

COMSATS University Islamabad

Registrar Office, Academic Unit (PS)

No. CUI-Reg/Notif- 1255/26/EFS: 64381

August 31, 2026

NOTIFICATION

The Academic Council, in its 44th meeting held on August 04, 2026, on the recommendations of the Board of Faculty of Engineering in its 38th meeting held on April 29, 2026, approved the revised Scheme of Studies for the **Bachelor of Science in Chemical Engineering**, effective from the Fall 2026.

However, to ensure uniformity across the CUI system, the approved Program Learning Outcomes (PLOs), Course Learning Outcomes (CLOs), along with the corresponding CLO-to-PLO and CLO-to-6Cs mappings, as specified in the respective course contents, shall be applicable to all enrolled students.

1. Program Duration

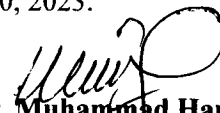
Minimum Duration:	04 Years	Minimum Semesters:	08	Minimum Credit Hours ¹ required:	140
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2. Framework of Courses and Credit Hours for Degree Program

Sr. No	Course Work	Minimum No. of Courses	Minimum No. of Credit Hours
1.	General Education Courses	17	42
2.	Major: Core Discipline Courses	30	78
3.	Interdisciplinary/Allied Courses	4	14
4.	Internship	1	0
5.	Capstone Project	2	6
Minimum No. of Courses required for BS in Chemical Engineering:		54	-
Minimum Credit Hours required for BS in Chemical Engineering:		-	140

All other requirements, terms, and conditions stipulated in the CUI Undergraduate Rules, Regulations, and Common Policies, as amended from time to time, shall remain applicable.

This partially modifies notification number CUI-Reg/Notif-1874/23/1964 dated August 30, 2023.


Dr. Muhammad Hanif
Additional Registrar

Distribution:

1. All Campus Directors / In-Charge, CUI Campuses
2. All Principal Officers / All Deans of Faculties
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5. All In-Charge (Academics / Examination / Registration / Admission / Accounts / HR), CUI Campuses
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8. Registrar Office / Academic Unit, CUI Principal Seat

CC:

1. SO to the Rector
2. PS to the Registrar

3. General Education:

3.1.Arts and Humanities (Mandatory Course)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	HUM123	Fundamentals of Philosophy	2(2, 0)	-

3.2.Natural Sciences (Mandatory Courses)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	CHM100	Chemistry I	4(3, 1)	-
2.	CHM201	Chemistry II	4(3, 1)	CHM100

3.3.Social Sciences (Mandatory Course)

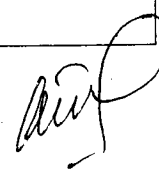
S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	HUM130	Fundamentals of Sociology	2(2, 0)	-

3.4.Functional English and Expository Writing (Mandatory Courses)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	HUM104	Functional English	3(3, 0)	-
2.	HUM120	Expository Writing	3(3, 0)	-

3.5.Quantitative Reasoning (Mandatory Courses-Any two of following courses)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	MTH101	Calculus I	3(3, 0)	-
2.	MTH102	Calculus II	3(3, 0)	MTH101
3.	MTH103	Exploring Quantitative Skills	3(3, 0)	-
4.	MTH104	Tools for Quantitative Reasoning	3(3, 0)	-



3.6.Ideology and Constitution of Pakistan (Mandatory Course)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	HUM113	Ideology and Constitution of Pakistan	2(2, 0)	-

3.7.Islamic Studies (Mandatory Course)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	HUM112	Islamic Studies	2(2, 0)	-

Non-Muslim students can opt for HUM116 Ethics 2(2, 0) course in lieu of HUM112 Islamic Studies

3.8.Application of Information and Communication Technology (ICT) (Mandatory Courses)-
Any two of the following courses

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	CSC141	Introduction to Computer Programming	4(3, 1)	-
2.	CSC101	Applications of Information and Communication Technologies	3(2, 1)	-
3.	EEE111	Introduction to Computers and Computing	1(0, 1)	-

3.9.Entrepreneurship (Mandatory Course)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	ENP475	International Entrepreneurship	3(3, 0)	-

3.10. Civics and Community Engagement (Mandatory Course)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	HUM208	Civics and Community Engagement	2(2, 0)	-



3.11. Understanding of Holy Quran (Mandatory Courses)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	HUM161	Understanding of Holy Quran – I (Fehm-e-Quran-I)	1(0, 1)	-
2.	HUM162	Understanding of Holy Quran – II (Fehm-e-Quran-II)	1(0, 1)	-

For non-Muslim students, these two credit hours may be adjusted with any suitable General Education course approved by the statutory bodies.

3.12. Pakistan Studies (Mandatory Course)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	HUM117	Pakistan Studies	2(2, 0)	-



1. **Option # 1: Single Major:** An undergraduate program with a single major is focused on one disciplinary specialization and comprises of a minimum of 134 credit hours including the requirements of field experience/internship and capstone project:

Core and Major Discipline Courses				
S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	CHE111	Introduction to Chemical Engineering	2(2, 0)	
2.	CHE112	Particulate Technology	3(2, 1)	
3.	CHE113	Chemical Process Principles	3(3, 0)	
4.	EGG100	Year 1 Project	1(0, 1)	
5.	CHE214	Fluid Mechanics for Chemical Engineers	4(3, 1)	PHY132
6.	CHE221	Chemical Process Industries	2(2, 0)	
7.	CHE215	Thermodynamics I for Chemical Engineers	2(2, 0)	CHM201
8.	CHE222	Transport Phenomena	3(3, 0)	MTH242
9.	CHE223	Fuels and Energy	3(2, 1)	
10.	CHE242	Engineering Materials	2(2, 0)	
11.	EGG200	Year 2 Project	1(0, 1)	
12.	CHE316	Unit Processes	2(2, 0)	
13.	CHE324	Mass Transfer Operations	4(3, 1)	
14.	CHE325	Heat Transfer Operations	4(3, 1)	
15.	CHE331	Chemical Reaction Engineering	4(3, 1)	CHE316
16.	CHE332	Thermodynamics II for Chemical Engineers	3(2, 1)	CHE215
17.	CHE333	Simultaneous Heat and Mass Transfer Operations	4(3, 1)	CHE324, CHE325

18.	EGG300	Year 3 Project	1(0, 1)	
19.	CHE426	Process Instrumentation	2(2, 0)	
20.	CHE427	Process Control	3(2, 1)	
21.	CHE435	Chemical Engineering Plant Design	3(3, 0)	
22.	CHE437	Process Modeling and Simulation	3(2, 1)	
23.	CHE429	Maintenance Engineering and Safety	2(2, 0)	
24.	CHE438	Biochemical Engineering	3(3, 0)	
25.	CHE141	General Engineering	3(2, 1)	
26.	EEE113	Engineering Drawing	1(0, 1)	
27.	CHE313	Occupational Health and Safety	1(1, 0)	
28.	CHE447	Artificial Intelligence for Chemical Engineers	3(3, 0)	
Credit Hours			72	

List of Electives-I (Select any one course from following list)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	CHE417	Corrosion Engineering	3(3, 0)	
2.	CHE418	Gas Processing	3(3, 0)	
3.	CHE428	Polymer Engineering	3(3, 0)	
4.	CHE450	Polymer and Rubber Technology	3(3, 0)	
5.	CHE462	Biochemical Separations	3(3, 0)	
6.	CHE463	Biochemical Process and Products	3(3, 0)	
7.	CHE480	Risk Management and Safety	3(3, 0)	
8.	CHE482	Waste Management	3(3, 0)	
9.	CHE490	Nuclear Engineering	3(3, 0)	

10.	CHE491	Novel Separation Processes	3(3, 0)	
11.	CHE492	Mineral Processing Technology	3(3, 0)	
12.	CHE495	Composite Materials	3(3, 0)	
13.	CHE475	Chemical Engineering: Basics and Beyond	3(3, 0)	
14.	CHE465	Dimensionless Groups in Chemical Engineering	3(3, 0)	
15.	CHE476	Heat Transfer Operations in Chemical Engineering	3(3, 0)	
16.	CHE477	Mass Transfer Operations in Chemical Engineering	3(3, 0)	
17.	CHE466	Reaction Kinetics in Chemical Engineering	3(3, 0)	
18.	CHE467	Principles of Energy and Environmental Engineering	3(3, 0)	
19.	CHE468	Synergistic Energy and Environmental Engineering	3(3, 0)	
20.	CHE478	Introduction to Energy Engineering	3(3, 0)	
21.	CHE479	Introduction to Environmental Engineering	3(3, 0)	
22.	CHE484	Introduction to Sustainable Engineering	3(3, 0)	
23.	CHE441	Fundamentals of Materials Engineering	3(3, 0)	
24.	CHE469	Nanomaterials and its Engineering Applications	3(3, 0)	
25.	CHE474	Introduction to Ceramics	3(3, 0)	
26.	CHE440	Data Science for Chemical Engineers	3(3, 0)	
27.	CHE442	Introduction to Composites	3(3, 0)	

28.	CHE443	Material Characterization Techniques	3(3, 0)	
29.	CHE444	Fundamentals of Polymers	3(3, 0)	
30.	CHE445	Machine Learning for Chemical Engineers	3(3, 0)	
31.	CHE451	Functional Polymers and Composite Materials	3(3, 0)	
32.	CHE452	Introduction to Polymer Chemistry	3(3, 0)	
33.	CHE453	Introduction to Reaction Kinetics	3(3, 0)	
34.	CHE454	Sustainable Polymers and Green Chemistry	3(3, 0)	
35.	PSA440	Innovative Approaches in Process Systems Engineering	3(3, 0)	
36.	PSA441	Computational Methods in Process Engineering	3(3, 0)	
37.	PSA450	Fundamentals of Process Dynamics and Control	3(3, 0)	
38.	PSA461	Core Concepts in Process Optimization	3(3, 0)	
39.	PSA452	Fundamentals of Sustainable Process Engineering	3(3, 0)	

List of Electives-II (Select any one course from following list)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	CHE415	Oil and Gas Production and Processing	3(3, 0)	
2.	CHE416	Petrochemical Engineering	3(3, 0)	
3.	CHE436	Petroleum Refinery Engineering	3(3, 0)	
4.	CHE446	Chemical Process Design and Simulations	3(3, 0)	

5.	CHE448	Process Systems Engineering	3(3, 0)	
6.	CHE470	Coal Combustion Technology	3(3, 0)	
7.	CHE471	Renewable Energy Resources	3(3, 0)	
8.	CHE472	Industrial Energy Systems	3(3, 0)	
9.	CHE481	Environmental Engineering	3(3, 0)	
10.	CHE483	Air Pollution and Control	3(3, 0)	
11.	CHE473	Fundamentals of Sustainable Energy Systems	3(3, 0)	
Total Credit Hours (72+6)			78	

2. Interdisciplinary/Allied Courses: Minimum 12 credit hours:

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	MTH242	Differential Equations	3(3, 0)	MTH102
2.	PHY132	Physics for Chemical Engineers	4(3, 1)	
3.	ECO302	Process Economics	3(3, 0)	
4.	MTH375	Numerical Computations	4(3, 1)	MTH242

3. Field Experience/Internship: (6-8 Weeks):

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	EGG497	Internship	0(0, 0)	

4. Capstone Project*: Minimum 03 credit hours:

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	EGG498	Final Year Project (Part I)	3(0, 3)	
2.	EGG499	Final Year Project (Part II)	3(0, 3)	EGG498

5. Remedial Course**

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	CHM102	Introduction to Chemistry	3(2, 1)	

Notes:

¹ 03 credit hours of theory is equivalent to 03 hours of lectures whereas 01 credit hour of lab is equivalent to 03 hours of lab session. All the lab sessions are graded. Students have to pass both theory and lab to earn the course credits.

† Courses with prerequisites can only be allowed if all prerequisite courses have been passed.

* Students must pass at least 80 credit hours (engineering and non-engineering subjects) to register for the final year project

** To be offered as a Non-Credit course to the students who have passed FSc/Equivalent with Physics, Mathematics, and Computer Studies/Science (ICS) combination, i.e., FSc/Equivalent with non-Pre-Engineering background. These students may preferably pass this remedial course in the 1st semester of their degree program. This course will not contribute to student's GPA.

Additional Notes:

1) Students enrolled in the Bachelor of Science in Chemical Engineering program have the flexibility to choose to pursue one additional minor as per the scenarios stated below. These minors can be selected from any category of courses recognized as minors by other programs offered at their respective CUI campus. This choice must adhere to the established rules and regulations of the University.

a) Scenario 1 - Single Major (140 credits):

This scenario centres on a single major in Chemical Engineering, demanding completion of 140 credits for completion. This breakdown includes 42 credits for General Education, 78 for the Core Major, 14 for Interdisciplinary Studies, non-credited mandatory Field Experience and 6 for the Capstone Project.

b) Scenario 2 - Single Major with Minor (152 credits):

In this case, a single major is accompanied by a minor, requiring a minimum of 152 credits in total. The components encompass 42 credits for General Education, 78 for the Core Major, 14 for Interdisciplinary Studies, non-credited mandatory Field Experience and 6 for the Capstone. Additionally, a 12-credit minor complements the major, fostering broader skills.

2) The study of the teachings of Sirat un-Nabi (P.B.U.H.) course will constitute a mandatory component of the curriculum for all undergraduate degree programs. This course will be conducted using a hybrid mode of instruction across the CUI System. Upon successful completion of the course, students will receive a certificate endorsed by the Head of Department (HoD).

3) **Deficiency:** Students with F.Sc/Equivalent with Physics, Mathematics and Computer Studies/Science (ICS) combination, i.e., F.Sc/Equivalent with non-Pre-Engineering background may preferably pass the remedial course in Chemistry i.e. CHM102- Introduction to Chemistry in the 1st semester of their degree program. This course will not contribute to students' GPA.

Framework for BS Chemical Engineering Program

- i. Minimum Duration: 04 Years
- ii. Minimum No. of Semesters: 08
- iii. No. of Credit Hours in each Semester: 15-18
- iv. Main Courses (including Labs):
 - a. Engineering Courses (List Attached) 33
 - b. Non-Engineering Courses (List Attached) 19
- v. Elective courses:
 - a. Engineering Courses (List Attached) 02
- vi. Total No. of Courses: 54
- vii. Total No of Credit Hours: 140

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Sub Area	Course Title	Theory	Lab	Credit Hours	Total	% Overall
Non-Engineering Domain								
WK-1/ WK-5/ WK-7/ WK-9	Humanities	English	Functional English	3	0	3	6	4.3%
			Expository Writing	3	0	3		
		Culture	Ideology and Constitution of Pakistan	2	0	2	10	7.1%
			Islamic Studies	2	0	2		
			Pakistan Studies	2	0	2		
			Fehm-e-Quran I	0	1	1		
			Fehm-e-Quran II	0	1	1		
			Fundamentals of Philosophy	2	0	2		
		Social Science	Civics and Community Engagement	2	0	2	4	2.9%
			Fundamentals of Sociology	2	0	2		
	Management Sciences	Professional Practice	International Entrepreneurship	3	0	3	6	4.3%
			Process Economics	3	0	3		

	Computer Science	Basic Computing	Introduction to Computers and Computing	0	1	1	1	0.7%
WK-1/ WK-2	Natural Sciences	Mathematics	Calculus I	3	0	3	9	6.4%
			Calculus II	3	0	3		
			Differential Equations	3	0	3		
		Chemistry	Chemistry I	3	1	4	8	5.7%
			Chemistry II	3	1	4		
		Physics	Physics for Chemical Engineers	3	1	4	4	2.9%
Total Credit Hours (Non-Engineering Domain)							48	34.3%
Engineering Domain								
WK-2/ WK-4/ WK-5	Advanced Computer and Information Science(s)	ICT/AI/Data Science/Cyber Security	Introduction to Computer Programming	3	1	4	11	7.9%
			Numerical Computations	3	1	4		
			Artificial Intelligence for Chemical Engineers	3	0	3		
WK-1/ WK-2/ WK-3/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-9	Engineering Foundation Courses		Introduction to Chemical Engineering	2	0	2	18	12.9%
			Particulate Technology	2	1	3		
			Chemical Process Principles	3	0	3		
			Fluid Mechanics for Chemical Engineers	3	1	4		
			Thermodynamics I for Chemical Engineers	2	0	2		
			Year 1 Project	0	1	1		
			Year 2 Project	0	1	1		

			Chemical Process Industries	2	0	2		
WK-1/ WK-2/ WK-3/	Engineering Breadth Courses		Transport Phenomena	3	0	3	22	15.7%
			Fuels and Energy	2	1	3		
WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-9			Mass Transfer Operations	3	1	4		
			Heat Transfer Operations	3	1	4		
			Process Instrumentation	2	0	2		
			Process Control	2	1	3		
			Maintenance Engineering and Safety	2	0	2		
			Year 3 Project	0	1	1		
WK-1/ WK-2/ WK-3/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-9	Major Based Core (Depth)		Chemical Reaction Engineering	3	1	4	22	15.7%
			Thermodynamics II for Chemical Engineers	2	1	3		
			Unit Processes	2	0	2		
			Process Modeling and Simulation	2	1	3		
			Biochemical Engineering	3	0	3		
			Simultaneous Heat and Mass Transfer Operations	3	1	4		
			Chemical Engineering Plant Design	3	0	3		
WK-1/ WK-2/ WK-3/ WK-4/	MultiDisciplinary Engineering Breadth		Engineering Drawing	0	1	1	13	9.3%
			General Engineering	2	1	3		

WK-5/ WK-6/ WK-7/ WK-9			Elective I	3	0	3		
			Elective II	3	0	3		
			Engineering Materials	2	0	2		
			Occupational Health and Safety	1	0	1		
WK-1/ WK-2/			Final Year Project (Part I)	0	3	3	6	4.3%
WK-3/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-9	Final Year Design Project		Final Year Project (Part II)	0	3	3		
WK-4/ WK-6/ WK-7/ WK-8 WK-9	Industrial Training		Internship	0	0	0	0	0.0%
Total Credit Hours (Engineering Domain)							92	65.7%
Total Credit Hours				111	29	140	140	100%

Tentative Scheme of Studies for BS Chemical Engineering Program w.e.f. Fall 2026 Intake

<u>Semester 1</u>				
1.	MTH101	Calculus I	3(3, 0)	
2.	PHY132	Physics for Chemical Engineers	4(3, 1)	
3.	EEE113	Engineering Drawing	1(0, 1)	
4.	HUM104	Functional English	3(3, 0)	
5.	CHE111	Introduction to Chemical Engineering	2(2, 0)	
6.	CHE141	General Engineering	3(2, 1)	
7.	HUM161	Fehm-e-Quran I	1(0, 1)	
			17(13, 4)	
<u>Semester 2</u>				
1.	MTH102	Calculus II	3(3, 0)	MTH101
2.	CHM100	Chemistry I	4(3, 1)	
3.	HUM208	Civics and Community Engagement	2(2, 0)	
4.	HUM112	Islamic Studies	2(2, 0)	
5.	CHE113	Chemical Process Principles	3(3, 0)	
6.	HUM120	Expository Writing	3(3, 0)	
7.	EGG100	Year 1 Project	1(0, 1)	
			18(16, 2)	
<u>Semester 3</u>				
1.	MTH242	Differential Equations	3(3, 0)	MTH102

2.	EEE111	Introduction to Computers and Computing	1(0, 1)	
3.	HUM123	Fundamentals of Philosophy	2(2, 0)	
4.	HUM113	Ideology and Constitution of Pakistan	2(2, 0)	
5.	CHM201	Chemistry II	4(3, 1)	CHM100
6.	CHE214	Fluid Mechanics for Chemical Engineers	4(3, 1)	PHY132
7.	HUM117	Pakistan Studies	2(2, 0)	
			18(15, 3)	
<u>Semester 4</u>				
1.	CSC141	Introduction to Computer Programming	4(3, 1)	
2.	CHE223	Fuels and Energy	3(2, 1)	
3.	CHE112	Particulate Technology	3(2, 1)	
4.	CHE215	Thermodynamics I for Chemical Engineers	2(2, 0)	CHM201
5.	CHE221	Chemical Process Industries	2(2, 0)	
6.	CHE222	Transport Phenomena	3(3, 0)	MTH242
7.	EGG200	Year 2 Project	1(0, 1)	
			18(14, 4)	
<u>Semester 5</u>				
1.	MTH375	Numerical Computations	4(3, 1)	MTH242
2.	HUM130	Fundamentals of Sociology	2(2, 0)	

3.	CHE316	Unit Processes	2(2, 0)	
4.	CHE324	Mass Transfer Operations	4(3, 1)	

5.	CHE325	Heat Transfer Operations	4(3, 1)	
6.	CHE313	Occupational Health and Safety	1(1, 0)	
7.	HUM162	Fehm-e-Quran II	1(0, 1)	
			18(14, 4)	

Semester 6

1.	ECO302	Process Economics	3(3, 0)	
2.	CHE331	Chemical Reaction Engineering	4(3, 1)	CHE316
3.	CHE332	Thermodynamics II for Chemical Engineers	3(2, 1)	CHE215
4.	CHE333	Simultaneous Heat and Mass Transfer Operations	4(3, 1)	CHE324, CHE325
5.	CHE242	Engineering Materials	2(2, 0)	
6.	EGG300	Year 3 Project	1(0, 1)	
			17(13, 4)	
Summer Semester	EGG497	Internship	0(0, 0)	

Semester 7

1.	CHE426	Process Instrumentation	2(2, 0)	
2.	CHE427	Process Control	3(2, 1)	
3.	CHE435	Chemical Engineering Plant Design	3(3, 0)	
4.	CHE437	Process Modeling and Simulation	3(2, 1)	

5.		Elective I	3(3, 0)	
6.	EGG498	Final Year Project (Part I)	3(0, 3)	
			17(12, 5)	
<u>Semester 8</u>				
1.	CHE429	Maintenance Engineering and Safety	2(2, 0)	
2.	CHE438	Biochemical Engineering	3(3, 0)	
3.	CHE447	Artificial Intelligence for Chemical Engineers	3(3, 0)	
4.	ENP475	International Entrepreneurship	3(3, 0)	
5.		Elective II	3(3, 0)	
6.	EGG499	Final Year Project (Part II)	3(0, 3)	EGG498
			17(14, 3)	
Total Credit Hours			140(111, 29)	

Mapping of GAs, PLOs, WKs, SDGs and ECs for BS Chemical Engineering Scheme of Studies (Fall 2026)

Course Code	Course Title	Graduate Attributes (GAs)	Program Learning Outcomes (PLOs)	Knowledge Profile (WKs)	Sustainable Development Goals (SDGs)	Engineering Competencies (ECs)
ChE Core Courses						
CHE111	Introduction to Chemical Engineering	GA1,2	PLO1,2	WK1,2,3	SDG 4 - Target 4.4, SDG 7 - Target 7.3, SDG 9 - Target 9.4, Target 9.5, SDG 12 - Target 12.2, SDG 13 - Target 13.3	EC1,2,3
CHE112	Particulate Technology (T)	GA1,2	PLO1,2	WK3	SDG 9 - Target 9.4, SDG 12 - Target 12.2, SDG 3 - Target 3.9, SDG 7 - Target 7.3, SDG 13 - Target 13.3, SDG 8 - Target 8.2	EC1,2,3
	Particulate Technology (L)	GA1,2,4,5,6,7,8,9,11	PLO1,2,4,5,6,7,8,9,11	WK2,3,4,6,7,9		EC2,3,6,8,10,11
CHE113	Chemical Process Principles	GA1,2	PLO1,2	WK1,2,3,4	SDG 9 - Target 9.4, SDG 12 - Target 12.2, SDG 7 - Target 7.3	EC1,3
CHE214	Fluid Mechanics for Chemical Engineers (T)	GA1,3,4,5,7,8,9	PLO1,3,4,5,7,8,9	WK2,3,4,5,6,8,9	SDG 7 - Target 7.2, SDG 9 - Target 9.4, SDG 12 - Target 12.6, SDG 13 - Target 13.2	EC1,4,5,8,10,11, 12,13

Course Code	Course Title	Graduate Attributes (GAs)	Program Learning Outcomes (PLOs)	Knowledge Profile (WKs)	Sustainable Development Goals (SDGs)	Engineering Competencies (ECs)
	Fluid Mechanics for Chemical Engineers (L)	GA1,2,3,4,5,6,7,8,9,11	PLO1,2,3,4,5,6,7,8,9,11	WK2,3,4,5,6,7,8,9		EC1,2,3,4,5,6,8,9,10,11,12,13
CHE215	Thermodynamics I for Chemical Engineers	GA1,2	PLO1,2	WK1,2,3,4	SDG 7 - Target 7.2, SDG 9 - Target 9.4, SDG 12 - Target 12.6, SDG 13 - Target 13.2	EC1,3
EGG100	Year 1 Project	GA1,2,5,6,7,8,9	PLO1,2,5,6,7,8,9	WK1,2,3,7,8,9	SDG 4 - Target 4.7, SDG 9 - Target 9.5, SDG 12 - Target 12.6	EC1,3,6,11,12,13
EGG200	Year 2 Project	GA1,2,5,6,7,8,9	PLO1,2,5,6,7,8,9	WK1,2,3,7,8,9	SDG 4- Target 4.4, SDG 9- Target 9.5, SDG 8- Target 8.6	EC1,3,6,11,12,13
CHE221	Chemical Process Industries	GA1,2,5	PLO1,2,5	WK3,4,6	SDG 8 - Target 8.2, SDG 9 - Target 9.4, SDG 12 - Target 12.6, SDG 13 - Target 13.2, SDG 8 - Target 8.2	EC1,3
CHE222	Transport Phenomena	GA1,2	PLO1,2	WK1,2,3	SDG 7- Target 7.3, SDG 9- Target 9.4, SDG 12- Target 12.6, SDG 13- Target 13.2	EC1,3
CHE223	Fuels and Energy (T)	GA1,2,3	PLO1,2,3	WK1,3,4		EC1,3,4

Course Code	Course Title	Graduate Attributes (GAs)	Program Learning Outcomes (PLOs)	Knowledge Profile (WKs)	Sustainable Development Goals (SDGs)	Engineering Competencies (ECs)
	Fuels and Energy (L)	GA1,2,4,5,6,7,8,9,11	PLO1,2,4,5,6,7,8,9,11	WK3,4,6,7,9	SDG 7- Target 7.2, SDG 9- Target 9.4, SDG 12- Target 12.2, SDG 13- Target 13.2	EC2,3,6,8,10,11
CHE324	Mass Transfer Operations (T)	GA1,3,4,5,7,8,9	PLO1,3,4,5,7,8,9	WK3,4,5,6,8,9	SDG 6- Target 6.3, SDG 9- Target 9.4, SDG 12- Target 12.4, SDG 9- Target 9.4, SDG 6- Target 6.3, SDG 13- Target 13.2	EC1,3,4,5,8,10,11,12,13
	Mass Transfer Operations (L)	GA1,2,3,4,5,6,7,8,9,11	PLO1,2,3,4,5,6,7,8,9,11	WK2,3,4,5,6,7,8,9		EC1,2,3,4,5,6,8,9,10,11,12,13
CHE325	Heat Transfer Operations (T)	GA1,2,3,4,5,7,8,9	PLO1,2,3,4,5,7,8,9	WK3,4,5,6,8,9	SDG 7- Target 7.3, SDG 9- Target 9.4, SDG 12- Target 12.5, SDG 13- Target 13.2, SDG 12- Target 12.5	EC1,3,4,5,8,10,11,12,13
	Heat Transfer Operations (L)	GA1,2,4,5,6,7,8,9,11	PLO1,2,4,5,6,7,8,9,11	WK2,3,4,6,7,9		EC2,3,6,8,10,11
CHE426	Process Instrumentation	GA1,2,3,5	PLO1,2,3,5	WK4,5,6	SDG 4- Target 4.4, SDG 9- Target 9.1, SDG 4- Target 4.4, SDG 12- Target 12.7	EC2,3,4
CHE427	Process Control (T)	GA1,2,3,5	PLO1,2,3,5	WK2,4,5,6	SDG 8- Target 8.2, SDG 9- Target 9.4, SDG 8- Target 8.2, SDG 12- Target 12.6	EC2,3,4
	Process Control (L)	GA1,2,4,5,6,7,8,9,11	PLO1,2,4,5,6,7,8,9,11	WK2,3,4,6,7,9		EC2,3,6,8,10,11

Course Code	Course Title	Graduate Attributes (GAs)	Program Learning Outcomes (PLOs)	Knowledge Profile (WKs)	Sustainable Development Goals (SDGs)	Engineering Competencies (ECs)
CHE429	Maintenance Engineering and Safety	GA1,2	PLO1,2	WK4	SDG 3- Target 3.9, SDG 8- Target 8.8, SDG 9- Target 9.1, SDG 12- Target 12.6, SDG 9- Target 9.1	EC1,3
EGG300	Year 3 Project	GA4,5,7,8,9,10,11	PLO4,5,7,8,9,10,11	WK1,2,3,4,5,6,7,8,9	SDG 4- Target 4.7, SDG 9- Target 9.5, SDG 12- Target 12.6	EC1,2,3,4,5,6,7, 8,9,10,11,12,13
CHE331	Chemical Reaction Engineering (T)	GA1,2,3,4,5,7,8,9	PLO1,2,3,4,5,7,8,9	WK3,4,5,6,8,9	SDG 7- Target 7.3, SDG 9- Target 9.4, SDG 12- Target 12.5, SDG 13- Target 13.2	EC1,3,4,5,8,10,1 1,12,13
	Chemical Reaction Engineering (L)	GA1,2,4,5,6,7,8,9,11	PLO1,2,4,5,6,7,8,9,11	WK2,3,4,6,7,9		EC2,3,6,8,10,11
CHE332	Thermodynamics II for Chemical Engineers (T)	GA1,2,3	PLO1,2,3	WK3,4,5	SDG 7- Target 7.3, SDG 9- Target 9.4, SDG 13- Target 13.2, SDG 12- Target 12.5, SDG 12- Target 12.5	EC2,3,4
	Thermodynamics II for Chemical Engineers (L)	GA1,2,4,5,6,7,8,9,11	PLO1,2,4,5,6,7,8,9,11	WK2,3,4,6,7,9		EC2,3,6,8,10,11
CHE316	Unit Processes	GA1,3,5	PLO1,3,5	WK3,4,5	SDG 7- Target 7.2, SDG 9- Target 9.4, SDG 12- Target 12.4, SDG 7- Target 7.2, SDG 13- Target 13.2	EC1,4

Course Code	Course Title	Graduate Attributes (GAs)	Program Learning Outcomes (PLOs)	Knowledge Profile (WKs)	Sustainable Development Goals (SDGs)	Engineering Competencies (ECs)
CHE437	Process Modeling and Simulation (T)	GA1,2,3,5	PLO1,2,3,5	WK2,3,4,5	SDG 4- Target 4.7, SDG 9- Target 9.4, SDG 12- Target 12.6, SDG 13- Target 13.2, SDG 4- Target 4.7	EC1,4
	Process Modeling and Simulation (L)	GA1,2,5,9	PLO1,2,5,9	WK2,3,4,6,9		EC1,3,8,10
CHE438	Biochemical Engineering	GA1,2,3,5	PLO1,2,3,5	WK1,3,4,5	SDG 2- Target 2.4, SDG 3- Target 3.9, SDG 9- Target 9.4, SDG 12- Target 12.2, SDG 3- Target 3.9	EC2,3,4
CHE333	Simultaneous Heat and Mass Transfer Operations (T)	GA1,3,4,5,7,8,9	PLO1,3,4,5,7,8,9	WK3,4,5,6,8,9	SDG 9- Target 9.4, SDG 7- Target 7.3, SDG 12- Target 12.2, SDG 13- Target 13.2	EC1,3,4,5,8,10,11,12,13
	Simultaneous Heat and Mass Transfer Operations (L)	GA1,2,3,4,5,6,7,8,9,11	PLO1,2,3,4,5,6,7,8,9,11	WK2,3,4,5,6,7,8,9		EC1,2,3,4,5,6,8,9,10,11,12,13
CHE435	Chemical Engineering Plant Design	GA1,3,4,5,7,8,9	PLO1,3,4,5,7,8,9	WK3,4,5,6,8,9	SDG 3- Target 3.9, SDG 8- Target 8.2, SDG 9- Target 9.4, SDG 12- Target 12.5, SDG 3- Target 3.9, SDG 8- Target 8.2	EC1,3,4,5,8,10,11,12,13

Course Code	Course Title	Graduate Attributes (GAs)	Program Learning Outcomes (PLOs)	Knowledge Profile (WKs)	Sustainable Development Goals (SDGs)	Engineering Competencies (ECs)
CHE141	General Engineering (T)	GA1	PLO1	WK1,3	SDG 4 - Target 4.7, SDG 7 - Target 7.3, SDG 9 - Target 9.4, SDG 12 - Target 12.5, SDG 4 - Target 4.7	EC1
	General Engineering (L)	GA1,2,4,5,6,7,8,9,11	PLO1,2,4,5,6,7,8,9,11	WK2,3,4,6,7,9		EC2,3,6,8,10,11
CHE242	Engineering Materials	GA1,2	PLO1,2	WK1,3	SDG 3- Target 3.9, SDG 9- Target 9.4, SDG 12- Target 12.5, SDG 13- Target 13.2, SDG 3- Target 3.9	EC1,3
CHE313	Occupational Health and Safety	GA1,2	PLO1,2	WK4,6,7	SDG 3 - Target 3.9, SDG 8 - Target 8.8, SDG 12 - Target 12.6, SDG 16 - Target 16.6	EC1,3,6,7
CHE440	Data Science for Chemical Engineers	GA1,2,5	PLO1,2,5	WK2,4,6	SDG 4- Target 4.7	EC2,3
CHE445	Machine Learning for Chemical Engineers	GA1,2,5	PLO1,2,5	WK2,4,6	SDG 4- Target 4.7, SDG 9- Target 9.4	EC2,3
EKG497	Internship	GA2,5,6,9,11	PLO2,5,6,9,11	WK4,6,7,8,9	SDG 3 - Target 3.9, SDG 17 - Target 17.6	EC6,8,9,10,11

EKG498	Final Year Project (Part I)	GA1,2,4,5,7,8,9	PLO1,2,4,5,7,8,9	WK1,2,3,4,5,6,7,8,9	SDG 4- Target 4.7, SDG 6- Target 6.3, SDG 7- Target	EC1,2,3,4,5,6,8, 10,11,12,13
Course Code	Course Title	Graduate Attributes (GAs)	Program Learning Outcomes (PLOs)	Knowledge Profile (WKs)	Sustainable Development Goals (SDGs)	Engineering Competencies (ECs)
					7.2, SDG 8- Target 8.2, SDG 9- Target 9.4, SDG 12- Target 12.6, SDG 13- Target 13.2, SDG 13 - Target 13.3	
EKG499	Final Year Project (Part II)	GA2,3,5,6,7,8,9,10,11	PLO2,3,5,6,7,8,9,10,11	WK1,2,3,4,5,6,7,8,9	SDG 4- Target 4.7, SDG 6- Target 6.3, SDG 7- Target 7.2, SDG 8- Target 8.2, SDG 9- Target 9.4, SDG 12- Target 12.6, SDG 13- Target 13.2, SDG 13 - Target 13.4	EC1,2,3,4,5,6,7, 8,9,10,11,12,13
CHE447	Artificial Intelligence for Chemical Engineers	GA1,3,5	PLO1,3,5	WK2,3,4,5	SDG 4- Target 4.7, SDG 9- Target 9.4, SDG 12- Target 12.6, SDG 13- Target 13.2, SDG 4- Target 4.7	EC1,4

Course Title:

Introduction to Chemical Engineering

Course Code: CHE111**Credit Hours:** 2(2, 0) **Course****Objectives:**

To develop a strong foundational understanding of core chemical engineering areas, including Thermodynamics, Unit Operations and Processes, Fluid Mechanics, Reaction Engineering, and Transfer Operations.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the fundamentals of core chemical engineering areas.	C2	PLO1	Communication	Through Assignments
2.	Solve basic problems of core chemical engineering areas.	C3	PLO1	-	-
3.	Compare different unit operations and processes of chemical engineering to reach an optimal solution.	C4	PLO2	Co-Intelligence	Through Assignments

Course Contents:

Introduction: past present and future chemical engineering, an overview of job opportunities. Basics of stoichiometry: unit and dimensions, choosing a basis. Fundamentals of material and energy balance. A Little Thermodynamics: thermodynamic system and surrounding, types of system, thermodynamic state and state functions, important fluid properties in thermodynamics and their relations. Unit operations and unit processes: concept of unit operation and important unit operations in chemical engineering. Concept of unit process and important unit processes in chemical engineering. Basics of fluid mechanics: concept of boundary layer, laminar and turbulent flow, eddies and wake formation, vena contracta, shear stress, compressibility of fluids, role of pressure in fluid mechanics, common pressure and flow measuring devices. Fundamentals of transfer operations: heat transfer, concept of evaporation, Mass transfer; stage processes, concept of distillation, leaching, extraction, diffusion, absorption, adsorption, drying, humidification, crystallization and membrane separation. Basics of reaction engineering and reactor design: stoichiometric coefficients, rate of reaction, order and molecularity of reaction, significance of rate constant, the nature of the reactor design problem, reactor types, concept of reaction time, holding

time/contact time/residence time, space time and space velocity. Use of computer-aided tools to apply and analyze concepts related to stoichiometry, transfer units, reaction engineering, fluid mechanics, unit processes and operations.

Recommended Books:

1. Ghasem, N., & Henda, R. (2025). *Principles of chemical engineering processes: Material and energy balances* (3rd ed.). CRC Press.
2. Felder, R. M., & Rousseau, R. W. (2023). *Elementary principles of chemical processes: Chemical engineering fundamentals* (5th ed.). Wiley.
3. Darby, R., & Chhabra, R. P. (2022). *Chemical engineering fluid mechanics* (3rd ed.). CRC Press.
4. Fogler, H. S. (2020). *Elements of chemical reaction engineering* (5th ed.). Pearson.
5. Smith, J. M., Van Ness, H. C., & Abbott, M. M. (2020). *Introduction to chemical engineering thermodynamics* (8th ed.). McGraw-Hill.
6. Incropera, F. P., & DeWitt, D. P. (2018). *Fundamentals of heat and mass transfer* (7th ed.). Wiley.
7. McCabe, W. L., Smith, J. C., & Harriott, P. (2004). *Unit operations of chemical engineering* (7th ed.). McGraw-Hill.

Course Title:

Course Code:

Credit Hours:

Particulate Technology

CHE112

3(2, 1)

Course Objectives:

To provide understanding of the fundamentals of unit operations involved in particulate technology and particle processing with the emphasis on applications and practical problems in chemical and process industries.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the fundamentals and construction/working principle of equipment related to the particulate technology and their safety aspects.	C2	PLO1	--	--
2.	Solve basic problems related to particle flow dynamics and separation equipment.	C3	PLO1	--	--
3.	Select appropriate size reduction and separation equipment for various industrial applications.	C4	PLO2	Communication, Co-intelligence	Through assignments

Course Contents:

Particle characterization; classification of solid particles and particle properties. Particle size analysis; measurement of particle size, particle size distribution and mean particle size. Size

reduction; nature of materials to be crushed, classification & working principles of crushing & grinding equipment and energy calculations of size reduction. Agglomeration. Particle formation; granulation, palletization, etc. Particle flow dynamics; flow of solids, measurement and control of solid flow rates, multiphase flow. Storage and transport; hopper design, pneumatic conveying, slurry flow, fluidization. Mixing; blending of solid particles, rate of mixing, solidliquid mixing, mixers and their types. Separation; cyclones, sieving, filtration, centrifuges, electrostatic separators, efficiency of separation and gravity settling. Safety; fire and explosion hazards, health hazards, etc.

Recommended Books:

1. Rhodes, M. J. (2024). *Introduction to particle technology* (3rd ed.). Wiley-VCH.
2. Chhabra, R. P., & Gurappa, B. (Eds.). (2019). *Coulson and Richardson's chemical engineering: Volume 2A, particulate systems and particle technology* (6th ed.). Butterworth-Heinemann.
3. Lee, S., & Henthorn, K. H. (Eds.). (2017). *Particle technology and applications* (1st ed.). CRC Press.
4. Seville, J. P. K., & Wu, C. Y. (2016). *Particle technology and engineering* (1st ed.). Butterworth-Heinemann.
5. McCabe, W. L., Smith, J. C., & Harriott, P. (2004). *Unit operations of chemical engineering* (7th ed.). McGraw-Hill Education.

Course Title:

Course Code:

Credit Hours:

Chemical Process Principles

CHE113

3(3, 0)

Course Objectives:

To develop students' ability to perform mass and energy balances for batch, continuous, and reactive systems, including processes with recycle, purge, and bypass streams. It emphasizes the formulation and solution of balance equations using analytical and computational tools such as MS Excel, alongside thermodynamic and gas property calculations.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe basic concepts related to material and energy balances.	C2	PLO1	--	--
2.	Apply fundamental concepts of material and energy balances of various chemical processes using conventional methods and computational tools.	C3	PLO1	--	--
3.	Analyze various industrial scenarios pertaining to chemical process principles.	C4	PLO2	Communication, and Co-Intelligence	Through Presentations, Assignments and/or Quizzes

Course Contents:

Mass balances for items of plant; choice of basis and datum for balances; overall and component mass balances; balances for batch and continuous plants; mass balances for systems with recycle, purge, and bypass streams; formulation of balance equations for reactive and non-reactive processes supported by computer aided tools to assist in automating multi-step mass balance calculations. Mass balances for unit operations and systems with tie components; systematic stoichiometric calculations for reacting systems; use of flow diagrams for clear representation of

process streams and reactions. Vapor pressure; saturation and partial saturation; humidity and humidification operations; balances for condensing systems. Dynamic mass balances for unsteadystate systems.

Energy balance concepts and units; forms of energy; application of the first law of thermodynamics; calculation of enthalpy changes using reference states and temperaturedependent heat capacity data. Applications of general energy balances without chemical reaction, including heating, cooling, mixing, and phase change operations; computational solutions of energy balance equations. Balances with chemical reaction, including mass and energy balances for reacting and combustion systems; adiabatic and non-adiabatic operation; efficiency and conversion calculations. Case studies on mass and energy balances for selected industrial chemical processes.

Recommended Books:

1. Himmelblau, D. M., & Riggs, J. B. (2023). *Basic principles and calculations in chemical engineering* (9th ed.). Pearson.
2. Felder, R. M., Rousseau, R. W., & Bullard, L. G. (2020). *Elementary principles of chemical processes* (4th ed.). John Wiley & Sons.
3. Ghasem, N., & Henda, R. (2019). *Principles of chemical engineering processes: Material and energy balances* (2nd ed.). CRC Press.
4. Martín, J. (2018). *Introduction to software for engineering problem solving*. Springer.

Course Title:

Course Code:

Credit Hours:

General Engineering

CHE141

3(2, 1)

Course Objectives:

The course aims to introduce fundamental laws and concepts of electrical and mechanical engineering and develop students' ability to solve basic engineering problems using conventional analytical methods. It provides foundational knowledge of electrical circuits, machines, electronics, and internal combustion engines. The course emphasizes understanding and application of core engineering principles in standard engineering contexts.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the fundamental laws of electrical and mechanical engineering and their industrial applications.	C2	PLO1	Cyber security, Communication	Through assignments, Group Presentations
2.	Solve basic problems of electrical and mechanical engineering	C3	PLO1	--	--

Course Contents:

Fundamentals of electricity and basic electrical/electronic components, Direct Circuits theory and practice, Alternating Circuits theory and practice, AC Induction Motor, fundamentals of electronics, electronics circuits, awareness of cybersecurity and safety aspects in electrical, electronic systems, their applications towards industrial control system, including introductory concepts of sensors, PLCs, and secure industrial control systems.

Introduction of mechanical engineering, theory of machines: Gears, Flywheels, Governor, Shafts, Cam Shafts, Crank Shafts, computer-based visualization and demonstrations of machine components and mechanisms, Heat Engines: classification, construction of Internal combustion (IC) engine, Types of IC engines, thermodynamic cycles of IC engines, competitive performance of two-stroke IC engine and four-stroke IC engine (IC), Spark Ignition IC Engines, Compression

IC engines, software-assisted IC engine sizing, power calculations, and performance comparison, Construction of turbines and compressors.

Recommended Books:

1. Wadhwa, C. L. (2024). *Basic electrical engineering*. New Age International.
2. Kumar, D. S. (2023). *Fundamentals of mechanical engineering*. S.K. Kataria & Sons.
3. Heywood, J. B. (2018). *Internal combustion engine fundamentals* (2nd ed.). McGraw-Hill Education.
4. Schultz, S. (2016). *Grob's basic electronics* (12th ed.). McGraw-Hill Education.
5. Alexander, C. K., & Sadiku, M. N. O. (2013). *Fundamentals of electric circuits* (5th ed.). McGraw-Hill.

Course Title:

Course Code:

Credit Hours:

Fluid Mechanics for Chemical Engineers

CHE214

4(3, 1)

Course Objectives:

This course aims to develop an understanding of fluid statics and fluid dynamics with emphasis on the conservation of mass, momentum, and energy. Students will learn to analyze fluid behavior under various flow conditions and apply fundamental equations to solve chemical engineering problems. The course also introduces fluid transportation using pumps, compressors, blowers, and fans, along with fluid metering techniques used in process industries.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe fundamentals of fluid statics, fluid mechanics including concepts of mass, momentum and energy conservation with realistic industrial examples	C2	PLO1	--	--
2.	Derive and apply the fluid statics and fluid flow equations over various chemical processes	C3	PLO1	--	--
3.	Define, investigate, analyze, and develop a solution for the Complex Engineering Problems by integrating the knowledge profiles encompassing the problem-solving steps	C6	PLO3	Creativity and Co-Intelligence	Through Complex Engineering Problem Assessment (CEP) – Written Report and Presentation

4.	Investigate Complex Engineering Problems in a methodical way using literature survey	C4	PLO4	Co-Intelligence	Through Complex Engineering Problem Assessment (CEP) – Written
					Report and Presentation
5.	Reconcile the conflicts arise while solving the Complex Engineering Problems	A4	PLO7	--	--
6.	Maintain professional behavior while working in a team for solving the Complex Engineering Problems	A5	PLO8	--	--
7.	Demonstrate results (oral and written) of the Complex Engineering Problems effectively at different levels.	P5	PLO5 (50%) PLO9 (50%)	Communication	Through Complex Engineering Problem Assessment (CEP) – Written Report and Presentation

Course Contents:

Concept & use of units, Dimensional analysis: Buckingham–pi theorem, Dimensional consistency, Gravity and centrifugal decanters. Fluid Statics: Pressure forces on surfaces, Pressure distribution, Static head calculations, Pressure measuring devices (U-shaped and inclined manometers and their applications). Stress in Fluids: Viscosity, Newton’s law of viscosity, Shear stress, shear rate/velocity gradient, Newtonian and non-Newtonian flow. Nature of flow: Laminar & turbulent flow, Compressible & non-compressible fluids. Fluid flow equations: Continuity equation (mass balance) and its application to flow fluid, Bernoulli’s equation and its applications (Momentum balance), Energy relationships & the Bernoulli equation. Calculations for laminar & turbulent pipe flow. Turbulence & boundary layers; Boundary layer thickness, Concept of eddies as a source to sustain turbulence. Flow of incompressible Newtonian fluids in pipes & channels: Shear stress in a pipe, Friction factor & pressure drop, Losses in fittings and bend pipes, Friction loss due to expansions and contractions, Friction in non-circular channels. Turbomachinery and its classifications: Concept of pump, Types of pumps, centrifugal pumps; Centrifugal pump characteristics, Cavitation and vaporization problems in pumps, NPSH, NPSHR and its application

Course Title:

Course Code:

Credit Hours:

in chemical engineering, Concept of specific speed, Similarity laws in centrifugal pumps, Pumps in series and parallel. Positive displacement pumps their classification, Characteristics and selection, Matching system characteristics with pump characteristics. Compressors, Blowers, Fans their classification, characteristics and selection. Fluid motion in the presence of solid particles. Relative motion between a fluid and a single particle. Drag force, Flow through packed beds. Fluidization and its applications in process industry.

Recommended Books:

1. Chassaing, P. (2022). *Fundamentals of fluid mechanics: For scientists and engineers*. Springer.
2. De Nevers, N. (2020). *Fluid mechanics for chemical engineers* (4th ed.). McGraw-Hill Higher Education.
3. White, F. M. (2008). *Fluid mechanics* (6th ed.). McGraw-Hill.
4. Hougen, O. A., & Watson, K. M. (2004). *Chemical process principles: Material and energy balances*. John Wiley & Sons.
5. McCabe, W. L., Smith, J. C., & Harriott, P. (2004). *Unit operations of chemical engineering* (7th ed.). McGraw-Hill.
6. Coulson, J. M., & Richardson, J. F. (1999). *Chemical engineering: Volume 1, fluid flow, heat transfer and mass transfer* (6th ed.). Butterworth-Heinemann.

Course Title: Thermodynamics I for Chemical Engineers

Course Code: CHE215

Credit Hours: 2(2, 0)

Course Objectives:

Introduce chemical engineering students to the fundamental principles of thermodynamics and phase behavior; enabling them to apply thermodynamic concepts to gases, solutions, and multiphase systems relevant to chemical processes and analyze energy changes in chemical systems.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the fundamentals of chemical engineering kinetics and thermodynamics	C2	PLO1	Communication	Through assignment
2.	Apply knowledge of the fundamentals of thermodynamics to find solutions to relevant problems under given constraints	C3	PLO1	--	--
3.	Analyze the behavior of fluids under different concentration and PVT conditions.	C4	PLO2	Co-Intelligence	Through assignment

Course Contents:

Kinetic Theory of Gases, Chemical thermodynamics: Scope and definitions; Isolated, closed and open systems; Intensive and extensive properties; State and functions of state; First law; Internal energy U; Enthalpy H; Reversibility; Calorimetry; Enthalpies of formation and reaction; Bond dissociation energy and mean bond energy; Dependence of U and H on temperature; Kirchhoff's equation; First law as applied to ideal gases; Isothermal; Isometric; isobaric; polytropic and adiabatic processes involving an ideal gas; P-V-T relationships for non-ideal gases.

Phase equilibria: Phase rule; one component systems; Clapeyron and Clausius- Clapeyron equations. Two component systems. Liquid-vapor equilibria. Ideal and Non-ideal solutions;

Composition of vapor in equilibrium with liquid; Fractional distillation. Azeotropes. Mixing. Liquid-solid equilibria. Eutectic. Compound formation. Solid solutions.

Recommended Books:

1. Lee, J. H., & Ramamurthi, K. (2022). *Fundamentals of thermodynamics*. CRC Press.
2. Çengel, Y. A., Boles, M. A., & Kanoğlu, M. (2019). *Thermodynamics: An engineering approach* (9th ed.). McGraw-Hill Education.
3. Smith, J. M., Van Ness, H. C., Abbott, M. M., & Swihart, M. T. (2018). *Introduction to chemical engineering thermodynamics* (8th ed.). McGraw-Hill Education.
4. Sandler, S. I. (2017). *Chemical and engineering thermodynamics* (5th ed.). John Wiley & Sons.
5. Eastop, T. D., & McConkey, A. (1999). *Applied thermodynamics for engineering technologists* (5th ed.). Prentice Hall.

Course Title: Chemical Process Industries

Course Code: CHE221

Credit Hours: 2(2, 0)

Course Objectives:

The aim of the course is to impart in-depth knowledge of various process industries.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the production processes of various chemical process industries.	C2	PLO1	--	--
2.	Sketch block and process flow diagram of process industry.	C3	PLO5	--	--
3.	Differentiate various technologies for a given industrial product.	C4	PLO2	Communication, Co-intelligence	Through assignments

Course Contents:

Acid industries (history, manufacturing, properties and uses), cement industry, sugar industry, fertilizer industry (history, manufacturing, properties and uses), caustic soda and soda ash industry, soap and detergent industry, plastic industry (types and their properties, manufacturing and uses), paper and pulp industry (manufacturing and uses), glass industry, explosives industry, paint industry and alcohol industry.

Recommended Books:

1. Jess A., Wasserscheid P. (2022). *Chemical Technology: From Principles to Products* (2nd ed.). Wiley.
2. Kent, J. A., Bommaraju, T. V., & Barnicki, S. D. (Eds.). (2017). *Handbook of industrial chemistry and biotechnology* (13th ed.). Springer Cham.
3. Kent, J. A. (Ed.). (2010). *Riegel's handbook of industrial chemistry* (10th ed.). Springer.
4. Pandey, G. N. (2006). *A textbook of chemical technology* (2nd ed., Vols. 1–2). Vikas Publishing House Pvt. Ltd.

5. Kirk-Othmer Foundation (Ed.). (2004). Kirk-Othmer encyclopedia of chemical technology (5th ed.). Wiley-Interscience.
6. Austin, G. T. (1984). Shreve's chemical process industries (5th ed.). McGraw-Hill International.

Course Title: Transport Phenomena

Course Code: CHE222

Credit Hours: 3(3, 0)

Course Objectives

This course aims to establish a rigorous foundation in the theory and application of momentum, heat, and mass transport processes by integrating fundamental principles with analytical and modern computational

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Explain the fundamental principles and analogies of transport phenomena.	C2	PLO1	--	--
2.	Apply macroscopic balances and shell balances to model steady-state transport systems.	C3	PLO1	--	--
3.	Solve differential transport equations for velocity, temperature and concentration profiles and associated fluxes.	C3	PLO1	--	--
4.	Analyze transport processes in chemical engineering systems using conservation equations	C4	PLO2	Co-intelligence	Assignments/Quiz

Course Contents:

The Three Transport Phenomena: momentum, energy, and mass; unifying concept of transport processes. Review of vectors and tensors, coordinate systems, differential operators, gradient, divergence and partial time derivatives. General Conservation Principles: conservation of mass, momentum, and energy; shell balances and transition from integral to differential forms; molecular and convective transport mechanisms; transport properties. Molecular Transport Laws: Newton's law of viscosity, Fourier's law of heat conduction, Fick's law of diffusion in vector-gradient form. Momentum Transport: shell balance applications, velocity profiles, shear stress distribution, volumetric flow rate in simple geometries; macroscopic momentum balances, continuity equation, Navier–Stokes equations; solutions for creeping flow and fully developed laminar flow; introduction to unsteady-state and turbulent flow. Dimensional Analysis: dimensional homogeneity, Buckingham π -theorem and dimensional numbers related to momentum, mass and energy transport. Energy Transport: shell balances and derivation of heat conduction equation; temperature profiles and heat flux in slabs, cylinders, and composite walls; two-dimensional conduction, convective heat transfer, forced and natural convection, use of correlations; macroscopic energy balances and applications to non-isothermal flow systems. Mass Transport: shell balances and derivation of convection–diffusion equation; steady-state diffusion in stagnant and moving media; equimolar counter-diffusion, diffusion through a stagnant film; mass transfer with homogeneous chemical reaction; convective mass transfer, mass transfer coefficients and correlations. Integrated Transport Analysis: case study illustrating a coupled two-dimensional momentum, heat, and mass transfer problem.

Recommended Books:

1. Tosun, İ. (2025). *Solved problems in transport phenomena: Mass transfer*. World Scientific Publishing Co.
2. Welty, J. R., Rorrer, G. L., & Foster, D. G. (2020). *Fundamentals of momentum, heat, and mass transfer* (7th ed.). John Wiley & Sons.
3. Plawsky, J. L. (2020). *Transport phenomena fundamentals* (4th ed.). CRC Press.
4. Bird, R. B., Stewart, W. E., Lightfoot, E. N., & Klingenberg, D. J. (2015). *Introductory transport phenomena*. John Wiley & Sons.
5. Tosun, İ. (2007). *Modeling in transport phenomena: A conceptual approach* (2nd ed.). Elsevier.

Fuels and Energy

CHE223

3(2, 1)

Course Objectives:

To provide students with a sound understanding of the selection, processing, upgrading, efficient utilization and environmental and societal impacts of fossil fuels and combustion/relevant calculations. Students will also learn fundamentals of renewable energy resources.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the industrial fuels, combustion phenomena and fuel processing	C2	PLO1	-	-
2.	Solve numerical problems regarding fuels and combustion	C3	PLO1	-	-
3.	Analyze various conventional and renewable energy technologies	C4	PLO2	Communication and CoIntelligence	Assignments and quizzes
4.	Design equipment related to fuel combustion and its applications	C6	PLO3	Creativity	Assignments, quizzes and Exams

Course Contents:

Overview of global and regional energy resources, survey of fossil fuels and industrial fuels and criteria for selection of fuels for industrial applications. Fossil Fuels: Coal, petroleum, and natural gas; properties and classification. Fuel upgrading techniques; carbonization, gasification, and fuel refining. Heating values and its measurements. Use of computer aided tools to calculate fuel properties. Combustion; fundamentals, principles of combustion, liquid fuel combustion; droplet burning mechanism, fluidized bed combustion. Combustion calculations (solid, liquid and gaseous fuels). Environmental aspects of combustion. Furnaces and Boilers; classification and operation. Flames; types, properties, stability, length, and temperature. Burners; working principles and classification of burners, design of industrial burners. Alternative and renewable energy Resources; fundamentals of Hydel, solar, wind, wave, tidal, geothermal and biomass. Overview of

Course Title:

Course Code:

Credit Hours:

hydrogen economy; hydrogen production technologies. Comparative evaluation of energy resources using efficiency, availability, cost, and environmental impact.

Recommended Books:

1. Turns, S. R. (2021). *An introduction to combustion: concepts and applications* (4th ed). McGraw-Hill.
2. Demirbas. (2021). *A bioenergy: biomass to biofuels*. Springer.
3. Boyle, G. (2020). *Renewable Energy: Power for a Sustainable Future* (4th ed.). Oxford University Press.
4. Basu, P. (2019). *Combustion and gasification in fluidized beds*. (2nd ed.). CRC Press.

Engineering Materials

CHE242

2(2, 0)

Course Objectives:

This course aims to provide basic knowledge of a range of materials used in engineering applications and processes, and to develop an understanding of material behavior and selection based on their characteristics and end-use applications.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the physical and chemical properties and characteristics of engineering materials including metals and nonmetals.	C2	PLO1	Communication	Through assignment
2	Apply knowledge of the properties of materials to find solutions to relevant problems.	C3	PLO1	- -	--
3	Compare engineering materials based on multiple selection criteria and recognize trade-offs between competing requirements	C4	PLO2	Co-Intelligence	Through assignments

Course Contents:

International standards for material testing. Chemical and physical properties of engineering materials. Mechanical properties; stress - strain relationships, tensile strength, impact strength, hardness, fatigue and creep. Phase diagrams of pure and binary systems. Properties, selection and applications of Ferrous metals; iron, carbon steel, alloy steel, tool steel, stainless steel and Nonferrous metals; aluminum, magnesium & titanium, copper and their alloys. Physical, chemical and structural properties and applications of polymers; thermoplastics, PVC, ABS, PTFE, nylon, polycarbonate, thermosets, synthetic rubbers, adhesives and coatings. Ceramic Materials; white wares, refractory ceramics, high performance ceramics, carbon fiber and concrete. Composite Materials. Biomaterials. Criteria for material selection; Mechanical, thermal, chemical, economic

Course Title:**Course Code:****Credit Hours:**

and environmental considerations. Introduction to material selection charts (e.g., Ashby charts). Corrosion; nature, types and protection (surface treatment & heat treatment).

Recommended Books:

1. Callister, Jr., W. D., and Rethwisch, D. G. (2022). *“Fundamentals of materials science and engineering”*. John Wiley & Sons.
2. Callister, Jr., W. D. Rethwisch, D. G. (2020). *Materials science and engineering: an introduction*. John Wiley & Sons.
3. Gupta, K. M. (2014). *“Engineering Materials: Research, applications and advances”*. CRC Press.
4. Ashby, M. F., and David, R. H. (2012). *“Engineering materials 1: an introduction to properties, applications and design”*. Vol. 1. Elsevier
5. Murray G., White C. V. and Weise W. (2007). *“Introduction to Engineering Materials*. CRC Press.
6. Chung, Y. (2006). *Introduction to materials science and engineering*. CRC Press.

Occupational Health and Safety

CHE313

1(1, 0)

Course Objectives:

This course aims to provide students with the knowledge and practical skills to apply occupational health and safety principles, implement safe work practices in office, industrial, and construction settings, and effectively identify, prevent, and control health and safety hazards in workplaces.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Elaborate on physical, chemical, electrical, and cyber hazards in laboratory and workplaces that threaten personal or others' safety and health.	C2	PLO1	Cyber Security, Communication	Through assignments, quizzes and/or Exam
2.	Solve the fundamental problems related to occupational health and safety.	C3	PLO1	N/A	N/A
3.	Analyze potential safety and health hazards citing the relevant regulations such as Ontario Occupational Health and Safety Regulations.	C4	PLO2	Co-intelligence	Through assignments.

Course Contents:

Health and safety foundations: nature and scope of health and safety, reasons/benefits and barriers for good practices of health and safety, legal framework and OHS management system. Fostering a safety culture: four principles of safety- RAMP (Recognize, Assess, Minimize, Prepare), re-thinking safety-learning from incidents, safety ethics and rules, roles and responsibilities towards safety, building positive attitude towards safety, safety cultures in academic institutions. Recognizing and communicating hazards: hazards and risk, types of hazards: physical (mechanical and non-mechanical), chemical (toxic and biological agents), electrical, fire, construction, heat and temperature, noise, cyber, and vibration, falling and lifting etc. learning the language of safety: Signs, symbols and labels, introduction to cyber hazards: types of cyber hazards relevant to OHS,

Course Title:**Course Code:****Credit Hours:**

impact on occupational health and safety, awareness and prevention. Technical safety reports for fire safety. Finding hazard information: material safety data sheets, safety data sheets and the GHS (Globally Harmonized Systems). Accidents and their effect on industry: costs of accidents, time lost, work injuries, parts of the body injured on the job, chemical burn injuries, construction injuries, fire injuries. Assessing and minimizing the risks from hazards: risk concept and terminology, risk assessment procedure, risk metric's, risk estimation and acceptability criteria, principles of risk prevention, selection and implementation of appropriate Risk controls, hierarchy of controls. Preparing for emergency response procedures: fire, chemical spill, first aid, safety drills / trainings: firefighting, evacuation in case of emergency. Stress and safety at work environment: workplace stress and sources, human reaction to workplace stress, measurement of workplace stress, shift work, stress and safety, improving safety by reducing stress, stress in safety managers, stress and workers compensation. Incident investigation: importance of investigation, recording and reporting, techniques of investigation, monitoring, review, auditing health and safety.

Recommended Books:

1. Rotaru, M. and Cioca, L.-I. (2024). *Occupational Health and Safety*. Bentham Science Publishers.
2. Mansdorf, S. Z. (2019). *Handbook of Occupational Safety and Health* (3rd ed). John Wiley & Sons, 2019.
3. Bailey, M. A. and Davis, F. D. (2016). *Occupational Safety and Health Law Handbook* (3rd ed). Rowman & Littlefield Publishing Group, Incorporated.
4. Stranks, J. (2006). *The Manager's Guide to Health and Safety at Work*. Kogan Page Publishers.
5. Jeremy W. Stranks, J. W. (2006). *The A-Z of Health and Safety*. Thorogood Publishing.

Unit Processes

CHE316

2(2, 0)

Course Objectives:

To develop a strong understanding of thermodynamic, kinetic principles and their application to industrial chemical processes. The course aims to enable students to analyze the mechanisms, kinetics, and thermodynamics of major industrial unit processes. It also instills the ability, in the students, to develop industrial process flow diagrams using computer-aided design software.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe important unit processes of industrial applications, with reference to their thermodynamic and kinetic characteristics	C2	PLO1	Communication	Assignment, Report writing and presentation
2.	Apply the fundamentals of chemical kinetics, reaction mechanisms and thermodynamics for unit processes	C3	PLO1	--	--
3.	Develop a process flow diagram for the production of various industrial chemicals using computeraided design software	C6	PLO3 (50%) PLO5 (50%)	Co-Intelligence, Creativity	Through Presentation/ assignments, exam.

Course Contents:

Applications of Thermodynamics in unit processes, sources of thermodynamic data, Chemical kinetics, Chemical-process kinetics, overview of basic calculations for evaluating reaction rate expressions and kinetic parameters. Factors affecting chemical processes, including reactor configuration, reactor shape, and the effect of back-mixing on process performance. Industrial Nitration processes, including kinetics, thermodynamics, mixed-acid systems, and equipment. Reduction processes, including metal–acid, catalytic, electrolytic, sulfide, alkali-metal, and other industrial methods. Halogenation, sulphonation, and sulfation processes. Amination by ammonolysis, covering catalysts, corrosion and pH effects, kinetics and thermodynamics, reactor design, and ammonia recovery. Oxidation and hydrogenation processes, including hydrocarbon synthesis, hydroformylation, and Fischer–Tropsch technology with reactor and economic considerations. Esterification and hydrolysis reactions and their industrial applications. Process flow diagram (PFD) development and interpretation using computer-aided design tools to represent industrial chemical processes, reactor systems, and auxiliary units.

Recommended Books:

Course Title:

Course Code:

Credit Hours:

1. Ullmann's Encyclopedia of Industrial Chemistry. (2023). *Ullmann's encyclopedia of industrial chemistry* (Online ed.). Wiley-VCH Verlag GmbH & Co. KGaA.
2. McCabe, W. L., Smith, J. C., & Harriott, P. (2021). *Unit operations in chemical engineering* (7th ed.). McGraw-Hill Education.
3. Kent, J. A. (2017). *Riegel's handbook of industrial chemistry* (9th ed.). Springer.
4. Olsen, J. C., & Cooney, D. O. (2001). *Unit processes and principles of chemical engineering*. Van Nostrand Reinhold.
5. Keyes, D. B. (2000). *The chemical engineering unit processes*. Engineering Experiment Station.
6. Groggins, P. H. (1995). *Unit processes in organic synthesis* (5th ed.). McGraw-Hill.

Mass Transfer Operations

CHE324

4(3, 1)

Course Objectives:

The Mass Transfer Operations course aims to equip students with a strong understanding of the fundamental theory and practical applications of separation processes governed by mass transfer phenomena, enabling them to analyse, design, and evaluate industrial separation systems reinforced through conventional and computational solutions.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the basic principles of mass transfer phenomena in Chemical Engineering processes and operations.	C2	PLO1	-	-
2.	Solve problems using principles of mass transfer	C3	PLO1	-	-
3.	Design equipment related to mass transfer operations	C6	PLO3	Creativity	Quiz, Exams

4.	Define, investigate, analyze, and develop a solution for the Complex Engineering Problems by integrating the knowledge profiles encompassing the problem-solving steps	C6	PLO3	Creativity and Co-Intelligence	Through Complex Engineering Problem Assessment (CEP)
5.	Investigate Complex Engineering Problems in a methodical way using literature survey	C4	PLO4	Co-Intelligence	Through Complex Engineering Problem Assessment (CEP)
6.	Reconcile the conflicts arise while solving the Complex Engineering Problems	A4	PLO7	-	-
7.	Maintain professional behavior while working in a team for solving the	A5	PLO8	-	-
	Complex Engineering Problems				
8.	Demonstrate results (oral and written) of the Complex Engineering Problems effectively at different levels.	P5	PLO5 (50%) PLO9 (50%)	Communication	Through Complex Engineering Problem Assessment (CEP) – Written Report and Presentation

Course Contents:

An introduction of mass transfer theories. Diffusion through gases and liquids. Fick's law. Use of computational tools for the calculations of mass transfer coefficients ($k_G a$) and ($k_L a$). Absorption: Design, evaluation and selection of gas absorption equipment; Packed and plate columns, vessels with agitators, centrifugal absorber and Spray towers. Chemisorption. Liquid-Liquid extraction: Introduction of Extraction Processes. Classification of extraction equipment, Stage-wise and Differential contacts. Development and utilization of equilibrium data. Calculation of the number of theoretical stages for various cases of counter current and co-current operations. Leaching: Fundamentals of mass transfer in leaching, Equipment for leaching. Calculation of the number of stages by graphical methods, plotting equilibrium data using computational tools for multistage cross/counter current processes. Crystallization: Growth and properties of crystals, saturation and nucleation, crystallization rate, impurities, effect of Temperature on solubility. Solubility and phase diagram, fractional crystallization, caking.

Course Title:**Course Code:****Credit Hours:**

Crystallizers; principles of construction and operations. Ion exchange: Ion Exchange Resins, Equilibrium and kinetics; Ion exclusion/ retardation. Ion exchange equipment. Filtration and Sedimentation: Filtration Theory; Fluid flow through the cake and combination of cloth and cake. Filtration Practices; Filtration equipment and calculation. Sedimentation of Particles: Theory of sedimentation, Flocculation, Solid flux in batch sedimentation and comparison of sedimentation with flow through fixed beds. Thickeners.

Selection of mass transfer equipment.

Recommended Books:

1. Sonawane, S. S., & Malika, M. (2025). *Hybrid nanofluids: Heat and mass transfer processes* (1st ed.). CRC Press.
2. Seader, J. D., Henley, E. J., & Roper, D. K. (2019). *Separation process principles: With applications using process simulators* (4th ed.). John Wiley & Sons, Inc.
3. Welty, J. R., Wicks, C. E., Wilson, R. E., & Rorrer, G. L. (2008). *Fundamentals of momentum, heat, and mass transfer* (5th ed.). John Wiley & Sons, Inc.
4. Dutta, B. K. (2007). *Principles of mass transfer and separation processes* (1st ed.). PrenticeHall of India Pvt. Ltd.
5. McCabe, W. L., Smith, J. C., & Harriott, P. (2005). *Unit operations in chemical engineering* (5th ed.). McGraw-Hill.

Heat Transfer Operations

CHE325

4(3, 1)

Course Objectives:

To develop proficiency in heat transfer fundamentals (conduction, convection, radiation, phase change) and apply these principles to the design, rating, and selection of industrial heat transfer equipment using analytical methods and computer-aided tools, while integrating modern engineering competencies for sustainable process operations.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)

1.	Discuss the fundamentals of heat transfer laws, modes, mechanisms, and empirical correlations.	C2	PLO1	--	--
2.	Solve problems using the principles of heat transfer.	C3	PLO1	--	--
3.	Evaluate the performance of Heat transfer equipment.	C5	PLO2	--	--
4.	Design of Heat Transfer equipment with consideration of key process parameters.	C6	PLO3	Creativity	Through assignments, Quiz and exams
5.	Define, investigate, analyze, and develop a solution for the Complex Engineering Problems by integrating the knowledge profiles encompassing the problem-solving steps	C6	PLO3	(Creativity and Co-Intelligence)	Through Complex Engineering Problem Assessment (CEP)
6.	Investigate Complex Engineering Problems in a methodical way using a literature survey	C4	PLO4	Co-Intelligence	Through Complex Engineering Problem Assessment (CEP)
7.	Reconcile the conflicts that arises while solving the	A4	PLO7		
	Complex Engineering Problems				
8.	Maintain professional behavior while working in a team for solving the Complex Engineering Problems	A5	PLO8		
9.	Demonstrate results (oral and written) of the Complex Engineering Problems effectively at different levels.	P5	PLO5 (50%) PLO9 (50%)	Communication	Through Complex Engineering Problem Assessment (CEP) – Written Report and Presentation

Course Title:**Course Code:****Credit Hours:****Course Contents:**

Fundamentals of engineering heat transfer: A brief introduction to heat transfer fundamentals. Modes and mechanisms of heat transfer. Conduction: Unsteady state heat transfer, 1-D conduction, Heat transfer through composite walls, conductive resistance through walls, critical thickness of insulation. Convection: convection in fluid (liquid and gases), free and forced convection, concept of thermal boundary layer, analogy between thermal and hydrodynamic boundary layer, convection inside tubes and pipes, convection outside tubes and pipes, convection in conduits, convective heat transfer coefficient. Importance of Nusselt Number in heat transfer. Radiation from black and real surfaces, radiation between black surfaces, radiation between grey surfaces, radiation from gases. Temperature and heat transfer: Log mean temperature difference, wall temperature, and caloric temperature, effect of wall temperature on viscosity of fluid. Film and overall heat transfer coefficients. Heat Exchangers: Selection criteria of heat exchangers, rating and design of heat exchangers [double pipe, shell and tube (by more than one method), and plate & frame heat exchangers] under different scenarios and fluid (liquid/gas) combinations. Heat transfer with phase change: dropwise and filmwise condensation; pool and nucleate boiling; design and operation; types and selection of single- and multi-component condensers and reboilers. Design/Rating of heaters and coolers. Design/rating of utility coolers using water as the cooling medium; design/rating of utility heaters using steam as the heating medium; computer-aided design/rating of heat exchangers/heaters/coolers; and pressure drop in heat exchangers/heaters/coolers based on fluid flow. Computer-aided design of heat exchangers.

Recommended Books:

1. Flynn, A. M., Akashige, T., & Theodore, L. (2025). *Kern's process heat transfer* (2nd edn). Wiley-Scrivener.
2. Kakaç, S., Liu, H., & Pramuanjaroenkij, A. (2020). *Heat exchangers* (4th edn). London, England: CRC Press.

3. Serth, R. W. and T. Lestina. (2014). Process Heat Transfer: *Principles, Applications and Rules of Thumb*, Elsevier Science.
4. Cengel, Y. A., & Ghajar, A. J. (2014). *Heat and mass transfer: Fundamentals and applications* (5th ed). New York, NY: McGraw-Hill Professional.
5. Bergman, T. L., Lavine, A. S., Incropera, F. P., & DeWitt, D. P. (2011). *Fundamentals of heat and mass transfer* (7ed). Chichester, England: John Wiley & Sons.
6. Holman, J. P. (2009). *Heat transfer* (10th ed). Maidenhead, England: McGraw Hill Higher Education.

Course Title: Chemical Reaction Engineering

Course Code: CHE331

Credit Hours: 4(3, 1)

Course Objectives:

To equip students with fundamental and applied skills in chemical reaction engineering for applying, analyzing, and designing batch and continuous reactors using kinetics, stoichiometry, and material and energy balances, supported by computer-aided tools.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the fundamentals of chemical reaction engineering.	C2	PLO1	- -	- -
2.	Apply the fundamentals of chemical reaction engineering	C3	PLO1	--	--
3.	Analyze reaction kinetics and reactor performance to compare reactor types and justify reactor selection	C4	PLO2	- -	- -
4.	Design isothermal and nonisothermal reactors.	C6	PLO3	Creativity	Through quiz
5.	Define, investigate, analyze, and develop a solution for the Complex Engineering Problems by integrating the knowledge profiles encompassing the problemsolving steps	C6	PLO3	Creativity and Co-Intelligence	Through Complex Engineering Problem Assessment (CEP)
6.	Investigate Complex Engineering Problems in a methodical way using literature survey	C4	PLO4	Co-Intelligence	Through Complex Engineering Problem Assessment (CEP)
7.	Reconcile the conflicts arises while solving the Complex Engineering Problems	A4	PLO7	-	-

8.	Maintain professional behavior while working in a team for solving the Complex Engineering Problems	A5	PLO8	-	-
9.	Demonstrate results (oral and written) of the Complex Engineering Problems effectively at different levels.	P5	PLO5 (50%) PLO9 (50%)	Communication	Through Complex Engineering Problem Assessment (CEP) – Written Report and Presentation

Course Contents:

Mole Balance: rate of reaction, general mole balance equation, mole balance equations for batch and continuous flow reactors. Conversion and Reactor Sizing: definition of conversion, design equations for batch and continuous flow reactors, sizing continuous flow reactors, reactors in series, definitions of space time and space velocity. Rate Law: basic definitions, reaction order and rate law, rates and reaction rate constant, Arrhenius equation, Arrhenius plot, activation energy. Stoichiometry: batch system, flow systems, reversible reactions, equilibrium conversion, Isothermal reactor design: using the principles of conversion; design structure for isothermal reactors, batch reactors, continuous stirred tank reactors, plug flow reactors, pressure drop in reactors, using principles of moles and molar flowrate; design structure for isothermal reactors, examples. Collection and analysis of rate data: algorithm for data analysis, method of excess, integral method, differential analysis, method of half-life, method of initial rates. Multiple reactions: basic definitions, selectivity, yield, scenarios for maximizing the desired product, reactor selection and operating conditions, comparative evaluation of reactor performance, justification of reactor choice based on selectivity and yield. Non-isothermal reactor design: energy balance, adiabatic operation, reactor staging, optimum feed temperature, use of computer-aided tools for the analysis and design of reaction engineering systems.

Recommended Books:

1. Fogler, H. S. (2024). *Elements of chemical reaction engineering* (6th ed.). Pearson Education.
2. Perkins, E. (2022). *Chemical reaction engineering*. WILLFORD Press.
3. Fogler, H. S. (2020). *Elements of chemical reaction engineering* (5th ed.). Pearson Education.
4. Hill, C. G., & Root, T. W. (2014). *Introduction to chemical engineering kinetics and reactor design* (2nd ed.). John Wiley & Sons.
5. Levenspiel, O. (2006). *Chemical reaction engineering* (3rd ed.). John Wiley & Sons.

Course Title: Thermodynamics II for Chemical Engineers

Course Code: CHE332

Credit Hours: 3(2, 1)

Course Objectives:

To equip students with fundamental and applied knowledge of thermodynamics in chemical engineering applications and make them industry-ready to perform power and refrigeration cycles analysis, evaluation, and design.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Solve engineering problems using equations and data from tables/charts of thermodynamic properties of fluids.	C3	PLO1	-	-
2.	Analyze different thermodynamic processes and parameters.	C4	PLO2	Co-Intelligence	Through assignments
3.	Evaluate different power and refrigeration cycles.	C5	PLO2		
4.	Design different power and refrigeration cycles.	C6	PLO3	Creativity and Communication	Through assignments

Course Contents:

Application of the first law to closed and open systems. Analysis of non-flow and steady-flow energy equations with practical examples. Working Fluids and Their Properties: Characteristics of liquids, vapors, and gases under varying conditions. Thermodynamic properties such as pressure, temperature, enthalpy, and specific volume. Thermodynamic Processes Exploration of reversible and irreversible processes. Analysis of throttling processes and non-steady-flow dynamics in realworld systems. Entropy and Energy Analysis The concept of entropy, its physical significance, and use in thermodynamic systems. Representation on T-S diagrams and the relationship between entropy, irreversibility, and efficiency. Exergy (availability) and its application to measure system performance. Heat Engine Cycles Detailed study of key thermodynamic cycles: Carnot cycle and its theoretical significance. Air standard cycles: Otto, Diesel, and Dual combustion cycles with performance metrics like mean effective pressure. Stirling and Ericsson cycles as alternatives.

Steam Power Cycles Rankine cycle and its modifications for efficiency improvements. Advanced cycles: Reheat and regenerative cycles with practical applications in power plants. Gas Turbine Cycles Basic and modified Brayton cycles. Use of power turbines and improvements for enhanced energy output. Refrigeration and Heat Pump Systems Principles of reversed heat engine cycles for cooling and heating applications. Vapor compression cycles, calculation of refrigeration load, and system design. Liquefaction of gases and its industrial applications. Graphical representation of the design of any specific thermodynamic cycle.

Recommended Books:

1. Potter, M. C., Allen, J. S., & Kroos, K. A. (2025). *Thermodynamics for engineers*. Cham, Switzerland: Springer Nature.
2. Smith, J. M., Van Ness, H., Abbott, M., & Swihart, M. (2021). *Introduction to chemical engineering thermodynamics ISE* (9th ed). Columbus, OH: McGraw-Hill Education.
3. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. B. (2020). *Fundamentals of engineering thermodynamics* (9th ed). Nashville, TN: John Wiley & Sons.
4. Sandler, S. I. (2020). *Chemical, biochemical, and engineering thermodynamics* (5th ed). Nashville, TN: John Wiley & Sons.
5. Cengel, Y. A., & Boles, M. A. (2019). *Thermodynamics: An Engineering Approach* (8th ed). New York, NY: McGraw-Hill Professional.
6. Eastop, T. D., & McConkey, A. (1993). *Applied thermodynamics for engineering technologists* (5th ed). London, England: Longman.

Course Title: Simultaneous Heat and Mass Transfer Operations

Course Code: CHE333

Credit Hours: 4(3, 1)

Course Objectives:

To equip students with fundamental and applied skills in simultaneous heat and mass transfer operations for analysis, design, and selection of unit operations using conventional and computational tools.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)

1.	Elaborate simultaneous heat and mass transfer phenomenon for chemical engineering unit operations	C2	PLO1	-	-
2.	Apply simultaneous heat and mass transfer concepts on various equipment.	C3	PLO1	-	-
3.	Design the selected simultaneous heat and mass transfer operations equipment.	C6	PLO3	Creativity	Through quizzes, examinations, complex engineering problem (CEP) assessment
4.	Define, investigate, analyze, and develop a solution for the Complex Engineering Problems by integrating the knowledge profiles encompassing the problem-solving steps	C6	PLO3	Creativity and Co-Intelligence	Through Complex Engineering Problem Assessment (CEP)
5.	Investigate Complex Engineering Problems in a methodical way using literature survey	C4	PLO4	Co-Intelligence	Through Complex Engineering Problem
					Assessment (CEP)
6.	Reconcile the conflicts that arise while solving the Complex Engineering Problems	A4	PLO7	-	-
7.	Maintain professional behavior while working in a team to solve the Complex Engineering Problems	A5	PLO8	-	-

8.	Demonstrate results (oral and written) of the Complex Engineering Problems effectively at different levels	P5	PLO5 (50%) PLO9 (50%)	Communication	Through Complex Engineering Problem Assessment (CEP) Written Report and Presentation
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Course Contents:

Distillation: Vapor-liquid equilibria: Review of fundamentals laws, partial vaporization and condensation. T-X-Y and X-Y diagrams. Composition calculations, generation/ development of equilibrium data. Relative volatility and its estimation. Binary system: Differential, flash and batch distillation, rectification. The fractionating column: calculation for number of plates; LewisSorel, McCabe-Thiele methods. Importance of the reflux ratio. Selection of economic reflux ratio. Plate efficiency. Multi-component distillation: Key components, Pseudo-Binary System, calculation of number of plates, selection of appropriate method, Lewis-Matheson and Underwood and Fenske methods. Azeotropic, Reactive, and Extractive distillation. Packed Column for distillation: Calculation of enrichment in packed column. Transfer units. Evaporation: Heat transfer in evaporators. Types of evaporators including vapor compression evaporators. Evaluation and selection of forward and backward feeds in single and multi-effect evaporators. Adsorption: Mass transfer in adsorption. Adsorption equilibria: Single-component adsorption, Langmuir and BET isotherms, Multicomponent adsorption. Overview of Adsorption equipment: Fixed beds, isothermal/non-isothermal, equilibrium/non-equilibrium operations. Regeneration of spent adsorbents. Humidification and Dehumidification: Review of humidity, humidification and dehumidification. Cooling Towers: Basic principles, types, features and operation of various cooling towers. Cooling tower design. Drying: Fundamentals, Rate of drying, mechanism, drying equipment: Types, working principles, construction, and selection of dryers. Use of conventional methods and computer aided tools for selection, analysis, and design of simultaneous heat and mass transfer operations.

Recommended Books:

1. Ray, A. K. (Ed.). (2023). *Coulson and Richardson's chemical engineering: Volume 2B, separation processes* (6th ed.). Butterworth-Heinemann
2. Çengel, Y. A., & Ghajar, A. J. (2020). *Heat and mass transfer: Fundamentals and applications* (6th ed.). McGraw-Hill Education.
3. Flynn, A. M., Akashige, T., & Theodore, L. (Eds.). (2019). *Kern's process heat transfer* (2nd ed.). John Wiley & Sons
4. Chhabra, R. P., & Shankar, V. (Eds.). (2017). *Coulson and Richardson's chemical engineering: Vol. 1B. Heat and mass transfer* (7th ed.). Elsevier.

5. McCabe, W. L., Smith, J. C., & Harriott, P. (2005). *Unit operations of chemical engineering* (7th ed.). McGraw-Hill.
- Foust, A. S., Wenzel, L. A., Clump, C. W., Maus, L., & Andersen, L. B. (1980). *Principles of unit operations* (2nd ed.). John Wiley & Sons.

Course Title: Process Instrumentation

Course Code: CHE426

Credit Hours: 2(2, 0)

Course Objectives:

This course aims to provide undergraduate chemical engineering students with a comprehensive understanding of fundamentals of process instrumentation. Working principles, selection of sensors for pressure, temperature, flow, level, and composition. The course will also instill the skills to develop and communicate Piping and Instrumentation Diagrams (P&IDs) for chemical processes/equipment and Layers of Protection Analysis (LOPA).

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the fundamentals of process instrumentation	C2	PLO1	Cybersecurity	Through Assignments and/or Quizzes
2.	Select the sensors and final control element based on process requirements and perform safety analysis	C4	PLO2	Co-Intelligence	Assignments
3.	Develop P&ID of chemical engineering processes	C6	PLO3 (70%) PLO5 (30%)	Communication Creativity	Through Assignments and/or Quizzes

Course Contents:

Role of process instrumentation in chemical industries; measurement systems and performance characteristics, cyber security. Principles of measurement and transduction: Uncertainty analysis: accuracy, precision, repeatability; basic statistics for experimental data; sampling concepts; calibration standards and procedures. Transmitters and Transducers; working principle and classification. Instruments; pressure, temperature, flow, level, and composition measuring instruments. Sensor selection: criteria based on process parameters. Development of Piping & Instrumentation Diagram (P&ID). Industrial case studies: instrumentation of key chemical engineering equipment. Review of HAZOP and Layer of Protection Analysis (LOPA).

Recommended Books:

1. PennWell. (2025). *Essentials of instrumentation for monitoring and control*. PennWell Books.
2. Dunn, W. C. (2021). *Introduction to instrumentation, sensors and process control (2nd ed.)*. Artech House.
3. NAPTA. (2020). *Process instrumentation (2nd ed.)*. Pearson
4. Dunn W. C. (2018). *Fundamentals of industrial instrumentation and process control (2nd ed.)* McGraw-Hill.
5. Patience, G. S. (2013). *Experimental methods and instrumentation for chemical engineers*. Elsevier.

Course Title: Process Control

Course Code: CHE427

Credit Hours: 3(2, 1) **Course**

Objectives:

Course Objectives:

To provide knowledge of process dynamics, empirical models from data; control system instrumentation, theory and practice of automatic control. In addition, the course promotes coding, co-intelligence by training students to collaboratively work with AI-assisted and for model development, analysis, and interpretation

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Prepare control strategy of the process and its mathematical models for control applications.	C3	PLO1		
2.	Analyze the dynamic response of the process with and without the P/I/D action of controllers	C4	PLO2	Communication	Presentation
3.	Evaluate tuning parameters of controllers by accessing the stability of the dynamic of process with and without controller.	C5	PLO2 (70%) PLO5 (30%)	Coding	Assignments and exams
4.	Design control loops to control various parameters influencing the chemical processes.	C6	PLO3(70%), PLO5(30%)	Creativity	Assignments and exams

Course Contents:

Introduction, principle model development. Process dynamics for first, second and higher order systems; linearization, transfer function models, effect of poles, zeros and time delays on system

response with computing integration. Empirical models from data, control system instrumentation. Introduction to single variable control loops systems such as pressure control, flow control, level control, temperature control loops, and multi-variable control loop systems. Introduction to feedback control; its objectives and PID control. Computer-aided analysis of closed loop systems; stability, root locus, frequency response using Bode and Nyquist plots. Multivariable and advanced control modules, using AI assisted tools to design simple feedforward, cascade, and fuzzy control strategies. Theory of automatic control; DCS, PLC, and SCADA. Introduction to process control simulation and controller design within the industrial sector.

Recommended Books:

1. Bequette, B. W. (2023). *Process control: modeling, design, and simulation* (2nd ed). Pearson.
2. Seborg, D. E., Edgar, T. F., Mellichamp, D. A., & Doyle, F. J. (2019). *Process dynamics and control* (4th ed). John Wiley & Sons.
3. Marlin, T. E. (2000). *Process control: designing processes and control systems for dynamic performance* (2nd ed). McGraw-Hill.
4. Luyben, W. L. (1990). *Process modeling, simulation and control for chemical engineers* (2nd ed). McGraw-Hill.
5. Stephanopoulos, G. (1984). *Chemical process control: an introduction to theory and practice*. Prentice Hall.

Course Title: Maintenance Engineering and Safety

Course Code: CHE429

Credit Hours: 2(2, 0)

Course Objectives:

This course aims to develop an understanding of effective maintenance strategies essential for reliable and efficient industrial operations. It focuses on both technical and managerial aspects of maintenance engineering to minimize breakdowns, reduce costs, and support sustainable practices. The course also emphasizes plant safety, highlighting its critical role in enhancing productivity, protecting personnel, and ensuring smooth, uninterrupted production processes across industries.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe fundamentals of maintenance engineering and safety.	C2	PLO1	---	---
2.	Apply the maintenance strategies and safety technology to solve relevant problems.	C3	PLO1	---	---
3.	Analyse the maintenance management system, accident and loss statistical methods and economics of accident prevention.	C4	PLO2	Co-Intelligence	Through assignments
4.	Evaluate the risks associated with equipment, products and operations.	C5	PLO2	Communication, Co-Intelligence	Through assignments

Course Contents:

Introduction. Types of maintenance; preventive, predictive, break down, corrective, scheduled. Total productive maintenance. Replacement; individual versus group replacement, replacement strategies. Internal versus external maintenance. Scheduling of maintenance. Computerized Maintenance. Organization of maintenance. Impact of safety on productivity. Overall safety of plant and personnel. Accident and loss statistics. Accident rate calculations. Accident analysis and

prevention. Types of accidents in chemical industry. Govt. regulations for industrial safety. Difference between accident and incident. Economics of accident prevention. Safety management. Hazard and risk assessment. Accident investigation and case history. Fires and explosions; fire triangles, flammability characteristics, preventions of fires and explosions. Exposure to volatile toxicants, dust and noises. Safety equipment, firefighting equipment and their uses.

Recommended Books:

1. Dhillon, B. S. (2023). *System safety, maintainability, and maintenance for engineers*. Taylor & Francis Ltd.
2. Panchal, D., Ram, M., Chatterjee, P., & Sachdeva, A. K. (ed). (2022). *Industrial reliability and safety engineering: Applications and practices*. CRC Press.
3. Crowl, D. A., & Louvar, J. F. (2011). *Chemical process safety: Fundamentals with applications* (3rd ed). Prentice Hall.
4. Mobley, R. K., Higgins, L., & Wikoff, D. (2008). *Maintenance engineering handbook* (7th ed). McGraw-Hill.
5. Mishra, R. C., & Pathak, K. (2002). *Maintenance engineering and management*. Prentice-Hall of India.

Course Title: Process Modeling and Simulation

Course Code: CHE437

Credit Hours: 3(2, 1)

Course Objectives:

In this course, students will learn how to develop dynamic and steady-state models based on first principles, solve ordinary differential equations, and simulate chemical processes numerically. The course emphasizes developing physical insight into real chemical systems and building problemsolving skills using a cloud-based programming language, while fostering creative problem formulation by encouraging exploration of alternative modeling assumptions. Strong emphasis is placed on effective communication of modeling ideas, assumptions, and results through clear visualizations, written assignments, and oral discussions. In addition, the course promotes cointelligence by training students to collaboratively work with AI-assisted and cloud-based programming tools for model development, analysis, and interpretation.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CL O	CLO Statement	Bloom Taxonom y Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the fundamentals/strategies related to mathematical modeling of various chemical engineering processes.	C2	PLO1	-	-
2.	Develop comprehensive mathematical models of various lumped parameter and distributed parameter systems that can mimic the various real life chemical engineering processes.	C6	PLO3(70%) PLO5(30%)	Coding, Cloud skills, Creativity	- For coding and cloud skills: Assignments - For creativity: All assessment tools

3.	Analyze chemical processes by examining mass and energy interactions within lumped-parameter and	C4	PLO2	Communication, Co-intelligence	- For coding, cloud skills and co-intelligence: Assignments
	distributed-parameter systems to interpret process behavior under varying operating conditions.				- For Communication: Assignments and Presentation(s)

Course Contents:

Introduction to Process Modeling and Simulation: Purpose and scope of modeling in chemical engineering; Definitions: modeling, simulation, verification and validation of models etc.; Types of models: empirical, mechanistic, hybrid; Fundamentals of Chemical Process Modeling: Classification of processes and models; Types of balances, Transport rates, Thermodynamic relation, Phase equilibrium, Chemical kinetics; Mass, energy, and momentum balance principles, Constitutive equations and thermodynamic laws, Degrees of freedom analysis; Step-by-Step Model Development Methodology: Defining the process system boundaries; Identifying inputs, outputs, and parameters; Writing balance equations; Building block modeling strategy; Modular thinking for complex systems; Lumped Parameter Systems: Concepts about convective heat exchange, chemical kinetic and reactors; Dynamic modeling of CSTR, tank, heater, and mixer; Dimensional analysis and scaling, Introduction to cloud-based code execution and co-intelligence for the solution or analysis of models; Distributed Parameter Systems: Transport equations in space and time in Cartesian, cylindrical and spherical coordinates; Mass Transport of Distributed Systems: Mass Transfer with Chemical Reaction, Plug Flow Reactor, Diffusion of Gas in Solid, Diffusion with Chemical Reaction, Leaching of Solute from Solid Particles, and applied examples; Heat Transfer Distributed Parameter Systems: Heat Transfer in a Non-isothermal Plug-Flow Reactor, Temperature Profile across a Composite Plane Wall, Radial Temperature Gradients in an Annular Chemical reactor, Heat Transfer from a Fin; Case Studies and Industrial Applications: Absorption of CO₂ from flue gas, Packed bed reactors, Production of Propylene Glycol in adiabatic reactor etc.

Recommended Books:

1. Ghasem, N. (2019). *Modeling and Simulation of Chemical Process Systems*. CRC Press.
2. Lona, L. M. F. (2018). *A Step-by-Step Approach to the Modeling of Chemical Engineering Processes*. Wiley.
3. Verma, A. K. (2015). *Process Modeling and Simulation in Chemical, Biochemical, and Environmental Engineering*. CRC Press.
4. Rasmuson, A., Andersson, B., Olsson L., Andersson R. (2014). *Mathematical Modeling in Chemical Engineering*. Cambridge University Press.

Course Title: Biochemical Engineering

Course Code: CHE438

Credit Hours: 3(3, 0)

Course Objectives:

This course aims to provide students with a comprehensive understanding of the fundamental principles of microbiology, biochemistry, and biochemical reaction systems relevant to engineering applications. It focuses on enabling students to analyze enzyme-catalyzed and microbial processes using biokinetic, transport, and mass transfer concepts. The course also develops students' ability to analyze, and design biochemical reactors by integrating theoretical knowledge with analytical and basic computational tools. Furthermore, it enhances problemsolving, design, and technical communication skills through the study of real-world biochemical engineering applications.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the fundamentals of microbiology, biochemistry, metabolism, and responsible handling of process data relevant to biochemical engineering applications.	C2	PLO1	Communication and cyber security	Assignment (Technical Report writing and presentation), and Exam
2.	Predict biokinetic parameters, gas–liquid mass transfer performance and reactor operating conditions using kinetic models and simulationbased approaches.	C3	PLO2	Co-Intelligence	Through assignments and/or Quizzes
3.	Estimate and interpret mass transfer requirements for biochemical processes using analytical and computational tools.	C5	PLO2 (70%) PLO5 (30%)	Coding, Cloud Skills and CoIntelligence	Through assignments and/or Quizzes

4.	Design biochemical reactors for various applications by integrating kinetics, mass transfer, and scale-up considerations.	C6	PLO3	Creativity and Co-Intelligence	Trough Exam and Assignments.
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Course Contents:

Basics of microbiology and biochemistry; structure and function of microorganisms and their role in biochemical processes. Enzyme classification; enzyme reaction kinetics for single-substrate systems; energy patterns in biological systems; enzyme inhibition and non-ideal enzyme kinetics. Enzyme isolation techniques, immobilized enzyme technology, and applications of biocatalysis. Transport phenomena in biochemical systems with emphasis on mass transfer in microbial systems and gas–liquid mass transfer, including oxygen transfer and uptake requirements. Prediction of volumetric gas–liquid mass transfer coefficients in batch cultivation systems using kinetic simulations. Biokinetic parameter estimation and introduction to basic computational tools (e.g., spreadsheet-based analysis) for kinetic modeling and process analysis. Kinetic modeling for predicting reactor operating conditions required to maintain optimal substrate levels and high cell concentrations. Introduction to bioprocess data integrity, safe handling of experimental and digital bioprocess data, and basic concepts of biocybersecurity related to laboratory data, process simulations, and digital bioprocess records. Design and analysis of biochemical reactors (fermenters), including aerobic and anaerobic systems, with scale-up considerations. Aerobic and anaerobic metabolism, photosynthesis, and biosynthesis. Application of biochemical and microbiological principles to commercial and industrial processes, supported through case-based discussions, data interpretation, and technical presentations.

Recommended Books:

1. Carlson, R., Morrissey, K., & Doran, P. M. (2024). *Bioprocess engineering principles* (3rd ed.). Elsevier.
2. Katoh, S., & Yoshida, F. (2009). *Biochemical engineering: A textbook for engineers, chemists and biologists*. Wiley-VCH.
3. Shuler, M. L., & Kargi, F. (2001). *Bioprocess engineering: Basic concepts* (2nd ed.). Prentice Hall PTR.
4. Clark, D. S., & Blanch, H. W. (1997). *Biochemical engineering* (1st ed.). CRC Press.
5. Lee, J. M. (1992). *Biochemical engineering*. Prentice-Hall.

Course Title: Chemical Engineering Plant Design

Course Code: CHE435

Credit Hours: 3(3, 0)

Course Objectives:

This course equips students with the skills to design chemical plants by integrating principles of equipment design, process optimization, economic analysis, and safety. It emphasizes practical applications, such as distillation, heat exchangers, and heat integration supported by computational tools and cybersecurity awareness, creative problem-solving, effective communication, and co-intelligence to prepare students for efficient and sustainable plant design.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Apply process design considerations, cost analysis and optimization techniques on a chemical engineering plant.	C3	PLO1	-	Through Quizzes
2.	Develop a solution that provides a feasible design of equipment for process industries.	C6	PLO3	Creativity	Through Quizzes and exams
3.	Develop safety protocols for on-site and surroundings and implement hazard analysis.	C6	PLO3	Cybersecurity	Through Quizzes and exams
4.	Define, investigate, analyze, and develop a solution for the Complex Engineering Problems by integrating the knowledge profiles encompassing the problem-solving steps	C6	PLO3	Creativity and Co-Intelligence	

5.	Investigate Complex Engineering Problems in a methodical way using literature survey	C4	PLO4	Co-Intelligence	Through Complex Engineering Problem Assessment (CEP)
6.	Reconcile the conflicts arises while solving the Complex Engineering Problems	A4	PLO7		Through Complex Engineering Problem (CEP)
7.	Maintain professional behavior while working in a team for solving the Complex Engineering Problems	A5	PLO8		Through Complex Engineering Problem Assessment (CEP) – Written Report and Presentation
8.	Demonstrate results (oral and written) of the Complex Engineering Problems effectively at different levels.	P5	PLO5 (50%) PLO9 (50%)	Communication	Through Complex Engineering Problem Assessment (CEP) – Written Report and Presentation

Course Contents:

Introduction: overview, nature of design, organization of chemical engineering project, codes and standards, design factors, system of units. Distillation Column: review of plate types, hydraulic design, efficiency calculations. Packed Column: review of packings and comparison with trays, hydraulic design. Pressure Vessel: general design considerations. Heat Exchangers: plate heat exchangers; types, selection criteria, design procedure. Process Heat Integration: overview, utility calculations, heat exchanger network design. Properties Estimation: prediction of various physical properties; density, viscosity, thermal conductivity, specific heat capacity, vapor pressure, diffusivity. Economic Analysis: introduction, costs,

revenues and profits, estimation of capital costs; rapid cost estimation methods, cost escalation, estimation of production costs and revenues. Safety and Loss Prevention: introduction, safety legislations, plant safety layers, intrinsic and extrinsic safety, material and process hazards, safety checklist, failure mode effect analysis, HAZOP, cyber security awareness. General site considerations: introduction, plant location and site selection, site layout, plant layout. Optimization: introduction, optimization of industrial processes, optimization in process design. Engineering ethics.

Recommended Books:

1. Peters, M. S., Timmerhaus, K. D., & West, R. E. (2025). *Plant design and economics for chemical engineers* (5th ed.). McGraw-Hill Education.
2. Towler, G., & Sinnott, R. (2022). *Chemical engineering design: Principles, practice and economics of plant and process design* (3rd ed.). Elsevier.
3. Turton, R., Shaeiwitz, J. A., Bhattacharyya, D., & Whiting, W. B. (2021). *Analysis, synthesis, and design of chemical processes* (5th ed.). Pearson.
4. Kemp, I. C., & Lim, L. S. (2020). *Pinch analysis for energy and carbon footprint reduction* (2nd ed.). Elsevier.
5. Seider, W. D., Widagdo, S., Seader, J. D., & Lewin, D. R. (2017). *Product and process design principles: synthesis, analysis, and design* (4th ed.). John Wiley & Sons.

Data Science for Chemical Engineers

CHE440

3(3, 0)

Course Objectives:

This course is intended to equip students with core data science competencies for chemical engineering applications. The course enables chemical engineering students to develop coding skills for data handling, modeling, and analytics; utilize cloud-based platforms for scalable computation and collaborative workflows and leverage co-intelligence by synergistically working with artificial intelligence tools to enhance decision-making. The course empowers chemical engineers, as domain experts, to critically understand, apply, and ethically adopt emerging AI and data-driven technologies within their respective chemical engineering domains.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe key concepts and tools in data science and their applications in chemical engineering.	C2	PLO1	- -	--
2.	Demonstrate the coding skills for performing data analysis, cleaning, and visualization on chemical engineering datasets, showing proficiency in applying these techniques to real-world problems.	P5	PLO5	Coding and Cloud Skills	Assignments
3.	Analyze chemical engineering data using exploratory data analysis (EDA) methods, identifying trends, correlations, and outliers, and applying appropriate techniques to draw meaningful insights from the data.	C4	PLO2		

Course Title:**Course Code:****Credit Hours:**

4.	Evaluate the performance of various models using appropriate metrics to assess model	C5	PLO2(70%) PLO5(30%)	Coding Cloud Skills and Co-Intelligence	Assignments
	effectiveness in real-world chemical engineering applications.				

Course Contents:

Definition and scope of data science. Role of data science in chemical engineering: process optimization, fault detection, and predictive maintenance. Overview of data lifecycle in chemical engineering. Fundamentals of Data Handling. Data types, sources, and formats in chemical engineering. Data Collection and Pre-processing: Types of data in chemical engineering (batch, time-series, experimental data), cleaning, normalization, and outlier detection. Principal Component Analysis (PCA) for dimensionality reduction. Time-series analysis for predictive maintenance and process monitoring. Exploratory Data Analysis (EDA): Descriptive statistics. measures of central tendency and variability. Data visualization tools in a programming language. Identifying trends, correlations, and anomalies in chemical process data. Probability and Statistics for Data Science. Fundamentals of probability and random variables. Hypothesis testing and confidence intervals. Regression analysis: linear and non-linear models. Statistical process control for chemical plants. Machine Learning Basics: Overview of supervised, unsupervised, and reinforcement learning. Regression and classification algorithms: applications in process control and monitoring. Clustering techniques: k-means, hierarchical clustering for fault diagnosis. Predictive analytics for yield and quality improvement. Applications and Case Studies in Chemical Engineering.

Recommended Books:

1. Romagnoli, J. A., Briceño-Mena, L., & Manee, V. (2024). *AI in chemical engineering: Unlocking the power within data* (1st ed.). CRC Press.
2. Mueller, J. P., & Massaron, L. (2021). *Machine learning for dummies* (2nd ed.). Wiley.
3. Kelleher, J. D., Mac Namee, B., & D'Arcy, A. (2020). *Fundamentals of machine learning for predictive data analytics: Algorithms, worked examples, and case studies* (2nd ed.). MIT Press.
4. Raschka, S., & Mirjalili, V. (2020). *Python machine learning: Machine learning and deep learning with Python, scikit-learn, and TensorFlow 2* (3rd ed.). Packt Publishing.
5. Aggarwal, C. C. (2018). *Neural networks and deep learning: A textbook*. Springer.
6. Alpaydin, E. (2014). *Introduction to machine learning* (3rd ed.). MIT Press.

7. Mohri, M., Rostamizadeh, A., & Talwalkar, A. (2018). *Foundations of machine learning* (2nd ed.). MIT Press.

Machine Learning for Chemical Engineers

CHE445

3(3, 0)

Course Objectives:

Machine learning has revolutionized engineering and non-engineering disciplines through its intelligent computational capabilities. This course is designed to equip students with core machine learning competencies. Students will develop coding skills to implement machine learning algorithms; utilize cloud-based platforms for scalable model training and deployment; and apply co-intelligence by collaboratively working with artificial intelligence tools to enhance problemsolving and decision-making in chemical engineering applications.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Describe the fundamental concepts, principles, and techniques of data science and machine learning.	C2	PLO1	- -	
2.	Demonstrate coding skills to prepare algorithms and programs for predictive analysis of process data using machine learning approaches including regression, neural networks, deep neural networks etc.	P5	PLO5	Coding and Cloud Skills	Assignments
3.	Analyze the effect of varying various parameters of machine learning techniques on the predictions.	C4	PLO2		

Course Title:**Course Code:****Credit Hours:**

4.	Evaluate the performance of machine learning models using appropriate metrics and techniques to ensure accuracy, reliability, and suitability	C5	PLO2(70%)/ PLO5 (30%)	Coding and Co-Intelligence	Assignments
	for solving real-world engineering problems.				

Course Contents:

Introduction to Machine learning in Chemical Engineering: Introduction to process data reconciliation in process industry, predictive data analytics and its applications in process industry and research, artificial intelligence, machine learning, deep learning, artificial neural networks, deep neural networks and their applications in chemical engineering, Process data analysis: Statistical techniques for data analysis. Preparing plant operation data for machine learning: data collection and cleaning for chemical processes, outliers and missing data handling, the curse of dimensionality, dimensionality reduction, principle component analysis etc. Regression: Linear regression, multivariate regression. Machine Learning: Elements of machine learning, supervised learning, unsupervised learning, semi-supervised learning. Artificial Neural Networks: Artificial neurons, basic elements, common architectures, feedforward neural networks, back propagation, etc. Deep Neural Networks: Deep architecture of neural networks, vanishing gradient, ReLU and dropout, etc. Convolutional Neural Network: Architecture of convolutional neural network, convolutional layer, pooling layer, etc. Case Studies related Chemical Industries: Application of machine learning on various case studies related to chemical engineering such as physical properties prediction, predictive maintenance in chemical plants, fault detection and diagnosis, process/energy optimization, yield improvement through optimization.

Recommended Books:

1. Romagnoli, J. A., Briceño-Mena, L., & Manee, V. (2024). *AI in chemical engineering: Unlocking the power within data* (1st ed.). CRC Press.
2. Kelleher, J. D., Mac Namee, B., & D'Arcy, A. (2020). *Fundamentals of machine learning for predictive data analytics: Algorithms, worked examples, and case studies* (2nd ed.). MIT Press.
3. Forsyth, D. (2019). *Applied machine learning*. Springer.
4. Aggarwal, C. C. (2018). *Neural networks and deep learning: A textbook*. Springer.
5. Charniak, E. (2018). *Introduction to deep learning*. MIT Press.
6. Alpaydin, E. (2014). *Introduction to machine learning* (3rd ed.). MIT Press.

Year 1 Project

EGG100

1(0, 1)

Course Objectives:

The project will be assigned to students based on the knowledge obtained from the courses taught in Semesters 1 and 2. Through this project, students will integrate and apply the acquired knowledge and skills using Computer-Aided Design (CAD) such as AutoCAD/Fusion, along with structured problem-solving approaches supported by collaborative (co-intelligence) teamwork, while professionally communicating and presenting their results effectively in both oral and written forms.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Explain societal responsibilities and basic environmental sustainability issues related to chemical engineering processes.	C2	PLO6	--	--
	Apply the knowledge gained during Year 1, encompassing the problem-solving steps and tools learned, computational platforms, and collaborative (co-intelligence) approaches to solve chemical engineering problems.	C3	PLO1 (70%)/ PLO2 (30%)	Communication, Co-intelligence	Develop PFD in AutoCAD and conducting material balance around the selected PFD.
3.	Practice professional skills while working in a group.	A5	PLO7 (50%), PLO8 (50%)	--	--

Course Title:

Course Code:

Credit Hours:

4.	Demonstrate results (oral and written) in an effective way at different levels.	P5	PLO5 (50%) PLO9 (50%)	Communication and Co-intelligence	Presentation/Viva
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Year 2 Project

EGG200

1(0, 1)

Course Objectives:

The Year-2 Project enables students to integrate and apply knowledge and skills acquired from courses taught in Semesters 3 and 4 to develop a well-defined project, with an emphasis on communication and fostering co-intelligence through effective teamwork and responsible use of digital tools.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Explain societal responsibilities and basic environmental sustainability issues related to chemical engineering processes.	C2	PLO6		Midterm and Final Term Evaluation - Report - Presentation - Viva-Voce
2.	Apply the knowledge gained during Year 2, encompassing the problem-solving steps and tools learned, computational platforms, and a collaborative (co-intelligence) approach to solve chemical engineering problems	C3	PLO1 (70%) PLO2 (30%)	Co-Intelligence Communication	
3.	Analyze the raw experimental/simulation data and results.	C4	PLO2		
4.	Practice professional skills while working in a group.	A5	PLO7 (50%) PLO8 (50%)	-	
5.	Demonstrate results (oral and written) effectively at different levels.	P5	PLO5 (50%) PLO9 (50%)	Co-Intelligence Communication	

Course Title:

Course Code:

Credit Hours:

Course Title: Year 3 Project

Course Code: EGG300

Credit Hours: 1(0, 1)

Course Objectives:

Year-3 Project enables students to integrate and apply the chemical engineering knowledge and analytical skills acquired in Semesters 5 and 6 to conceive, investigate, and develop either an entrepreneurial/business concept or a research-driven solution to a well-defined problem. The course emphasizes systematic inquiry through literature and market analysis, data collection, feasibility evaluation, and evidence-based reasoning to address technical and sustainability considerations. It further fosters critical thinking, and professional responsibility in the ethical use of data and digital tools, to communicate project outcomes clearly and persuasively in written, oral, and visual forms for technical, academic, and professional audiences.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Develop an entrepreneurial/business plan and/or a researchdriven solution, based on systematic investigation, that would lead to sustainable business, product, process, or knowledge contribution	C6	PLO10 (50%) PLO11 (50%)	Co-Intelligence	Midterm and Final Term Evaluation - Report - Presentation - Viva-Voce
2.	Investigate the entrepreneurial/business idea or research problem in a methodical way using literature survey, prior studies, and market/technology history.	C4	PLO4	--	

3.	Reconcile the conflicts arising while working on complex entrepreneurial/business activities or research	A4	PLO7	--	
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	investigations, using teamwork, critical analysis, and evidencebased decision-making.				
4.	Maintain professional behavior while conducting entrepreneurial/business activities and/or carrying out research work, including responsible use of data, citations, and collaborative practices.	A4	PLO8	--	
5.	Demonstrate results (oral, written, and poster display) of the complex entrepreneurial/business activity or research work effectively for technical, academic, and professional audiences.	P5	PLO5 (50%) PLO9 (50%)	Co-Intelligence Communication	

Internship

EGG497

0(0, 0)

Course Objectives:

Provide students with a practical learning platform to help them gain hands-on, working knowledge within domain of discipline in particular and broader exposure based performance development edge. Nurturing future needs of industrial sector through developing harmony by allowing them to work and develop the next generation of technological services.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)

Course Title:

Course Code:

Credit Hours:

1.	Demonstrate the engineering skills in identifying the industrial problems/needs.	P4	PLO11	--	--
2.	Differentiate the existing and new industrial processes.	C4	PLO2	Co-Intelligence	Reports
3.	Demonstrate results (oral and written) effectively at different levels.	P5	PLO5 (50%) PLO9 (50%)	Communication	Through Reports, Presentation and viva
4.	Adapt rules and regulations for effective operation in the industry.	A4	PLO6 (50%) PLO11 (50%)	--	--

Final Year Project (Part I)

EGG498

3(0, 3)

Course Objectives:

Final Year Project (Part I) involves the identification and formulation of an open-ended chemical engineering design problem, supported by a comprehensive literature review. Students are required to develop process concepts, block and process flow diagrams, and perform material and energy balance calculations, which constitute a core assessed component of the course. Computational and simulation tools are used to support calculations and preliminary design.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
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Course Title:

Course Code:

Credit Hours:

1.	Propose process selection based on sound scientific knowledge, engineering data, and sustainability considerations.	C6	PLO1 (30%) PLO4 (70%)	Creativity	Proposal and Supervisor Evaluations
2.	Apply material and energy balance principles to estimate flow-rates, compositions, and energy requirements in a complex chemical process using conventional and computeraided tools.	C3	PLO2 (70%) PLO5 (30%)	Co-Intelligence	Material & Energy Balance, and Supervisor Evaluations
3.	Practice professional skills and ethics while working in a group.	A5	PLO7 (50%) PLO8 (50%)	--	--
4.	Demonstrate results (oral and written) effectively at different levels.	P5	PLO5 (50%) PLO9 (50%)	Communication	Proposal, Material & Energy Balance, and Supervisor Evaluations

Final Year Project (Part II)

EGG499

3(0, 3)

Course Objectives:

Final Year Project (Part II) builds upon the work completed in Final Year Project (Part I) and aims to develop a complete and integrated chemical process design through detailed design evaluation and optimization. The course focuses on design of process equipment, process simulation and analysis, design and evaluation of control loops, economic feasibility analysis, safety and hazard assessment with an awareness of cybersecurity, and appropriate selection of construction materials using sound engineering principles and validated data.

Course Title:

Course Code:

Credit Hours:

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Demonstrate the knowledge gained and skills developed during FYP-1 in FYP-2	P5	PLO1 (50%) PLO11 (50%)	Communication	Internal, External and Supervisor Evaluations
2.	Design process units and control loops according to the given process flow diagram using conventional methods and computer-aided tools	C6	PLO3 (70%) PLO5 (30%)	Creativity, Co-Intelligence	Design, Internal, External, and Supervisor Evaluations
3.	Practice professional skills and ethics while working in a group	A5	PLO7 (50%) PLO8 (50%)	-	Design, Report Technical, Internal, External and Supervisor Evaluations
4.	Demonstrate results (oral and written) effectively at different levels	P5	PLO5 (50%) PLO9 (50%)	Communication	Internal, External and Supervisor Evaluations
5.	Perform risk assessment and remediation analysis on chemical plants keeping into consideration the social, safety, health and environmental issues with an awareness of cybersecurity pertaining to the project	C5	PLO2 (50%) PLO6 (50%)	Co-intelligence and Cyber security	Internal, External and Supervisor Evaluations

6.	Evaluate the plant layout, economic and sustainability considerations inherent to the design process	C5	PLO2 (50%) PLO6 (50%)		
7.	Demonstrate management skills to plan and execute plant design project	P5	PLO10 (50%) PLO11 (50%)		

Course Title: Artificial Intelligence for Chemical Engineers

Credit Hours: 3(3, 0)

Course Code: CHE447

Course Objectives:

The course is designed to build a solid foundation in artificial intelligence, machine learning, generative AI, and agentic AI, highlighting their importance in intelligent decision-making. It introduces students to the complete AI project lifecycle, including data management, model development, deployment, and collaborative roles. Students are also trained to apply AI-based solutions, automation tools, and agent-oriented workflows to practical problems across different domains. Furthermore, the course emphasizes the ethical, societal, legal, and economic aspects of AI, promoting its responsible and thoughtful use.

CLOs and Mapping with PLOs – Integration of Relevant 6Cs:

CLO	CLO Statement	Bloom Taxonomy Level	PLO Mapped	6C Integrated	Assessment Tool (for relevant 6C)
1.	Explain the fundamental concepts of artificial intelligence, its ethical, legal, and societal considerations.	C2	PLO1	- -	
2.	Use prompt engineering techniques to effectively perform engineering tasks using generative artificial intelligence tools.	P5	PLO5	Coding	Assignments and semester project
3.	Apply machine learning principles to chemical engineering data for applications such as soft sensing, and fault detection etc.	P5	PLO5	Coding	Assignments and semester project
4.	Develop conceptual artificial intelligence—	C6	PLO3	Coding,	Assignments and

	enabled solution to address real-world problems.			Cloud Skills and Co-Intelligence	semester project
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Course Contents:

Artificial Intelligence Foundation: concepts, history, components, architectures, challenges, limitations, societal and philosophical aspects, future of AI, applications of AI in chemical and instrumentation industries etc. Generative AI Concepts: introduction to generative AI, working principles, applications code generation, technical report writing, research assistance, AI hallucinations. Case studies using generative AI: constructing generative AI software, deployment of generative AI software. Prompt Engineering: prompt definition, structure (role, task, context, constraints, output format), zero-shot and few-shot prompting, persona and step-by-step prompting, prompt design and refinement, output evaluation, applications in various chemical engineering problems. Introduction to Agentic AI: concept of agentic AI, AI agents vs chatbots, autonomous decision-making, task planning and execution, human-in-the-loop systems. Ethics and Responsible Use of AI: issues related to bias in AI systems, protection of data privacy, intellectual property rights, maintenance of academic integrity, frameworks for AI governance, challenges of misinformation, and the need for responsible and ethical application of AI technologies. Introduction to Machine Learning: structured and unstructured process data, supervised, unsupervised and semi-supervised learning, model evaluation, applications in predictive maintenance, soft sensors, fault detection and process monitoring.

Recommended Books:

1. Staron, M. (2026). *Engineering Generative AI-Based Software*. Morgan Kaufmann (Elsevier).
2. Nagasubramanian, D. (2026). *Agentic AI for Engineers - Architecting Goal-Driven Systems*. Apress.
3. Albada, M. (2025). *Building Applications with AI Agents - Designing and Implementing Multiagent Systems*. O'Reilly.
4. He, C., & Ren, J. (2025). *Applied AI Techniques in the Process Industry- From Molecular Design to Process Design and Optimization*. WILEY-VCH.
5. Posthoff, C. (2024) *Artificial Intelligence for Everyone*. Springer Nature.
6. Narayanan, A. & Kapoor, S. (2024). *AI Snake Oil: What Artificial Intelligence Can Do, What It Can't, and How to Tell the Difference*. Princeton University Press.
7. Mollick, R. (2024). *Co-Intelligence: Living and Working with AI*. Portfolio.
8. Romagnoli, J. A., Briceño-Mena, L., & Manee, V. (2024). *AI in chemical engineering: Unlocking the power within data* (1st ed.). CRC Press.
9. Phoenix, J. & Taylor, M. (2024). *Prompt Engineering for Generative AI Future-Proof Inputs for Reliable AI Outputs at Scale*. O'Reilly.
10. Kelleher, J. D., Mac Namee, B., & D'Arcy, A. (2020). *Fundamentals of machine learning for predictive data analytics: Algorithms, worked examples, and case studies* (2nd ed.). MIT Press.

