جامعة الأنبار - قسم الهندسة الكيميائية والبتروكيماوية

UNIVERSITY OF ANBAR

CHEMICAL & PETROCHEMICAL ENGINEERING

CHEMICAL AND PETROCHEMICAL ENGINEERING DEPARTMENT CATALOGUE

2024-2023

Abstract

The Chemical Engineering Catalogue serves as a comprehensive resource detailing the various aspects of chemical engineering, a discipline that merges principles of chemistry, physics, mathematics, biology, and economics to efficiently use, produce, design, transport, and transform energy and materials. This catalogue provides an extensive overview of the academic and professional landscape within chemical engineering, encompassing detailed descriptions of core subjects, advanced topics, and emerging trends.

Scientific Committee

chemical.engineering@uoanbar.edu.iq

1. Introduction

This Chemical Engineering (ChE) handbook is crafted to guide and support students throughout their journey toward earning a Bachelor of Science degree in Chemical Engineering at the University of Anbar. It serves as an essential resource for both new and continuing students within the College of Engineering, providing detailed insights into the requirements of the undergraduate ChE program and university-wide expectations.

The handbook ensures that each course's curriculum comprehensively covers all necessary materials essential for a thorough understanding of Chemical Engineering principles. It emphasizes the attainment of National Graduate Outcomes (NGO's), aligning with industry standards and benchmarks for graduating students.

Furthermore, the ChE department underscores the ethical and societal implications inherent in the work of Chemical Engineers, emphasizing their crucial role in advancing and benefiting society. Faculty members of the ChE department hope that students find this handbook invaluable during their academic journey and wish them success in their studies and future careers.

2. Vision, Mission, and Objective

2.1 Vision

The Department of Chemical and Petrochemical Engineering aims to achieve excellence and foster creativity on a local, regional, and global scale. This is to be realized through the production of high-caliber graduates and the conduct of research that aligns with the evolving needs of society.

2.2 Mission

Preparing teams in the Chemical and Petrochemical Engineering department involves ensuring scientific excellence, providing comprehensive training, and qualifying individuals to meet market needs. This is achieved through conducting applied research aimed at solving industry-related problems.

2.3 Objectives

1- Educating engineers with a strong foundation in fundamental scientific and engineering principles, equipped with knowledge in the field of chemical and petrochemical engineering and staying abreast of its advancements.

2- Supplying the job market with exceptionally qualified and skilled chemical engineers who can serve as exemplary professionals contributing to society.
3- Continuously assessing and updating the academic curricula to align with global advancements in the field of chemical engineering sciences.
4- Supplying the necessary scientific and technical consultations to broaden collaboration between the department's staff and beneficiary entities, including factories, relevant departments, and consulting offices.

3. Chemical and Petrochemical Engineering Program

The Chemical Engineering department pushes the boundaries of knowledge in the field through foundational and applied research led by faculty and students. It applies chemical engineering principles to address significant national and regional challenges, focusing on areas such as chemical process design, thermal and fluid sciences, and production technologies.

The outcomes for the Chemical Engineering Program are designed to ensure that graduates achieve specific objectives:

1. Application of mathematics, science, and engineering principles to design experiments, analyze data, and draw conclusions.
2. Identification and resolution of engineering problems or processes to meet defined needs, considering practical constraints such as economic feasibility, environmental impact, social considerations, ethical implications, health and safety requirements, manufacturability, and sustainability.
3. Understanding the broader implications of engineering solutions within global, economic, environmental, and societal contexts.
4. Effective communication skills and a commitment to continuous learning throughout their careers.
5. Proficiency in utilizing modern engineering techniques, skills, and tools necessary for professional practice in chemical engineering.

4. Accreditation

The Bachelor of Science in Chemical Engineering degree offered by the Chemical Engineering Department (CHED) is making good progress toward accreditation by the Engineering Accreditation Commission of National Graduate Outcomes (NGO).

5. Enrolment and Graduation Rates

Bachelor of science in chemical and petrochemical engineering enrollment and graduation rates:

Year	Enrollment	Degree awarded
2012-2013	39	-
2013-2014	34	-
2014-2015	24	-
2015-2016	38	34
2016-2017	41	23
2017-2018	39	28
2018-2019	39	18
2019-2020	32	36
2020-2021	44	35
2021-2022	22	26
2022-2023	26	30
2023-2024	22	34

6. Program Educational Objectives (PEOs)

6.1 Statement of Program Educational Objectives (PEOs)

Program Educational Objectives (PEOs) for undergraduate students in chemical engineering typically outline the expected accomplishments and career development goals that graduates of the program should achieve within a few years of completing their degree. While specific PEOs can vary among institutions, here is a general set of objectives for Chemical and Petrochemical engineering undergraduates:

1. Professional Competence: Graduates will apply fundamental principles of chemical engineering to analyze and solve complex engineering problems in various industries.
2. Continuous Learning: Graduates will engage in lifelong learning, keeping abreast of advancements in chemical engineering and related fields through professional development activities and further education.
3. Sustainability: Graduates will apply sustainable practices in the design, operation, and optimization of chemical processes, recognizing the importance of minimizing environmental impact and resource use.

6.2 Student Learning Outcomes (SLO's)

SLO-1: Technological Skills

The graduate makes appropriate use of technologies to communicate, collaborate, solve problems, make decisions, and conduct research, as well as foster creativity and life-long learning. The graduate is able to use state-of-the-art technological resources and tools and keeps up on advancements in her or her field of study and/or practice.

SLO-2: Problem Solving Abilities

The graduate is able to creatively solve problems from both analytic and applied perspectives using multiple approaches, integrating sciences, engineering, and the humanities. The graduate is able to recognize, incorporate and adapt to the limitations and consequences of applying various problem solutions.

SLO-3: Innovation and Design

The graduate often makes discussions and observations that lead to new ideas or hypotheses. He or she formulate novel solutions while moving beyond the conventional to new methods blending creative and practical approaches, constructions and designs which may involve pioneering applications along the interface of engineering and modern technology. The graduate has the ability to create highly sophisticated designs and implement them which are considered state-of-the-practice in his or her field.

SLO-4: Research Abilities

The graduate is able to collect and process data, information and knowledge to answer specific questions or generate new conceptual models and hypotheses. The graduate evaluates these models and hypotheses using the appropriate experimental, mathematical and statistical approaches.

SLO-5: Leadership

The graduate is able to articulate a vision or goal in such a manner as to promote collaboration and successful implementation. The graduate displays a willingness to overcome adversity and work diligently in pursuit of goals, thus serving as a role model for others.

SLO-6: Communication

The graduate employs an understanding of audience, purpose and context to communicate effectively in a range of situations using appropriate media while displaying a significant aptitude for presenting scientific and technical materials to diverse audiences.

SLO-7: Human Resources and Interactions

The graduate is able to work either independently or in diverse groups to effectively and efficiently to respond to academic and work requirements.

SLO-8: Engagement

The graduate uses his or her knowledge and skills, including those associated with engineering and applied science, to make a positive difference on issues of public concern.

6.3 ABET Student Outcomes (SO's)

SO-1:

An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

SO-2:

An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

SO-3:

An ability to communicate effectively with a range of audiences.

SO-4:

An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

SO-5:

An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. SO-6: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

SO-7:

An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

6.4 Iraqi National Accreditation Criteria (ICAEE)

6.4.1 National Graduate Outcomes (NGO's)

NGO-i: An ability to distinguish, identify, define, formulate, and solve engineering problems by applying principles of engineering, science and mathematics .

NGO-ii: An ability to produce engineering designs that meet desired needs within certain constraints by applying both analysis and synthesis in the design process .

NGO-iii: An ability to create and carry out proper measurement and tests with quality assurance, analyze and interpret results, and utilize engineering judgment to make inferences .

NGO-iv: An ability to skillfully communicate orally with a gathering of people and in writing with various managerial levels.

NGO-v: An ability to perceive ethical and professional responsibilities in engineering cases and make brilliant judgments taking into account the consequences in worldwide financial, ecological and societal considerations .

NGO-vi: An ability to perceive the continual necessity for professional knowledge growth and how to find, assess, assemble and apply it properly .

NGO-vi: An ability to work adequately on teams and to set up objectives, plan activities, meet due dates, and manage risk and uncertainty.

Table 1 Relation between SOs(ABET) and NGOs (ICAEE)

SOs (ABET)/NGOs(ICAEE)						
1/i	2/ii	3/iv	4/v	5/vii	6/iii	7/vi

6.5 Relating GOs to PEOs

The achievement of the Graduate Outcomes ensures that our graduates are well equipped to achieve the Program Educational Objectives in actual practice following graduation. The linkage between the individual Program Educational Objective (PEOs) and the Graduate

Outcomes (GOs) is shown below in Table 2 and their relationships are briefly described as follows:

Table 2: Relating GOs to PEOs

PEOs	Graduate Outcomes (GOs)						
	i	ii	iii	iv	v	vi	vii
PEOs #1	X		X	X		X	
PEOs #2		X	X	X		X	
PEOs #3	X		X		X		X

7. Course Description

7.1 Course Coding System

7.1.1 Course Code and Number:

The course code follows the format CHE 000, where "CHE" represents the department (e.g., Chemical Engineering), and the number (000) indicates the number of the existence of subject in the course distribution among the level.

7.1.2 Course Title

Course Title: This gives the name of the course, providing an insight into the course content.

7.1.3 Credit Hours Structure

Parenthesized Numerals (e.g., (4-3-1-3)):

Credit Hours: Total number of credits for the course.

Classroom Hours: Hours spent in the classroom each week (1 hour = 1 credit hour).

Tutorial Hours: Hours spent in tutorials each week (credit hour = 0).

Laboratory Hours: Hours spent in the lab each week (2 hours = 1 credit hour).

7.1.4 Prerequisites

Prerequisites: These are listed in the course description and ensure students have the necessary background before enrolling in an advanced course. Prerequisites can be satisfied through:

Previous education or training.

7.1.5 Transfer credits.

Credit by examination.

7.2 Courses Categories

The course categories for Chemical and Petrochemical Engineering are divided into three main classes: University Requirements, College Requirements, and Department Requirements. Table (2, 3, and 4) show these courses.

Table 2 University courses requirements

Course Coding	Course Title	Credits	Hours/Week			
			Theo.	Tut.	Prac.	Prerequisite
UOA 001	English language 1	2	2	0	0	None
UOA 002	Human rights	1	1	0	0	None
UOA 003	Arabic Language	3	3	0	0	None
UOA 004	English Language II	2	2	0	0	None
UOA 005	English Language III	2	2	0	0	None
UOA 006	Ethics and Leadership skills	3	3	0	0	None
UOA 007	English Language IV	2	2	0	0	None
	Total Credit	15	15	0	0	
				15		hr./week

Table 3 College courses requirement

Course Coding	Course Title	Credits	Hours/Week			
			Theo.	Tut.	Prac.	Prerequisite
COE 001	Calculus I	3	3	1	0	None
COE 002	Physics I	3	3	0	2	None
COE 003	Chemistry	3	2	0	2	None
COE 004	Fundamental of electrical circuits	3	2	0	2	
COE 005	Computer Science	3	2	0	2	None
COE 006	Physics II	3	2	0	2	None
COE 007	Calculus II	3	3	1	0	None
COE 008	Engineering Workshops	2	1	0	2	None
COE 009	Engineering Drawing	4	1	0	3	None
COE 010	Engineering Mechanics (Statics)	3	3	1	0	None
COE 011	Calculus III	3	3	1	0	
COE 012	Calculus IV	3	3	1	0	None
COE 013	Engineering Materials	3	2	0	2	None
COE 014	Engineering Statistics	3	3	0	0	
COE 015	Numerical analysis	3	3	1	0	None
	Total Credit	42	34	6	15	
				55		hr/week

Table 4 Department courses requirements

Code	Course Title	Credits	Hours/Week			
			Theo.	Tut.	Prac.	Prerequisite
CHE 001	Principles of Chemical Eng. I	3	3	1	0	None
CHE 002	Principles of Chemical Eng. II	3	3	1	0	None
CHE 003	Organic Chemistry	3	2	0	2	None
CHE 004	Thermodynamic I	3	3	1	0	None
CHE 005	Fluid Mechanics I	3	3	1	0	None
CHE 006	Physical Chemistry	3	2	0	2	None
CHE 007	Chemical Industry I	2	2	0	0	None
CHE 008	Thermodynamic II	3	2	0	2	None
CHE 009	Fluid Mechanics II	3	2	0	2	None
CHE 010	Mass Transfer	3	3	1	0	None
CHE 011	Chemical Industry II	2	2	0	0	None
CHE 012	Analytical Chemistry	3	2	0	2	None
CHE 013	Unit Operation I	3	3	1	0	None

CHE 014	Heat Transfer I	3	3	1	0	None
CHE 015	Reactor Design I	3	3	1	0	None
CHE 016	Characteristics of petroleum and natural gas engineering	3	3	1	0	None
CHE 017	Petrochemicals Industries I	3	3	1	0	
CHE 018	Engineering Composite Material	2	2	0	0	None
CHE 019	Unit Operation II	3	3	1	0	None
CHE 020	Heat Transfer II	3	3	1	0	None
CHE 021	Reactor Design II	3	3	1	0	None
CHE 022	Natural Gas Engineering	2	2	0	0	None
CHE 023	Petrochemical Industries II	3	3	0	0	None
CHE 024	Water Treatment	2	2	0	0	None
CHE 025	Petroleum Refinery I	3	3	0	0	None
CHE 026	Transport Phenomena	3	3	1	0	None
CHE 027	Process Control	3	3	1	0	None
CHE 028	Engineering Economy	3	3	1	0	None
CHE 029	Senior Design Project I	3	1	0	4	None
CHE 030	Equipment Design	3	3	1	0	None
CHE 031	Engineering Catalysis	2	2	0	0	None
CHE 032	Petroleum Refinery II	3	3	0	0	None
CHE 033	Corrosion Engineering	2	2	0	0	None
CHE 034	Simulation and Modeling	3	2	0	2	None
CHE 035	Environmental Engineering	2	2	0	0	None
CHE 036	Senior Design Project II	3	1	0	4	None
	Total Credit	100	90	17	20	
				127		hr/week

7.3 Program Structure and Study Plan

The Chemical Engineering program is designed to provide a comprehensive education in chemical engineering principles and practices. The program is structured over four years, with each year comprising two semesters (Fall and Spring). The course numbering system helps students identify the level and specific content of each course.

7.4 Courses distribution

In addition to above tables, the set of the courses below are indicated with credits hours for each course the in four years of study, which summarize the graduation requirements.

Table 5: First level, semester 1

No.	Code	Course Title	Credits	Hours/Week			
				Theo.	Tut.	Prac.	Prerequisite
1	UOA 001	English language 1	2	2	0	0	None
2	UOA 002	Human rights	1	1	0	0	None
3	COE 001	Calculus I	3	3	1	0	None
4	COE 002	Physics I	3	3	0	2	None
5	COE 003	Chemistry	3	2	0	2	None
6	COE 004	Fund. of electrical circuit	3	2	0	2	None
7	COE 005	Computer Science	3	2	0	2	None
8	CHE 001	Principles of Chemical Eng. I	3	3	1	0	None
Total			18	16	2	6	None

		24	

Table 6: First level, Semester 2

No.	Code	Course Title	Credits	Hours/Week			
				Theo.	Tut.	Prac.	Prerequisite
1	UOA 003	Arabic Language	3	3	0	0	None
5	COE 006	Physics II	3	2	0	2	None
3	COE 007	Calculus II	3	3	1	0	None
4	COE 008	Engineering Workshop	2	1	0	2	None
5	COE 009	Engineering drawing	4	1	0	3	None
6	CHE 002	Principles of Chemical Eng.II	3	3	1	0	None
7	CHE 003	Organic Chemistry	3	2	0	2	None
Total			22	17	2	7	None
				26			

Table 7:Second level, Semester 1

No.	Code	Course Title	Credits	Hours/Week			
				Theo.	Tut.	Prac.	Prerequest
1	UOA 004	English Language II	2	2	0	0	None
2	COE 010	Mechanics (Static)	3	3	1	0	None
3	COE 011	Calculus III	3	3	1	0	None
4	CHE 004	Thermodynamic I	3	3	1	0	None
5	CHE 005	Fluid Mechanics I	3	3	1	0	None
6	CHE 006	Physical Chemistry	3	2	0	2	None
7	CHE 007	Chemical Industry I	2	2	0	0	None
Total			19	15	4	2	
				21			

Table 8: Second level, Semester 2

No.	Code	Course Title	Credits	Hours/Week			
				Theo.	Tut.	Prac.	Prerequest
1	COE 012	Calculus IV	3	3	1	0	None
2	COE 013	Engineering Materials	3	2	0	2	None
3	CHE 008	Thermodynamic II	3	2	0	2	None
4	CHE 009	Fluid Mechanics II	3	2	0	2	None
5	CHE 010	Mass Transfer	3	3	1	0	None
6	CHE 011	Chemical Industry II	2	2	0	0	None
7	CHE 012	Analtyical Chemistry	3	2	0	2	None
8							
Total			20	16	2	8	
				26			

Table 9: Third level, Semester 1

No.	Code	Course Title	Credits	Hours/Week			
				Theo.	Tut.	Prac.	Prerequest
1	UOA 005	English III	2	2	0	0	None
2	COE 014	Engineering Statistics	3	3	0	0	None
3	CHE 013	Unit Operation I	3	3	1	0	None
4	CHE 014	Heat Transfer I	3	3	1	0	None
5	CHE 015	Reactor Design I	3	3	1	0	None
6	CHE 016	Characteristics of Petro. & Natural Gas Eng.	3	3	1	0	None
7	CHE 017	Petrochemicals Industries I	3	3	1	0	
8	CHE 018	Engineering Composite Material	2	2	0	0	None
Total			22	22	5	0	
				27			

No.	Code	Course Title	Credits	Hours/Week			
				Theo.	Tut.	Prac.	Prerequisite
1	COE 015	Numerical analysis	3	3	1	0	None
2	CHE 019	Unit Operation II	3	3	1	0	None
3	CHE 020	Heat Transfer II	3	3	1	0	None
4	CHE 021	Reactor Design II	3	3	1	0	None
5	CHE022	Natural Gas Engineering	2	2	0	0	None
6	CHE 023	Petrochemical Industries II	3	3	0	0	None
7	CHE 024	Water Treatment	2	2	0	0	None
Total			19	19	4	0	
				23			

Table 10:Third level, Semester 2

Table 11: Forth level, Semester 1

No.	Code	Course Title	Credits	Hours/Week			
				Theo.	Tut.	Prac.	Prerequest
1	UOA 006	Ethics and Leadership skills	3	3	0	0	None
2	UOA 007	English Language IV	2	2	0	0	None
3	CHE 025	Petroleum Refinery I	3	3	0	0	None
4	CHE 026	Transport Phenomena	3	3	1	0	None
5	CHE 027	Process Control	3	3	1	0	None
6	CHE 028	Engineering Economy	3	3	1	0	None
7	CHE 029	Senior Design Project I	3	1	0	4	None
Total			20	18	3	4	
				25			

Table 12: Forth level, Semester 2

No.	Code	Course Title	Credits	Hours/Week			
				Theo.	Tut.	Prac.	Prerequest

1	CHE 030	Equipment Design	3	3	1	0	None
2	CHE 031	Engineering Catalysis	2	2	0	0	None
3	CHE 032	Petroleum Refinery II	3	3	0	0	None
4	CHE 033	Corrosion Engineering	2	2	0	0	None
5	CHE 034	Simulation and Modeling	3	2	0	2	None
6	CHE 035	Environmental Engineering	2	2	0	0	None
7	CHE 036	Senior Design Project II	3	1	0	4	None
Total			18	15	1	6	
				22			

7.5 Relating Courses Learning Outcomes to NGOs

Table 13 Relating course outcomes to NGO's

NGOs	i	ii	iii	iv	v	vi	vii
ABET SOs	1	2	6	3	4	7	5
FIRST YEAR							
Calculus-I	×						
Physics	×		×				×
Arabic Language				×			
Chemistry	×		×				×
Fundamentals of Electrical Eng.	×		×				×
English Language-I				×			
Human rights				×	×		
Calculus-II							
Applied Physics	×		×				
Principles of Chemical Engineering I							
Principles of Chemical Engineering I							
Engineering Drawing	×			×			
Engineering Mechanics (Static)	×						
Computer Science	×		×				×
Democracy				×	×		
SECOND YEAR							
Calculus-III	×						
Physical Chemistry	×						
Fluid Mechanics I	×	×					
Thermodynamic -I	×		×				×
Technology of Chemical Industries I	×		×				×
English Language-II				×			

Engineering Workshops	×		×				×
Calculus-IV	×						
Analytical Chemistry	×	×					
Fluid Mechanics II	×		×				×
Thermodynamic-II	×		×			×	×
Mass Transfer	×		×				×
Strength of Materials	×						
Technology of Chemical Industries II	×						
THIRD YEAR							
Heat Transfer I	×						×
Reactor Design I	×		×				×
Unit Operation I							
Engineering Statistics	×						
Technology of Petrochemical Industries I	×						
Properties of Petroleum and Natural gas	×					×	×
Composite Materials	×	×					×
Heat Transfer II	×	×					
Reactor Design II	×	×		×			×
Unit Operation II	×	×					
Engineering Numerical Methods	×						
Technology of Petrochemical Industries II	×		×				×
Technology of Natural gas	×		×				×
Water Treatment	×	×					×
English Language-III				×			
FOURTH YEAR							
Petroleum Refinery I	×	×			×	×	
Engineering Economy							
Processes Control	×	×					×
Environmental Engineering	×		×				×
Administration and Leadership Skills				×	×		×
Engineering Corrosion	×	×					×
Senior Design I	×	×			×	×	×
Transport Phenomenon	×					×	×
Technology of Catalysts	×	×					

Petroleum Refinery II	×	×			×		×
Modeling & Simulation	×	×			×		
Senior Design II	×	×			×	×	×
English Language-IV				×			

7.6 Course syllabus

7.6.1 University Requirements

UOA 001: English Language I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support learning activity

Prerequisites:

None

Course Description:

This course is designed to enable academic writing course which provides an opportunity for the students to learn and practice the skills needed for handling topics related to the field of study. The course emphasizes the development of academic writing skills as well as the ability to read and think critically. Students will learn to use the library and appropriate online resources to find and evaluate sources to inform, develop and support their ideas in term paper writing. They will also learn skills for reading analysis, such as comprehension and inference.

Course Topics:

Tenses; Vocabulary (Jobs); Question forms; Writing (informal letter). Present simple; Present continuous; Have/have to; Writing (Linking words +Describing a person). Past simple; Past continuous; Have + noun; Writing (a story 1); Count and noncount nouns; Expression of quantity; Articles; Vocabulary (clothes); Writing (filling in forms); Verb patterns; Would like and like; Will and going to; Writing (postcard); What … like? Comparative and superlatives; Vocabulary (adjective formation); Writing (relative closes); Present perfect; Tense revision; Vocabulary (men and women); Writing (a biography); have to & got to; have to & should & must; Vocabulary (job description); Writing (formal letter)

Course Learning Outcomes:

- Develop academic writing
- Apply reading skills
- Expand academic vocabulary through reading
- Speak through group discussions and debates

Recommended Textbook(s):

John & Liz Soars, "New Headway Plus- Pre-Intermediate Student's Book", 10th ed 2012

UOA 002: Human rights and Democracy

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support learning activity

Prerequisites:

None

Course Description:

This course is designed to give the student the definition of freedom and the right language and idiomatically and legitimacy of the user, Origin of the right in the eyes of Islamic law, Elements of the right and types of, Personal freedom, Intellectual freedom, Rights and economic freedoms, Islam and Slavery, Human rights objectives, The use of freedom and the right general project, The right of a Muslim to his Muslim brother, Parental rights, Right neighbor, The right of women, Human rights in the heavenly religions, Religious tolerance in Islam.

Course Topics:

This course provides a comprehensive exploration of human rights, democracy, and freedom. It begins with an introduction to these principles, followed by an examination of their origin in Islamic law. The course then delves into the various elements and types of human rights and freedoms, with a specific focus on economic and political aspects. The historical perspective on Islam and slavery is explored, followed by an analysis of the objectives inherent in human rights and democracy. The course also covers the practical aspects of utilizing freedom and public rights. Finally, it concludes with a discussion on the rights of Muslims and their connection to broader humanity. The allocated hours for each topic ensure a thorough and balanced understanding of the subject matter.

Course Learning Outcomes

- Explain the concept of "human rights and democracy"
- The status of human rights and freedoms in Islam
- Define and describe the relationship between human rights and democracy

Recommended Textbook(s)

Human rights and freedoms. Prof. Dr. Mustafa Al-Zalmi.

UOA 003 Arabic Language I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type :

Support

Prerequisites:

None

Course Description:

This course aims at building students' familiarity with and competence in Arabic literature in its various genres to increase their ability to appreciate literature and to develop their awareness of its concepts through the study of poetry, novel and the short story.

Course Topics:

Study the text of the Quran and analysis, In the language and spelling and rules, the rules of writing the hamza, Written verbatim by Arab and Za - Rules of number and numerical adjective, punctuation, the method of detection for words in Arabic Dictionaries, In the applications of grammar and language- the actor and his deputy, Debutante and the news Acts missing, Equated with the letters already Byproducts, The case and exception, Ancient literary studies, Definition of literature and its importance, Ages historical Arabic literature –

Modern Literary Studies, Study the texts of poetic eras (pre-Islamic, Islamic, Umayyad, Abbasid, Andalusia), Study of ancient prose texts (speeches, messages), examine the texts of modern poetry and contemporary, examine the texts of modern prose (drama, novel, article)

Course Learning Outcomes:

- Develop academic essay writing proficiency
- Apply reading skills
- Expand academic vocabulary through reading
- Improve critical thinking skills
- Developing the student's intellectual property in the field of the Arabic language, to acquire verbal and actual ability and skill.

Recommended Textbook(s):

- The Meanings of Grammar - Fadel Al-Samarrai

UOA 004 English Language II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support learning activity

Prerequisites:

English Language I

Course Description:

This course is designed to enable students to achieve academic oral and written communication to the standard required for English language at university level. The course integrates all the language skills with emphasis on writing. It stimulates students' imagination, and promotes personal expression. Course activities include writing various types of academic essays, acquiring advanced academic vocabulary and getting involved in group discussions and debates. In addition, the course also includes other skills to consolidate the main skills, such as further readings in civil engineering.

Course Topics:

This course encompasses a comprehensive exploration of language elements and writing skills. It is structured into distinct units, each focusing on specific linguistic aspects and practical applications. Topics include a study of various tenses, an expansion of job-related vocabulary, understanding question forms, and the art of crafting informal letters. Students will delve into present simple and continuous tenses, as well as the nuanced use of "have" and "have to." The course progresses to cover past simple and continuous tenses, incorporating the use of "have" with nouns, and the creation of narrative structures, exemplified in the writing of a story. Students will also master the intricacies of count and noncount nouns, expressions of quantity, and the usage of articles.

Course Learning Outcome:

- Develop academic essay writing proficiency
- Promote reading skills
- Expand academic vocabulary through reading
- Promote speaking ability through group discussions and debates
- Promote critical thinking skills

Recommended Textbook(s)

- John & Liz Soars, "New Headway Plus- Pre-Intermediate Student's Book", 10th ed 2012

UOA 005 English Language III

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support learning activity

Prerequisites:

English Language I, English Language II

Course Description:

This course is designed to enable students to achieve academic oral and written communication to the standard required for English language at university level. The course integrates all the language skills with emphasis on writing. It stimulates students' imagination, and promotes personal expression. Course activities include writing various types of academic essays, acquiring advanced academic vocabulary and getting involved in group discussions and debates. In addition, the course also includes other skills to consolidate the main skills, such as further readings in civil engineering.

Course Topics:

This course encompasses a comprehensive exploration of language elements and writing skills. It is structured into distinct units, each focusing on specific linguistic aspects and practical applications. Topics include a study of various tenses, an expansion of job-related vocabulary, understanding question forms, and the art of crafting informal letters. Students will delve into present simple and continuous tenses, as well as the nuanced use of "have" and "have to." The course progresses to cover past simple and continuous tenses, incorporating the use of "have" with nouns, and the creation of narrative structures, exemplified in the writing of a story. Students will also master the intricacies of count and noncount nouns, expressions of quantity, and the usage of articles.

Course Learning Outcomes :

- Develop academic essay writing proficiency
- Promote reading skills
- Expand academic vocabulary through reading
- Promote speaking ability through group discussions and debates
- Promote critical thinking skills

Recommended Textbook(s)

John & Liz Soars, "New Headway Plus- Pre-Intermediate Student's Book", 10th ed 2012

UOA 006 Ethics and Leadership Skills

Module Type:

Support learning activity

Prerequisites:

None

Course Description:

This course is tailored for engineering students aspiring to move into management and leadership roles. It provides insights into the role of an engineering leader and helps you identify your own strengths and areas for

improvement when leading a project. You'll learn to capitalize on your strengths and manage your weaknesses, build effective relationships with team members, and create an inspiring environment that encourages each person to reach their full potential. Additionally, the course covers handling various ethical challenges specific to the engineering profession.

Course Topics:

This course offers a thorough overview of engineering leadership and ethics. It begins with an Introduction to Leadership, discussing the definition, importance in engineering, and whether leaders are born or made. Next, Leadership and Management Styles explores command vs. servant leadership, management styles, and core competencies of effective leaders. Effective Team Leadership covers teamwork essentials, roles, and the leader's role in guiding teams. Practical Implementation focuses on time management, project activities, effective meetings, feedback, and recognition. Communication addresses types, influences, and habits for effective peer connections.

The course further discusses Leadership Styles in engineering, touching on modern leadership and servant leadership principles. Professional Ethics and Engineering Ethics sections outline core ethical principles and professional codes. Ethical Issues in Engineering covers safety, sustainable design, and environmental ethics. Finally, students learn Steps in Confronting Moral Dilemmas and engage in Case Studies to apply these principles in real-world scenarios.

Course Learning Outcomes :

- Develop a solid foundation in leadership principles, including understanding different leadership styles and the roles of leaders and managers.
- Build effective team management and communication skills to motivate, guide, and connect with peers.
- Apply practical skills in project management, time management, and constructive feedback.
- Gain a strong grasp of professional ethics, including how to confront moral dilemmas and address ethical issues in engineering practice.

Recommended Textbook(s)

- Benator, Barry and Thumann, Albert "Project Management and Leadership Skills for Engineering and Construction Projects." 2003, The Fairmont Press, Inc., USA
- Fleddermann, C. B. (2012). Engineering Ethics. Upper Saddle River, NJ: Prentice Hall. 3- Code of Ethics-Iraqi Engineers Association.

UOA 007 English Language IV

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support learning activity

Prerequisites:

English Language I, English Language II, English Language III

Course Description:

This course prepares students in the Chemical Engineering department to meet university-level standards in both oral and written academic communication. Emphasizing writing while incorporating all language skills, the course encourages creativity and personal expression. Students will enhance critical thinking through engagement with complex scientific topics. Activities include writing different types of academic essays, expanding advanced academic vocabulary, and participating in group discussions and debates. Additional skills, such as readings related to chemical engineering, support the primary learning goals of the course.

Course Topics:

This course encompasses a comprehensive exploration of language elements and writing skills. It is structured into distinct units, each focusing on specific linguistic aspects and practical applications. Topics include a study of various tenses, an expansion of job-related vocabulary, understanding question forms, and the art of crafting informal letters. Students will delve into present simple and continuous tenses, as well as the nuanced use of "have" and "have to." The course progresses to cover past simple and continuous tenses, incorporating the use of "have" with nouns, and the creation of narrative structures, exemplified in the writing of a story. Students will also master the intricacies of count and noncount nouns, expressions of quantity, and the usage of articles.

Course Learning Outcomes :

- Develop academic essay writing proficiency
- Promote reading skills
- Expand academic vocabulary through reading
- Promote speaking ability through group discussions and debates
- Promote critical thinking skills

Recommended Textbook(s)

- John & Liz Soars, "New Headway Plus- Pre-Intermediate Student's Book", 10th ed 2012

7.6.2 College Requirements

COE 001 Calculus I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support or related learning activity

Prerequisites:

None

Course Description:

Calculus I introduces foundational concepts of calculus, focusing on limits, derivatives, and integrals of functions of a single variable. Students will learn techniques for evaluating limits, computing derivatives, and understanding their applications to real-world problems, such as rates of change and optimization. The course also covers the basics of integration, including definite and indefinite integrals, and explores the Fundamental Theorem of Calculus. Emphasis is placed on problem-solving and the development of analytical skills, preparing students for advanced studies in mathematics, science, and engineering.

Course Topics:

Calculus I covers fundamental topics essential for understanding calculus and its applications. The course begins with an exploration of **Limits and Continuity**, introducing limits, their properties, and the concept of continuity in functions. Students then progress to **Derivatives**, learning the definition and interpretation of derivatives, along with techniques such as the product, quotient, and chain rules, and implicit differentiation. Applications of derivatives are covered, including motion, rates of change, optimization, and curve sketching. In **Applications of Derivatives**, students analyze functions for increasing/decreasing behavior and concavity, find extrema, and solve related rates problems. The course then introduces **Integrals**, covering antiderivatives, indefinite integrals, and the calculation of definite integrals as areas under curves, with the Fundamental Theorem of Calculus as a central concept. Lastly, **Applications of Integrals** provide students with tools for finding areas between curves and an introduction to volume concepts, particularly solids of revolution. These topics collectively form the foundation needed for more advanced studies in mathematics, science, and engineering.

Course Learning Outcomes

- To develop mathematical skill so that students are able to sketch the graph of various functions and evaluate Limits by using different techniques including L'Hospital's rule.
- Apply mathematical methods and principals in solving various derivative problems from Engineering fields, involving applications of derivatives.
- Demonstrate algebraic facility with algebraic topics including exponential, logarithmic, and trigonometric functions,
- Compute derivative and antiderivative of algebraic, trigonometric, in trigonometric, exponential, logarithmic, and apply them to solve problems in a range of engineering applications.

Recommended Textbook(s)

- Stewart, J., Clegg, D. K., & Watson, S. (2020). Calculus: early transcendental. Cengage Learning.
- Thomas, G. 8., Haas, J., Heil, C., & Weir, M. (2018). Thomas' Calculus. Pearson Education Limited.
- Stroud, K. A., & Booth, D. J. (2020). Engineering mathematics. Bloomsbury Publishing.

COE 002 Physics I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Basic Learning Activities

Prerequisites:

None

Course Description:

Physics I for Chemical Engineering Principles introduces essential physics concepts with a focus on their applications in chemical engineering. The course covers fundamental topics including kinematics, dynamics, energy, momentum, and rotational motion, providing students with a solid understanding of forces, work, and energy conservation. Fluid mechanics is explored in-depth, examining fluid properties, dynamics, and flow behaviors crucial to chemical processes. Thermodynamics is also introduced, covering heat, temperature, and the foundational laws governing energy transfer and entropy. Through these topics, students gain a physics foundation critical to analyzing and solving problems in chemical engineering.

Course Topics:

Physics I for Chemical Engineering Principles provides a foundational understanding of physics topics essential for chemical engineering applications. The course begins with **Kinematics and Dynamics**, covering motion in one and two dimensions, Newton's laws of motion, and force applications. Next, **Work, Energy, and Power** introduces the work-energy theorem, kinetic and potential energy, and energy conservation. **Systems of Particles and Momentum** covers the center of mass, linear momentum conservation, and collisions, with applications in chemical processes. **Rotational Motion and Dynamics** explores rotational kinematics, torque, and angular momentum, along with their applications in engineering contexts. The course also includes **Fluid Mechanics,** addressing fluid properties, fluid statics and dynamics, Bernoulli's equation, and fluid flow relevant to chemical processing. Finally, **Thermodynamics** focuses on temperature, heat, and thermal expansion, along with the first and second laws of thermodynamics, heat engines, and entropy—core concepts for understanding chemical processes. Together, these topics provide the physics background necessary for chemical engineering principles.

Course Learning Outcomes

- Apply fundamental principles of motion, forces, energy, and momentum to solve engineering problems relevant to chemical processes.

- Analyze fluid mechanics and thermodynamics concepts, including fluid behavior and energy transfer, in the context of chemical engineering.
- Integrate core physics concepts to understand and address practical challenges in chemical engineering applications.

Recommended Textbook(s)

- R.D. Knight, Physics for Scientists and Engineers, 2nd ed., Pearson 2008 Laboratory Manual, Compiled by Instructor

COE 003 Chemistry

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Basic learning activities

Prerequisites:

None

Course Description:

This General Chemistry course for Chemical Engineering introduces fundamental chemical principles essential to understanding chemical processes in engineering. Topics include atomic structure, chemical bonding, stoichiometry, thermochemistry, and the properties of gases, liquids, and solids. The course also covers chemical kinetics, equilibrium, acid-base reactions, and thermodynamics, with a focus on practical applications in chemical engineering. Through problem-solving, laboratory experiments, and real-world examples, students will build a strong foundation in chemistry concepts critical for advanced study and practice in chemical engineering.

Course Topics:

The General Chemistry course for Chemical Engineering covers essential topics that build a foundation for chemical engineering applications. Beginning with **Atomic Structure and Periodicity**, students explore atomic theory, electron configurations, and periodic trends. The course then moves to **Chemical Bonding**, examining ionic, covalent, and metallic bonds, as well as molecular geometry. Stoichiometry focuses on mole calculations and **reaction stoichiometry**, followed by **Thermochemistry,** where students learn about energy changes, enthalpy, entropy, and Gibbs free energy**. States of Matter** includes the properties of gases, liquids, and solids, along with the ideal gas law. In **Chemical Kinetics,** students analyze reaction rates and influencing factors, while **Chemical Equilibrium** introduces dynamic equilibrium and Le Chatelier's Principle. The course also covers **Acids and Bases**, exploring pH, buffer solutions, and titration, and includes **Electrochemistry**, focusing on redox reactions and electrochemical cells. An **Introduction to Organic Chemistry** provides an optional overview of basic organic structures and functional groups. These topics equip students with the chemistry knowledge necessary for advanced studies in chemical engineering.

Course Learning Outcomes

- Apply fundamental concepts of atomic structure, bonding, stoichiometry, and thermochemistry to analyze chemical reactions and properties of matter.
- Solve problems involving chemical kinetics, equilibrium, and electrochemistry, with a focus on applications in chemical engineering.
- Demonstrate foundational knowledge of acids, bases, and introductory organic chemistry relevant to engineering contexts

Recommended Textbook(s)

- Pauling, L. (1988). *General chemistry*. Courier Corporation.
- Chang, R., & Overby, J. (1986). General chemistry. New York: Random House.

COE 004 Fundamental of Electrical Circuits

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Learning Activity

Prerequisites:

None

Course Description:

Basic Concepts & Basic Laws: System of units, voltage and current, circuit elements, voltage and current sources, electrical resistance and conductance, power and energy, Ohm's and Kirchhoff's laws, Resistances in series and parallel, current and voltage division, delta-star and star-delta transformations. DC circuits' analysis: Nodal analysis, Nodal Analysis with Voltage Sources, Mesh analysis, Mesh Analysis with Current Sources. Circuit Theorems: Linearity Property, Superposition, source transformation, Thevenin's theorems, Norton's theorems and maximum power transfer theorems. Capacitors and Inductors: series and parallel connections of capacitors and inductors.

Course Topics:

Systems of Units, Charge, Current, voltage, power and Energy. Voltage and current sources, electrical resistance and conductance. Ohm's law. Nodes, Branches, and Loops. Series/parallel connections of resistors. Voltage Division and Current Division. Kirchhoff's current law and Kirchhoff's voltage law. Wye-Delta Transformations, Delta to Wye Conversion, Wye to Delta Conversion. Series/parallel DC circuit analysis. Nodal analysis, Nodal Analysis with Voltage Sources. Mesh analysis. Mesh Analysis with Current Sources. Superposition theorem. Thevenin's Theorem and Norton's theorem. Source transformation. Maximum power transfer theorem. Capacitance and capacitors series/parallel connections. Inductance and inductors series/parallel connections.

Course Learning Outcomes

- Define concepts of electric current, voltage, power, Kirchhoff's
- Apply Ohm's Law in series and parallel connections .
- Apply Thevenin's theorem and Maximum power transfer and superposition theorems for circuit analysis .
- Apply nodal and mesh analysis to solve DC circuits
- Apply superposition and source transformation methods to solve DC circuits.
- Apply Thevenin's Theorem and Norton's theorem to solve DC circuits.
- Apply Source transformation and maximum power transfer theorem
- Analyze electric circuit using simulation software

Recommended Textbook(s)

- Alexander and Sadiku "Fundamentals of Electric Circuits" Third Edition McGraw Hill.
- Boylestad, R. L., Introductory Circuit Analysis (10th Edition).

COE 005 Computer science

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support learning activity

Prerequisites:

None

Course Description:

This course provides an introduction to the fundamental concepts of computer science. Students will explore key topics including programming, algorithms, data structures, and the basics of computer systems. Emphasis is placed on developing problem-solving skills and computational thinking, enabling students to write efficient code and understand the principles behind software and hardware operations. Through hands-on exercises and projects, students will gain practical experience in designing, coding, and testing programs, laying a solid foundation for further studies in computer science.

Course Topics:

This introductory Computer Science course covers key topics including programming fundamentals, such as syntax, variables, control structures, and functions. Students learn algorithm design and problem-solving techniques, along with essential data structures like arrays, lists, and trees, and basic searching and sorting algorithms. The course introduces Object-Oriented Programming (OOP), focusing on classes, inheritance, and polymorphism. Students explore computer systems and hardware basics, including memory, storage, and processors, and learn file I/O and databases with SQL.

Course Learning Outcomes

- Analyze, design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs .
- Identify problems and formulate solutions for systems .
- Communicate effectively with a range of audience.
- Work effectively as part of a team to develop and deliver quality software artifacts.
- Design solutions using approaches that integrate ethical, social, legal, and economic responsibilities

Recommended Textbook(s)

Computer basics book and its office applications

COE 006 Physics II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Basic Learning Activities

Prerequisites:

Physics I

Course Description:

Physics II for Chemical Engineering focuses on advanced physical principles critical to chemical engineering applications, with an emphasis on electricity, magnetism, optics, and wave phenomena. Topics include electric fields, electric potential, currents, and the behavior of electric and magnetic fields in matter. Students will explore electromagnetic waves, Maxwell's equations, and their relevance to chemical processes, along with the fundamentals of optics, such as light reflection, refraction, and optical devices. The course integrates theoretical concepts with practical applications through

problem-solving and laboratory experiments, providing students with a solid understanding of the physics that underpin chemical engineering systems and technologies.

Course Topics:

Physics II for Chemical Engineering covers essential topics in electricity, magnetism, optics, and wave phenomena, with a focus on their application in engineering contexts. The course begins with **Electrostatics**, including electric fields, electric potential, and Gauss's law, followed by **Electric Circuits**, where students study Ohm's law, resistors, Kirchhoff's laws, and both DC and AC circuits. **Magnetism** explores magnetic fields, Ampère's law, and electromagnetic induction, while **Electromagnetic Waves** covers Maxwell's equations and their relevance to chemical engineering. The course also includes **Optics**, focusing on reflection, refraction, diffraction, and the behavior of lenses and optical systems, along with **Wave Phenomena**, including wave motion, the Doppler effect, and standing waves. Together, these topics provide students with the physics knowledge essential for understanding electrical, magnetic, and optical systems in chemical engineering.

Course Learning Outcomes

- Apply the principles of electrostatics, electric circuits, and magnetism to analyze and solve engineering problems involving electric fields, current flow, and magnetic interactions.
- Understand and apply Maxwell's equations and the behavior of electromagnetic waves in the context of chemical engineering systems and processes.
- Analyze optical systems, including lenses and wave phenomena, and apply these concepts to solve practical problems related to light and wave behavior in chemical engineering applications.

Recommended Textbook(s)

R.D. Knight, Physics for Scientists and Engineers, 2nd ed., Pearson 2008 Laboratory

Manual, Compiled by Instructor

COE 007 Calculus II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Basic Learning Activities

Prerequisites:

Calculus I

Course Description:

Calculus II for Chemical Engineering builds on fundamental calculus concepts with a focus on advanced techniques and applications relevant to chemical engineering. Topics include integration techniques, sequences and series, parametric equations, polar coordinates, and an introduction to multivariable calculus. Students will learn methods of solving complex integrals, apply calculus to model and analyze engineering processes, and use differential equations to describe systems in chemical engineering. This course equips students with the mathematical tools needed for problem-solving in advanced chemical engineering courses and professional practice.

Course Topics:

Calculus II for Chemical Engineering covers advanced calculus topics essential for engineering applications. The course begins with **Advanced Integration Techniques**, including methods such as integration by parts, trigonometric substitution, partial fractions, and improper integrals. Students apply these techniques in

Applications of Integration, calculating areas between curves, volumes, arc lengths, and surface areas of revolutions, with practical applications in physics and engineering. **Sequences and Series** introduces convergence, divergence, series tests, and Taylor series. The course also explores **Parametric Equations and Polar Coordinates**, covering parametric curves, derivatives, polar graphing, and calculations of area and arc length in polar form. An **Introduction to Differential Equations** familiarizes students with basic ordinary differential equations, including separable and linear first-order ODEs, with applications to chemical engineering processes. Finally, an **Introduction to Multivariable Calculus** introduces functions of multiple variables, partial derivatives, and the gradient, equipping students with tools for more complex engineering analysis. Together, these topics provide the calculus foundation necessary for chemical engineering.

Course Learning Outcomes

- Apply advanced integration techniques and series to solve complex mathematical problems in engineering contexts.
- Use parametric and polar coordinate systems to analyze curves, areas, and volumes relevant to engineering applications.
- Solve basic differential equations and perform multivariable calculus operations, applying these skills to model and analyze chemical engineering processes.

Recommended Textbook(s)

- Stewart, J., Clegg, D. K., & Watson, S. (2020). Calculus: early transcendental. Cengage Learning.
- Thomas, G. 8., Haas, J., Heil, C., & Weir, M. (2018). Thomas' Calculus. Pearson Education Limited.
- Stroud, K. A., & Booth, D. J. (2020). Engineering mathematics. Bloomsbury Publishing.

COE 008 Engineering Workshops

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Supporting learning Activities

Prerequisites:

None

Course Description:

The Engineering Workshops course provides hands-on experience with the tools, techniques, and practices commonly used in engineering design and manufacturing. Students will learn basic workshop skills such as machining, welding, 3D printing, and assembling mechanical and electrical components. The course emphasizes safety protocols, precision, and the application of theoretical concepts in real-world engineering projects. Through practical exercises and group projects, students gain valuable skills in fabricating prototypes, troubleshooting, and problem-solving, which are essential for success in engineering practice.

Course Topics:

The *Engineering Workshop Practices* course introduces essential skills, beginning with workshop safety and tool handling. Topics include machining (lathe, milling, precision measurement), welding (MIG, TIG), and 3D printing alongside CAD basics. Students also learn electrical assembly, soldering, mechanical fastening, and prototype fabrication, gaining experience in planning, testing, and troubleshooting. Emphasis on precision measurement ensures quality control, while an introduction to CNC machining covers automated manufacturing. Finally, students develop project management and teamwork skills for successful project execution.

Course Learning Outcomes:

- Demonstrate safe, effective use of machining, welding, 3D printing, and assembly tools for creating engineering components and prototypes.
- Apply precision measurement and quality control techniques to ensure high standards in fabrication.
- Collaborate in team-based projects to design, troubleshoot, and manage engineering tasks from concept to completion.

Recommended Textbook(s):

By topics.

COE 009 Engineering Drawing

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Supporting learning Activities

Prerequisites:

None

Course Description:

The fundamentals of engineering drawing including orthographic projection, dimensioning, sectioning, exploded and auxiliary views, assembly drawings, and SolidWorks. Homework drawings are of parts fabricated by the student in the lab.

Course Topics:

The fundamentals of engineering drawing involve core techniques used to communicate precise technical information about parts and assemblies. Key topics include: Orthographic Projection - A method of creating multiple views (e.g., front, top, side) to represent an object accurately in two dimensions. Dimensioning and Sectioning - Providing exact measurements and creating cross-sectional views to reveal interior details, useful for complex parts. Exploded, Auxiliary, and Assembly Views - Techniques that allow engineers to visualize parts in relation to each other, as in exploded views for disassembled parts and auxiliary views for angled features. SolidWorks - A 3D CAD software that allows for digital part modeling and assembly, enhancing visualization and prototyping capabilities.

Course Learning Outcomes:

- Recognize the value of engineering graphics as a language of communication.
- Infer the nature of engineering graphics, the relationships between 2D and 3D environments.
- Comprehend and deduce orthographic projections of an object.
- Visualize wide variety of objects and drawing the missing views.
- Comprehend and deduce section views

Recommended Textbook(s):

Interpreting Engineering Drawings, Jensen, C.H. and Helsel, G.D., 7th ed., Thomson Delmar Learning, 2007

COE 010 Engineering Mechanics (Static)

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Learning Activity

Prerequisites:

None

Course Description:

The objective of this course is to introduce students to the basic concepts of engineering mechanics. We will start by reviewing the general method of mechanics and principles of analysis. Then, we will define the basic quantities (force and moment) and relations, which are necessary for describing and analyzing, in a systematic mathematical way, the equilibrium of particles and rigid bodies. Along the way, students will also learn how to treat distributed loads and how to find the centroid/center of gravity and moments of inertia of bodies and areas. Eventually, we will put a strong emphasis on applying the concepts to solving the equilibrium of simple structures (trusses, frames and machines) and analyzing internal forces in beams, when they are acted on by external loads.

Course Topics:

The study of force systems in two and three dimensions involves understanding the resultant and equivalence of forces. This includes the definition of moments and couples, examining couples in both 2D and 3D systems, and analyzing force systems with couples. In 3D force systems, determining the resultant and equivalence involves analytical solutions and may also include systems with couples. The concept of the free body diagram (FBD) is essential in visualizing forces acting on rigid bodies and establishing equilibrium conditions, with equilibrium equations applicable in both 2D and 3D spaces. Distributed forces, such as those acting over a surface or volume, involve calculating the center of gravity and centroids to understand the balance of forces. Friction, a critical factor in many systems, requires knowledge of friction coefficients and laws, and often involves solving systems that incorporate frictional forces. Additionally, internal forces within structures like beams and shafts can be diagrammed to illustrate force distribution. Truss structures, commonly used in engineering, require structural analysis methods, such as the method of sections and the method of joints, to determine forces within each member of the structure.

Course Learning Outcomes

- Draw free-body diagrams
- Formulate and solve the equations of equilibrium
- Analyze internal forces for simple structures
- Construct shear force and bending moment diagrams for beams
- Determine the centroid, center of gravity, and moment of inertia
- Determine friction forces and their effects on rigid bodies

Recommended Textbook(s)

R.C. Hibbeler, Engineering Mechanics: Statics, Prentice Hall, 12th ed.2010.

COE 011 Calculus III

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Learning Activity

Prerequisites:

None

Course Description:

This course extends the concepts of single-variable calculus to functions of several variables, providing essential mathematical tools for engineering analysis. Students will study topics such as partial derivatives, multiple

integrals, and vector calculus. Applications include optimization, surface area, volume calculations, and physical models in engineering contexts. Emphasis is placed on developing problem-solving skills and applying multivariable calculus to real-world engineering problems.

Course Topics:

In Calculus III, the focus is on extending calculus to multiple dimensions, covering vectors, partial derivatives, and multiple integrals. Students will study topics such as gradient, divergence, and curl, as well as line and surface integrals. Applications include optimization with and without constraints, volume and surface area calculations, and physical interpretations through Green's, Stokes', and divergence theorems in engineering contexts.

Course Learning Outcomes

- Analyze and interpret multivariable functions and their physical representations.
- Compute derivatives and integrals of multivariable functions, and apply these to solve engineering problems.
- Apply vector calculus concepts to analyze physical systems and phenomena.
- Utilize mathematical tools in modeling and solving complex real-world problems.

Recommended Textbook(s)

Thomas Calculus, by George B. Thomas, Jr, Eleventh Edition Media Upgrade 2008"

COE 012 Calculus IV

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Learning Activity

Prerequisites:

None

Course Description:

This course uses to Understand methods of solving First order and Higher order ordinary differential equations along with some physical Application. Demonstrate the relevance of the mathematical methods learnt to chemical engineering. Understand the concept of Fourier-series representation of periodic functions and their application.

Course Topics:

Some of the areas covered in a single-variable calculus course include: Polynomials, Derivatives, Logarithmic functions, Limits, Integration, Qualities of the real number system. Multivariable Calculus: Differentiation involving several variables, Vector-valued functions, Multiple integration, Line integrals, Vector analysis and surface integrals. Differential Equations: Linear systems of differential equations, Fourier series applications, Stability, Bifurcations, Numerical methods, Nonlinear systems. Linear algebra and the closely related analytic geometry are used extensively in natural sciences like chemistry. Students enrolled in a linear algebra course learn about solutions to linear equations, linear independence, determinants, eigenvalues, subspaces and matrices as well as vectors.

Course Learning Outcomes

- Identify various types of equations and their particular solution.
- Understand finite differences and their applications in interpolation and extrapolation.
- Identify formulate and solve chemical engineering problems.

- Use the techniques, skills and modern mathematical tools necessary for engineering practice in chemical engineering applications.
- Be familiar with the differential equations and able to use the relevant equations in solving the problems.

Recommended Textbook(s)

Thomas Calculus, by George B. Thomas, Jr, Eleventh Edition Media Upgrade 2008"

COE 013 Engineering Materials

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This subject introduces the basic principles of materials engineering stressing the relationship between internal structures to mechanical properties, the effects of alloying and material processing on properties, some common engineering materials and the selection of materials for design

Course Topics:

Distinguish between Engineering Materials; STRUCTURE OF MATERIALS (Atomic structure, Subatomic structure (level), Macroscopic structure, Microscopic structure); CLASSIFICATION OF MATERIALS (Metals, Ceramics, Polymers, Composites); ADVANCED MATERIALS (Semiconductors, Biomaterials, Smart Materials, Nanomaterials); introduce students How to analysis of Particle's (External loads, Joint Load, Member Load, Analysis of Internal Forces); Introduce students How to analysis of Rigid Body ; What is a stress, simple stress? (Definition of Stress, Simple, Stresses, Normal stress, Solved Examples in Normal Stress); What is a shearing stress? (Definition of Shearing Stress, Solved Examples in Shearing Stress); What is a Bearing Stress? (Definition of bearing Stress, Solved Examples in bearing Stress); Distinguish between tube and spherical pressure vessels (Thin-Walled Cylinder Pressure Vessels, Spherical Shell, Solved Examples in Thin-Walled Pressure Vessels); study the relationships among the various forms of material deformation under load (Axial deformation and strain, Stiffness, K, Multiple axial loads, Solved Examples in axial deformation); What is a thermal stress? (Analysis of Thermal Stress, Solved Examples in Thermal Stress); How to draw shear force, and bending moment diagram; How to use Deformation of Members; distinguish between Analytical and graphical deflection, buckling; Special Topic .

Course Learning Outcomes

- Distinguish between Engineering Material.
- To introduce students How to analysis of Particle's.
- To introduce students How to analysis of Rigid Body.
- Distinguish between Stress, Simple Stress, Bearing Stress, distinguish between Tube and Spherical Pressure Vessels, Bearing Stress Thermal stress,
- Study the relationships among the various forms of material deformation under load
- How to draw Shear force, and bending moment diagram, Shear force, and bending moment diagram
- Distinguish between Analytical and graphical deflection, buckling

Recommended Textbook(s)

- Hibbeler, R.C. Mechanics of Material, Prentice Hall

COE 014 Engineering Statistics

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Basic Learning Activities

Prerequisites:

None

Course Description:

Statistical Engineering models are based on mathematics and probability theory. This course provides students with a working knowledge of fundamental statistics principles and probability in addition to a preface to the regression and correlation analysis. By the end of the semester, students should be able to determine when each of the various topics we have covered is appropriate to use, and to apply them to practical engineerin8 situations or problems. This course will cover techniques on data collection (presentation, descriptive statistics, basic elements of probability theory, sampling techniques theory, statistical estimation, hypothesis testing and regression analysis.

Course Topics:

Fundamentals (Introduction to Statistics): Introduction; Descriptive and inferential statistics; Variables and Types of Data; Data Collection and Sampling Techniques; Observational and Experimental Studies.**Presentation of a Statistical Data:** introduction; Organizing Data; Grouped Frequency Distributions or Frequency Distributions Table; Graphs: Histograms, Frequency Polygons, and Ogive; Other Types of Graphs. **Data Description:** Measures of Central Tendency (Mean, Median and Mode); **Measures of Variation:** Population Variance and Standard Deviation; Sample variance and Standard Deviation; Variance and Standard Deviation for Tabulated Data; range. Coefficient of Variation. **Discrete Probability Distributions:** Probability Distributions; Mean, Variance, Standard an Deviation; The Binomial Distribution; The Poisson Distribution ; **Continuous Probability Distributions the Normal Distribution:** Normal Distributions; Applications of the Normal Distribution; Normal Distributions Formula; The Standard Normal Distribution; Finding Areas Under the Standard Normal Distribution curve (Table Method); A Normal Distribution Curve as a Probability Distribution Curve; Applications of the Normal Distribution; Determining Normality; The Normal Distribution Approximation to the Binomial Distribution. **Confidence intervals and Sample Size:** Preface; Confidence intervals for the Mean When o is Known: A point estimates; An interval estimates Confidence intervals. Sample Size; t-Distribution; Confidence intervals for the Mean when σ is Unknown; The chi-square Distribution. Confidence intervals for Variances and Standard Deviations Confidence interval for a Variance; Confidence interval for a Standard Deviation. **Hypothesis Testing:** Preface; Steps in Hypothesis Testing-Traditional Method: The null hypothesis (Ho); The alternative hypothesis (Hr); The level of significance. z Test for a Mean; P-Value Method for Hypothesis Testing; t Test for a Mean; z Test for a Proportion χ^2 Test for a Variance or Standard Deviation **Testing the Difference Between Two Means, Two Proportions, and Two Variances:** Preface. Testing the Difference Between Two Means: Using the z Test; Testing the Difference Between Two Means of independent Samples: Using the t T; **Testing the Difference Between Two Means:** Dependent Samples; Testing the Difference Between Two Variances **Correlation and Regression:** Preface Scatter Plots and Correlation; Regression; Coefficient of Determination and Standard Error of the Estimate.

Course Learning Outcomes

- Use a number of methods and techniques for collecting and presentation the sets of data.
- Calculation and demonstration the center tendency and variation of data;
- Compute the probabilities in a simple case and using the rules of probability in computing .
- Give an account of the concept random variable and be able to use some common probability distributions;
- Understand the meaning of the central limit theorem;

- Use point and interval estimates for some typical statistical problems;
- Apply elementary regression for fitting measured data.

Recommended Textbook(s)

- Elementary Statistics A Step-by-Step Approach, Eighth Edition, By Allan G. Bulman
- Probability and Statistics for Engineers and Scientists, Fourth Edition, By Sheldon Ross

COE 015 Numerical analysis

Module type:

Basic learning activity

Prerequisite:

None

Course Description

The numerical methods course involves solving engineering problems drawn from all fields of engineering. The numerical methods include: error analysis, roots of nonlinear algebraic equations, solution of linear and transcendental simultaneous equations, matrix and vector manipulation, curve fitting and interpolation, numerical integration and differentiation, solution of ordinary and partial differential equations.

Course Topics:

Error Analysis: Measuring Errors; Sources of Error; Consistency, Order, Smoothness and Convergence. **Roots of equations (Nonlinear Equations):** Bisection Method; False-Position Method (Optional); Newton-Raphson Method; Secant Method (Optional). **Simultaneous Linear algebraic Equations**: Gauss-Elimination method (simple and partial pivoting methods); Gauss-Jordan Method; Matrix Inversion method. Indirect **(Iterative) Method:** Jacobi Method; Gauss-Seidel Method; Successive Over-Relaxation Method. **Numerical Differentiation and Integration**: Numerical differentiation using difference method; Numerical Integration, Trapezoid and Simpson's Rules; Extrapolation of Errors. **Interpolation and Curve Fitting:** Direct Fit Polynomial; Least Squares Method; Logarithmic regression (Optional); Exponential regression (Optional); Linear interpolation, Quadratic Interpolation; Lagrange Interpolation (Optional); Newton Divided Difference Interpolation (Optional). **Numerical Solutions of Ordinary Differential Equations:** Initial Value Problem; Euler's Method; Runge-Kutta 2^{nd}; Runge-Kutta 4^{th}; Higher Order Equations; Boundary Value Problem; Equilibrium (Finite Difference) Method. **Numerical Solutions of Partial Differential Equations**

Course Learning Outcomes:

- To gain experience in error analysis.
- Understanding the different numerical methods to solve systems of linear and nonlinear equations.
- Understanding the different numerical methods for differentiation, integration, and solving a set of ordinary differential equations.
- Understanding how numerical methods can be implemented in MATLAB software.

Recommended Textbook:

- Stoer, J., Bulirsch, R., Bartels, R., Gautschi, W., & Witzgall, C. (1980). *Introduction to numerical analysis* (Vol. 1993). New York: Springer.

7.6.3 Department Courses Requirements

CHE 001 Principles of Chemical Engineering I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course introduces students to the fundamental principles and concepts of chemical engineering. It covers the basic principles of material and energy balances, fluid mechanics, and thermodynamics as applied to chemical processes.

Course Topics:

Part One: Introduction to chemical engineering processes (introductory aspect to chemical engineering, introductory aspect to chemical engineering industries, the plain of chemical process development); dimensions, units, and their conversion (units and dimensions, operations with units, conversion of units and conversion factors, force, dimensional consistency (homogeneity), significant figures); moles, density, and concentration (the mole, density, specific gravity, flow rate, mole fraction and mass fraction, analysis of multicomponent solutions and mixture, concentration);choosing a basis, temperature, pressure and its conversion (choosing a basis, temperature, pressure). **Part Two: Material Balance** Introduction to material balances/terminologies (the concept of a material balance, open and closed systems, steady-state and unsteady-state systems, multiple component systems); general strategy for solving material balances (accounting for chemical reactions in material balances, material balances for batch and semi-batch processes, a general strategy for solving material balance problems); solving material balance problems for single units without reaction (analyze a problem statement, apply the general strategy for solving material balance problem); the chemical reaction equation and stoichiometry (stoichiometry, stoichiometric coefficients terminology for applications of stoichiometry); the chemical reaction equation and stoichiometry/ other terminologies (limiting and excess reactants, conversion and degree of completion, selectivity, yield); material balances for processes involving reaction by species material balances (species material balances for processes involving a single reaction, species material balances for processes involving multiple reactions); material balances for processes involving reaction by element material balances (element material balances for processes involving multiple reactions); material balances for single units processes involving combustion (terminologies of combustion, examples on combustion); material balances for processes involving recycle without chemical reaction (introduction, recycle without chemical reaction); material balances for processes involving recycle with chemical reaction (recycle with chemical reaction, overall fraction conversion, single - pass fraction conversion); material balances for processes involving bypass and purge with and without chemical reaction.

Course Learning Outcomes

- The ability to choose the industrial process and conduct mathematical analysis to balance the materials entering and leaving the industrial process units, and then determine its conditions, the chemicals used in it, and the equipment necessary to complete it.
- The engineer must be familiar with the most important basic principles of chemical process engineering that he needs to reach the optimal design of the chemical process because the design represents a production and commercial goal.
- The student must be able to develop industrial, chemical, or processing processes used to produce and develop chemical, pharmaceutical, and food products.

- The engineer must be a pioneer in green engineering by choosing a controlled, economical chemical process that leaves no impact on the environment.

Recommended Textbook(s)

- Felder R. M. and Rousseau, R. W. "Elementary Principles of Chemical Processes" John Wiley & Sons.
- Himmelblau, D. M., & Riggs, J. B. (2012). Basic principles and calculations in chemical engineering. FT press.

CHE 002 Principles of Chemical Engineering II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisite:

CHE 001 Principles of Chemical Engineering I

Course Description:

Energy forms and energy balances and thermodynamic principles. Balances on non-reactive processes Balances on reactive processes including fuels and combustion. Solution of simultaneous material and energy balance equations for process flow sheets using suitable software's (computer laboratory).

Course Topics:

Energy and energy balance; (Forms of energy, the first law of thermodynamics, energy balances on closed systems, energy balance on opens systems, table of thermodynamic data, energy balance procedures, mechanical energy balances). Balances on nonreactive processes (Elements of energy balance calculations, changes in pressure at constant temperature, changes in temperature, phase change operations, mixing and solution, psychrometric chart). Balances on reactive processes (Heats of reaction, Hess's law, formation reactions and heats of formation, heats of combustion, energy balances on reactive processes, fuels and combustion).

Course Learning Outcomes:

- Able to identify, use and convert various forms of energy.
- To use tabulated energy-related data.
- Able to perform energy balances on non-reactive systems.
- Able to perform energy balances on reactive systems.
- Able to understand and perform energy balance calculations on combustion reactions.

Recommended Textbook(s)

- Felder R. M. and Rousseau, R. W. "Elementary Principles of Chemical Processes" John Wiley & Sons.
- Himmelblau, D. M., & Riggs, J. B. (2012). Basic principles and calculations in chemical engineering. FT press.

CHE 003 Organic Chemistry

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support learning Activity

Prerequisites:

None

Course Description:

Introduce and develop an understanding the basic concepts of organic chemistry, understanding the concepts of organic reactions for analysis of unit processes Students will learn the polymeric chemistry.

Course Topics:

Introduction & Classification Organic Chemistry, names of organic compounds, Aliphatic compounds, alkyl halides properties, preparation and reactions, Bonding and isomerism. Alkanes and cycloalkanes. Alkenes and alkynes. Aromatic compounds. Alcohols, phenols and thiols. Ethers and epoxies. Aldehydes and ketones. Carboxylic acids and their derivatives. Amines.

Course Learning Outcomes

- Able to differentiate between different types of organic materials and structures.
- Able to relate materials properties and performance to the structure.
- Understanding different property of organic and aromatic material.
- Apply physics and chemistry to relate materials structure to their properties.

Recommended Textbook(s)

- Morrison, R. Thornton; Boyd, R. Neilson "Organic Chemistry" 6th edition, 2001
- Skoog, D.A., West D.M., Holler F.J., and Crouch S.R. “Fundamentals of analytical chemistry”, 8ed edition, brooks/Cole Cengage Learning. 2004

CHE 004 Thermodynamic I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Learning Activity

Prerequisites:

None

Course Description:

This course introduces the foundational principles of thermodynamics with a focus on applications in chemical engineering. Topics include the laws of thermodynamics, thermodynamic properties of pure substances, and the relationships between energy, work, and heat. Students will explore concepts such as phase equilibrium, thermodynamic cycles, and energy transformations. The course emphasizes problem-solving skills and provides a basis for understanding the behavior of chemical systems under various conditions.

Course Topics:

What is thermal systems engineering?; Getting started in thermodynamics: introductory concepts and definitions; concepts of unit and dimension and fundamental variables; Using energy and the first law of thermodynamics/mechanical concepts of energy; Energy and the first law of thermodynamics/broadening our understanding of mechanical work; Evaluating properties of pure substance; The first law of thermodynamics for closed systems; The first law of thermodynamics for open systems ((introduction, conservation of mass for a control volume open systems); The first law of thermodynamics for open systems conservation of energy for a control volume open systems); General applications of the first law of thermodynamics for open systems(nozzles and diffusers, turbines, compressors and pumps); General

applications of the; first law of thermodynamics for open systems (throttling devices, heat exchangers evaporator, condenser, and boiler); The ideal gas laws and ideal gas mixtures (the ideal gas laws); the real gas laws and real gas mixtures (compressibility); The real gas laws and real gas mixtures (equation of state); The real gas laws and real gas mixtures (equation of state)

Course Learning Outcomes

- The student will be able to employ the laws of thermodynamics in simulating the thermal power cycle.
- To enable the student to employ the second law of thermodynamics and its relationship to entropy in the mathematical analysis of steam and gas power plants, refrigeration and liquefaction.
- That the student distinguishes the relationship between heat and other forms of energy, and the conversion of thermal energy into different types of energy and vice versa, that is, how different types of energy are transformed into thermal energy, in the thermal power cycle.

Recommended Textbook(s)

- Smith, E. B. (2004). Basic chemical thermodynamics (Vol. 35). Imperial College Press.

CHE 005 Fluid Mechanics I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

Fluid Mechanics I is an introductory course that explores the behavior of fluids (liquids and gases) and their applications in engineering. The course covers fundamental principles, equations, and analysis techniques to understand and predict fluid flow.

Course Topics:

Introduction and Fundamental Concepts; Definition of stress; definition of fluid; fluid properties; viscosity; causes of viscosity; application of viscosity concept; compressibility; surface tension of liquids; surface tension phenomenon; capillarity; dimensions and units. **PRESSURE DISTRIBUTION in FLUIDS** Forces a fluid Elements; Pressure on a Stationary fluid; Pressure Forces on a Fluid Element; Incompressible Fluid; Compressible Fluid; Pressure Measurements; Manometers; Piezometer Tube; U-Tube; Manometers to Measure Pressure Difference; Inverted Tube Manometer; Hydrostatic Forces on Submerged Plan Surface Hydrostatic Forces on Curved Surface; Buoyancy and Stability of Floating Body; Buoyancy Force; Stability; Stability Related to Water Line; Fluid in Rigid – Body Motion; Acceleration on a Straight Path; Rotation in a Cylindrical Container**. FLUID FLOW – BASIC CONCEPT** Definitions; Description of Fluid Motion; Variation of Flow Parameters in Time and Space; Material Derivative and Acceleration Streamline, Path Lines, Stream Tube, Streak Lines; Streamline; Path Line; Stream Tube; Streak Line; Movement of Fluid Element; Pure Translation; Linear Deformation; Rate of Deformation in the Fluid Element; Rotation. DYNAMICS of FLUID FLOW: Types of System; Basic Laws; Conservation of Mass- The Continuity Equation; Continuity Equation – Differential Form; Continuity Equation (C.E)- Vector From Free Body Method; Energy Equation of Ideal Flow a long a Stream Line;

Conservation of Momentum; Linear Momentum (L.M); The Application of Momentum Theorem; Angular Momentum (Moment of Momentum); Radial – Flow Devices.

Course Learning Outcomes

- Have a working knowledge of the basic properties of fluids and understand of viscosity, the consequences of the frictional effects it causes in fluid flow and calculate the capillary rise (or drop) in tubes due to the surface tension effect.
- Analyze and determine the pressure distribution in fluid static problems under different load conditions .
- Determine the manometer pressure for different shapes and locations.
- Determine the magnitude, direction and location of pressure force on submerged body.
- Find the magnitude and direction forces produced from fluid flow motion .
- Apply energy equation along stream line, then find the resultant pressure.
- Use control volume analysis to determine the forces associated with fluid flow, and volume analysis to determine the moments caused by fluid flow and the torque transmitted .

Recommended Textbook(s)

Fundamentals of fluid mechanics, 2nd edition by Dr. Mustafa B. Al-hadithi

CHE 006 Physical Chemistry I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Basic learning activities

Prerequisites:

None

Course Description:

This course introduces students to the fundamental principles and concepts of chemical engineering. It covers the basic principles of material and energy balances, fluid mechanics, and thermodynamics as applied to chemical processes.

Course Topics:

Introduction to Physical Chemistry; Review of gas behavior from both theory and empirical viewpoints :The perfect gas: states of gases, the gas laws; Real gases: the Van der Waals equation ;The First law of Thermodynamics: the basic concepts; Work , heat, energy: The Internal energy; Expansion work ; Heat transactions (Heat Capacities); Enthalpy; Adiabatic changes; Thermochemistry: Standard enthalpy changes; Standard enthalpies of formation; The temperature dependence of reaction enthalpies. The Second law of thermodynamics: The dispersal of Energy; Entropy; Entropy change accompanying specific processes (Expansion, Phase transition, Heating). The Third law of Thermodynamics: The Nernst theorem; The Third law Entropies. Gibbs Free Energy (and Helmholtz Free Energy): Criteria of spontaneity; Maximum work; Maximum non-expansion work; Standard molar Gibbs energies (Properties of the Gibbs Energy. What is Nanotechnology.

Course Learning Outcomes

- Able to demonstrate an understanding of gas behavior using different equations of state and kinetic molecular model.

- Able to demonstrate an understanding of thermodynamics laws and their applications .
- Able to demonstrate knowledge about kinetics laws, define the rate of reaction and the rate constant .
- Skilled in problem solving and analytical reasoning as applied to scientific problems.

Recommended Textbook(s)

Atkins, P., De Paula, J., & Keeler, J. (2023). Atkins' physical chemistry. Oxford university press.

CHE 007 Chemical Industry I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Basic learning activities

Prerequisites:

None

Course Description:

This course provides an introduction to the fundamentals of the chemical process industry, focusing on its role in the production of essential materials and products. Students will explore the industrial-scale production of key chemical compounds, including petrochemicals, polymers, fertilizers, and basic inorganic and organic chemicals. The course emphasizes the principles of process design, raw material selection, process economics, and environmental considerations.

Course Topics:

The *Chemical Industry I* course covers the **foundational aspects of the chemical process industry**, emphasizing its significance in producing essential materials such as petrochemicals, polymers, fertilizers, and basic inorganic and organic chemicals. Students will explore **the sources and processing of raw materials**, such as crude oil, natural gas, minerals, and biomass, and learn about key industrial chemical processes, including those for ethylene, ammonia, methanol, and sulfuric acid production. **Core principles of material and energy balances**, as well as common unit operations like distillation, extraction, and chemical reactions, are examined in detail. The course introduces process design and **the challenges of scaling up from laboratory to industrial production**, alongside the economic considerations of chemical manufacturing. **Safety and risk management** practices are emphasized to ensure industrial standards are met. Additionally, **sustainability and environmental impact** are central to the course, with a focus on green chemistry and waste minimization. Students will analyze case studies of real-world processes and explore modern trends and innovations shaping the chemical industry, preparing them for advanced studies and practical applications in this field.

Course Learning Outcomes

- Demonstrate an understanding of key industrial chemical processes, including the production of petrochemicals, polymers, fertilizers, and inorganic and organic chemicals.
- Perform material and energy balance calculations to analyze and optimize chemical processes at an industrial scale.
- Apply principles of process design to conceptualize and evaluate chemical production systems, considering scalability and industrial feasibility.

- Assess safety hazards, risk factors, and environmental impacts in chemical processes, and propose strategies for sustainable and green chemistry practices.

Recommended Textbook(s)

- Shreve's Chemical Process Industries ,5th edition,1988
- د.جابر شنشول جمالي،الصناعات البتروكيمياوية،الجامعة التكنولوجية 2

CHE 008 Thermodynamic II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Learning Activities

Prerequisites:

CHE 004 Thermodynamic I

Course Description:

This course builds upon the foundational principles introduced in Thermodynamics I. It explores advanced concepts of thermodynamics with a focus on real-world applications in engineering and the physical sciences. Emphasis is placed on understanding the behavior of real systems, advanced energy conversion processes, and the practical design of thermodynamic cycles.

Course Topics:

The second law of thermodynamics and entropy (Introducing the Second Law:, Identifying Irreversibility's:, Applying the Second Law to Thermodynamic Cycles, Analysis of Carnot heat engines, Analysis of Carnot refrigerators and heat pumps); **using entropy** (Introducing Entropy, Entropy Change in Internally Reversible Processes, Entropy Balance for Closed Systems, Entropy Rate Balance for Control Volumes, Isentropic Processes, Isentropic Efficiencies of Turbines, Nozzles, Compressors, and Pumps); **analysis of engineering systems based on the second law of thermodynamics** (Analysis of Closed System According to 2nd Law of Thermodynamics, Analysis of Open System According to 2nd Law of Thermodynamics); **applications of second law in vapor power cycles** (Production of Power from Heat, Kind of Power Cycles, Modeling Vapor Power Systems, Analyzing Vapor Power Systems-Carnot and Rankine Cycle); **deviation of actual vapor power cycles from ideal Rankine cycles** (Introduction, Mathematical Analysis Deviation of Actual Vapor Power Cycles from Ideal Rankine Cycles); **modification methods of the steam Rankine cycles**(Using Economizer, Increase Pressure in the Boiler, Decrease Pressure in the Condenser, Increase Temperature of Superheated Steam in the Boiler, Reheated Cycle, The Regenerative Cycle); **nuclear power system cycles** (Kind of Nuclear Power System Cycle, Analysis of nuclear system cycles based on 2nd Law of Thermodynamics); **applications of second law in gas power cycles** (Reciprocating Combustion Engines); **applications of second law in gas power cycles** (Gas Turbine Brayton Engine Cycle); **applications of second law in refrigeration and liquefaction cycles** (Air Refrigeration system); **applications of second law in refrigeration and liquefaction cycles** (Vapor Compression system); **applications of second law in refrigration and liquefaction cycles** (Vapor Absorption system); **applications of second law in refrigration and liquefaction cycles (refrigerants)**; **vapor liquid equilibrium** (duhem's theorem, phase behavior for vapor –liquid system, vle qualitative behavior, vle by modified raoult's law); general review

Course Learning Outcomes

- The student will be able to employ the laws of thermodynamics in simulating the thermal power cycle.

- To enable the student to employ the second law of thermodynamics and its relationship to entropy in the mathematical analysis of steam and gas power plants, refrigeration and liquefaction.
- That the student distinguishes the relationship between heat and other forms of energy, and the conversion of thermal energy into different types of energy and vice versa, that is, how different types of energy are transformed into thermal energy, in the thermal power cycle.

Recommended Textbook(s)

- J. M. Smith, H.C.Van Ness, M.M. Abbott (Introduction to Chemical Engineering Thermodynamics) , Seventh Edition, McGraw- Hall(2005)
- J.W. Tester, M. Modell, (Thermodynamics and its Application), 3rd Edition, Printice Hall, (1997)

CHE 009 Fluid Mechanics II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Learning Activities

Prerequisites:

CHE 005

Course Description:

Student's knowledge of dynamic fluid specifications in general and how to simulate the practical side theoretically, Introduce the student to how to calculate the coefficients of friction and the energy lost during the movement of fluids, introduce students to the design laws of centrifugal pumps, how to use engineering applications in the laws of mass, time, continuity and momentum for fluid motion and deduce forces of which.

Course Topics:

Pumping of liquids, calculation of total head NPSH, performance, characteristics curves, calculation of horsepower, types of pumps, compressible fluid: general equation, isothermal and adiabatic condition work and compressors fans and blowers. Mixing: equipment and operation, degree of mixing, power curve, scale up of liquid mixing, non Newtonian fluid: type of fluid calculation of friction, pressure drop for general time, independent in laminar and turbulent flow, flow through granular bed, and packed column, fixed bed and fluidized bed .

Course Learning Outcomes

- Students will demonstrate a knowledge of the fundamentals of head, pump and type of fluid mechanics.
- Students will demonstrate the ability to use various techniques for analyzing problems with mixing.
- Students will demonstrate an understanding of the basics of non-Newtonian fluid.
- Students will demonstrate the ability to design packed column fluidized bed.

Recommended Textbook(s)

- Fluid Mechanics by White
- Fundamentals of Fluid Mechanics by Mustafa B. Hadithe

CHE 010 Mass Transfer I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Learning Activity

Prerequisites:

None

Course Description:

The course aims to provide deeper knowledge, a wide scope and improved understanding of the mechanics in mass transfer as well as a better insight into analytical and empirical methods applied in analysis and synthesis of mass transfer. The student should gain knowledge to apply the theories to relevant engineering.

Course Topics:

Introduction to mass transfer and diffusion; Definition of mass transfer; Types of mass diffusion; Mass transfer theories; Boundary condition; Steady mass diffusion through a wall ;Diffusion in a moving medium ;Mass convection ;Mass convection relations

Course Learning Outcomes

- To be able to distinguish between equimolar counter diffusion and diffusion through stagnant/ no diffusing medium
- To be able to calculate the diffusion coefficient using correlation
- To be able to calculate mass transfer flux using a diffusion flux

Recommended Textbook(s)

- Coulson, J.M., Richardson, J.F., Backhurst, J.R and Harker, J.H. “Chemical Engineering vol.2” , 4th Edition, Pergamon Press, Oxford, U.K, 1991.
- Geankoplis, C.J., “Transport Processes and Unit operations” 3rd ed., Prentice-Hall, Inc, Edgewood Cliffs, N.J., 1993.

CHE 011 Chemical Industry II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Basic learning activities

Prerequisites:

CHE 007 Chemical Industry I

Course Description:

This course provides an introduction to the fundamentals of the chemical process industry, focusing on its role in the production of essential materials and products. Students will explore the industrial-scale production of key chemical compounds, including petrochemicals, polymers, fertilizers, and basic inorganic and organic chemicals. The course emphasizes the principles of process design, raw material selection, process economics, and environmental considerations.

Course Topics:

The course provides an in-depth exploration of various chemical production processes, highlighting their thermodynamic principles and industrial applications. Key topics include the production of **ammonium nitrate**, focusing on its role in fertilizers and industrial applications, and **nitric acid**, emphasizing oxidation reactions and energy considerations in production. The synthesis of **urea** for agricultural and industrial purposes will also be examined, with a focus on reaction pathways and optimization of production conditions.**Oxygen and nitrogen production** through air separation methods will be discussed, emphasizing thermodynamic efficiency and cryogenic techniques. **Soap and detergent production** will be analyzed, covering the saponification process, surfactant chemistry, and the energy requirements of these manufacturing systems. Similarly, the thermodynamics of **oil production**, including refining processes and cracking methods, will be addressed.

The course also delves into building and material industries, covering the production of **cement**, **ceramics**, and **glass**, with a focus on the high-temperature processes involved, heat recovery, and energy optimization strategies. **Whiteware production** and its relevance to ceramics will also be explored.In the domain of food and pharmaceutical industries, topics include **fermentation processes** for alcohol, biofuels, and pharmaceuticals, and **sugar production**, with a focus on energy-efficient extraction and crystallization processes. The production of **pharmaceutical products** will emphasize thermodynamic considerations in reaction engineering and purification methods.

Course Learning Outcomes

- Understand the use of different types of flow diagrams in chemical applications
- Develop a basic understanding of chemical processes.
- Understand the principles of materials manufacturing processes.
- Understand various types of chemical and physical operations.

Recommended Textbook(s)

- Shreve's Chemical Process Industries ,5th edition,1988
- د.جابر شنشول جمالي،الصناعات البتروكيمياوية،الجامعة التكنولوجية 2

CHE 012 Analytical Chemistry

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Basic learning activities

Prerequisites:

None

Course Description:

This course introduces the fundamental principles and techniques of analytical chemistry, tailored for applications in chemical engineering. It focuses on quantitative and qualitative analysis methods essential for process monitoring, quality control, and research in the chemical industry. Students will gain practical and theoretical knowledge of analytical techniques used to characterize raw materials, intermediates, and final products in chemical engineering processes.

Course Topics:

This course covers a comprehensive range of analytical techniques essential for chemical engineering applications. **Gravimetric and volumetric analysis techniques** form the foundation for precise and accurate determination of chemical compositions in various materials. The principles and applications of **spectroscopy**, including UV-Vis, IR, Atomic Absorption, and Mass Spectrometry, are explored to provide insights into molecular and atomic-level analyses. **Electrochemical analysis**, including potentiometry, voltammetry, and conductometry, is discussed for its applications in monitoring reaction progress and assessing material properties.

Course Learning Outcomes

- Apply analytical methods to solve chemical engineering problems and optimize industrial processes.
- Interpret data from spectroscopic and chromatographic analyses.
- Use modern analytical tools for process control and product characterization.
- Implement statistical methods to ensure accuracy and reliability of experimental results.
- Understand the role of analytical chemistry in sustainable and green engineering practices.

Recommended Textbook(s)

- Pauling, L. (1988). *General chemistry*. Courier Corporation.
- Chang, R., & Overby, J. (1986). General chemistry. New York: Random House.

CHE 013 Unit Operation I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Learning Activity

Prerequisites:

None

Course Description:

The aim of this module is to deepen the students' knowledge of the unit operations with a focus on distillation, absorption, adsorption and drying processes. This provides a foundation for the Chemical Engineering in Practice modules in the second semester of the 3rd year and for the Process Design modules in the 4th year.

Course Topics:

The Unit Operations I course begins with an introduction to the fundamental principles of unit operations, highlighting their role in chemical engineering processes and industrial applications. Among the key topics covered are distillation and leaching, two essential mass transfer operations. Distillation focuses on the separation of liquid mixtures based on differences in volatility, including concepts like vapor-liquid equilibrium, relative volatility, and design methods such as the McCabe-Thiele approach for binary systems. Leaching, on the other hand, emphasizes the extraction of a soluble component from a solid matrix using a liquid solvent,

exploring equilibrium relationships, mass transfer mechanisms, and calculations for single-stage and multi-stage operations. These topics provide a strong foundation for understanding and analyzing separation processes in chemical engineering.

Course Learning Outcomes:

- Explain the fundamental principles and concepts underlying unit operations in chemical engineering.
- Identify and describe the common unit operations used in chemical processes, such as distillation, filtration, extraction, and crystallization.
- Analyze and solve problems related to the design and operation of unit operations, including mass and energy balances.
- Apply mathematical and computational techniques to model and simulate unit operations processes.

Recommended Textbook(s):

- McCabe, W. L., Smith, J. C., & Harriott, P. (1993). *Unit operations of chemical engineering*. McGraw-Hill.
- Seader, J. D., Henley, E. J., & Roper, D. K. (2006). Separation process principles.

CHE 014 Heat Transfer I

This is a required course for the Chemical and Petrochemical Engineering Program

Module Type:

Core Learning Activity

Prerequisites:

None

Course Description:

This course deals mainly with an introduction of thermal energy transfer problems which occur in the process industry (Chemical, Petrochemical, food, Pharmaceuticals, etc.) It also gives an Introduction to the 3 modes of heat transfer: Conduction, convection and radiation, heat transfer. Finally, the course reviews heat transfer with phase change and describe heat exchangers and their design

Course Topics:

Conduction: Steady state heat transfer by conduction; conduction through single plane; conduction through composite plane; conduction though cylindrical annulus; conduction through composite pipe; conduction though single spherical wall; conduction though composite spherical walls. **Convection:** Introduction to convection; dimensionless analysis; natural convection; forced convection; correlations for convections and its different forms for different actual situation such as heating and cooling inside tubes outside tubes in turbulent; transition and laminar flow. **Radiation:** Principles, grey bodies, black bodies, emissivity, Kirchhoff's law, Planck's law, absorbing, non-absorbing bodies. Overall heat transfer coefficient, fouling factors, Logarithmic mean temperature difference for parallel, counter-current and mixed flow arrangements**. Heat transfer with phase change: Boilers- condensers Introduction to multi tubular heat exchangers:** Types, classification, constructions, applications, sizing. Effectiveness Steps for design of Multi tubular heat exchangers without phase change: general considerations, introduction to TEMA codes. **Thermal and mechanical design for shell and tube multi**

tubular selection: Fluid allocations, heat transfer calculations (tube side- shell side), Determination of initial and final thermal areas, pressure drop calculations), optimization.

Course Learning Outcomes:

- To familiarize the students with basic modes of heat transfer, appreciate the physical principles and basic concepts underlying the transfer of heat by conduction, convection and radiation.
- To present the methodology required to solve problems to be encountered in actual practice (determine heat transfer coefficient, LMTD).
- To introduce the student to the design of heat exchangers
- To familiarize the students with the concept of heat transfer parameters measurement (conductivity, heat flux, temperatures…)
- To enable students to prepare written technical reports and oral presentation.
- To expose students to open ended problems solving

Recommended Textbook(s):

- Holman, J. P. (1986). Heat transfer. McGraw Hill.

CHE 015 Reactor Design I

This is a required course for the Chemical and Petrochemical Engineering Program

Module Type:

Core Learning Activity

Prerequisites:

None

Course Description:

This course provides a detailed and in-depth analysis to the principles of chemical kinetics, and reactor analysis and design. The topics in chemical kinetics include: rate constants, reaction order, rate equations for elementary and complex reactions, kinetic data analysis, and product distribution. In reactor analysis and design, discussion is focused on ideal reactor systems and arrangements, including batch reactors, plug flow reactors, continuous stirred tank reactors, and recycle reactors. The last part of the course considers homogeneous and heterogeneous catalytic reactions. The design component consists of how to make an appropriate choice of reactor type and operating conditions to optimize a desired product; sizing such reactors and determining conversion levels under various conditions of temperature and pressure; determination of reaction kinetics from experimental data.

Course Topics:

A Reactor Design I course introduces the foundational principles of chemical reactor engineering, focusing on the design and analysis of different reactor types, including batch reactors, continuous stirred-tank reactors (CSTRs), plug flow reactors (PFRs), and packed-bed reactors. It begins with a review of stoichiometry and reaction kinetics, including rate laws, reaction orders, and the Arrhenius equation to understand the temperature and pressure dependence of reaction rates. Students learn to apply mass and energy balances to derive performance equations for ideal reactors under steady-state and transient-state conditions. The course emphasizes isothermal reactor design, including batch reactors, CSTRs, and PFRs, with calculations of reactor volumes for single and multiple reactions. Topics also cover multiple reactions, such as series, parallel, and complex reactions, with a focus on optimizing selectivity and yield. Additionally, it introduces the concept of non-ideal reactor behavior using residence time distribution (RTD) to analyze deviations from ideality, such as dead zones and bypassing. Thermal effects, including exothermic and endothermic reactions, are examined to address thermal stability and

avoid runaway reactions. The basics of catalysis, including homogeneous and heterogeneous catalytic mechanisms, are also discussed. Finally, the course provides an introduction to reactor scale-up, addressing the challenges of transitioning from laboratory to industrial-scale operations, while considering economic and environmental factors.

Course Learning Outcomes:

- Understand reactor fundamental
- Apply stoichiometry and kinetics
- Perform mass and energy balance
- Design isothermal Reactors
- Understand isothermal reactors
- Explore catalyst basic

Recommended Textbook(s):

- Mann, U. (2009). Principles of chemical reactor analysis and design: new tools for industrial chemical reactor operations. John Wiley & Sons.

CHE 016 Characteristics of Petroleum and Natural Gas Engineering I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course is designed to provide students with a comprehensive understanding of the principles, technologies, and practices involved in the exploration, extraction, and processing of petroleum and natural gas. Students will learn about the entire petroleum and gas production lifecycle, from reservoir characterization to refining and distribution. The course integrates concepts from various engineering disciplines to address the challenges and opportunities within the petroleum and gas industry.

Course Topics:

Introduction to History of Petroleum and Natural gas; Definition of Petroleum and its classification, Physical and chemical properties of Crude oil and natural gas; Definition of Crude oil & natural gas Classification; Organic and Inorganic theories of formation of crude oil and natural gas, Rock Types (Igneous, Sedimentary and Metamorphic); General chemical hydrocarbon composition in petroleum. Hydrocarbons (Paraffins, Olefins, and Naphthene's); Classification of Laboratory test and physical properties (Slat Content, the weight percentage of sulfur content, Pour point and Cloud point, Ash Content.); Origin of Hydrocarbons; Thermal Cracking, Catalytic Cracking, Hydro cracking; Properties of Natural gas (Molecular weight, viscosity, pressure, Temperature, density, compressibility factor and specific gravity); Types of natural gas (Resources, Rich gas, lean gas); Gaseous fuel; Principal uses of natural gas (Natural gas industry-Petrochemicals- Energy- calorific values); Natural gases impurities; Principles of low temperature processes: relative volatility, boiling points, component mixtures; Coke performance.

Course Learning Outcomes

- Understand the characteristics of crude oil properties and natural gas
- Understand the mechanism of oil exploration techniques

- Familiar with steps of oil field development
- Familiar with crude oil products and test methods
- identify the geological origins of petroleum reservoirs and reservoir fluids
- illustrate the differences between conventional and unconventional reservoirs

Recommended Textbook(s)

- Characterization and Properties of Petroleum Fractions, M. R. Riazi
- The Chemistry and Technology of Petroleum, FOURTH EDITION, JAMES G. SPEIGHT.
- Handbook of Petroleum Processing, DAVID S. J. "STAN" JONES, PETER R. PUJAD´O,2006.

CHE 017 Petrochemical Industry I

This is a required course for the Chemical and Petrochemical Engineering Program

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course provides chemical engineering undergraduates with an in-depth exploration of the chemical and petrochemical industry. Students will gain comprehensive insights into the processes, technologies, and challenges involved in the production of chemicals and petrochemicals. The course covers a range of topics, including raw material selection, reaction engineering, process optimization, safety considerations, and environmental impacts.

Course Topics:

General chemical process; Water softening by ion exchanger; Lime-Soda ash process; Hydrogen production processes; Ammonia production process; Soap production; Detergent production; Fermentation processes; Petrochemical engineering, feedstock, intermediate, finished product; Primary fractionator or stabilizers, hydrogen separator, methane and their derivatives; propylene and derivatives; Phenol and poly propylene; Introduction of benzene derivatives; polymers (LDPE, HDPE, PP, PVC, PS).

Course Learning Outcomes

- Understand and use of different types of flow diagrams in chemical and petrochemical applications
- Develop a basic understanding of chemical processes.
- Understand the principles of materials manufacturing processes.
- Understand various types of chemical and physical operations.

Recommended Textbook(s)

- Shreve, R. N., & Brink Jr, J. A. (1977). Chemical Process Industries (No. 4th Edition). McGraw-Hill Book Co.

CHE 018 Engineering Composite Materials

This is a required course for the Chemical and Petrochemical Engineering Program

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course provides an in-depth understanding of the principles, manufacturing, properties, and applications of composite materials. It begins with an introduction to composite materials, emphasizing their importance in engineering applications due to their superior strength-to-weight ratio, stiffness, and tailorability. The course covers the classification of composites, including fiber-reinforced composites, particle-reinforced composites, and structural composites.

Course Topics:

Key topics include the behavior and properties of matrix materials (polymers, metals, and ceramics) and reinforcement materials (fibers and particles), along with their interactions. Students will learn about the fundamental mechanics of composites, including micromechanics and macro-mechanics, and analyze stress-strain behavior, failure mechanisms, and design considerations. The course also explores manufacturing techniques such as lay-up processes, filament winding, resin transfer molding, and additive manufacturing for composites. Applications in aerospace, automotive, marine, and civil engineering are discussed, along with sustainability and recycling challenges.

Course Learning Outcomes:

- Understand the Fundamentals of Composites
- Analyze Material Properties
- Apply Mechanics of Composites
- Understand Manufacturing Processes

Recommended Textbooks:

- Matthews, F. L., & Rawlings, R. D. (1999). Composite materials: engineering and science. Elsevier.

CHE 019 Unit Operation II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

Unit Operation I

Course Description:

This course is a complementary to the third–year course Unit Operation I at which the student gained an introductory to unit operations through studying diffusion, absorption, and distillation in the first place. The covered topics in this course are meant to deal with: Boundary layer theory and its applications in chemical processes, the analogies between momentum, heat, and mass transfer such as Reynolds analogy, the Evaporation which is a type of the separation process, drying (mainly used in food industry), humidification and dehumidification to design cooling towers, extraction, crystallization, and adsorption.

Course Topics:

Part A Evaporation: heat transfer in evaporators, boiling at submerged surface; forced convection, boiling at submerged surface; vacuum operation; multiple effect evaporators, general principles comparison between backward and forward feeds; **Part B: Drying**: introduction and general principles rate of drying, dry periods; Humidification terms; humidity data for air water system and cooling Towers **Part C: Crystallization**: crystallization and type of crystal, yields and heat and material balances in crystallization models of crystallization mechanical and physical separation processes sedimentation; filtration.

Course Learning Outcomes

- The concept of two-phase systems and the interactions and separation techniques involved in the operation.
- Know how to fully design a cooling tower.
- Understand and apply the concepts of boiling point rises and particle analysis during evaporation.
- Design Evaporators, Crystallizers, Distillation columns and Dryers.

Recommended Textbook(s)

- C.J. Geankoplis, Transport Processes and Unit Operations, 3rd edition, Prentice Hall Inc., 1993.
- J.F. Richardson, J.H. Harker, J.R. Backhurst, Coulson and Richardson's Chemical Engineering: Volume 2, 5th edition, Butterworth-Heinemann, 2002

CHE 020 Heat Transfer II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

Heat Transfer I

Course Description:

The goals of this course are to enable students to provide a thorough understanding and practical applications heat transfer analysis for determinate the solution in petrochemical engineering problems. Testing and examine heat transfer under different load conditions to find the solution behavior. Understanding and applying mathematical model for the solution of indeterminate different modes of heat transfer for various problems in industry. Understanding the solar energy determination for various solar applications and energy saving.

Course Topics:

Free convection heat transfer calculation; Heat exchanger types and flow arrangement; Overall heat transfer coefficient, fouling factor and LMTD for parallel flow and counter flow. Effectiveness-NTU method, parallel and counter flow heat exchanger; Heat exchanger design and multi-pass cross flow. Different regimes of boiling and mechanism of condensation. The boiling curve; Pool boiling correlations; Condensation heat transfer phenomena; Film condensation inside horizontal tube. Definitions, concept of a black body, Kirchoff's law, Lambert's Cosine Law; Stefan-Boltzmann's law; Plank's distribution law, Wein's displacement law, configuration factor. Radiation heat exchange between two parallel plates. Methods of Solving Radiation Problems; Radiation Heat Transfer in Two-Surface Enclosures; Radiation Heat Transfer in Three-Surface Enclosures Concept of solar energy. Atmospheric and Solar Radiation Calculations .

Course Learning Outcomes

- Understand the physical mechanism of natural convection, Derive the governing equations of natural convection, and obtain the dimensionless Grashof number by nondimensionalizing them, Evaluate the Nusselt number for natural convection associated with vertical, horizontal, and inclined plates as well as cylinders and spheres
- Perform a general energy analysis on heat exchangers.
- Obtain a relation for the logarithmic mean temperature difference for use in the LMTD method, and modify it for different types of heat exchangers using the correction factor.
- Develop relations for effectiveness, and analyze heat exchangers when outlet temperatures are not known using the effectiveness-NTU method.
- Differentiate between evaporation and boiling, and gain familiarity with different types of boiling, develop a good understanding of the boiling curve and the different boiling regimes corresponding to different regions of the boiling curve.
- Calculate the heat flux and its critical value associated with nucleate boiling, and examine the methods of boiling heat transfer enhancement.
- Derive a relation for the heat transfer coefficient in laminar film condensation over a vertical plate, calculate the heat flux associated with condensation on inclined and horizontal plates .
- Classify electromagnetic radiation, and identify thermal radiation, understand the idealized blackbody, and calculate the total and spectral blackbody emissive power.Obtain relations for net rate of radiation heat transfer between the surfaces of a two-zone enclosure, including two large parallel plates, two long concentric cylinders, and two concentric spheres. Determine the solar energy analysis on flat plate solar collector.

Recommended Textbook(s)

Holman, J. P. (1986). Heat transfer. McGraw Hill.

CHE 021 Reactor Design II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

Reactor Design I

Course Description:

This course enables the student to develop a clear understanding of the fundamentals of practical reactor engineering; Understanding the chemical reaction engineering. Focus is placed on non ideal batch, plug flow, and continuous stirred reactor design. Reaction engineering applications in various engineering and environmental processes are also presented .

Course Topics:

Basic of -non isothermal reactors; Energy balance and first thermodynamic law; Calculation of conversion for reversible reactions; Enthalpy and heat of reaction; Adiabatic operation; PFR design for adiabatic operation; Mix flow reactor adiabatic and non-adiabatic operation for plug reactor with recycle; Multiple-Reactor Systems in series and in parallel, choosing same type of reactors; Multiple-Reactor Systems in series and in parallel; choosing different type of reactors, Recycle; Reactor for non-isothermal; Multiple-Reactor Systems in series and in parallel; choosing shape type of reactors Autocatalytic Reactions; Size Comparison of Single Reactors and multiple; Reactors in non-adiabatic; Preparatory week before the final Exam

Course Learning Outcomes

- Implement energy balance on batch, PFR and XSTR
- Find the characteristic design of adiabatic PFR and CSTR
- Vary the reaction kinetics in homogeneous systems and apply mathematical numerical and / or analytical methods in unsteady state batch reactor
- Set up the mathematical models of the processes with multiple chemical reaction in various types of reactors (kinetic and reactor model) and apply the methodology of chemical engineering when choosing a reactor for the implementation of certain types of reactions
- Apply the above out comes to design a complex reactor for a certain industrial application

Recommended Textbook(s)

- Mann, U. (2009). Principles of chemical reactor analysis and design: new tools for industrial chemical reactor operations. John Wiley & Sons.

CHE 022 Natural Gas Engineering

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisite:

None

Course Description:

This course provides an in-depth understanding of the engineering principles and practices related to natural gas production, processing, and utilization, with a focus on chemical engineering applications. Students will explore the origins, properties, and compositions of natural gas, along with its role as a critical energy source. The course emphasizes the design and operation of natural gas processing units, including gas separation, dehydration, sweetening, and liquefaction.

Course Topics:

Key topics include the thermodynamics and fluid mechanics of natural gas systems, flow measurement, and compression, as well as the technologies for removing impurities such as CO_2, H_2S, and water vapor. Students will learn about pipeline transportation, storage systems, and the environmental aspects of natural gas production and usage, such as emissions control and carbon capture. The course also introduces advanced concepts such as LNG production, unconventional gas resources, and the integration of natural gas systems with renewable energy.

Course Learning Outcomes:

- Understand natural gas fundamental
- Analyze Gas Processing Operations
- Evaluate Pipeline and Transportation system
- Address Environmental and Safety Concerns

Recommended Textbooks:

- Lyons, W. C., & Plisga, G. J. (2011). Standard handbook of petroleum and natural gas engineering. Elsevier.

CHE 023 Petrochemical Industry II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core activity learning

Prerequisite:

CHE 017 Petrochemical Industry I

Course Description:

The Petrochemical Industry II course builds on foundational knowledge of petrochemical processes and focuses on advanced topics within the petrochemical sector. This course delves into the production, processing, and application of petrochemical products, emphasizing economic, environmental, and technological aspects.

Course Topics:

The Petrochemical Industry II course covers a range of topics, starting with an overview of petrochemical production processes, including cracking methods, reforming processes, alkylation, and polymerization. It then delves into key petrochemical products such as ethylene, propylene, benzene, toluene, xylene, and their applications in polymers and fertilizers. The course emphasizes process optimization and control, including the use of process flow diagrams and control strategies. Environmental and safety considerations are also critical, addressing emissions, pollution control, and regulatory compliance. Additionally, students will explore the economic aspects of the petrochemical industry, including market analysis, pricing strategies, and global supply chain dynamics. Finally, the course will discuss emerging technologies and trends, such as bioplastics, innovations in processes, and the impact of renewable energy on the sector.

Course Learning Outcomes:

- Understand and explain advanced petrochemical production processes.
- Analyze the economic factors influencing the petrochemical industry.
- Assess the environmental impact of petrochemical operations and propose mitigation strategies.
- Evaluate safety practices and regulatory requirements in petrochemical plants.
- Explore and discuss emerging trends and technologies in the petrochemical sector.

Recommended Textbooks:

- Shreve, R. N., & Brink Jr, J. A. (1977). Chemical Process Industries (No. 4th Edition). McGraw-Hill Book Co.

CHE 024 Water Treatment

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core activity learning

Prerequisite:

None

Course Description:

The Water Treatment course for the Chemical Engineering Department provides a comprehensive understanding of the principles, technologies, and processes involved in the treatment of water for

various applications, including drinking water, industrial use, and wastewater management. Emphasizing both theoretical knowledge and practical applications, this course prepares students to tackle real-world water quality challenges.

Course Topics:

The course covers a variety of essential topics, including the fundamentals of water chemistry and microbiology, the design and operation of water treatment systems, and the regulatory frameworks governing water quality. Key treatment processes such as coagulation, flocculation, sedimentation, filtration, disinfection, and advanced oxidation processes will be explored in detail. Additionally, students will examine the design of treatment facilities, the role of membrane technologies, and the importance of sustainable practices in water management. Case studies on water treatment in different contexts will provide insights into current challenges and innovative solutions in the field.

Course Learning Outcomes:

- Understand the physical and chemical properties of water and their implications for treatment processes.
- Analyze and design various water treatment systems for both potable and non-potable applications.
- Evaluate the effectiveness of different treatment methods and select appropriate technologies based on water quality requirements.
- Apply regulatory standards and guidelines to water treatment practices.
- Conduct case studies and propose innovative solutions to contemporary water quality challenges.

Recommended Textbooks:

- Hendricks, D. W. (2018). Water treatment unit processes: physical and chemical. CRC press.

CHE 025 Petroleum Refinery I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course provides an in-depth understanding of the processes involved in refining crude oil into commercially valuable products. It covers the principles, technologies, and economic aspects of petroleum refining, as well as environmental and safety considerations.

Course Topics:

Introduction to Petroleum Refining: Overview of the petroleum industry. Role and importance of refining in the energy sector. Historical developments in refining. Crude Oil Characteristics: Composition of crude oil. Physical and chemical properties of crude oil. Factors influencing crude oil selection for refining. Distillation and Fractionation: Atmospheric distillation. Vacuum distillation. Fractionation of crude oil into different product streams. Cracking Processes: Catalytic cracking. Thermal cracking. Hydrocracking. Fluid catalytic cracking (FCC).

Hydrotreating and Hydrodesulfurization: Removal of sulfur and other impurities. Hydrogenation processes. Catalysts and reactor design. Alkylation and Isomerization: Alkylation for high-octane gasoline. Isomerization for octane improvement. Acid-catalyzed alkylation. Reforming: Catalytic reforming for high-octane gasoline. Reaction mechanisms. Catalyst selection and optimization. Hydro processing: Hydrocracking. Hydrotreating of diesel and jet fuel. Catalysts and process design. Product Blending and Specifications: Blending of gasoline, diesel, and other products. Quality specifications and standards. Octane and cetane ratings. Petrochemical Production: Integration of refining and petrochemical processes. Production of olefins and aromatics. Feedstock considerations for petrochemicals. Environmental and Safety Considerations: Environmental impact of refining operations. Emissions control and regulations. Process safety management. Economics of Refining: Cost analysis of refining processes. Profitability factors and market dynamics. Refinery optimization and planning. Refinery Utilities: Energy integration. Water and wastewater treatment. Steam and power generation. Emerging Technologies: Advanced process control. Digitalization and Industry 4.0 in refining. Renewable and sustainable technologies in refining. Global Refining Industry Trends: Market dynamics and global refining capacity. Shifting trends in fuel demand. Impact of geopolitical factors on the industry. Case Studies and Project Work: Analysis of real-world refining scenarios. Design and optimization projects.

Course Learning Outcomes

- Explain and apply the principles for the management of hydrocarbon molecules to form refined and petrochemical products from crude oil
- Explain, analyze, and assess the technologies of processes that comprise a modern refinery and petrochemicals complex
- Explain and apply the principles for analyzing and improving the profitability of refining and petrochemicals processing
- Apply troubleshooting skills in resolving operating problems
- Identify the challenges facing the refining and petrochemicals industry, and will gain virtual work experience on a virtual oil refinery and petrochemicals site

Recommended Textbook

- Coker, A. K. (2018). Petroleum Refining Design and Applications Handbook, Volume 1. John Wiley & Sons.

CHE 026 Transport Phenomena

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

Transport Phenomena is a fundamental course in chemical engineering that explores the principles governing the movement of mass, energy, and momentum in various engineering systems. The course integrates concepts from fluid mechanics, heat transfer, and mass transfer to provide students with a comprehensive understanding of the underlying phenomena and their applications in chemical processes.

Course Topics:

Introduction of transport phenomena, Newton's law of viscosity, Molecular Theory of the viscosity of gases at low density. Shell momentum Balance and boundary conditions; Flow of a falling film, flow through a circular tube; Flow through an annulus, flow through two adjacent immiscible fluids;

Equation of continuity, equation of motion, equation of change, Use of the equation of change to solve flow problems, tutorial about the previous subjects. Fourier's law of heat conduction, shell energy balance and boundary conditions; Heat conduction with electrical source, heat conduction with a nuclear heat source, with a viscous heat source, chemical heat source, and through composite walls; Energy equation , special forms of the equations of change to solve steady state problems; Fick's law of binary diffusion ,temperature and pressure dependence of diffusivities; Shell mass balance, boundary conditions , diffusion through a stagnant gas film; Diffusion into a falling liquid film, diffusion and chemical reaction inside a porous catalyst; Equation of continuity for multicomponent mixture, Research Analogies between heat, mass and momentum transport, list and explain differences between Analogies between heat, mass and momentum transport, list and explain differences between them.

Course Learning Outcomes :

- Students are familiar and are able to apply the basic concepts conservation of mass, energy, and momentum.
- Students can formulate and solve problems in fluid, energy and mass transport
- The ability to choose and apply mathematical and numerical methods for solving transport phenomena problems.

Recommended Textbook(s)

- Bird, R. B., Stewart, W. E., & Lightfoot, E. N. (Year). Transport Phenomena (Edition). John Wiley & Sons.

CHE 027 Control Process

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course introduces students to the fundamental principles of process control, focusing on the analysis and design of control systems for engineering processes. Topics include dynamic modeling, feedback control, stability analysis, and the application of control strategies to various engineering systems.

Course Topics:

Introduction to automatic control; Representation of control components; Representation of control systems: Mass, spring damper system. Representation of control systems: Hydraulic system. Representation of control systems: Pneumatic system; Representation of control systems: Electrical system; Representation of control systems: Thermal system; Steady-state operation; Laplace transformer; Transient and steady-state responses; Steady-state errors in control systems; Stability of control systems; The rout locus method.

Course Learning Outcomes

- Identify open and closed loop control system and formulate mathematical model for physical systems
- Interpret and apply block diagram representations of control systems and design PID controllers based on empirical tuning rules
- Compute stability of linear systems using the Routh array test and use this to generate control design constraints
- Use Evans root locus techniques in control design for real world systems
- Analyze performance characteristics of system using Frequency response methods
- Learn the measurement systems, errors of measurement, as well as explain working principles of sensors and transducers.

Recommended Textbook(s)

- Bequette, B. W. (2003). Process control: modeling, design, and simulation. Prentice Hall Professional.
- Nise, N. S. (2020). *Control systems engineering*. John Wiley & Sons.

CHE 028 Engineering Economy

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support or related Activity Learning

Prerequisites:

None

Course Description:

Topics covered in this course include time value of money, analysis of alternatives using net present value and internal rate of return, depreciation, taxes, and inflation. Monte Carlo simulation is used throughout the course to study variability in engineering designs and the resulting economic impact. Engineering ethics case studies are presented and analyzed. Contemporary economic issues affecting engineers are discuses.

Course Topics:

Calculate the value of money according to time: Compares single payment at present with single payment in the future; Compares single payment in the future with annual payment; Compares single payment at present with annual payment; Calculates the value of money using arithmetic and geometric gradients; Compares alternative investment decisions; Compares alternative investment decisions using present worth, future worth and annual worth methods; Compares alternatives using rate of return and incremental rate of return methods; Performs benefit/cost analysis; Finds the most economical solution among alternatives in engineering problems; Could learn the fundamental knowledge about investment planning.

Course Learning Outcomes

- Understand and apply fundamental concepts and use of terminology of engineering economics.
- Derive and use the engineering economy factors to account for the time value of money.
- Use multiple factors to find equivalent amounts for cash flows that have nonstandard placement.
- Make computations for interest rate and cash flows that are on a time basis other than a year.
- Utilize Present, Future Worth Analysis and Annual Worth Analysis techniques to evaluate and select alternatives.
- Perform Incremental Rate of Return analysis to select best alternative of multiple projects

Recommended Textbook(s)

- Panneerselvam, R. (2013). Engineering economics. PHI Learning Pvt. Ltd.
- White, J. A., Grasman, K. S., Case, K. E., Needy, K. L., & Pratt, D. B. (2020). *Fundamentals of engineering economic analysis*. John Wiley & Sons.

CHE 029 Senior Design Project I

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support or related Activity Learning

Prerequisites:

None

Course Description:

Senior Design Project I is a capstone course for chemical engineering students that integrates knowledge from prior coursework to solve complex, real-world engineering problems. Students work in teams to design a chemical process or system, addressing economic, environmental, safety, and sustainability considerations. The course emphasizes project planning, problem-solving, communication, and teamwork. It often involves significant research, modeling, and simulation using industry-standard tools.

Course Topics:

Potential Topics Covered:

Process Design and Simulation: Development of chemical processes using software like Aspen Plus, HYSYS, or MATLAB. Flowsheet creation, process optimization, and economic analysis. **Reaction Engineering and Kinetics**: Reactor design and optimization; Selection of catalysts and operating conditions. **Heat and Mass Transfer Systems:** Design of heat exchangers, distillation columns, or other separation units; Energy integration and process efficiency. **Process Control and Safety:** Control system strategies for dynamic processes; Hazard analysis using techniques like HAZOP or FMEA. **Environmental Impact and Sustainability:** Lifecycle assessment and environmental compliance; Implementation of sustainable practices in design. **Economic Evaluation:** Capital and operational cost estimation; Feasibility studies and return-on-investment analysis. **Scale-Up and Pilot Plant Design:** Transitioning laboratory-scale designs to industrial-scale processes.

Course Learning Outcomes

- Technical Proficiency: Apply fundamental chemical engineering principles to analyze and design processes; Use advanced computational tools for simulation and optimization.

- Problem Solving: Identify and formulate engineering problems using a systematic approach; Develop innovative solutions considering multiple constraints.
- Teamwork and Collaboration: Work effectively as part of a multidisciplinary team; Manage tasks and delegate responsibilities efficiently.
- Communication Skills: Prepare professional technical reports and presentations; Communicate technical content to diverse audiences, including non-technical stakeholders.
- Project Management: Develop and follow a structured project timeline; Manage resources, deadlines, and milestones.
- Ethical and Sustainable Engineering: Incorporate sustainability principles into designs; Evaluate ethical and societal implications of engineering decisions.
- Critical Thinking: Evaluate process alternatives using quantitative and qualitative metrics.;Assess trade-offs between cost, efficiency, safety, and environmental impact.

This course is an essential step in preparing students for professional roles in the chemical engineering field, enabling them to transition smoothly into industry or advanced studies.

Recommended Textbook(s)

- By topics

CHE 030 Equipment Design

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course provides students with the knowledge and skills required to design various types of engineering equipment, machinery, and systems. It covers the entire design process, from conceptualization and analysis to detailed design, drawing preparation, and fabrication considerations. The course also addresses factors such as safety, environmental impact, and economic feasibility in equipment design.

Course Topics:

PART A: An introduction to the design of chemical engineering units; Nature of design; Codes and standards; Design factors; Part B – Flowsheeting; Flowsheet presentation; Part C- Piping and instrumentation: The P &I diagram; Valve Selection; Pipe size selection; Part D- Separational Column; Introduction to continuous distillation; design method for binary system; Approximate column sizing; plate contractors; plate hydraulic design; Part E- Heat Transfer Equipment: Introduction; basic design procedure and theory; overall heat transfer equipment;

Course Learning Outcomes

- Ability to demonstrate general knowledge of chemical process & equipment design .
- Ability to general design of a chemical plants and construct flowsheets.
- Ability to design of piping systems & pumps.
- Ability to design of heat & mass transfer equipment design

Recommended Textbook(s)

- Sinnott, R. A. Y. (2014). Chemical engineering design (Vol. 6). Elsevier

CHE 031 Technology of Catalyst

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course explores the principles and applications of catalysts in chemical processes. It covers the design, synthesis, characterization, and industrial applications of catalysts in various fields, including petrochemicals, environmental protection, and fine chemical synthesis.

Course Topics:

Introduction to Catalysis; Catalyst materials; Structures of catalytic pellets; Kinetics models for heterogeneous reactions; Chemical and physical adsorption; Catalyst characterization; Rate equation for solid-liquid catalytic reactions; Rate equation in terns of fluid phase concentration at the catalyst surface; Adsorption of inert; Problems in catalyst rate equation derivation; Design equation of reactors for gas-solid reactions.

Course Learning Outcomes

- Derive various equations in adsorption phenomena.
- Estimate process variables like adsorption rate, adsorption constants, surface area of catalyst.
- Write and solve reaction rate equation in heterogeneous systems.
- Understand the significance of the catalysis in the reactor design.

Recommended Textbook(s)

- Fogler, H. S. (2020). Elements of Chemical Reaction.

CHE 032 Petroleum Refinery II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

Petroleum Refinery II is an advanced course that focuses on the chemical and physical processes involved in refining crude oil into valuable products, such as fuels, lubricants, and petrochemical feedstocks. The course emphasizes modern refining technologies, process optimization, and

environmental considerations. Topics include catalytic processes, product specifications, and emerging trends in refining. It prepares students to address challenges in the industry, including operational efficiency, sustainability, and regulatory compliance.

Course Topics:

Advanced Refining Processes: Catalytic cracking, hydrocracking, and catalytic reforming. Alkylation and isomerization processes for high-octane fuels. Hydrotreating and hydrodesulfurization for sulfur removal. **Petrochemical Production:** Integration of refining with petrochemical processes. Production of key feedstocks like ethylene, propylene, and aromatics. **Product Specifications and Quality Control:** Properties of refined products such as gasoline, diesel, jet fuel, and lubricants. Meeting regulatory and market requirements. **Environmental Considerations:** Emissions control and wastewater treatment in refineries. Carbon capture and utilization in refining operations. Safety and Hazard Analysis: Risk assessment in refining process; Implementation of safety standards and protocols. Emerging Technologies and Trends: Refinery modernization and digitization; Renewable fuels and bio-refineries. Transitioning toward a low-carbon refining industry.

Course Learning Outcomes

- Technical and Analytical Skills: Apply chemical engineering principles and process simulation tools to design and optimize refinery operations. Solve complex engineering problems while balancing economic, environmental, and safety considerations.
- Environmental and Regulatory Awareness: Evaluate environmental impacts and implement strategies for reducing emissions and waste in refineries. Understand and apply regulatory standards to ensure compliance and sustainability.
- Industry Readiness and Innovation: Demonstrate knowledge of emerging trends in refining and renewable energy integration. Collaborate effectively on multidisciplinary teams to develop innovative solutions for a low-carbon future.

Recommended Textbook(s)

- Coker, A. K. (2018). Petroleum Refining Design and Applications Handbook, Volume 1. John Wiley & Sons.

CHE 033 Corrosion Engineering

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

Corrosion Engineering focuses on understanding the mechanisms, prevention, and control of corrosion in various industrial systems. The course provides an in-depth study of electrochemical principles, corrosion types, materials selection, and protective strategies. Topics include corrosion in different environments, coatings, inhibitors, and advanced techniques for monitoring and managing corrosion. The course prepares students to address corrosion challenges in industries such as oil and gas, power generation, chemical processing, and construction.

Course Topics:

Introduction to Corrosion: Definition, importance, and economic impact of corrosion; Fundamentals of corrosion science, including electrochemical reactions and thermodynamics. **Types of Corrosion:** Uniform corrosion; Galvanic corrosion; Pitting, crevice, intergranular, and stress corrosion cracking; Microbiologically influenced corrosion (MIC). **Corrosion in Specific Environments:** Corrosion in aqueous environments, soil, and high-temperature systems. Corrosion in oil and gas pipelines, marine environments, and industrial equipment. **Corrosion Testing and Monitoring:** Laboratory techniques for corrosion rate measurement; Field monitoring methods, including electrochemical impedance spectroscopy (EIS). **Corrosion Prevention and Control:** Materials selection and design considerations; Use of coatings, cathodic protection, and inhibitors; Environmental control strategies. **Case Studies and Industrial Applications:** Analysis of real-world corrosion problems and solutions; Failure analysis due to corrosion.

Course Learning Outcomes

- Understand Corrosion Fundamentals: Explain corrosion principles, including electrochemical mechanisms and thermodynamics; Identify and classify corrosion types and their causes.
- Implement Corrosion Control Strategies: Select and apply materials, coatings, cathodic protection, and inhibitors for corrosion prevention; Assess and design systems to mitigate corrosion in industrial applications.
- Solve Real-World Corrosion Problems: Analyze failures using diagnostic tools and propose effective solutions; Apply corrosion knowledge to industry challenges and stay updated on emerging technologies.

Recommended Textbook(s)

- Jones, D. A. (1996). Principles and prevention. *Corrosion*, *2*, 168.

CHE 034 Engineering Analysis (Simulation and Modeling)

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course explores advanced mathematical techniques essential for solving complex problems in engineering and applied sciences. It covers topics such as differential equations, special functions, Laplace transformations, Fourier series, and partial differential equations. Emphasis is placed on analytical and computational methods to model dynamic systems, analyze wave and heat transfer phenomena, and solve simultaneous and boundary value problems. Through theoretical understanding and practical applications, students will develop critical skills to tackle engineering challenges effectively.

Course Topics:

Differential Equations (D.E): Linear Differential Equations (L.D.E): Homogeneous D.E**;** Non- Homogeneous D.E**. Special Functions:** Gamma Function; Beta Function**. Laplace Transformation:** Definition of Laplace Transform**;** Laplace Transform Formulas**;** Laplace Transform Properties**.** The Inverse Laplace Transform: Inverse Laplace Transform Properties**;** Methods of Solution of Inverse Laplace Transform**:** Solution of Differential Equations using Laplace Transformation**;** Solution of the Simultaneous Differential Equations using Laplace Transformation**;** Revision problem classes. **Fourier Series:** Periodic Function**;** Euler Formulas**;** Even and Odd Functions**;** Half Range Expansions**. Partial Differential Equations**:

Definitions; Formation of Partial Differential Equations; **Solution of Partial Differential Equations under boundary conditions:** Direct Integration Method; Separation of Variable Method;Laplace Transform Method; **Applications of Partial Differential Equations:** One Dimensional Wave Equation; One Dimensional Heat Flow Equation

Course Learning Outcomes

- Understand Linear Differential Equations (Homogenous and Non- Homogenous)
- To understand solution of differential equations using Laplace Transformation
- Solve periodic function using Fourier series.
- Understand how the Partial Differential Equations under boundary conditions can be solved.

Recommended Textbook(s)

- Zill, D., Wright, W. S., & Cullen, M. R. (2011). Advanced engineering mathematics. Jones & Bartlett Learning.
- Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, 2011, John Wiley.

CHE 035 Engineering Environment

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Core Activity Learning

Prerequisites:

None

Course Description:

This course aims to equip chemical engineering undergraduates with the knowledge and skills necessary to address environmental challenges in their future professional endeavors, fostering a sense of responsibility for sustainable and ethical engineering practices.

Course Topics:

Introduction-Environment, environmental Engineering, environmental Engineering Rule, Pollution, pollution types, Wastewater, wastewater characteristics, wastewater sources, Effluent wastewater quality, wastewater treatment plant, Air pollution, Air pollutant types, Air pollution effects, Air quality Standards, dispersion equations, Air pollution treatment Solid Waste Management: Types, characteristics, sources and quantities of solid waste; Collection disposal and recycling. Environmental Legislation and Regulations Sustainable environmental engineering Sustainability, Sustainable Engineering, and Sustainable Engineering Design

Course Learning Outcomes

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design a system component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability .
- An ability to identify, formulate and solve engineering problems .
- The broad education necessary to understand the impact of engineering solutions in a global economic and environmental and societal context .
- Recognition of the need for, and an ability to engage in life-long learning .
- Knowledge of contemporary issues .
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Recommended Textbook(s)

- Environmental Engineering, Peavy etal.
- Fundamental of environmental engineering, James.
- Warren Viessman Jr., Mark J. Hammer, Elizabeth M. Perez, Paul A. Chadik, Water Supply & Pollution Control, Prentice Hall, 8th ed., 2009.

CHE 036 Senior Design Project II

This is a required course for the Chemical and Petrochemical Engineering Program.

Module Type:

Support or related Activity Learning

Prerequisites:

None

Course Description:

Senior Design Project II is the continuation of the capstone design sequence for chemical engineering students, focusing on the completion and presentation of a comprehensive chemical process or system design. Building on work initiated in Senior Design Project I, students refine their designs, conduct detailed analysis, and deliver final reports and presentations. The course emphasizes technical rigor, professionalism, and the integration of multidisciplinary knowledge, with a strong focus on real-world applicability and sustainability.

Course Topics:

Process Refinement and Optimization: Advanced simulation and iterative improvements; Sensitivity analysis and optimization for cost, energy, and environmental impact. **Equipment Design**: Detailed specifications for equipment such as reactors, heat exchangers, and separators; Fabrication considerations and materials of construction. **Process Safety and Risk Analysis**: Comprehensive safety evaluations using tools like HAZOP and LOPA; Emergency response planning and safety protocol design. **Economic and Market Analysis**: Advanced financial modeling, including cash flow analysis and risk assessment; Assessment of market conditions and potential economic viability. **Regulatory and Environmental Compliance**: Integration of regulatory standards and codes; Environmental impact assessments and mitigation strategies. **Final Deliverables**: Creation of professional engineering design packages; Preparation of detailed technical drawings, specifications, and data sheets. **Implementation and Feasibility Studies**: Scaling from pilot to full production; Feasibility studies for project implementation in industrial settings.

Course Learning Outcomes

- **Design Integration**: Complete a comprehensive design of a chemical process or system that integrates knowledge from all major areas of chemical engineering; Optimize designs for technical, economic, and environmental performance.
- **Advanced Problem Solving**: Tackle complex, open-ended problems with innovative solutions; Validate and verify designs through detailed calculations and simulations.
- **Professional Communication**: Deliver high-quality technical reports and presentations; Articulate design decisions and outcomes clearly to both technical and non-technical audiences.
- **Team Leadership and Collaboration**: Lead and manage project teams effectively, demonstrating leadership and collaboration skills; Resolve conflicts and ensure smooth team dynamics.
- **Ethics and Sustainability**: Demonstrate commitment to ethical decision-making and sustainable engineering practices; Address societal, environmental, and economic considerations in the final design.

- **Technical Documentation**: Develop a complete engineering design package, including PFDs, P&IDs, and detailed equipment specifications; Prepare documentation suitable for industrial implementation or academic review.
- **Project Execution and Review**: Manage project timelines, budgets, and deliverables effectively; Respond constructively to peer, faculty, and external stakeholder feedback.
- **Preparation for Industry**: Demonstrate readiness for professional roles in chemical engineering by applying advanced engineering tools and principles; Build confidence in transitioning from academic training to industry challenges.

Key Deliverables

- Finalized process design, including all calculations, models, and simulations.
- Detailed technical report covering all aspects of the project.
- Professional presentations to faculty, peers, and industry representatives.
- Design package including safety analysis, economic evaluation, and implementation recommendations.

This course serves as the culmination of the chemical engineering program, equipping students with the skills and experience needed for a successful career in engineering or further studies.

Recommended Textbook(s)

- By topics