depreciation
2. Acquire awareness about methods of estimating cost of the project profitability, income ratio, balance sheet and inflation.
3. Illustrate the economic design consideration in chemical industry and methods of principles of management, organization, production planning and its inventory.

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, financial efficiency, Human factors and capital account.	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 Outcome

CO1	Understand the capital cost and the value of money for the complete plant
CO2	Analyze the project prifitability, balance sheet and inflation in design of process plant.
CO3	Illustrate the economic operation of the equipment
CO4	Evaluating the various principles of management and its organization
CO5	Remember the production planning, control chart preparation and quality control

TEXT BOOK:

T1 Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, 2004.

T2 Schweyer. H.E, "Process Engineering Economics", Mc Graw Hill, 1969.

T3 James R. Cooper, "Process Engineering Economics", Marcel Delkker Inc, New York, 2003

REFERENCES:

R1 F.C. Jelen and J.H. Black, "Cost and Optimization Engineering", McGraw Hill, 3rd Edn., 1992

R2 Ahuja K.K, Industrial management, Khanna publishers, New Delhi, 1985.

R3 Harry Silla, " Chemical Process Engineering: Design and Economics", 1st Edition, CRC press, USA, 2003

R4 Sivasubramanian V, "Process Economics and Industrial Management",1 st Edition, New Delhi, Galcotia Publishers, 2008.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7202	PROCESS EQUIPMENT DESIGN	3	1	0	4

The student should be able to

Course Objective

1. Summarize the concepts of unit operations and unit processes in chemical engineering.
2. Impart knowledge on the concepts of design of major equipment
3. Design the plant layout and pipe line with proper materials.

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. ASTM Standards and BIS Standards.	12
	Total Instructional Hours	**60**

Course Outcome

CO1	Estimate the overall heat transfer coefficient for heat exchangers.
CO2	Calculate the area of single effect evaporator and drying rate.
CO3	Evaluate the design parameters of distillation,absorption and adsorption columns.
CO4	Choose the appropriate reactor for the desired process.
CO5	Design the layout of chemical process plant and provide solution for materials of construction.

TEXT BOOK:

T1 Green D. W., "Perry's Chemical Engineer's Handbook", 8th Edition McGraw Hill, 2007

T2 Coulsion and Richardson's., "Chemical Engineering Design - Volume 6", Pergamon; 2nd edition, 1993

T3 Process Equipment Design by M. V. Joshi, 3rd edition, Macmillan India Limited 2003.

REFERENCES:

R1 R. K. Sinnott, "Coulson & Richardson's Chemical Engineering", Vol. 6, Butterworth Heinermann, Oxford, 1996.

R2 Dawande, S. D., "Process Design of Equiment", 4th Edition, Central Techno Publications, Nagpure, 2005.

R3 Baranan, C.R., "Rules of Thumb for Chemical Engineers", Gulf Publishing Co, Texas, 1996.

R4 Kern D.Q., Process Heat Transfer, McGraw Hill book Co.Inc., 1982

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	22CH7001	DESIGN AND SIMULATION LAB	0	0	4	2

The student should be able to

Course Objectives

1. Impart knowledge about basics principles of engineering design and their application in creating innovative solutions.
2. Analyze and solve Engineering problems.
3. Provide hands-on experience in applying design and simulation techniques.

S.No.	LIST OF EXPERIMENTS
1	PS2001-Basic process operation suite for distillation using ProSimulator standard models.
2	PS2003-Basic process operation suite for Centrifugal Pump using ProSimulator standard models.
3	PS2005-Basic process operation suite for Heat Exchangers using ProSimulator standard models.
4	PS2008-Basic process operation suite for CSTR in Series using ProSimulator standard models.
5	PS2010-Basic process operation suite for PFR using ProSimulator standard models.
6	PS2011-Basic process operation suite for Cyclone Separator using ProSimulator standard models.
7	PS2016-Basic process operation suite for Evaporator using ProSimulator standard models.
8	PS2019-Basic process operation suite for Ball Mill using ProSimulator standard models.
9	PS2021-Basic process operation suite for Batch Reactor using ProSimulator standard models.
10	PS2022-Basic process operation suite for Cement Plant Operation using ProSimulator standard models.
11	PS2023-Basic process operation suite for Fixed bed Reactor using ProSimulator standard models.
12	PS2101-Basic process operation suite for Crystallizer ProSimulator standard models.
	Total Practical Hours 45

Upon completion of the course, students can be able to

Course Outcomes

1. *Identify* the basic components and operational principles of unit operations such as distillation, heat exchange, and pumping using ProSimulator models.
2. *Simulate* standard chemical process equipment like CSTR, PFR, and evaporators using ProSimulator to understand their dynamic behavior.
3. *Analyze* the effect of process variables (temperature, pressure, flow rate) on the performance of systems like cyclone separators, crystallizers, and ball mills.
4. *Evaluate* the steady-state and transient performance of batch and fixed bed reactors through ProSimulator simulations for process optimization.
5. *Develop* safe and efficient operating procedures for integrated chemical plants like cement production using ProSimulator tools.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7203	BIOCHEMICAL ENGINEERING	3	0	0	3

The student should be able to

Course Objective

1. Understand the basic principles of chemical engineering and their application to biological systems.
2. Examine the significance of metabolic engineering
3. Apply process control techniques in bioprocess industries

Unit	Description	Instructional Hours
I	**INTRODUCTION**: Introduction- Lipids, Proteins, Nucleic acid and medium formulation. Industrial biochemical processes with typical examples, comparing chemical and biochemical processes, development and scope of biochemical engineering as a discipline. Industrially important microbial strains; their classification; structure; cellular genetics.	9
II	**KINETICS OF ENZYME ACTION**: Kinetics of enzyme catalyzed reaction, Classification of the enzymes, substrate complex and enzyme action, modulation and regulation of enzyme activity, types of inhibition. Immobilized enzyme technology: enzyme immobilization, Immobilized enzyme kinetics: effect of external mass transfer resistance.	9
III	**KINETICS OF MICROBIAL GROWTH**: Kinetics of cellular growth in batch and continuous culture, models for cellular growth unstructured, structured and cybernetic models, medium formulation. Thermal death kinetics of cells and spores, stoichiometry of cell growth and product formation, Design and analysis of biological reactors.	9
IV	**AERATION AND AGITATION:** Transport phenomena in Bioprocess systems; gas liquid mass transfer in cellular systems. Bubble aeration and mechanical agitation, Design and analysis of Bioreactors.	9
V	**DOWN STREAM PROCESSING**: Process & Methods of Downstream Processing. Strategies to recover and purify products; separation of insoluble products, filtration and centrifugation; cell disruption methods; dialysis, ultra filtration and reverse osmosis, chromatographic separation, Final steps in purification –crystallization and drying.	9
	Total Instructional Hours	45

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

Course Outcome

CO1	Understand the fundamental concepts of biochemical engineering.
CO2	Identify and interpret the kinetic parameters in different Reactors.
CO3	Apply the growth models for optimization
CO4	Develop the ability to design novel bioprocesses for their research in various areas.
CO5	Apply the Engineering concepts in efficient bioprocess performance.

TEXT BOOK:

T1 James E. Bailey& David F. Ollis, "Biochemical Engineering Fundamentals"., McGrew- Hill Education 1986

T2 Shuler & Kargi, "Bioprocess Engineering" , Prentice Hall of India Pvt.Ltd 2002

T3 Levenspiel O., John. " Chemical Reaction Engineering", John Wiley& Sons (Asia), 3rd Ed., 2000

T4 Aiba S, Humphrey A E and Millis N F, "Biochemical Engineering", Academic Press 1973

REFERENCES:

R1 Smith J.M., "Chemical Engineering" Kinetics, Smith., Mc Graw Hill

R2 Scott Fogler H., "Elements of Chemical Reaction Engineering", Prentice Hall of India

R3 Ghasem Najafpour., "Biochemical Engineering and Biotechnology" Elsevier, 2015

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7301	AQUACULTURE AND FISHERIES BUSINESS MANAGEMENT	3	0	0	3

Course Objective

The student should be able to

1. **Understand** the economic and business aspects of aquaculture and fisheries, including market dynamics, financial planning, and policy frameworks.
2. **Analyze** business feasibility, risks, and marketing strategies for sustainable aquaculture and fisheries enterprises.
3. **Develop** business plans and entrepreneurial solutions while considering regulatory compliance and resource management.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO AQUACULTURE AND FISHERIES BUSINESS**: Overview of aquaculture & fisheries sectors- Global trends and economic significance- Key stakeholders in the value chain- Business models in aquaculture (small-scale to industrial).	9
II	**BUSINESS PLANNING AND FEASIBILITY ANALYSIS**: Market assessment & demand analysis- Financial planning (cost-benefit, ROI, break-even analysis)- Risk assessment in aquaculture ventures- Writing a business plan for fisheries/aquaculture.	9
III	**MARKETING AND SUPPLY CHAIN MANAGEMENT:** Market segmentation & consumer behaviour- Branding, pricing, and distribution strategies- Cold chain logistics & post-harvest handling- Export-import policies & certification (e.g., MSC, ASC).	9
IV	**FINANCIAL AND RESOURCE MANAGEMENT:** Capital investment & funding sources- Budgeting, accounting, and financial reporting-Sustainable resource utilization (feed, water, energy)-Government schemes & subsidies.	9
V	**POLICY, REGULATIONS, AND ENTREPRENEURSHIP**: National & international fisheries policies- Licensing, compliance, and environmental laws-Entrepreneurship opportunities in aquaculture-Case studies of successful fisheries businesses.	9
	Total Instructional Hours	45

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

Course Outcome

CO1	Explain the fundamentals of aquaculture and fisheries business.
CO2	Develop a business plan for an aquaculture enterprise
CO3	Evaluate marketing strategies for fisheries products
CO4	Apply financial management principles in aquaculture operations.
CO5	Analyze regulatory frameworks and entrepreneurial opportunities

TEXT BOOK:

T1 Pillay, T. V. R., & Kutty, M. N. (2005). Aquaculture: Principles and Practices (2nd ed.). Wiley-Blackwell.

T2 Engle, C. R. (2015). Aquaculture Businesses: A Practical Guide to Economics and Marketing. 5m Publishing.

T3 Hishamunda, N., Ridler, N. B., & Bueno, P. (2009). Business Planning for Commercial Aquaculture. FAO Fisheries Technical Paper.

REFERENCES:

R1 Tisdell, C. (2015). Economics and Marketing of Aquaculture Products. Edward Elgar Publishing.

R2 Knapp, G., Roheim, C. A., & Anderson, J. L. (2013). The Great Salmon Run: Competition Between Wild and Farmed Salmon.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7302	CLIMATE-RESILIENT COASTAL AND OCEAN ENTREPRENEURSHIP	3	0	0	3

Course Objective

The student should be able to

1. **Understand** the principles of entrepreneurship within the context of climate-resilient coastal and ocean economies.
2. **Analyze** business opportunities and risks in marine sectors affected by climate change.
3. **Develop** entrepreneurial models aligned with sustainability, innovation, and adaptive coastal strategies.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO CLIMATE RESILIENCE AND BLUE ENTREPRENEURSHIP**: Climate change impacts on coastal and marine ecosystems - Blue economy: scope, sectors, and potential - Principles of climate resilience in entrepreneurship - Resilient business ecosystems in coastal regions - Climate risk mapping and vulnerability assessments.	9
II	**OPPORTUNITIES IN COASTAL AND MARINE ENTERPRISES**: Sustainable fisheries and aquaculture ventures - Marine ecotourism and recreational services - Seaweed, algae, and marine biotechnology enterprises - Renewable ocean energy startups (wind, wave, tidal) - Climate-adaptive agriculture and integrated coastal livelihoods.	9
III	**INNOVATION, TECHNOLOGY, AND BUSINESS MODELS**: Climate-smart innovation in ocean sectors - Circular economy and waste-to-value models in coastal zones - Technology incubation and marine startups - Digital tools (GIS, blockchain, IoT) in ocean businesses - Blue carbon and ecosystem service valuation.	9
IV	**FINANCIAL STRATEGIES AND POLICY ENABLERS**: Business financing and investment for climate-resilient enterprises - Role of government schemes and international funding (GEF, Blue Bonds) - Risk mitigation strategies and insurance in coastal sectors - Marine spatial planning and regulatory frameworks - Public-private-community partnerships.	9
V	**CASE STUDIES AND ENTREPRENEURIAL ECOSYSTEM DEVELOPMENT**: Coastal startup ecosystems in India and globally - Gender-inclusive and community-led entrepreneurship - Entrepreneurship for disaster resilience and recovery - Success stories: marine biotech, ecotourism, blue farming - Entrepreneurial roadmap and mentorship opportunities.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Explain the concept of climate-resilient entrepreneurship in the context of coastal and ocean sectors.
CO2	Identify viable business opportunities in marine and coastal environments.
CO3	Apply innovative and digital tools to enhance sustainability in ocean entrepreneurship.
CO4	Evaluate financing, risk, and regulatory aspects in establishing coastal ventures.
CO5	Analyze successful climate-resilient startups and develop context-specific entrepreneurial strategies.

TEXT BOOK:

T1 Pauli, G. (2010). *The Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs*. Paradigm Publications.

T2 Dutz, M. A. et al. (2018). *The Jobs of Tomorrow: Technology, Productivity, and Prosperity in Latin America and the Caribbean*. World Bank (relevant chapters on entrepreneurship & resilience).

T3 Herrington, M., & Kew, P. (2018). *Global Entrepreneurship Monitor 2018/19: Blue Economy Lens*. GEM Consortium.

REFERENCES:

R1 World Bank (2021). *Practitioner's Guide for Climate-Resilient Coastal Development*.

R2 UNDP (2020). *Innovation and Entrepreneurship in Small Island Developing States*.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7303	MARINE AND COASTAL RESOURCE MANAGEMENT	3	0	0	3

Course Objective

The student should be able to

1. **Understand** the ecological, economic, and social significance of marine and coastal resources.
2. **Analyze** sustainable management strategies, policy frameworks, and conservation methods for marine ecosystems.
3. **Apply** resource assessment tools and management practices to real-world marine and coastal environments.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO MARINE AND COASTAL ECOSYSTEMS**: Overview of oceanic and coastal ecosystems (estuaries, mangroves, coral reefs, seagrass beds) - Biodiversity and ecological services - Resource potential: fisheries, minerals, energy (offshore wind, tidal) - Threats to marine environments: pollution, overfishing, habitat degradation, climate change - Role of local communities and indigenous knowledge.	9
II	**COASTAL ZONE MANAGEMENT AND PLANNING**: Integrated Coastal Zone Management (ICZM): principles and frameworks - Coastal vulnerability and disaster risk management - Land-use planning and shoreline protection - Coastal zone regulations (e.g., CRZ in India) - Tools for coastal planning: GIS, remote sensing, participatory mapping.	9
III	**MARINE RESOURCE ASSESSMENT AND MONITORING**: Fisheries stock assessment methods - Ecosystem-based management (EBM) - Marine spatial planning (MSP) - Monitoring techniques for water quality, biodiversity, and marine pollution - Role of marine protected areas (MPAs) in conservation.	9
IV	**GOVERNANCE, POLICY, AND INTERNATIONAL AGREEMENTS**: Marine policy frameworks: UNCLOS, MARPOL, CBD, SDG 14 - Role of national and international institutions (MOEFCC, FAO, IMO) - Blue economy and sustainable development goals - Marine law and resource rights - Community-based and co-management approaches.	9
V	**SUSTAINABLE UTILIZATION AND CASE STUDIES**: Eco-tourism and sustainable fisheries - Climate change adaptation in coastal zones - Restoration of coastal ecosystems (coral, mangroves) - Socioeconomic aspects: livelihood, gender, and equity - Case studies: Integrated management success stories from India and global regions.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Describe the ecological importance and threats to marine and coastal ecosystems.
CO2	Apply integrated coastal zone management tools and strategies.
CO3	Conduct marine resource assessment and monitoring using appropriate techniques.
CO4	Analyze governance frameworks and international agreements relevant to marine conservation.
CO5	Evaluate sustainable utilization practices through real-world case studies.

TEXT BOOK:

T1 Vallega, A. (1999). *Fundamentals of Integrated Coastal Management*. Kluwer Academic Publishers.

T2 Kay, R., & Alder, J. (2005). *Coastal Planning and Management* (2nd ed.). CRC Press.

T3 Cicin-Sain, B., & Knecht, R. W. (1998). *Integrated Coastal and Ocean Management: Concepts and Practices*. Island Press.

REFERENCES:

R1 FAO (2020). *The State of World Fisheries and Aquaculture*. FAO, Rome.

R2 UNEP (2006). *Marine and Coastal Ecosystems and Human Well-being: A Synthesis Report Based on the Findings of the Millennium Ecosystem Assessment*.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7304	OCEAN ENGINEERING	3	0	0	3

Course Objective

The student should be able to

1. **Understand** the fundamental principles and scope of ocean engineering, including ocean environment and dynamics.
2. **Analyze** offshore structures, materials, hydrodynamic forces, and foundation systems.
3. **Apply** engineering knowledge to the design, construction, and sustainability of ocean-based systems.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO OCEAN ENGINEERING AND OCEAN ENVIRONMENT**: Scope and importance of ocean engineering - Properties of seawater: salinity, temperature, density - Ocean currents, tides, waves, and coastal processes: Wind-wave theory – deep and shallow water waves - Marine sediment transport and coastal erosion.	9
II	**OCEAN STRUCTURES AND MATERIALS**: Types of offshore structures: fixed, floating, compliant - Structural components: jackets, moorings, risers - Materials used in marine environment – corrosion and protection - Fatigue, wear, and design considerations under ocean conditions - Stability and buoyancy principles for marine structures.	9
III	**HYDRODYNAMICS AND DESIGN LOADS**: Wave-structure interaction - Hydrostatic and hydrodynamic forces - Morison equation and applications - Current and wind load estimation - Dynamic response and damping of offshore systems.	9
IV	**FOUNDATION AND INSTALLATION TECHNIQUES**: Seabed characterization and soil properties - Pile foundations, suction caissons, and gravity bases - Installation of offshore structures - Marine construction methods and equipment - Monitoring and maintenance of foundations.	9
V	**OCEAN ENGINEERING APPLICATIONS AND CASE STUDIES**: Offshore oil & gas platforms - Subsea pipelines and cables - Offshore renewable energy: wind, tidal, and wave systems - Coastal and harbor structures - Case studies: major offshore projects and failures.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Describe oceanographic processes relevant to engineering applications.
CO2	Identify and evaluate materials and design considerations for ocean structures.
CO3	Calculate hydrodynamic forces acting on marine structures using wave theories.
CO4	Analyze seabed conditions and foundation systems for offshore structures.
CO5	Assess engineering applications through real-world ocean engineering case studies.

TEXT BOOK:

T1 Sarpkaya, T., & Isaacson, M. (1981). *Mechanics of Wave Forces on Offshore Structures*. Van Nostrand Reinhold.

T2 Gerwick, B. C. (2007). *Construction of Marine and Offshore Structures* (3rd ed.). CRC Press.

T3 Dean, R. G., & Dalrymple, R. A. (1991). *Water Wave Mechanics for Engineers and Scientists*. World Scientific

REFERENCES:

R1 API RP 2A-WSD (2007). *Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms*. American Petroleum Institute.

R2 DNVGL-RP-C205 (2017). *Environmental Conditions and Environmental Loads*. DNV GL.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7305	SUSTAINABLE MARINE RESOURCES AND CIRCULAR ECONOMY	3	0	0	3

Course Objective

The student should be able to

1. **Understand** the concept of sustainability and circular economy in the context of marine ecosystems.
2. **Analyze** strategies for sustainable use and regeneration of marine resources, including waste valorization.
3. **Apply** circular economy principles in marine-based industries through case studies and policy frameworks.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO MARINE SUSTAINABILITY AND CIRCULAR ECONOMY**: Overview of marine ecosystem services and resource exploitation - Introduction to sustainability science in marine systems - Principles of the circular economy: reduce, reuse, recycle, and regenerate - Differences between linear and circular models - Blue economy and sustainability goals (SDG 12, 14).	9
II	**SUSTAINABLE MARINE RESOURCE UTILIZATION**: Fisheries and aquaculture management practices - Sustainable harvesting methods - Marine biotechnology and bioresources (algae, enzymes, bioactive compounds) - Marine energy systems: wave, tidal, ocean thermal energy conversion (OTEC) - Carbon credits and ecosystem-based management.	9
III	**CIRCULAR STRATEGIES IN MARINE INDUSTRIES**: Waste minimization in seafood processing - Recovery of fishery by-products (chitin, collagen, oil) - Marine litter, microplastics, and circular waste management - Biorefineries and marine bioeconomy - Role of innovation and digitalization in circular marine practices.	9
IV	**POLICIES, STANDARDS, AND CIRCULAR BUSINESS MODELS**: International marine sustainability regulations (EU Green Deal, FAO, UNEP) - Marine certification schemes (MSC, ASC, ISO standards) - Business models for circular economy: sharing, product-service systems - Public-private partnerships and stakeholder engagement - Policy interventions and incentives for circular practices.	9
V	**CASE STUDIES AND FUTURE DIRECTIONS**: Case studies: circular innovations in aquaculture, fisheries, and shipping - Sustainable coastal tourism and eco-labels - Community-based approaches and indigenous resource management - Marine ecosystem restoration and blue carbon projects - Future pathways and global initiatives for marine circular economy.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Explain the concepts of sustainability and circular economy in marine resource management.
CO2	Apply sustainable practices to marine-based resource utilization and extraction.
CO3	Analyze circular strategies to reduce waste and enhance value from marine resources.
CO4	Evaluate policies and frameworks that support circular business models in marine sectors.
CO5	Assess real-world cases of sustainable and circular approaches in marine systems.

TEXT BOOK:

T1 Kirchherr, J., Reike, D., & Hekkert, M. (2017). *Conceptualizing the Circular Economy: An Analysis of 114 Definitions*. Resources, Conservation & Recycling.

T2 Pauli, G. (2010). *The Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs*. Paradigm Publications.

T3 European Commission (2020). *A New Circular Economy Action Plan For a Cleaner and More Competitive Europe*.

REFERENCES:

R1 UNEP (2018). *Mapping the Value of Ecosystems for the Blue Economy*.

R2 OECD (2019). *Rethinking Innovation for a Sustainable Ocean Economy*.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7306	BLUE ECONOMY ENTREPRENEURSHIP	3	0	0	3

Course Objective

The student should be able to

1. Understand the concept of the blue economy and its significance in sustainable development.
2. Identify entrepreneurial opportunities within the blue economy sector.
3. Analyze case studies of successful blue economy ventures.
4. Develop business plans integrating blue economy principles.
5. Evaluate the challenges and opportunities in implementing blue economy initiatives.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BLUE ECONOMY** Definition and scope of the blue economy- Historical context and evolution- Importance of the ocean economy in global sustainability- Policy and Regulatory Frameworks in the Blue Economy- Future Trends and Opportunities in the Blue Economy.	9
II	**BLUE ECONOMY SECTORS AND OPPORTUNITIES** Exploration of key sectors: fisheries, aquaculture, marine tourism, renewable energy, biotechnology, and ocean conservation-Identification of emerging trends and market gaps-Market Analysis and Business Models in the Blue Economy.	9
III	**SUSTAINABLE BUSINESS PRACTICES IN THE BLUE ECONOMY** Principles of sustainability and circular economy applied to marine industries-Innovation in resource management and waste reduction- Case studies of companies implementing sustainable practices- Risk Management and Resilience.	9
IV	**BLUE TECHNOLOGIES AND INNOVATION** Overview of cutting-edge technologies in ocean exploration, monitoring, and conservation -Role of digitalization, IoT, AI, and robotics in blue economy entrepreneurship-Community Engagement and Social Impact.	9
V	**BUSINESS MODEL AND MANAGEMENT SKILLS** Business model canvas and value proposition design for blue economy ventures-Financing options and funding mechanisms for ocean startups- Entrepreneurial Leadership and Management Skills.	9
	Total Instructional Hours	**45**

Course Outcome

CO1	Comprehensive Understanding of Blue Economy Principles.
CO2	Identification and Assessment of Blue Economy Entrepreneurial Opportunities.
CO3	Critical Analysis of Successful Blue Economy Ventures.
CO4	Proficient Development of Blue Economy Business Plans.
CO5	Thorough Evaluation of Challenges and Opportunities.

TEXT BOOK:

T1	Polimeni, J. M., Mayumi, K., Giampietro, M., & Alcott, B. (2008). The Jevons Paradox and the Myth of Resource Efficiency Improvements. Earthscan.
T2	"Blue Growth: The 21st Century Maritime Economy" by OECD.
T3	"Ocean Solutions, Earth Solutions" edited by Elisabeth Mann Borgese.
T4	"Blue Urbanism: Exploring Connections between Cities and Oceans" edited by Timothy Beatley.
T5	"The Blue Economy: 10 Years, 100 Innovations, 100 million Jobs" by Gunter Pauli.

REFERENCES:

R1	Hawken, P. (2010). The Ecology of Commerce: A Declaration of Sustainability (Revised Edition). Harper Business.
R2	Wackernagel, M., & Rees, W. (1996). Our Ecological Footprint: Reducing Human Impact on the Earth. New Society Publishers.
R3	Pauli, G. A. (2010). The Blue Economy: 10 Years, 100 Innovations, 100 million Jobs. Paradigm Publications.
R4	Doppelt, B. (2017). Transformational Resilience: How Building Human Resilience to Climate Disruption Can Safeguard Society and Increase Wellbeing. Greenleaf Publishing.
R5	Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The Trajectory of the Anthropocene: The Great Acceleration. The Anthropocene Review, 2(1), 81–98.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22CH7307	CARBON CAPTURE TECHNOLOGY	3	0	0	3

Course Objective

The student should be able to

1. **Understand** the fundamentals of carbon capture technologies and the role they play in mitigating climate change.
2. **Analyze** various carbon capture methods, including post-combustion, pre-combustion, and oxy-fuel combustion techniques.
3. **Evaluate** the design, integration, and techno-economic aspects of carbon capture, utilization, and storage (CCUS) systems.

Unit	Description	Instructional Hours
I	**Introduction to Carbon Capture**: Climate change and role of CO_2 emissions – Global carbon cycle and greenhouse gas inventory – Need for carbon capture – Overview of CCUS – Global initiatives, carbon pricing and climate policies – Classification of capture technologies – Technology readiness levels (TRLs) and deployment trends.	9
II	**Post-combustion Capture**: Flue gas characteristics – Chemical absorption using amines: MEA, DEA, advanced solvents - Physical absorption, adsorption (zeolites, MOFs), membrane separation – Heat integration and solvent regeneration – Hybrid capture systems - Solvent regeneration – Techno-economic analysis – Commercial case studies.	9
III	**Pre-combustion and Oxy-fuel Combustion**: Fuel processing: gasification, reforming – CO shift reaction – CO_2 separation in syngas – Oxy-combustion process – Combustor design and flue gas treatment – Technical and economic comparison of capture routes – Process integration.	9
IV	**Carbon Storage and Utilization**: Geological sequestration – Enhanced oil recovery (EOR) – Site selection, characterization, and monitoring (seismic, tracers) - Mineral carbonation – CO_2 utilization in chemicals and fuels – Monitoring and risk assessment.	9
V	**Techno-economics, Environmental Impact and Future Trends**: Energy penalty and cost estimation – LCA of capture systems – Policy and regulatory frameworks – Emerging technologies (DAC, bio-CCS) – Case studies of industrial deployment.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Explain the need, scope, and classification of carbon capture technologies.
CO2	Analyze the post-combustion capture process including solvents, adsorption, and membranes.
CO3	Evaluate pre-combustion and oxy-fuel methods for CO_2 capture and their process integrations.
CO4	Apply knowledge on CO_2 storage and utilization options, including EOR and mineralization.
CO5	Assess the environmental, economic, and regulatory aspects of carbon capture technologies.

TEXT BOOK:

T1 Kenji Yamaji (2008), *Energy Technology Perspectives for a Low-Carbon Future*, IEA Publications.

T2 Paul Feron (Ed.) (2016), *Absorption-Based Post-Combustion Capture of Carbon Dioxide*, Woodhead Publishing.

T3 N. H. Abu-Zahra et al. (2013), *CO_2 Capture: Principles and Applications*, Wiley.

REFERENCES:

R1 IPCC Special Report on Carbon Dioxide Capture and Storage, 2005.

R2 Global CCS Institute Reports and Technical Briefs (www.globalccsinstitute.com)

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

Chairman - BoS
CHE - HiCET

Chairman

Dean (Academics)
HiCET

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

Course Objective

The student should be able to

1. **Understand** the fundamentals of chemical process safety, accident causation, and loss prevention.
2. **Analyze** fire, explosion, toxicological hazards, risk assessment, and hazard identification methods.
3. **Apply** safety management, hazard analysis tools, and economic evaluation for accident prevention and process safety improvement.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO PROCESS SAFETY AND TOXICOLOGICAL HAZARDS**: Importance of process safety in chemical industries - Accident history, loss statistics, and regulatory framework - Concepts of safety culture and safety management systems - Toxicological principles: dose-response relationships, exposure limits, toxicity indices - Industrial hygiene and exposure assessment.	9
II	**FIRE, EXPLOSION AND PREVENTION METHODS**: Fire triangle, fire classifications, and combustion fundamentals - Ignition sources, flash point, autoignition, flammability limits - Vapor cloud explosions, BLEVE, dust explosions, confined and unconfined explosions - Prevention of fire and explosion: inerting, purging, explosion suppression, venting - Case studies of industrial fires and explosions.	9
III	**SOURCE MODELS, DISPERSION AND RELIEF SYSTEMS**: Source models: gas and liquid releases, two-phase flow - Dispersion models: Gaussian plume models, dense gas dispersion - Relief system design: relief scenarios, sizing of relief valves, venting systems - Pressure relief systems: API standards, flare systems - Emergency pressure relief and depressurization.	9
IV	**HAZARD IDENTIFICATION, RISK ASSESSMENT AND RELIABILITY**: Hazard identification techniques: Checklists, What-if, HAZOP analysis - Fault tree analysis (FTA), Event tree analysis (ETA) - Layers of Protection Analysis (LOPA), Quantitative Risk Assessment (QRA) - Failure modes, reliability block diagrams, availability and maintainability - Safety instrumented systems (SIS), safety integrity levels (SIL).	9
V	**ACCIDENT INVESTIGATION AND ECONOMICS OF SAFETY**: Process accident investigation: root cause analysis, investigation methods - Human factors in accident causation - Safety audits, incident reporting, and corrective actions - Cost of accidents: direct, indirect, hidden costs - Economic evaluation of safety measures and loss prevention.	9
	Total Instructional Hours	**45**

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

Course Outcome

CO1	Explain accident causation, loss prevention, and toxicological impacts in process industries.
CO2	Analyze fire, explosion phenomena, and preventive safety measures.
CO3	Apply dispersion models and relief system design for chemical release scenarios.
CO4	Perform hazard identification, risk assessment, and reliability analysis using standard methods.
CO5	Conduct accident investigation and economic evaluation of safety measures.

TEXT BOOK:

T1 Crowl D.A. and Louvar J.F., Chemical Process Safety: Fundamentals With Applications.

T2 Lees F.P. Lee's Loss Prevention in Process industries: Hazard Identification, Assessment and control

T3 Kletz T, What Went Wrong? Case Histories of Process Plant Disasters: How They Could Have Been Avoided

REFERENCES:

R1 Marhavilas, P. K., Koulouriotis, D., & Gemeni, V. (2011). *Risk Analysis and Assessment Methodologies in the Work Sites: On a Review, Classification and Comparative Study of the Scientific Literature of the Period 2000–2009.* Journal of Loss Prevention.

R2 Mannan, S. (2012). *Lees' Loss Prevention in the Process Industries* (4th ed.). Butterworth-Heinemann.

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

Chairman - BoS
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Dean (Academics)
HiCET

ACADEMIC COUNCIL * HINDUSTHAN COLLEGE OF ENGG & TECH * Chairman