

COMSATS University Islamabad

Registrar Office, Academic Unit (PS)

No: CUI-Reg/Notif- 1874/23/1964

August 30, 2023

NOTIFICATION

Academic Council in its 37th special meeting held on August 22, 2023, on the recommendations of 32nd special meeting of Board of Faculty of Engineering, approved following Scheme of Studies of Bachelor of Science in Chemical Engineering BS (CHE), effective from Fall 2023 as per HEC Undergraduate Education Policy, 2023:

Nomenclature for BS Degree: Bachelor of Science in Chemical Engineering

Minimum Duration:	04 Years	Minimum Semesters:	08	Minimum Credit Hours ¹ required:	136
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Course Work:

Sr. No	Course Work	Minimum No. of Courses	Minimum No. of Credit Hours
1.	General Education Courses	14	37
2.	Major: Core Discipline Courses	29	76
3.	Interdisciplinary/Allied Courses	4	14
4.	Internship	1	3
5.	Capstone Project	2	6
Minimum No. of Courses required for BS in Chemical Engineering:		50	-
Minimum Credit Hours required for BS in Chemical Engineering:		-	136

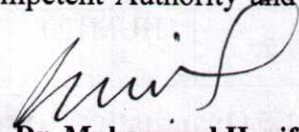
Note: Common policies and procedures notified vide No. CUI-Reg/Notif-1794/23/1884, date August 25, 2023 relating to Undergraduate Degree Programs approved by the Competent Authority and amended from time to time shall be applicable.

Distribution:

1. All Directors, CUI
2. All Deans, CUI
3. Incharge Islamabad Campus, CUI
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CC:

1. PS to Rector CUI
2. PS to Registrar CUI


Dr. Muhammad Hanif
Deputy Registrar

1. General Education:**1.1.Arts and Humanities (Mandatory Course)**

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

1.2.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

1.3.Social Sciences (Mandatory Course)

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

1.4.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)	-

1.5.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.	MTH114	Tools for Quantitative Reasoning	3(3, 0)	



1.6.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)	-

1.7.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

**1.8.Application 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)	

1.9.Entrepreneurship (Mandatory Course)

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	MGT250	Introduction to Entrepreneurship	2(2, 0)	-

1.10. 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)	-

W.P.

1. **Option # 1: Single Major:** An undergraduate program with a single major is focused on one disciplinary specialization and comprises of a minimum of 130 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	3(3, 0)	
24.	CHE438	Biochemical Engineering	3(3, 0)	
25.	CHE141	General Engineering	3(2, 1)	
26.		Elective I	3(3, 0)	
27.		Elective II	3(3, 0)	
28.	EEE113	Engineering Drawing	1(0, 1)	
29.	CHE313	Occupational Health and Safety	1(1, 0)	

Elective Courses (for Elective I)

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.	CHE459	Textile Processing	3(3, 0)	
5.	CHE450	Polymer and Rubber Technology	3(3, 0)	
6.	CHE462	Biochemical Separations	3(3, 0)	
7.	CHE463	Biochemical Process and Products	3(3, 0)	
8.	CHE480	Risk Management and Safety	3(3, 0)	
9.	CHE482	Waste Management	3(3, 0)	

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10.	CHE490	Nuclear Engineering	3(3, 0)	
11.	CHE491	Novel Separation Processes	3(3, 0)	
12.	CHE492	Mineral Processing Technology	3(3, 0)	
13.	CHE495	Composite Materials	3(3, 0)	
14.	CHE417	Corrosion Engineering	3(3, 0)	

Elective Courses (for Elective II)

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)	

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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: (4-6 Weeks) Minimum 03 credit hours:

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	EGG497	Internship	3(0, 3)	

4. Capstone Project*: Minimum 03 credit hours:

S. No.	Course Code	Course Title	Credit Hours	Prerequisite(s)†
1.	EGG498	Final Year Project I	3(0, 3)	
2.	EGG499	Final Year Project II	3(0, 3)	CHE331, EGG498

5. Remedial Course**


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

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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 (136 credits):**
This scenario centres on a single major in Chemical Engineering, demanding completion of 136 credits for completion. This breakdown includes 37 credits for General Education, 76 for the Core Major, 14 for Interdisciplinary Studies, 3 for Field Experience and 6 for the Capstone Project.
- b) Scenario 2 - Single Major with Minor (148 credits):**
In this case, a single major is accompanied by a minor, requiring a minimum of 148 credits in total. The components encompass 37 credits for General Education, 76 for the Core Major, 14 for Interdisciplinary Studies, 3 for Field Experience and 6 for the Capstone. Additionally, a 12-credit minor complements the major, fostering broader skills.
- 2). The study of the Holy Quran and teachings of Sirat un-Nabi (P.B.U.H) courses will constitute a mandatory component of the curriculum for all undergraduate degree programs. These courses will be conducted using a hybrid mode of instruction across the CUI System. Upon successful completion of each 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.
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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)	31
	b. Non-Engineering Courses (List Attached)	19
v.	Elective courses	
	a. Engineering Courses (List Attached)	02
vi.	Total No. of Courses:	50
vii.	Total No of Credit Hours	136

Non-Engineering Domain

Knowledge Profile* (WK-1 to WK-8)	Knowledge Area	Sub Area / Comparison	Name of Courses	Credit Hours	Total Courses	Total Credits	% Overall
WK-2	Natural Science	Math	Calculus I	3(3, 0)	3	9	6.6
			Calculus II	3(3, 0)			
			Differential Equations	3(3, 0)			
WK-1	Natural Science	Physics	Physics for Chemical Engineers	4(3, 1)	3	12	8.8
		Chemistry	Chemistry I	4(3, 1)			
			Chemistry II	4(3, 1)			
WK-7	Humanities	English	Functional English	3(3, 0)	7	16	11.8
			Expository Writing	3(3, 0)			
		Culture	Islamic Studies	2(2, 0)			

			Ideology and Constitution of Pakistan	2(2, 0)			
			Civics and Community Engagement	2(2, 0)			
			Fundamentals of Philosophy	2(2, 0)			
		Social Sciences	Fundamentals of Sociology	2(2, 0)			
	Management Sciences	Professional Practice	Process Economics	3(3, 0)	2	5	3.7
			Entrepreneurship	2(2, 0)			
Total (Non-Engineering Domain, minimum 30 credit hours)				42	15	42	30.9
Engineering Domain							
Knowledge Profile* (WK-1 to WK-8)	Knowledge Area	Sub Area / Comparison	Name of Courses	Credit Hours	Total Courses	Total Credits	% Overall
WK-2/ WK-4/ WK-5/ WK-6	Computer and information Science	ICT/AI/ Data Science/ Cyber Security	Introduction Computers and Computing	1(0, 1)	3	9	6.6
			Introduction to Computer Programming	4(3, 1)			
			Numerical Computations	4(3, 1)			
WK-3/ WK-2	Foundation Engineering Courses		Introduction to Chemical Engineering	2(2, 0)	8	18	13.2

			Particulate Technology	3(2, 1)			
			Chemical Process Principles	3(3, 0)			
			Fluid Mechanics for Chemical Engineers	4(3, 1)			
			Thermodynamics I for Chemical Engineers	2(2, 0)			
			Year 1 Project	1(0, 1)			
			Year 2 Project	1(0, 1)			
			Chemical Process Industries	2(2, 0)			
WK-4/ WK-2/ WK-1	Core Breadth of Engineering discipline		Transport Phenomena	3(3, 0)	8	23	16.9
			Fuels and Energy	3(2, 1)			
			Mass Transfer Operations	4(3, 1)			
			Heat Transfer Operations	4(3, 1)			
			Process Instrumentation	2(2, 0)			
			Process Control	3(2, 1)			
			Maintenance Engineering and Safety	3(3, 0)			
			Year 3 Project	1(0, 1)			
WK-5/	Core Depth of Engineering		Chemical Reaction	4(3, 1)	7	22	16.2

WK-6	Discipline		Engineering				
			Thermodynamics II for Chemical Engineers	3(2, 1)			
			Unit Processes	2(2, 0)			
			Process Modeling and Simulation	3(2, 1)			
			Biochemical Engineering	3(3, 0)			
			Simultaneous Heat and Mass Transfer Operations	4(3, 1)			
			Chemical Engineering Plant Design	3(3, 0)			
WK-1/ WK-2/ WK-3/ WK-4	Multidisciplinary Engineering Courses		Engineering Drawing	1(0, 1)	6	13	9.6
			General Engineering	3(2, 1)			
			Elective I	3(3, 0)			
			Elective II	3(3, 0)			
			Engineering Materials	2(2, 0)			
			Occupational Health and Safety	1(1, 0)			
WK-6/ WK-8/ WK-7	Final Year Design Project (FYDP/ Capstone	Integration of innovative, creative, technical, management	Final Year Project (Part I)	3(0, 3)	2	6	4.4
			Final Year Project (Part II)	3(0, 3)			

		and presentation skills of a graduate towards final year.				
WK-6/ WK-7	Industrial Training	Internship	3(0, 3)	1	3	2.2
Total (Engineering domain, minimum 85 credit hours)			94	35	94	69.1
Total (Credit Hours, 130-136)			136	50	136	100

**Tentative Scheme of Studies for BS Chemical Engineering Program
w.e.f. Fall 2023 Intake**

<u>Semester 0 (For Lateral Intake)**</u>				
Sr. No.	Course Code	Course Title	Credit Hours	Pre-Requisite (s)
1.	CHE112	Particulate Technology	3(2, 1)	
2.	CHE113	Chemical Process Principles	3(3, 0)	
3.	CHE214	Fluid Mechanics for Chemical Engineers	4(3, 1)	
4.	CHE215	Thermodynamics I for Chemical Engineers	2(2, 0)	
5.	CHE221	Chemical Process Industries	2(2, 0)	
6.	CHE242	Engineering Materials	2(2, 0)	
			16(14, 2)	
<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)	
			16(13, 3)	
<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.	HUM110	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)	

Semester 3

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.	CHE242	Engineering Materials	2(2, 0)	
			18(15, 3)	

Semester 4

1.	CSC141	Introduction to Computer Programming	4(3, 1)	
2.	MGT250	Introduction to Entrepreneurship	2(2, 0)	
3.	HUM130	Fundamentals of Sociology	2(2, 0)	
4.	CHE112	Particulate Technology	3(2, 1)	
5.	CHE215	Thermodynamics I for Chemical Engineers	2(2, 0)	CHM201
6.	CHE222	Transport Phenomena	3(3, 0)	MTH242

7.	EGG200	Year 2 Project	1(0, 1)	
			17(14, 3)	
<u>Semester 5</u>				
1.	MTH375	Numerical Computations	4(3, 1)	MTH242
2.	CHE221	Chemical Process Industries	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)	
			17(14, 3)	
<u>Semester 6</u>				
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.	EGG300	Year 3 Project	1(0, 1)	
			15(11, 4)	
Summer Semester	EGG497	Internship	3(0, 3)	
<u>Semester 7</u>				
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.	CHE223	Fuels and Energy	3(2, 1)	
2.	CHE429	Maintenance Engineering and Safety	3(3, 0)	
3.	CHE438	Biochemical Engineering	3(3, 0)	
4.		Elective II	3(3, 0)	
5.	EGG499	Final Year Project (Part II)	3(0, 3)	CHE331, CHE498
			15(11, 4)	
Total Credit Hours			136 (106, 30)	

**** Grant of Associate Degree and Lateral Intake is subject to approval/policy by PEC**

COURSE CONTENTS

Course Title: Year 1 Project

Course Code: EGG100

Credit Hours: 1(0, 1)

Course Objectives:

The project will be assigned to the students, based on the knowledge obtained from the courses taught in Semesters 1 and 2. The students will be able to integrate the knowledge and skills acquired in these two semesters through this project.

Course Learning Outcomes:

CLO	CLO Statement	Domain/Level	PLO
CLO 1	Apply the knowledge gained during year 1 encompassing the problem-solving steps	C3	PLO 12
CLO 2	Practice professional skills while working in a group	A5	PLO 9
CLO 3	Demonstrate results (oral, written) in an effective way at different levels	P5	PLO 10

Course Title: Year 2 Project

Course Code: EGG200

Credit Hours: 1(0, 1)

Course Objectives:

The project will be assigned to the students, based on the knowledge obtained from the courses taught in Semesters 3 and 4. The students will be able to integrate the knowledge and skills acquired in these two semesters through this project.

Course Learning Outcomes:

CLO	CLO Statement	Domain/Level	PLO
CLO 1	Apply the knowledge gained during year 1 encompassing the problem-solving steps	C3	PLO 12
CLO 2	Practice professional skills while working in a group	A5	PLO 9
CLO 3	Demonstrate results (oral, written) in an effective way at different levels	P5	PLO 10

Course Title: Year 3 Project

Course Code: EGG300

Credit Hours: 1(0, 1)

Course Objectives:

The project will be assigned to the students, based on the knowledge obtained from the courses taught in Semesters 5 and 6. The students will be able to integrate the knowledge and skills acquired in these two semesters through this project.

Course Learning Outcomes:

CLO	CLO Statement	Domain/Level	PLO
CLO 1	Apply the knowledge gained during year 1 encompassing the problem-solving steps	C3	PLO 12
CLO 2	Practice professional skills while working in a group	A5	PLO 9
CLO 3	Demonstrate results (oral, written) in an effective way at different levels	P5	PLO 10

Course Title: Final Year Project I

Course Code: EGG498

Credit Hours: 3(0, 3)

Course Objectives:

The students will be assigned the project based on the knowledge obtained in Semesters 1, 2, 3, 4, 5, and 6.

Course Learning Outcomes:

CLO	CLO Statement	Domain	PLO
CLO1	Propose process selection based on sound scientific knowledge, engineering data, and sustainability considerations.	C6	PLO1 (0.3), PLO4 (0.7)
CLO2	Estimate the flowrates/compositions and energy requirements of raw materials/products using material and energy balance of a complex chemical production process.	C3	PLO2
CLO3	Practice professional skills and ethics while working in a group.	A5	PLO8 (0.5), PLO9 (0.5)
CLO4	Demonstrate results (oral, written) in an effective way at different levels.	P5	PLO5 (0.5), PLO10 (0.5)

Course Title: Final Year Project II

Course Code: EGG499

Credit Hours: 3(0, 3)

Course Objectives:

This project will be extension of the work carried out in Final Year Project I.

Course Learning Outcomes:

CLO	CLO Statement	Domain	PLO
CLO1	Demonstrate the knowledge gained and skills developed during FYP-1 in FYP-2.	P5	PLO12
CLO2	Design process units and control loops according to the given process flow diagram.	C6	PLO3 (0.7), PLO4 (0.3)
CLO3	Practice professional skills and ethics while working in a group.	A5	PLO8 (0.5), PLO9 (0.5)
CLO4	Demonstrate results (oral, written) in an effective way at different levels.	P5	PLO5 (0.5), PLO10 (0.5)
CLO5	Perform risk assessment and remediation analysis on chemical plant keeping into the consideration the social, safety, health and environmental issues pertaining to the project.	P5	PLO4 (0.3), PLO6 (0.7)
CLO6	Demonstrate the plant layout, economic and sustainability considerations inherent to the design process.	P5	PLO7 (0.5), PLO11 (0.5)
CLO7	Demonstrate management skills to plan and execute plant design project.	P5	PLO11 (0.5), PLO12 (0.5)

Course Title: Occupational Health and Safety

Course Code: CHE313

Credit Hours: 1(1, 0)

Course Objectives:

To study workplace occupational health and safety, safe work practices in offices, industry, and construction as well as how to identify and prevent or correct problems associated with occupational safety and health in these locations as well as in the home.

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 and vibration, falling and lifting etc. learning the language of safety: Signs, symbols and labels. 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.

Course Learning Outcomes:

CLO	CLO Statement	Domain/Level	PLO
CLO 1	Elaborate the hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others	C2	PLO1
CLO 2	Demonstrate the methods to eliminate the hazard, and control unsafe or unhealthy hazards	C3	PLO1
CLO 3	Illustrate a coherent analysis of a potential safety or health hazard both verbally and in writing, citing the Ontario Occupational Health and Safety Regulations as well as supported legislation	C4	PLO2
CLO 4	Discuss the changes created by WHMIS and OSHA legislation in everyday life	C3	PLO 1

Recommended Books:

1. S. Z. Mansdorf. Handbook of Occupational Safety and Health. 3rd edition. John Wiley & Sons, 2019.
2. Melissa A. Bailey, and Frank D. Davis. Occupational Safety and Health Law Handbook. 3rd edition. Rowman & Littlefield Publishing Group, Incorporated, 2016.
3. Jeremy Stranks. The Manager's Guide to Health and Safety at Work. Kogan Page Publishers, 2006.
4. Jeremy W. Stranks. The A-Z of Health and Safety. Thorogood Publishing, 2006.

Course Title: Fundamentals of Sustainable Energy Systems

Course Code: CHE473

Credit Hours: 3(3, 0)

Course Objectives:

To provide students with the knowledge of sustainability, energy resources, energy economics, and analysis methodologies.

Course Contents:

Thermodynamic fundamentals: introduction, laws of thermodynamics, exergy. Sustainable energy: sustainability principles; energy crisis, sustainable development, practices, challenges, key sustainability consideration; challenge of climate change, energy economic efficiency, energy return on energy invested, cost of energy production. Energy resources: Conventional energy resources; fossil fuels, nuclear power, renewable energy resources; wind energy, solar photovoltaics, solar thermal, ocean and geothermal energy, biomass and biofuels, hydroelectric generation. Economics of energy generation and conservation systems: unit cost of energy, payback period, time value of money, inflation, total life cycle costs, internal rate of return, capital recovery factor, levelized cost of energy, societal and environmental costs. Energy system analysis methodologies: life cycle approach, process chain analysis, input-output analysis, energy return on energy invested.

Ammonia as a potential substance: synthesis, storage, use in power generation systems, simultaneous use as fuel and working fluid/refrigerant, performance analysis of ammonia-fueled systems. Hydrogen and fuel cells: hydrogen economy, production methods, hydrogen storage, hydrogen transportation and distribution, hydrogen utilization, fuel cells; types, systems, applications.

Recommended Books:

1. Kutscher, C.F., Milford, J.B., and Kreith, F., "Principles of Sustainable Energy Systems", 3rd edition, CRC Press, 2019.
2. Kreith, F., and Krumdieck, S., "Principles of Sustainable Energy Systems", 2nd edition, CRC Press, 2013.

3. I. Dincer, and C. Zamfirescu, "Sustainable Energy Systems and Applications", Springer, 2011.

4.

Course Learning Outcomes:

CLO	CLO Statement	Domain/Level	PLO
CLO 1	Discuss the fundamentals of sustainability energy systems	C2	PLO1
CLO 2	Solve various problems related to the sustainable energy systems	C3	PLO1
CLO 3	Analyze various sustainable energy systems based on key performance indicators	C4	PLO2