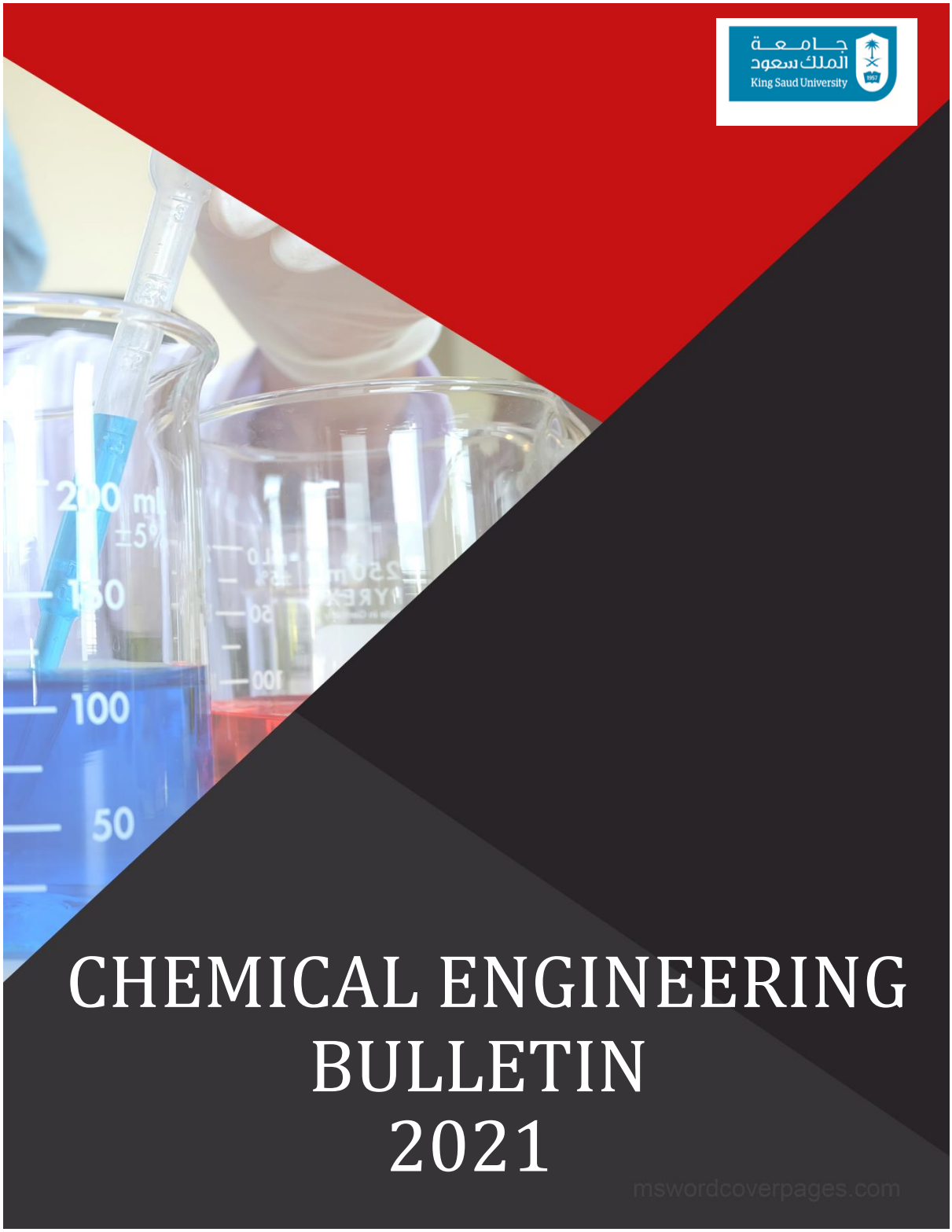

CHEMICAL ENGINEERING BULLETIN 2021

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Chemical Engineering

Chemical Engineers play a vital role in industrial development and economic prosperity in the Kingdom of Saudi Arabia due to the vast contribution of the chemical and petrochemical industries in the overall Saudi economy. The recent expansions in materials and processed minerals of non-petroleum origin (e.g. phosphates, uranium, iron ...etc.) provide new working grounds for chemical engineers. Other major working areas for chemical engineers are in water desalination (the Kingdom has the largest productivity of desalinated water worldwide), industrial waste treatment, military industries, extractive-metallurgy (iron, gold, aluminum), building materials, fertilizers and industrial cleaners. Also, Chemical Engineering encompasses biochemical engineering, which involves the pharmaceutical and food industries and biotechnology. The work of chemical engineers extends from the design and planning of new industrial projects to the operation, control and development of existing industries.

The Department

Chairman Message:

We at the Chemical Engineering Department look for quality education through accreditation, dynamic academic programs and modern teaching tool to attain national and international recognition and outstanding community services.

Dr. Abdul Aziz Abdullah Alghyamah
Chairman of Chemical Engineering Department

1. OVERVIEW

The Chemical Engineering Department was established in 1394 H (1974 G) in the College of Engineering at King Saud University. The department offers a Bachelor of Science in Chemical Engineering. As of the second semester of the academic year 2020/2021 there are 200 undergraduate students enrolled in the department. A total of 32 are expected to graduate. On the graduate level, the department offers a Master of Science in chemical engineering (thesis and non-thesis options), Master of Science in polymers engineering and PhD in Chemical Engineering. The department included during the academic year 2020/2021 a total of 27 faculty members (13 professors, 7 associate professors and 7 assistant professors) and 3 lecturers. All faculty members are holders of PhD from prestigious worldwide universities. The department also has 4 full time teaching assistants, 5 lab technicians and 2 administrative staff. In addition, the program has 7 researchers holders of PhD degree. All the staff is working hard and in harmony to maintain excellence in academic, research and administrative spheres.

The department has very well equipped laboratories. Some of these laboratories enable the students to visualize the various chemical processes and how they are interrelated. Besides the student's laboratories, the department contains faculty laboratories in which they conduct their own research. Undergraduate students are often integrated in the research activities carried out by faculty and benefit from the experience. Also, the department has advanced computation facilities either through University and College computers or the Department computers facilities. The computer laboratories are equipped with a number of design, simulation, and control packages that are used by the students to enhance the understanding of the various chemical processes.

The department pays special attention to the issue of academic accreditation in order to continuously improve the department standards of teaching and learning. The department already received the full accreditation from ABET on 2010 and was renewed on 2017. The department also received another full accreditation from the National Commission of Assessment and Academic Accreditation (NCAAA) on 2015.

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2. DEPARTMENT VISION, MISSION AND EDUCATIONAL OBJECTIVES

Vision:

To be a pioneer in chemical engineering education and research as well as in building a knowledge community.

Mission:

The Department of Chemical Engineering strives to provide excellent education to students through an accredited academic program, serve the local community, contribute to the progress of the chemical engineering profession, and conduct innovative research.

Program Educational Objectives:

A graduate of the B.Sc. in CHE program should be able to:

Objective 1: Pursue successful careers in the oil and gas, chemical, petrochemical, and water desalination industries as well as in other related industries.

Objective 2: Make successful transitions from the traditional chemical engineering career path into business, government, education, and other fields.

Objective 3: Demonstrate commitment to life-long learning through successful completion of an advanced degree, continuing education course(s), professional development course(s), and/or industry training course(s).

Student Outcomes:

- SO1: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- SO2: 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
- SO3: An ability to communicate effectively with a range of audiences.
- SO4: 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.
- SO5: 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.
- SO6: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- SO7: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

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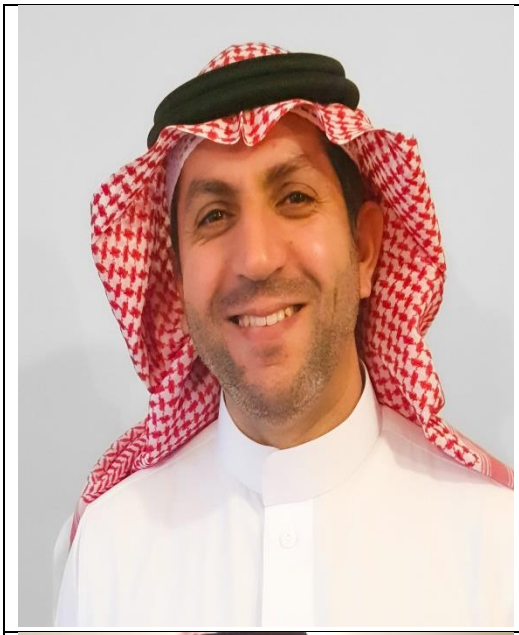

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4. INDUSTRIAL ADVISORY COUNCIL

The department has its own industrial advisory council that formulates the liaison between the department and the industrial sector. The council also assists the department in updating and shaping its academic and teaching plans. The council was established in 2008, and the current members are:

Name	Affiliation	Position
Eng abdulrehman Al-Fadhel	Manager Riyadh Refinery Department	Deputy Manager
Dr. Ahmed Al-Arifi	Saline water conversion cooperation	Advisor
Dr. Wajeeh Moughrabiah	SABIC	Director
Eng. Saad alshammari	Al-Ahsa Development Co	Executive Vice President
Eng. Mohammed Al-Zamil	BATIC Investments & Logistics Company	Managing Director
Eng. Amjad Arab	Saudi Electric Company	Executive Vice President

5. ADMISSION REQUIREMENTS & REGULATIONS

5.1. Student Admissions B.Sc Programs

The College admits about 600 students every year, with clear admission criterion that is based on having General High School Certificate (Science Section) with a minimum composite score of 80%. The 100% composite score is distributed among: 30% for the high school test, 30% for Capabilities Test and 40% Achievement Test. It should be noted that the Capabilities Test administrated by the National Center for Assessment in ETEC is similar to the General Aptitude Test (GAT) or to the Scholastic Aptitude Test (SAT). The Achievement Test was introduced in 2007. It is a subject achievement test whose score is reported as a composite score of a test administered in the following subjects: Math, Physics, Chemistry, Biology, and English. Students are required to take this test prior to application for admission to the university. In addition, the student must have a minimum score of 87% in mathematics, physics and chemistry. However, such criterion can vary depending on the admission policy of the college.

5.1.1. Admission of Students who have finished the First Common Year of Science Colleges

Students are accepted by merit according to the following rule:
0.25 x Mark of Achievement Test + 0.25 x Mark of Capabilities Test + 5 x cumulative GPA of Common first year + points of the course Math101

The college accepts about 550 students for the first semester and 50 students for the second semester. The general rule of the college is to reach the target value of the student to faculty ratio of 20 recommended by the Ministry of Education.

5.1.2. Students Allocation to College Departments

After successfully passing 28 out of the 34 credit hours of the first year at the college, a student must submit, electronically, a request to the Deanship of Admission & Registration, prioritizing his preference of the different disciplines. Students are allocated in departments based on their GPA and department capacity.

5.1.3. Transfer Students and Transfer Courses

The policies for transfer students are clearly specified for three different cases as follows:

1. Transfers from other colleges within the university (internal transfer)
2. Transfers from other universities (external transfer)
3. Transfers from other departments within the COE

The details of these policies are accessible and posted on the website, https://engineering.ksu.edu.sa/en/node/4999. All arrangements for student transfer or course

transfer are made by qualified faculty members to ensure that all requirements and regulations are satisfied. These arrangements are made prior to the beginning of the semester, so that the student will be informed about the decision in adequately timed manner. The following sub-sections briefly describe the transfer requirements for the different cases.

5.1.4. Internal Student Transfer

- Students from Science Colleges of KSU must have a minimum cumulative GPA of 4.0 out of 5.0 and have grade B in Math.
- Student from KSU Health Colleges must have a minimum cumulative GPA of 4.35 out of 5.0, and they should have completed successfully or obtained an equivalence of the Common first year for the Science Colleges.
- The cumulative GPA is calculated after a student completes at least 12 hours after the Common first year (not including courses of the university requirements: Islamic culture and Arabic language).
- If the College's intake capacity is exceeded, the Dean of the COE may accept no more than fifty students satisfying the transfer criteria.
- Acceptance of students is done by merit when all the conditions are satisfied.
- Transfer from Humanities Colleges is not accepted.

5.1.5. External Student Transfer

- The student must have a minimum cumulative GPA of 4.25 out of 5.0 or its equivalent from an accredited college of engineering.
- The student must have a minimum score of 80% in mathematics courses studied in his college.
- The student must not have successfully completed more than 35 credit hours after the first common year or equivalent requirements for college of engineering at his university.
- If the student did not study a common first year in his college, the University has the right to ask the student to study the KSU Common first year for Science Colleges, or otherwise what the University deems suitable after carrying out all the equivalences for the student).

  Once these conditions are satisfied the student is considered as a visiting student and is allowed to register at least 12 credit hours according to his study plan in his previous college and in coordination with the COE at KSU. The 12 credit hours should not include courses of Islamic culture and Arabic language. The student must also obtain a GPA in that semester of at least 4.0 out of 5.

5.1.6. Students Transfer from other Departments of the College

- Students from another department of the college must have a cumulative GPA higher than the lowest GPA admitted to the department.
- A prescribed form must be filled-in by the student for final approval by the College Students Affairs Unit.
- The priority of acceptance is given to the students with the higher grades, on the basis of available seats in each department.

5.1.7. Credit Transfer

It is permissible for the students to transfer credits of courses studied in a recognized engineering college, if the courses are equivalent to those offered by the college departments. Approval of the department is perquisite for the transfer acceptance. The transferred credits should not be more than 40% of the total credits of a degree plan of the college of engineering at KSU. Transferred credits are not included in the GPA, but a grade of at least C should be scored to pass courses. The following table lists the number of transfer students over the last five years.

Number of Transfer Students to each programm (including the general ingineering) in the last five Academic Years*

Academic Year	EE	CE	SE	PEG	ME	IE	CHE	GE
2020/21	8	5	2	1	24	33	9	59
2019/20	9	14	2	1	19	19	4	36
2018/19	10	7	5	1	18	19	2	27
2017/18	1	9	3	0	7	11	2	66
2016/2017	1	7	1	0	2	9	4	118

*EE: Electrical engineering; CE: Civil engineering; SE: Survey engineering; PEG: Petroleum and natural gas; ME: mechanical engineering; IE: industrial engineering; CHE: Chemical engineering; GE: general engineering

5.2. Graduate Programs

5.2.1. Admission Requirements

Degree	Admission Requirements
	1. Applicant must hold a bachelor's degree in chemical engineering with a minimum of a "Very Good" GPA, or applicant's general GPA as well as the GPA of the specialty courses (chemical engineering courses) at the bachelor's stage

• **M. Sc. in Chemical Engineering** • **M. Sc. in Polymer Engineering**	are at least "6.75/10" each for applicants having a "Good" GPA. **2.** Applicant of other engineering disciplines must hold a bachelor's degree with a minimum of a "Very Good" GPA. **3.** Bachelor's degrees from technical colleges or equivalent are not accepted.
Ph. D. in Chemical Engineering	**1.** Applicant must hold a bachelor degree in chemical engineering with a minimum of a "Very Good" GPA. **2.** Applicant must hold a master's degree in chemical engineering with a minimum of a "Very Good" GPA or equivalent. **3.** A score of at least 6.1 in the TOEFL-IBT test or equivalent. **4.** A score of at least 70 in the General Aptitude Test or 144 in the GRE-Quantitative test.

6. PRACTICAL TRAINING

Students in the department are required to complete a 10 weeks practical training requirement in an area related to Chemical Engineering. Prior to undertaking the practical training program, the student must obtain the approval of the department and he must have completed, successfully, at least 110 credit hours including the CFY (or 78 credit hours excluding the CFY). Students enrolling in the practical training program are not allowed to take simultaneously any course or the graduation project.

7. ACADEMIC PROGRAMS

7.1. Bachelor of Science in Chemical Engineering Program

7.1.1. Introduction

The B.S. program aims at preparing the students to satisfy the needs of the industrial and public sectors and also to contribute to the national industrial development in the Kingdom. Therefore, the department is keen to include in its program, besides the basic chemical engineering subjects, courses that cover the most important industries (such as petrochemical industries and water desalination) in the Kingdom. The B.S. program is a five years program (10 semesters)**.**

7.1.2. Requirements:

7.1.3. Course Requirements (165 credit hours)

To complete the graduation requirements for a B. S. in Chemical Engineering, the students are required to successfully pass a total of 165 credit hours (32 credit hours from the Common First Year, CFY and 132 credit hours and 1 (no-grade) credit hour of practical training as shown in Table 7.1 with a minimum GPA of 2.75 out of 5.0. The program is divided into:

- 32 credit hours of Common First Year Requirements. The breakdown is shown in (Table 7.2)
- 8 credit hours of University requirements (Table 7.3) of which:
  - 2 credit hours are compulsory (Table 7.3A)
  - 6 credit hours are elective to be taken from IC courses (Table 7.3B)..
- 48 credit hours of College requirements (Table 7.4) of which:
  - 40 credit hours are compulsory courses for all departments (Table 7.4A)
  - 6 credit hours of additional courses from a list of optional courses offered by the College of Engineering (Table 7.4B)
  - 2 credit hours of free courses to be taken by the student from any college but not from his department (Table 7.4C)
- 77 credit hours of departmental requirements (Table 7.5) of which:
  - 49 credit hours are core courses (Table 7.5A),
  - 4 credit hours of graduation project (Table 7.5B),
  - 11 of foundation chemistry courses (Table 7.5C)
  - 12 credit hours of elective courses (Table 7.5D) to be selected from the list of electives offered by the department (Table 7.5E).
  - 1 credit hour (NP, no-grade pass or fail) of practical training (Table 7.5F).
  - The department provides its students with a chance to register a zero credit hour, no-grade course in research project (Table 7.5G); this course is NOT required for graduation.

- The recommended semester schedule - Chemical Engineering Program (Table 7.6)

7.1.4. Senior Graduation Project Requirements (4 credit hours)

The graduation project is divided into two parts (2 credit hours each). The student is eligible to register for Senior Graduation Project-1 if he completes successfully at least 129 credit hours including the CFY (or 97 credit hours excluding the CFY) and successfully passing all courses at level 7 and below (levels 1-7). The Senior Graduation Projects (1 and 2) can only be taken during the first and second semesters (not during summer semester).

7.1.5. Practical Training Requirements (no-grade credit hour)

Students in the department are required to complete a 10 weeks practical training requirement in an area related to Chemical Engineering. Prior to undertaking the practical training program, the student must obtain the approval of the department and he must have completed, successfully, at least 110 credit hours including the CFY (or 78 credit hours excluding the CFY). Students enrolling in the practical training program are not allowed to take simultaneously any course or the graduation project.

7.1.6. Tables of Requirements & Typical Plan

A typical plan of study for a B. S. in Chemical Engineering is presented in Table 7.1

Table 7.1 SUMMARY OF B.S. DEGREE REQUIREMENTS IN CHEMICAL ENGINEERING

Requirements	Cr. Hr.	Description
Common First Year	**32**	General Chemistry (4) Differential Calculus (3) Statistics (3) English (12) Writing Skills (2) University Skills (3) IT Skills (3) Entrepreneurship (1) Health and Fitness (1)
University	**8**	**Islamic Studies**: Compulsory (2) Electives (6)
College	**48**	Common (40) Additional (6) free course (2)
Department	**77**	Core (49) Projects (4) CHE Electives (12) Foundation Chemistry (11) Practical training (1, NP) Research Project (0, NP)
Total	**165**	

Table 7.2: Common First Year (32 credit hours)

Level 1			
Course Code	**Course Title**	**Cr. Hr. (X,Y,L)**	**Pre-requisite**
*ENGS 10x	English language	6(6,9,0)	
MATH 101	Differential Calculus	3(3,1,0)	
ENT 101	Entrepreneurship	1(1,0,0)	
CHEM 101	General Chemistry	4(3,0,2)	
ARAB 100	Writing Skills	2(2,0,0)	
Total		**16**	

Level 2			
Course Code	**Course Title**	**Cr. Hr. (X,Y,L)**	**Pre-requisite**
*ENGS 11x	English	6(6,9,0)	
CUR 101	University Skills	3(3,0,0)	
CT 101	IT skills	3(0,0,6)	
STAT 101	Introduction to Statistics	3(2,2,0)	
EPH 101	Health Education & Fitness	1(1,1,0)	
Total		**16**	

(X,Y,L) X = Lectures; Y = Tutorials; L = Lab.

*The specific English course taught depends on the results of a placement English test administered to students

7.3.: UNIVERSITY REQUIREMENTS (TOTAL 8 CREDIT HOURS)

TABLE 7.3A: COMPULSORY COURSES (2 CREDIT HOURS)

Course Code	Course Title	Cr. Hr.	Nature
IC 107	Ethics of the Profession	2(2, 0, 0)	Compulsory
Total		**2**	

TABLE 7.3B: OPTIONAL COURSES (The student must choose 3 courses (6 hours) from the list below)

Course Code	Course Title	Cr. Hr.	Nature
IC 100	Studies in Prophet Biography	2(2, 0, 0)	Elective
IC 101	Origins of Islamic Culture	2(2, 0, 0)	Elective
IC 102	Family in Islam	2(2, 0, 0)	Elective
IC 103	The Economic System in Islam	2(2, 0, 0)	Elective
IC 104	The Political System in Islam	2(2, 0, 0)	Elective
IC 105	Human Rights	2(2, 0, 0)	Elective
IC 106	Medical Jurisprudence	2(2, 0, 0)	Elective
IC 108	Contemporary Issues	2(2, 0, 0)	Elective
IC 109	Role of Women in Development	2(2, 0, 0)	Elective
	Total	**6**	

7.4: COLLEGE REQUIREMENTS (48 CREDIT HOURS)

Table 7.4A COLLEGE COMPULSORY COURSES (40 CREDIT HOURS)

Course Code	Course Title	Cr. hr. (X,Y,L)	Pre-requisites
MATH 106	Integral Calculus	3 (3,2,0)	MATH 101
MATH 107	Vectors and Matrices	3 (3,2,0)	MATH 101
MATH 203	Differential & Integral Calculus	3 (3,2,0)	MATH 106; MATH 107
MATH 204	Differential Equations	3 (3,2,0)	MATH 203

PHYS 103	General Physics (1)	4 (3,0,2)	
PHYS 104	General Physics (2)	4 (3,0,2)	PHYS 103
ENGL 109	Language & Communication	2 (2,1,0)	
ENGL 110	Technical Writing	2 (2,1,0)	ENGL 109
GE 201	Statics	3 (3,1,0)	MATH 106; MATH 107
GE 104	Basics of Engineering Drawing	3 (2,0,2)	
GE 106	Introduction to Engineering Design	3 (2,1,2)	GE 104
GE 203	Engineering and Environment	2 (2,0,0)	CHEM 101; MATH 101
GE 402	Engineering Projects Management	3 (3,1,0)	
GE 403	Engineering Economy	2 (2,1,0)	
	Total	**40**	

(X,Y,L) X = Lectures; Y = Tutorials; L = Lab.

Table 7.4B COLLEGE ADDITIONAL COURSES FOR CHE PROGRAM (6 CREDIT HOURS)

Course Code	Course Title	Cr. hr. (X,Y,L)	Pre-requisites
GE 209	Computer Programming	3 (2,0,2)	
MATH 254	Numerical Methods	3 (3,2,0)	MATH 107
	Total	**6**	

Table 7.4C: COLLEGE FREE COURSE FOR CHE PROGRAM (2 CREDIT HOURS)

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisites
xxxxxx	Free elective	2	
	Total	**2**	

7.5 CHEMICAL ENGINEERING REQUIREMENTS

Table 7.5A CORE COURSES (49 CREDIT HOURS)

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisites
CHE 201	Chemical Engineering Principles (1)	3 (3,1,0)	CHEM 101
CHE 202	Chemical Engineering Principles (2)	2 (2,1,0)	CHE 201
CHE 205	Chemical Engineering Thermodynamics (1)	2 (2,1,0)	CHEM 101
CHE 206	Chemical Engineering Thermodynamics (2)	2 (2,1,0)	CHE 205
CHE 219	Fundamentals of Materials Engineering	3 (3,1,0)	CHEM 101
CHE 234	Momentum Transport	3 (3,1,0)	CHE 201
CHE 320	Chemical Reaction engineering	3 (3,1,0)	CHE 206
CHE 333	Unit Operations	2 (2,1,0)	CHE 201
CHE 334	Heat Transfer	3 (3,1,0)	CHE 202
CHE 335	Mass Transfer	3 (3,1,0)	CHE 234
CHE 336	Process Safety	1 (1,1,0)	CHE 320
CHE 366	Chemical Engineering Laboratory (1)	2 (0,0,4)	CHE 335
CHE 406	Computational Techniques	2 (1,1,2)	MATH 254; CHE 201
CHE 409	Separation Processes	3 (3,1,0)	CHE 335
CHE 412	Computer Aided Chemical Process Design	3 (2,1,2)	CHE 334
CHE 415	Process Control	3 (3,1,0)	CHE 406
CHE 420	Economics of Chemical Processes	2 (1,1,2)	GE 403
CHE 423	Selected Topics in Chemical Engineering (2)	2 (2,1,0)	Successful Completion of 120 credit hours

CHE 426	Heterogeneous Reactor Engineering	3 (3,1,0)	CHE 320
CHE 466	Chemical Engineering Laboratory (2)	2 (0,0,4)	CHE 426
	Total	**49**	

NP= No grade (Pass or Fail)

Table 7.5B SENIOR GRADUATION PROJECTS (4 CREDIT HOURS)

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisites
CHE 496	Graduation Project (1)	2(2,0,0)	Complete successfully 129 credits hours and passing all courses in levels 1-7.
CHE 497	Graduation Project (2)	2(2,0,0)	CHE 496
	Total	**4**	

(X,Y,L) X = Lectures; Y = Tutorials; L = Lab.

Table 7.5C FOUNDATION CHEMISTRY COURSES (11 CREDIT HOURS)

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisites
CHEM 230	Principles of Physical Chemistry	3(3,0,0)	CHEM 101
CHEM 244	Principles of Organic Chemistry (1)	2(2,0,0)	
CHEM 245	Principles of Organic Chemistry (2)	2(2,0,0)	CHEM 244
CHEM 350	Instrumental Analysis for non-major	4(2,0,4)	CHE 201
	Total	**11**	

Table 7.5D ELECTIVE COURSES (12 CREDIT HOURS)

(Each student is required to take 12 cr. hr. from the list of ChE elective courses in Table 5E)

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisites
CHE 4**	Elective (1)	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 4**	Elective (2)	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 4**	Elective (3)	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 4**	Elective (4)	3(3,1,0)	Successful completion of 120 Cr. hrs.
	Total	**12**	

Table 7.5E LIST OF CHE ELECTIVE COURSES

(Each student is required to take 12 cr. hr. from the following list of ChE elective courses)

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisites
CHE 413	Desalination and Water Treatment	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 422	Selected Topics in Chemical Engineering (1)	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 425	Selected Topics in Chemical Engineering (3)	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 427	Pollution Prevention in Chemical Industries	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 428	Production of Building and Cementing Materials	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 429	Energy and Chemical Industries	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 430	Corrosion Engineering	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 433	Electrochemical Engineering	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 434	Extractive metallurgy & metals recycling	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 437	Waste Treatment Processes	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 438	Water Chemistry & Chemical Analysis	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 440	Introduction to Biochemical Engineering	3(3,1,0)	Successful completion of 120 Cr. hrs.

CHE 441	Petroleum Refining Engineering	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 442	Petrochemical Industries	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 443	Natural Gas Processing	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 445	Biological Wastewater Treatment	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 446	Environmental Biotechnology	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 447	Fundamentals of Polymer Sciences and Engineering	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 448	Fundamentals of Mineral Processing	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 449	Membrane Separations	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 450	Renewable Energy	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 451	Risk Assessment and Hazard Control	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 452	Food Processing Technologies	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 453	Composite Science & Engineering	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 454	Process Energy Optimization	3(3,1,0)	Successful completion of 120 Cr. hrs.
CHE 467	Process Integration	3(3,1,0)	Successful completion of 120 Cr. hrs.

(X,Y,L) X = Lectures; Y = Tutorials; L = Lab; NP=No grade (Pass or Fail)

Table 7.5F CHE PRACTICAL TRAINING REQUIREMENT (COMPULSORY; 1 NP)

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisites
CHE 999	Practical Training	1 (NP)	Successful Completion of 110 credit hours
	Total	**1**	

NP= No grade (Pass or Fail)

Table 7.5G CHE ELECTIVE COURSE WITHOUT CREDIT HOURS (0 NP)

(This is an optional elective course with no credit hours; no required for the B.S. degree in CHE)

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisites
CHE 998	Research Project	0 (NP)	Successful completion of 129 cr. hr.

Table 7.6 RECOMMENDED SEMESTER SCHEDULE - CHEMICAL ENGINEERING PROGRAM

Level 1			
Course Code	**Course Title**	**Cr. Hr. (X,Y,L)**	**Pre-requisite**
*ENGS 10x	English language	6(6,9,0)	
MATH 101	Differential Calculus	3(3,1,0)	
ENT 101	Entrepreneurship	1(1,0,0)	
CHEM 101	General Chemistry	4(3,0,2)	
ARAB 100	Writing Skills	2(2,0,0)	
Total		**16**	

Level 2			
Course Code	**Course Title**	**Cr. Hr. (X,Y,L)**	**Pre-requisite**
*ENGS 11x	English	6(6,9,0)	
CUR 101	University Skills	3(3,0,0)	
CT 101	IT skills	3(0,0,6)	
STAT 101	Introduction to Statistics	3(2,2,0)	
EPH 101	Health Education & Fitness	1(1,1,0)	
Total		**16**	

*The specific English course taught depends on the results of a placement English test administered to students

Level 3			
Course Code	**Course Title**	**Cr. Hr. (X,Y,L)**	**Pre-requisite**
IC 1xx	Optional IC course	2(2,0,0)	
PHYS 103	General Physics (1)	4(3,0,2)	

Level 4			
Course Code	**Course Title**	**Cr. Hr. (X,Y,L)**	**Pre-requisite**
PHYS 104	General Physics (2)	4(3,0,2)	PHYS 103
ENGL 110	Technical Writing	2(2,1,0)	ENGL 109

MATH 106	Integral Calculus	3(3,2,0)	MATH 101
MATH 107	Vectors & Matrices	3(3,2,0)	MATH 101
ENGL 109	Language & Communication	2(2,1,0)	
GE 104	Basics of Engineering Drawing	3(2,0,2)	
Total		**17**	

MATH 203	Differential and Integral Calculus	3(3,2,0)	MATH 106 MATH 107
GE 106	Introduction to Engineering Design	3(2,1,2)	GE 104
GE 201	Statics	3(3,1,0)	MATH 106 MATH 107
GE 203	Engineering and Environment	2(2,0,0)	CHEM 101 MATH 101
Total		**17**	

Level 5

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisite
MATH 204	Differential Equations	3(3,2,0)	MATH 203
CHEM 244	Principles of Organic Chemistry (1)	2(2,0,0)	
CHEM 230	Principles of Physical Chemistry	3(3,0,0)	CHEM 101
CHE 201	Chemical Engineering Principles (1)	3(3,1,0)	CHEM 101
CHE 205	Chemical Engineering Thermodynamics (1)	2(2,1,0)	CHEM 101
CHE 219	Fundamentals of Materials Engineering	3(3,1,0)	CHEM 101
Total		**16**	

Level 6

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisite
IC 107	Ethics of the Profession	2(2,0,0)	
CHEM 245	Principles of Organic Chemistry (2)	2(2,0,0)	CHEM 244
GE 209	Computer Programming	3(2,0,2)	
CHE 202	Chemical Engineering Principles (2)	2(2,1,0)	CHE 201
CHE 206	Chemical Engineering Thermodynamics (2)	2(2,1,0)	CHE 205
CHE 234	Momentum Transport	3(3,1,0)	CHE 201
xxx	Free Elective	2	
Total		**16**	

Level 7

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisite
IC 1xx	Optional IC course	2(2,0,0)	
MATH 254	Numerical Methods	3(3,2,0)	MATH 107
CHE 333	Unit operations	2(2,1,0)	CHE 201
CHE 334	Heat Transfer	3(3,1,0)	CHE 202
CHE 335	Mass Transfer	3(3,1,0)	CHE 234
CHE 320	Chemical Reaction Engineering	3(3,1,0)	CHE 206
Total		**16**	

Level 8

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisite
CHEM 350	Instrumental Analysis for non-major	4 (2,0,4)	CHE 201
GE 403	Engineering Economy	2 (2,1,0)	
CHE 366	Chemical Engineering Laboratory (1)	2 (0,0,4)	CHE **335**
CHE 406	Computational Techniques	2 (1,1,2)	MATH 254 CHE 201
CHE 409	Separation Processes	3 (3,1,0)	CHE 335
CHE 426	Heterogeneous Reactor Engineering	3 (3,1,0)	CHE 320
CHE 336	Process Safety	1 (1,1,0)	CHE 320
Total		**17**	

Level 9

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisite
IC 1xx	Optional IC course	2(2,0,0)	
CHE 412	Computer Aided Chemical Process Design	3(2,1,2)	CHE **334**
CHE 415	Process Control	3(3,1,0)	CHE 406
CHE 423	Selected Topics in Chemical Engineering (2)	2(2,1,0)	Complete successfully 120 credits hours

Level 10

Course Code	Course Title	Cr. Hr. (X,Y,L)	Pre-requisite
GE 402	Engineering Projects Management	3(3,1,0)	
CHE 4xx	Elective (2)	3(3,1,0)	Complete successfully 120 credits hours
CHE 4xx	Elective (3)	3(3,1,0)	Complete successfully 120 credits hours
CHE 4xx	Elective (4)	3(3,1,0)	Complete successfully 120 credits hours

CHE 420	Economics of Chemical Processes	2(1,1,2)	GE 403
CHE 4xx	Elective (1)	3(3,1,0)	Complete successfully 120 credits hours
CHE 496	Graduation Project (1)	2(2,0,0)	Complete successfully 129 credits hours and passing all courses in levels 1-7.
Total		**17**	

CHE 466	Chemical Engineering Laboratory (2)	2(0,0,4)	CHE 426
CHE 497	Graduation Project (2)	2(2,0,0)	CHE 496
CHE 999	Practical Training	1 (NP)	Complete successfully 110 credits hours
CHE 998	Research Project	0 (NP)	Complete successfully 129 credits hours
Total		**17**	

NP: No grade (Pass or Fail)
(X,Y,L) X = Lectures; Y = Tutorials; L = Lab.

7.1.7. Course Description
7.1.7.1 Common First Year

ENGS 10X: English language ***6(6,9,0)***

This initial stage of the course is designed to give the students a strong foundation in the language, improving their command of English as well as improving their vocabulary, reading, writing and communication skills. In the process of improving these skills, students will also develop their confidence in the language and also their presentation skills. These all contribute to the life skills of the student and help to prepare them for their future studies and careers beyond KSU. As the course progresses and students reach a higher level of English, the focus will switch to the academic side of the language. This will involve preparing students for the style of language they will need for their future studies.
Pre-requisites: None.

MATH 101: Differential Calculus ***3(3,1,0)***

Limits and Continuity: The Concept of Limit, Computation of Limits, Continuity and its Consequences, Limits Involving Infinity, Formal Definition of the Limit. Differentiation: The Concept of Derivative, Computation of Derivatives (The Power Rule, Higher Order Derivatives, and Acceleration), the Product and Quotient Rules, The Chain Rule, Derivatives of Exponential and Logarithmic Functions, Implicit Differentiation and Inverse Trigonometric Functions, the Mean Value Theorem. Applications of Differentiation: Indeterminate Forms and L'Hopital's rule, Maximum and Minimum Values, Increasing and Decreasing Functions, Concavity and the Second Derivative Test, Optimization, Related Rates.

Textbook: Robert T. Smith, and Roland R. Minton, "Calculus, early Transcendental functions", Third Edition, 2007.
Pre-requisite: None

ENT 101 Entrepreneurship ***1(1,0,0)***

Pre-requisites: None.

CHEM 101: General Chemistry ***4(3,0,2)***

Stoichiometry: SI Units, chemical formulas, the mole, methods of expressing concentration, Calculations based on chemical equations. Gases: laws, kinetic theory, deviation and van der Waals equation. Thermochemistry: Types of enthalpy changes, Hess Law and its applications,, first law of thermodynamics. Solutions: Type of solutions and laws related , colligative properties. Chemical kinetics: Law of reaction rate, reaction order, factors affecting the rates. Chemical Equilibrium : Relation between Kc & Kp, Le Chatelier's principle and factor affecting equilibrium. Ionic equilibrium: Acid and base concepts, pH calculations of acid, base and buffer solutions. Atomic Structure: emission spectrum, Bohr's theory de Broglre's hypothesis, quantum numbers, electronic configuration of elements, consequences of the periodic table.
Pre-requisites: None.

ARAB 100: Writing Skills ***2(2,0,0)***

ENGS 11X: English ***6(6,9,0)***

The final assessment for the course is the highly regarded International English Language Testing System (IELTS), which is used as a qualifying test for students wishing to attend university in many countries including the UK and Australia. Specialist material will be used to prepare students for this test with the aim of reaching an IELTS score of 5.0 by the end of the year.
Pre-requisites: None.

CUR 101: University skills ***3(3,0,0)***

Learning skills**:** Self management for learning, Learning tools, Reading strategies, Second language learning skills, Test administration.
Thinking skills: Theory Of Inventive Problem Solving (TRIZ), Rounding Thinking, Expanding perception, Creative thinking. Research skills: Problem determining, Search for information strategies, Sites of sources, access this information, Using thin formation, Information construction, Information evaluation.
Pre-requisites: None.

CT 101: IT skills ***3(0,0,6)***

Basic Concepts of Information Technology, Using a computer and Managing Files, Word Processing, Spreadsheets, Databases, Presentation.
Pre-requisites: None.

STAT 101: Introduction to Statistics ***3(2,2,0)***

Descriptive statistics; Probability; Random variables and probability distribution functions; Statistical inference; Correlation and simple linear regression.
Pre-requisites: None.

EPH 101: Health Education and Fitness ***1(1-1-0)***

Subjects about general health and body and brain fitness.

Pre-requisites: None.

7.1.7.2 University Requirements

IC 100 - Studies in Prophet Biography	2(2,0,0)
IC 101 - Origins of Islamic Culture	2(2,0,0)
IC 102 - Family in Islam	2(2,0,0)
IC 103 - The Economic System in Islam	2(2,0,0)
IC 104 - The Political System in Islam	2(2,0,0)
IC 105 - Human Rights	2(2,0,0)
IC 106 - Medical Jurisprudence	2(2,0,0)
IC 107 - Ethics of the Profession	2(2,0,0)
IC 108 - Contemporary Issues	2(2,0,0)
IC 109 - Role of Women in Development	2(2,0,0)

7.1.7.3 College Requirements

A- Compulsory courses

MATH 106: Integral Calculus ***3(3,2,0)***

The definite integral, fundamental theorem of calculus, the indefinite integral, change of variable, numerical integration. Area, volume of revolution, work, arc length. Differentiation and integration of inverse trigonometric functions. The logarithmic, exponential, hyperbolic and inverse hyperbolic functions. Techniques of integration: substitution, by parts, trigonometric substitutions, partial fractions, miscellaneous substitutions. Indeterminate forms, improper integrals. Polar coordinates.

Textbooks: 1- Robert T. Smith, and Roland R. Minton, "Calculus, early Transcendental functions", 3rd Edition.
2- Earl W. Swokowski, Michael Olinick, Dennis Pence, and Jeffery A. Cole "Calculus", 6th Edition.

Pre-requisite: MATH 101

MATH 107: Vectors and Matrices ***3(3,2,0)***

Vectors in two and three dimensions, scalar and vector products, equations of lines and planes in space, surfaces, cylindrical and spherical coordinates. Vector valued functions, their limits, continuity, derivatives and integrals. Motion of a particle in space, tangential and normal components of acceleration. Functions in two or three variables, their limits, continuity, partial derivatives, differentials, chain rule, directional derivatives, tangent planes and normal lines to surfaces. Extrema of functions of several variables, Lagrange multipliers. Systems of linear equations, matrices, determinants, inverse of a matrix, Cramer's rule.

Textbook: Edward and Penny, "Calculus", international edition.

Pre-requisite: MATH 101

MATH 203: Differential & Integral Calculus ***3(3,2,0)***

Infinite series, convergence and divergence of infinite series, integral test, ratio test, root test and comparison test. Conditional convergence and absolute convergence, alternating series test. Power series, Taylor and Maclaurin series. Double integral and its applications to area, volume, moments and centre of mass. Double integrals in polar coordinates. Triple integral in rectangular, cylindrical and spherical coordinates and applications to volume moment and centre of mass. Vector fields, line integrals, surface integrals, Green's theorem, the divergence theorem, Stoke' theorem.

Textbook: 1- Robert T. Smith, and Roland R. Minton, "Calculus, early Transcendental functions", 3rd Edition.
2- Earl W. Swokowski, Michael Olinick, Dennis Pence, and Jeffery A. Cole "Calculus", 6th Edition.

Pre-requisite: MATH 106 and MATH 107

MATH 204: Differential Equations ***3(3,2,0)***

Various types of first order equations and their applications. Linear equations of higher order. Systems of linear equations with constant coefficients, reduction of order. Power series

methods for solving second order equations with polynomial coefficients. Fourier series, Fourier series for even and odd functions. Complex Fourier series. The Fourier integral.

Textbook: Dennis G. Zill and Michael R Cullen, "Differential equations with boundary value problems", 6th edition
Pre-requisite: MATH 203

PHYS 103: General Physics (1) ***4(3,0,2)***
Introduction (Vectors), Motion in one dimension with constant acceleration, Motion in two dimensions with application to projectile motion and circular motion, Newton's Laws of Motion, Work and Energy, Potential Energy and law of conservation of Energy, Linear Momentum and Collisions, Rotation of rigid object about a fixed axis.
Pre-requisites: None.

PHYS 104: General Physics (2) ***4(3,0,2)***
Electricity and Magnetism: Coulomb's law, electric fields, Gauss' Law, electric potential, potential energy, capacitance and dielectric, currents and resistance, electrical energy and power, direct current circuits, Kirchhoffs rules, magnetic fields, motion of charged particle in a magnetic field, sources of the magnetic field, Ampere's law, Faraday's law of induction, self inductance, energy in a magnetic field, mutual inductance, alternating current circuits, the RLC series circuit, power in an A.C. circuit, resonance in RLC services circuit.
Pre-requisites: PHYS 103.

ENGL 109 – Language and Communication ***2(2,1,0)***
ENGL 109 includes *English for Specific Purpose* (ESP) units that cover terminology and expressions, in various engineering disciplines. The course is designed to improve the communication and reading skills of engineering students. It equips the student with essential linguistic expertise for his engineering study and prospective professional career.
Textbook: Eric H. Glendinning & Norman Glendinning, "Oxford English for Electrical and mechanical Engineering", Oxford University Press (2000).
Pre-requisites: None.

ENGL 110 – Technical Writing ***2(2,1,0)***
English 110 is intended to enhance technical writing skills. It equips students with writing basics and techniques required for constructing clear and persuasive presentation of their ideas, on various forms including reports, presentations, worksheets, CVs' and memos. The course highlights effective writing features including: focus, organization, support & elaboration, style, and conventions. It emphasizes on observing ethical norms in writing.
Textbook: Daphne Mackey, "Send me a Message: *A step-by-step approach to business and professional writing*", McGraw Hill (2006)
Pre-requisites: ENGL 109.

GE 104: Basics of Engineering Drawing ***3(2,0,2)***
The course includes the drawing of Orthographic and isometric projections. Other topics include scaling, sectioning, dimensioning and blue print reading. The course is taught using free hand, AutoCAD and AutoDesk Invetor

Textbook: Fundamentals of Graphics Communication, Bertoline, G.R., And Weibe, E.N., Mc Grew-Hill Inc., New York, 5th edition, 2007

References: A Manual of Engineering Drawing Practice, C.H. Simons and D.E. Maguire, Hodder & Stoughton.
Engineering Drawing and Graphic Technology, French T. E., Charles J. V. and Foster R.J., 14th Edition, McGraw-Hill,1993.

Pre-requisites: None.

GE 106: Introduction to Engineering Design *3(2,1,2)*

Engineering profession, jobs, and disciplines; Elements of engineering analysis; Introduction to engineering design and team formation; Engineering problem definition; Engineering system Architecture and physical function decomposition; human factor, environment, and safety issues in design; Generation of alternative concepts; Evaluation of alternatives and selection of a concept, Design defense, performance evaluation, and reporting; Engineering ethics.

Textbook: Philip Kosky, Robert T. Balmer, William D. Keat, George Wise, Exploring Engineering: An Introduction to Engineering and design, 4th ed.

Pre-requisite: GE 104

GE 201: Statics *3(3,1,0)*

Force systems; vector analysis, moments and couples in 2D and 3D. Equilibrium of force systems. Analysis of structures; plane trusses and frames. Distributed force system; centroid of simple and composite bodies. Area moments of inertia. Analysis of beams. Friction.

Textbook: Meriam, J. L. and Kraige, L. G. “Engineering Mechanics, Volume 1, Statics”, SI units Version

Pre-requisite: MATH 106 & MATH 107

GE 203: Engineering and Environment *2(2,0,0)*

This course introduces the impact of engineering and industrial activities on the environment. The lectures cover basics of ecosystems, environmental balance, types of pollution, and types, sources, and limits of pollutants; in addition to fundamentals of Environmental Impact Assessment (EIA). Pollution control technologies and examples of pollution from various engineering and industrial sectors are also covered.

Textbook: G. Tyler Miller, Scott Spoolman. Living in the Environment, 17th edition. Cengage Learning (2014)
Jerry A. Nathanson, Richard A. Schneider. Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control, 6th edition. Pearson Education, Limited (2014)

Pre-requisite: CHEM 101, MATH 101

GE 402: Engineering Projects Management *3(3,1,0)*

This course introduces techniques that provide rational solutions to a range of project management decisions encountered in engineering projects. Students are expected to gain a detailed understanding of some of the techniques, tools and processes available and their application in starting, planning, managing and finishing engineering projects; The course covers project management fundamentals including projects life cycle, project planning and

scheduling techniques, cash flow forecasting, performance evaluations, estimating and cost control; project organizations; Introduction to risk management.

Textbook: Meredith, J. R., Mantel Jr, S. J., & Shafer, S. M. (2013). Project management in practice. Wiley Global Education

Prerequisite: None

GE 403: Engineering Economy ***2(2,1,0)***

This course is being offered to the students who enroll in the College of Engineering to give them fundamental knowledge and understandings on Cost concepts, Time value of money operations, Measuring the worth of investments, Comparison of alternatives, Depreciation, and Economic analysis of public projects

Textbook: John A. White, Kenneth E. Case and David B. Pratt, "Principles of engineering economic analyses", 5th edition.

Pre-requisites: None

B- Additional courses

GE 209: Computer Programming ***3(2,0,2)***

To introduce computer programming for solving engineering problems in MATLAB environment

Textbook: MATLAB for Engineers by Holly Moore, Pearson; 5th edition (2017).52

Pre-requisites: None.

MATH 254: Numerical Methods ***3(3,2,0)***

Various numerical methods for solving nonlinear equations. Direct and iterative methods for solving systems of linear equations along with error estimate. Polynomial interpolation with error formula. Numerical differentiation and integration with error terms. An introduction to numerical solution of ordinary differential equations.

Textbook: Rizwan Butt and Yacine Benhadid, "An Introduction to Numerical Analysis"

Pre-requisite: MATH 107

7.1.7.4 Department Requirements

A- Core Courses

CHE 201: Chemical Engineering Principles (1) ***3(3,1,0)***

The course gives a brief account of the origin and role of Chemical Engineering. It also provides the students with the tools and the correct methods of performing engineering calculations and units. It also shows the students the basic concepts and procedures to perform material balances on single and multiple units for both non-reactive and reactive processes including combustion reactions.

Textbook: Felder R. M. and Rousseau, R. W. "Elementary Principles of Chemical Processes" John Wiley & Sons.

Pre-requisite: CHEM 101

CHE 202: Chemical Engineering Principles (2) ***2(2,1,0)***

The course teaches the students how to perform energy balances on reactive and nonreactive systems using tabular and equation-based data. The students expand their previous knowledge in formulating and solving problems in energy balances and also problems that require simultaneous solution of material and energy balances. The students also learn how to use psychrometric charts.

Textbook: Felder R. M. and Rousseau, R. W. "Elementary Principles of Chemical Processes" John Wiley & Sons.

Pre-requisite: CHE 201

CHE 205: Chemical Engineering Thermodynamics (1) ***2(2,1,0)***

In this module, the principles of chemical engineering thermodynamics (first and second laws) are presented with their applications for closed and open systems. The volumetric properties of pure fluids and their calculation using different equations of state (Ideal gas, Virial and cubic EoS) and other generalized correlations are also described in details. Moreover, the physical and chemical heat effects are also presented as well as the thermodynamic properties of fluids, the fundamental equations, Maxwell relations, residual properties and steam tables.

Textbook: Smith, J.M.; Van Ness, H.C.; and Abbott, M.M. "Introduction to Chemical Engineering Thermodynamics", 7th ed. McGraw Hill, 2005.

Pre-requisite: CHEM 101

CHE 206: Chemical Engineering Thermodynamics (2) ***2(2,1,0)***

The main topics covered in this course are: Application of thermodynamics for flow processes (Throttling, turbines, expanders, compressors, pumps); Heat engines and refrigerators (Carnot cycle, Rankine cycle, vapor compressor cycle, heat pumps); Introduction to liquid vapor equilibrium (VLE) calculations (Qualitative description, Raoult's law, Henry's law, modified Raoult's law, azeotrope); Theory of solution thermodynamics (Chemical potential, partial molar properties, fugacity, fugacity coefficient); Chemical reaction equilibria (The reaction coordinate, the standard Gibbs energy, evaluation of the equilibrium constant, effect of temperature)

Textbook: Smith, J.M.; Van Ness, H.C.; and Abbott, M.M. "Introduction to Chemical Engineering Thermodynamics", 7th ed. McGraw Hill, 2005.

Pre-requisite: CHE 205

CHE 219: Fundamentals of Materials Engineering ***3(3,1,0)***

Classification of materials, Structure of materials, Properties and processing of materials. Engineering applications of materials.

Textbook: William D. Callister, "Materials Science and Engineering an introduction", John Wiley & Sons, 7th ed. 2007.

Pre-requisite: CHEM 101

CHE 234: Momentum Transport ***3(3,1,0)***

This course deals with the study of concept of momentum and mechanical energy transport of fluids, by examining fluid statics and dynamics, viscosity, fluid friction, pumping, settling and flow through porous media. The course presents also definitions of Non-Newtonian fluids, and discusses dimensional analysis.

Textbook: Geankoplis, G.J: Transport Processes and Unit Operations, Prentice Hall, 4th edition, 2008.
Pre-requisite: CHE 201

CHE 320: Chemical Reaction Engineering ***3(3,1,0)***

Understanding how chemical reactors work lies at the heart of almost every chemical processing operation. Design of the reactor is no routine matter, and many alternatives can be proposed for a process. Reactor design uses information, knowledge and experience from a variety of areas - thermodynamics, chemical kinetics, fluid mechanics, heat and mass transfer, and economics. CRE is the synthesis of all these factors with the aim of properly designing and understanding the chemical reactor.

Textbook: H. Scott Fogler, "Elements of Chemical Reaction Engineering", Prentice-Hall, 5th ed., 2016.
Pre-requisite: CHE 206

CHE 333: Unit Operations ***2(2,1,0)***

This course deals mainly with the study and concept of the operations involving particulate solids: properties, modification, separation, settling and flow through porous media.

Textbook: W. L. McCabe, J. C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 6th ed., McGraw-Hill, Inc., New York, 2001.

Pre-requisite: CHE 201

CHE 334: Heat Transfer ***3(3,1,0)***

Introduction and mechanisms of heat transfer. Steady state heat transfer by conduction. Individual and overall coefficients of heat transfer. Heat Transfer correlation in convection. Natural and forced convection, and Radiation. Heat transfer with phase change. Design of heat exchangers.

Textbook: F. Kreith, R. Manglik, M. Bohn, "Principles of heat transfer", Cengage Learning, 7th edition, 2011.
Pre-requisite: CHE 202

CHE 335: Mass Transfer ***3(3,1,0)***

This course teaches the students the basic concepts involving the molecular transport of mass in gases, and liquids and Fickian and non-Fickian mass transport in solids; Prediction of convective mass transport coefficients for various geometries; Interphase mass transfer and

importance of mass transport resistances; Design of separation units involving continuous packed bed as well as tray absorption towers.

Textbook: Geankoplis, G.J: Transport Processes and Unit Operations, Prentice Hall, 4th edition, 2008.

Pre-requisite: CHE 234

CHE 336: Process Safety *1(1,1,0)*

The course provides the students with the fundamentals and applications of chemical process safety, process safety-related standards and regulations, toxicology, toxic release and dispersion model, process hazard identification including HAZOP, and fires and explosions.

Textbook: D. A. Crowl and J. F. Louvar. Chemical Process Safety, Fundamentals with Applications. 3rd. edition, 2011.

Prerequisite: CHE 320

CHE 366: Chemical Engineering Laboratory (1) *2(0,0,4)*

Carry out experiments of filtration and solid handling; Carry out experiment on double pipe heat exchangers to measure the overall heat transfer coefficient, based on the three modes of heat transfer and the LMTD; Measure the friction factors of fluid flows and the minimum fluidization velocity; Measure experimentally the different parameters related to mass transfer operations: concentration of CO_2 in water, gas diffusion and liquid diffusion.

Pre-requisite: CHE 335

CHE 406: Computational Techniques *2(1,1,2)*

Apply knowledge in mathematics, applied mathematics and basic chemical engineering principles to numerically solve CHE problems. Familiarize the students with basic concepts and procedures in programming numerical methods to solve and analyze solutions to typical CHE problem.

Textbook: J. B. Riggs, An Introduction to Numerical Methods for Chemical Engineers, 2nd Edition, Texas Tech University Press, 1994.

Pre-requisite: CHE 201 and MATH 254

CHE 409: Separation Processes *3(3,1,0)*

This course deals with the design of distillation columns involving binary and multi-components; Application of equilibrium stage analysis to solvent extraction; Drying and humidification methods; Cooling towers for air-water system: fundamentals, types, and design.

Textbook: Geankoplis, G.J: Transport Processes and Unit Operations, Prentice Hall, 4th edition, 2008.

Pre-requisite: CHE 335

CHE 412: Computer Aided Chemical Process Design *3(2,1,2)*

Introduction to process simulators such as ASPEN PLUS, CHEMCAD, etc. Principles of process synthesis and design. Development of steady-state mass and heat balances and sizing

for a chemical process with the aid of process simulators. Optimization of process flowsheet. Computer-aided analyses of large-scale chemical processes.

Textbook: Seider, Seader, Lewin, Widagdo, "Product and Process Design Principles: Synthesis, Analysis and Evaluation, 3rd Edition, 2010.

Pre-requisite: CHE 334

CHE 415: Process Control *3(3,1,0)*

Introduction and significance of control; Feedback and feed forward control; Dynamics of first and second order systems; Overall transfer function testability; Controllers (P, PI, PID etc.) & final control elements; Introduction to stability of chemical processes; Introduction to frequency response techniques; Routh's criteria, Bode plots, Nyquist method;

Textbook: Stephanopoulos, G., "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall, 1984.

Pre-requisite: CHE 406

CHE 420: Economics of Chemical Processes *2(1,1,2)*

The use of chemical engineering and economic principles in the design of a complete chemical plant. General design considerations regarding environmental, health, safety and selection of plant location. Process design development. Sizing, selection and costing of equipment. Capital and operating cost estimation. Profitability indicators: ROI, PBP, NPV, and discounted cash flow return (IRR). Alternative investments and replacements. Introduction to computer-aided design. Optimization solution methodology. Linear programming (Graphical and computer application). Relevant Computer laboratory

Textbook: Turton, R. et al., "Analysis, Synthesis, and design of chemical processes", Prentice Hall, 2012.

Pre-requisite: GE 403.

CHE 423: Selected Topics in Chemical Engineering (2) *2(2,1,0)*

This course involves a variety of selected topics in chemical engineering. The contents of course depend on community/industry needs and/or instructor specialization and/or students' needs and/or contemporary issues. The course acquaints the students with various Chemical Engineering topics which affect the profession or society or the scientific community at large.
Prerequisite: Successful completion of 120 credit hrs.

CHE 426: Heterogeneous Reactor Engineering *3(3,1,0)*

This course focuses on various aspects of catalysis including preparation, promoters, inhibitors, and determination of properties. It also discusses transport processes involved in catalysis and catalyst deactivation. Diffusional (internal and external) effects are also presented. Heterogeneous reactors involving solid-gas systems are designed in this course.

Textbook: H. Scott Fogler, "Elements of Chemical Reaction Engineering", Prentice-Hall, 5th ed., 2016.
Pre-requisite: CHE 320

CHE 466: Chemical Engineering Laboratory (2) ***(0,0,4)***
Experiments will focus on: Separation processes: distillation and L-L extraction: Reaction Engineering: Batch, CSTR and PFR: Control: stability tests and control
Pre-requisite: CHE 426

B- Seniors' Graduation Project Requirements

CHE 496: Graduation Project (1) ***2(2,0,0)***
This course is aimed at providing the students with the opportunity to unify all their previous course's knowledge or utilize it into one project by designing a chemical process and/or perform experimental work and presenting it a formal report. The topics of the course vary with requirements.
Pre-requisite: Successful completion of 129 cr. Hr and finishing all level 7 and below requirements

CHE 497: Graduation Project (2) ***2(2,0,0)***
This course is the second part of final year project and it is a continuation of the first project (CHE 496)
Pre-requisite: CHE 496

C- Foundation Chemistry Courses

CHEM 230: Principles of Physical Chemistry ***3(3,0,0)***
Molecular kinetic theory of gases, first law of thermodynamics, thermo chemistry, second and third laws of thermodynamics, free energies, adsorption and heterogeneous catalysis.
Pre-requisite: CHEM 101

CHEM 244: Principles of Organic Chemistry (1) ***2(2,0,0)***
Aliphatic Hydrocarbons: Structure, nomenclature, stereochemistry (confirmation of alkane, stereochemistry of cycloalkanes and alkenes (Z, E), synthesis and reactions. Aromatic Hydrocarbons: Benzene, aromaticity, nomenclature, reactions (activation and orientation), polynuclear urenes. Alkyl halides, nomenclature, synthesis and reactions, optical isomerism (SN1, SN2 reactions)
Pre-requisite: None

CHEM 245: Principles of Organic Chemistry (2) ***2(2,0,0)***
Classification, nomenclature, physical properties, synthesis and reactions of the following organic classes: Alcohols, ethers, phenols, aldehydes, ketones, carboxylic (and their derivatives) and amines.
Pre-requisite: CHEM 244

CHEM 350: Instrumental Analysis for non-major ***4(2,0,4)***
Principles and applications of spectrophotometric and Electro-analytical methods in the determinations of Organic and Inorganic samples
Pre-requisite: CHE 201

D- Elective Courses

Each student is required to select four courses (12 hrs) from the list of elective courses:

CHE 413: Desalination and Water Treatment ***3(3,1,0)***

Study of the scientific, technical as well as economical aspects of desalination of seawater and brackish water with special reference to local conditions. Recovery of minerals as by-products. Solar energy utilization

Prerequisite: Successful completion of 120 credit hours

CHE 422: Selected Topics in Chemical Engineering (1) ***3(3,1,0)***

This course involves a variety of selected topics in chemical engineering. The contents of course depend on community/industry needs and/or instructor specialization and/or students' needs and/or contemporary issues. The course acquaints the students with various Chemical Engineering topics which affect the profession or society or the scientific community at large.

Prerequisite: Successful completion of 120 credit hrs.

CHE 425: Selected Topics in Chemical Engineering (3) ***3(3,1,0)***

This course involves a variety of selected topics in chemical engineering. The contents of course depend on community/industry needs and/or instructor specialization and/or students' needs and/or contemporary issues. The course acquaints the students with various Chemical Engineering topics which affect the profession or society or the scientific community at large.

Prerequisite: Successful completion of 120 credit hrs.

CHE 427: Pollution Prevention in Chemical Industries ***3(3,1,0)***

Introduce students to the environmental laws and regulations for solid waste, water, and air pollutions, hazardous waste management, and life cycle assessment concept with case studies. The course presents available remediation techniques for pollution prevention and waste minimization.

Prerequisite: Successful completion of 120 credit hours

CHE 428: Production of Building and Cementing Materials ***3(3,1,0)***

To teach the students about building material used in various sectors of civilization as well as their production processes and properties and merits.

Prerequisite: Successful completion of 120 credit hours

CHE 429: Energy and Chemical Industries ***3(3,1,0)***

The course covers the following: - energy Analysis of Energy Utilization in The Process Industry. Types and sources of fuels. Optimization of energy consumption in chemical industries. Classifications and manufacturing of fuels. Renewable energy sources potentials and utilizations, Energy and the environmental .Case study. Field trip. Energy-related economics and environmental issues will be discussed.

Prerequisite: Successful completion of 120 credit hours

CHE 430: Corrosion Engineering ***3(3,1,0)***

The course covers: Corrosion engineering definition & importance, Classification & Nature of corrosion processes, Corrosion in selected environments, Corrosion testing and monitoring, Corrosion prevention and control.

Prerequisite: Successful completion of 120 credit hours

CHE 433: Electrochemical Engineering ***3(3,1,0)***

The course covers the fundamentals of electrochemical engineering, electrochemical cells, thermodynamics and kinetics of electrochemical systems, selected applications of electrochemical engineering.

Prerequisite: Successful completion of 120 credit hours

CHE 434: Extractive Metallurgy and Metals Recycling ***3(3,1,0)***

Perform engineering calculations, which include material & energy balances applied in extractive metallurgical processes. Familiarize the students with basic concepts and procedures that it is applied in minerals processing: calcination, pyrometallurgy, hydrometallurgy, electrometallurgy, and the basic processes for metals recycling.

Prerequisite: Successful completion of 120 credit hours

CHE 437: Waste Treatment Processes ***3(3,1,0)***

Acquire a general information about the waste management and disposal; Sources and classification of wastes; Effects of waste on the health, safety and environmental. Be aware of Local and international laws, regulations and standards related to waste treatment and management. Study different waste treatment processes.

Prerequisite: Successful completion of 120 credit hours

CHE 438: Water Chemistry & Chemical Analysis ***3(3,1,0)***

The students are exposed to the basic concepts of water properties and chemistry needed for water and desalination processes. Basic Principles, Major aquatic chemical processes, Analytical data required for desalination applications, Principles of disinfection, Oxidation – reduction reactions in water.

Prerequisite: Successful completion of 120 credit hours

CHE 440: Introduction to Biochemical Engineering ***3(3,1,0)***

Application of Chemical Engineering principles and approaches to biologically-based systems and processes. Elements of applied microbiology: Enzyme & Fermentation kinetics, Bioreactor design, scale-up and scale-down, Down-stream processing.

Prerequisite: Successful completion of 120 credit hours

CHE 441: Petroleum Refining Engineering ***3(3,1,0)***

Characterization and evaluation of crude petroleum. Application of chemical engineering to the oil industry. Refining techniques, physical separation, chemical conversion and treating processes. Design and costing of refinery equipment. Product testing and specifications. Environmental issues

Prerequisite: Successful completion of 120 credit hours

CHE 442: Petrochemical Industries ***3(3,1,0)***

The course provides the students with the techniques and economics of the production of basic and intermediate petrochemicals as well as some products with special reference to conditions prevailing in Saudi Arabia.

Prerequisite: Successful completion of 120 credit hours

CHE 443: Natural Gas Processing ***3(3,1,0)***
This course deals mainly with the study of concept of gas processing, the principal types of natural gas, and its applications both as feedstock in petrochemicals industries and as an energy sources. The course also discusses the main low temperatures process such as liquefaction cycles, and separations process related to natural gas. It also introduces recent advanced technology related to LNG, storage and transport equipment
Prerequisite: Successful completion of 120 credit hours

CHE 445: Biological Wastewater Treatment ***3(3,1,0)***
Introduce the students to the fundamentals of biochemical operations in waste water treatment, stoichiometry and kinetics of biochemical operations, applications to analysis and design of suspended growth reactors and attached growth reactors.
Prerequisite: Successful completion of 120 credit hours

CHE 446: Environmental Biotechnology ***3(3,1,0)***
Provide the students with the fundamental background knowledge in the area of Environmental Biotechnology. Students should be able to understand the role of microorganisms in processes such as biofilm formation, bio-corrosion, mineral leaching, composting, bioremediation and production of a fine chemical from a renewable resource and to understand how to manipulate environmental conditions to enhance or retard a given process.
Prerequisite: Successful completion of 120 credit hours

CHE 447: Fundamentals of Polymer Sciences and Engineering ***3(3,1,0)***
This course familiarizes the students with the polymer classifications and properties. To familiarize the students with basic concepts and procedures to perform polymer processing. Understanding the concepts of viscoelasticity, solubility and rubber elasticity. Establishing polymerization reaction mechanism, kinetics, reaction rates and polymer reactors.
Prerequisite: Successful completion of 120 credit hours

CHE 448: Fundamentals of Minerals Processing ***3(3,1,0)***
Provide the student with a basic understanding of mineral processing industry. The mining component of the course will introduce the mineral processing methods and the economic evaluation of mineral properties. The mineral processing component will introduce mineral separation processes including gravity, electrostatic and flotation separation
Prerequisite: Successful completion of 120 credit hours

CHE 449: Membrane Separations ***3(3,1,0)***
Overview of separation processes based on the application of membranes; Definition and explanation of terms related to membrane separation ; Mass transport in membranes and their modelling; Membrane materials, membrane modules, membrane flow patterns, membrane cascades; External mass-transfer resistances; Dialysis and electro-dialysis, Reverse osmosis, Gas permeation, Ultra-filtration, Microfiltration, Pervaporation.
Prerequisite: Successful completion of 120 credit hours

CHE 450: Renewable Energy ***3(3,1,0)***
To familiarize the students with concept and different sources of renewable energy, their need and benefit and application. Estimation of the energy produced from each source of Energy renewable and classical

Prerequisite: Successful completion of 120 credit hours

CHE 451: Risk Assessment and Hazard Control *3(3,1,0)*
The course covers various topics regarding risk assessment in chemical industries. Introduction to the concepts of hazard, risk, and risk assessment.Risk Assessment Methodologies. Hazard Identification and Control. Hazard and Operability Method (HAZOP). Implementing Process Hazard Analysis (PHAs) in design. Lessons Learned from Accidents
Prerequisite: Successful completion of 120 credit hours

CHE 452: Food Processing Technologies *3(3,1,0)*
Food processing, an integral part of chemical engineering, is a vital industrial sector which includes a variety of chemical engineering unit operations. Indeed, from raw materials to the final products and byproducts food systems may be subjected to many operations such as cutting, washing, fluidization, mass transfer extractive operations, thermal/cold treatment, pressing, drying, etc. Understanding the relationship ‘‘food material-technology’’ is central for a successful implementation of any food processing operation. To do so from processing engineering perspectives, knowledge of food properties and the influence of food constituents on these properties should be insured.
Textbook: P. Fellows. Food Processing Technology: Principles and Practice, 2nd Edition
Prerequisite: Successful completion of 120 credit hours

CHE 453: Composite Science & Engineering *3(3,1,0)*
Production/fabrication processes of composite materials; The Concept of Reinforcement; Definition and importance of Matrix
Textbook: Composite Materials: Science and Engineering (Materials Research and Engineering) 2012 by Krishan K. Chawla
Prerequisite: Successful completion of 120 credit hours

CHE 454: Process Energy Optimization *3(3,1,0)*
Principles of process heat integration. Fundamentals of pinch analysis. Introduction to Aspen Energy Analyzer. Energy optimization of chemical process. Preliminary Heat exchanger network. Optimum heat exchanger network.
Prerequisite: Successful completion of 120 credit hours

CHE 467: Process Integration *3(3,1,0)*
The course presents systematic and state-of-the-art techniques for understanding the global insights of mass and energy flows within a chemical process (plant) and how these integrated insights can be used to optimize process performance. A variety of mathematical and visualization tools are presented. The course investigates the recent advances in chemical process integration and synthesis. In particular, emphasis is given to fundamental integration and synthesis methodologies along with their applications to the process industries.
Prerequisite: Successful completion of 120 credit hours

CHE 998: Research Project *1 (NP)*
The course is designed to serve the research needs of the students. The course is not required for graduation; so students may opt to register it or otherwise. The consent of the faculty member with whom the student might work is essential.
Prerequisite: Successful completion of 129 credit hours.

CHE 999: Practical Training *0 (NP)*

Students in the department are required to complete a 10 weeks summer training requirement in an area related to Chemical Engineering. Prior to undertaking the summer training program, the student must obtain the approval of the department and he must have completed, successfully, at least 110 credit hours including the CFY (or 78 credit hours excluding the CFY). Students enrolling in the summer training program are not allowed to take simultaneously any course or projects.

Prerequisite: Successful completion of 110 credit hours

7.2. Master of Science Program Chemical Engineering

The department has been offering the degree of Master of Science in (M.S.) Chemical Engineering since 1401/1402 H (1981/1982 G). To cope with the global changes in the chemical engineering education and more importantly satisfy the local job demand, the department has enhanced its classical Master's program to include thesis and non-thesis options as well as added a specialized program as discussed in the following sections.

7.2.1. Program Objectives

- Prepare graduate students in various fields to satisfy the requirement for economic growth in the industrial sector
- Strengthen ties between the department and the industrial sector for the development of process industries

7.2.2. Program Tracks

- Chemical and Petrochemical Industries
- Materials Engineering
- Desalination and Water Treatment
- Process Synthesis and Control
- Bioprocess Engineering

7.2.3. Program Study Plan (Thesis Option)

A. Successful completion of 24 credit hours of graduate courses distributed as follows:

- Fifteen (15) credit hours from the compulsory courses
- Nine (9) credit hours from the elective courses

B. Completion and successful defense of a thesis

7.2.4. Program Structure (Thesis Option)

Number and Type of Courses	Credit Hours
5 Compulsory Courses	15
3 Elective Courses	9
CHE 600 Thesis	…
Total	24

7.2.5. Program Study Plan (Course Option)

A. Successful completion of 42 credit hours of graduate courses distributed as follows:

- Twenty one (21) credit hours from the compulsory courses
- Fifteen (15) credit hours from the elective courses

B. Successful completion of a research project which comprises two parts, each having three credit hours. Each part is graded pass or fail.

7.2.6. Structure (Course Option)

Number and Type of Courses	Credit Hours
7 Compulsory Courses	21
5 Elective Courses	15
CHE 598 Project 1	3
CHE 599 Project 2	3
Total	42

7.2.7. Course Description

7.2.7.1. Compulsory Courses

GE 501	Simulation of Engineering Systems on Computer
CHE 543	Advanced Chemical Engineering Thermodynamics
CHE 544	Advanced Reaction Engineering
CHE 545	Advanced Transport Phenomena 1
CHE 547	Advanced Separation Processes (for course option)
CHE 577	Computer-aided Process Design (or course option)
MATH 506	Ordinary and Partial Differential Equations

7.2.7.2. Elective Courses

CHE 525	Materials Engineering
CHE 526	Corrosion and its Control
CHE 527	Corrosion in Oil and Gas Industries
CHE 535	Membrane Technology
CHE 536	Nanotechnology and Nanomaterials
CHE 537	Oxidation at High Temperature
CHE 538	Electrochemical Engineering
CHE 539	Selected topics in Materials Engineering
CHE 540	Thermal Separation Processes
CHE 546	Advanced Transport Phenomena 2
CHE 547	Advanced Separation Processes (for thesis option)
CHE 548	Multiphase Flow

CHE 549	Combustion Engineering and Furnaces
CHE 550	Catalysis in Chemical Reactors
CHE 552	Petrochemical Processes
CHE 553	Advanced Petroleum Refining Engineering
CHE 554	Polymer Science and Engineering
CHE 555	Oil and Natural Gas Economics
CHE 556	Chemical Engineering Application in Waste Treatment
CHE 557	Air Pollution Engineering
CHE 558	Chemical Plant Management
CHE 559	Process Safety and Occupational Health
CHE 560	Selected Topics in Chemical and Petrochemical Industries
CHE 572	Membrane Separation Processes
CHE 573	Water Treatment Engineering
CHE 574	Water Quality
CHE 575	Selected Topics in Desalination and Water Treatment
CHE 577	Computer-Aided Process Design (for thesis option)
CHE 578	Process Identification
CHE 579	Process Synthesis
CHE 580	Process Integration
CHE 581	Process Optimization
CHE 582	Computational Fluid Dynamics
CHE 583	Nonlinear Analysis of Dynamic Processes
CHE 584	Advanced Control for Industrial Processes
CHE 585	Modern Control Theory
CHE 586	Assessment of Benefits of Advanced Control Systems
CHE 587	Data Acquisition and Digital Control in Laboratory Experiments
CHE 588	Selected Topics in Process Synthesis and Control
CHE 590	Biochemical Engineering
CHE 591	Bioseparation Engineering
CHE 592	Enzyme Engineering
CHE 593	Bioremediation
CHE 594	Bioreaction Engineering
CHE 595	Selected Topics in Bioprocess Engineering
CHE 597	Advanced Topics in Chemical Engineering
Project 1	CHE 598 (for course option)
Project 2	CHE 599 (for course option)
CHE 600	Thesis
ME 556	Alloy theory

7.2.8. Master of Science Program Polymer Engineering

7.2.8.1. Program Objectives

The objectives of the program can be summarized as follows:

- Prepare Saudi engineers to advance and meet the work requirements of the polymer industrial sector
- Encourage the scientific research in polymer engineering and its applications
- Build cooperation with the polymer industry to improve manufacturing practice

7.2.8.2. Degree Requirements

A. Successful completion of 24 credit hours of graduate courses distributed as follows:

- Fifteen (15) credit hours from core courses
- Nine (9) credit hours from elective courses

B. Completion and successful defense of a Master's thesis. The student is allowed to register the thesis after completion of 12 credit hours.

7.2.8.3. Program Structure

Number and Type of Courses	Credit Hours
5 Core Courses	15
3 Elective Courses	9
Thesis	-
Total	24

7.2.8.4. Courses Description

7.2.8.4.1. Core Courses

Course Code	Course Title
CHE 515	Advanced Transport Phenomena 1
CHE 561	Fundamentals of Polymer Engineering
CHE 562	Polymer Reaction Engineering
CHE 563	Polymer Properties and Rheology
CHE 564	Polymer Processing

7.2.8.4.2. Elective Courses

Course Code	Course Title
CHE 544	Advanced Reaction Engineering
CHE 565	Polymer Characterization and Synthesis Laboratory
CHE 566	Polymer Degradation
CHE 567	Micromechanics
CHE 568	Polymer Surfaces and Adsorption
CHE 569	Advanced Topics in Polymer Engineering
CHE 570	Modeling and Simulation in Polymer Synthesis and Processing
CHE 571	Non-Newtonian Flow and Heat Transfer in Polymers
MATH 506	Ordinary and Partial Differential Equations
CHEM 581	Polymer Solutions

7.2.8.5. Master Course Description

CHE 511: Advanced Transport Phenomena 1 **3(3+0)**

Transport in laminar flow, turbulent flow, between two phases, and large flow systems. Transport by radiation.

CHE 525: Materials Engineering **3(3+1)**

Structure and properties of materials. Structure and properties of alloys:various phase diagrams for ferrous and non-ferrous alloys. Use of X-ray and SEM in materials engineering. Fabrication process of materials. Joining process of materials. Deformation and fracture of materials.

CHE 526: Corrosion and Its Control **3(2+2)**

Electrochemical nature of corrosion. Corrosion cells, thermodynamics of corrosion reaction, and potential/pH diagram. Types of corrosion. Types of environments: atmosphere, underground, boilers, and water. Metallurgical aspects of corrosion: structure of metals and alloys in relation to corrosion Stress corrosion cracking. Effect of heat treatment. Effect of hydrogen on ferrous and non-ferrous metals. Corrosion control: design in relation to corrosion. Design in chemical engineering: inhibitors, metallic coatings, inorganic coatings, organic coatings, and cathodic and anodic protection. Corrosion testing.

CHE 527: Corrosion in Oil and Gas Industries **3(3+0)**

Thermodynamics and kinetics of corrosion. Metallurgical aspects. Suitable materials, Corrosion monitoring, Pipeline corrosion, Stress corrosion, Cracking and failure analysis. Microbiological corrosion. Corrosion protection and control.

CHE 535: Membrane Technology **3(3+0)**

Membrane structure and function. Manufacture of membranes. Characterization. Selection and use of membrane systems. Applications of membrane separation in various chemical, petrochemical, biochemical, and water treatment processes.

CHE 536: NanoTechnology and NanoMaterials **3(3+1)**

Introduction to concepts of nanotechnology in view of the construction and utilization of functional structures designed from atomic or molecular scale. Introduction to quantum mechanics. Phenomena at nanoscale. Introduction to nanomaterials. Overview of general synthesis, processing strategies, and requirements: CVD, MOCVD, soft lithography, dip-pen lithography, and self-assembly. Overview of some nanomaterials: nanocatalysis, electronic materials, electrocatalysis and fuel cells, carbon nanotubes, and other applications in polymers and biotechnology fields. Characterization of nanomaterials.

CHE 537: Oxidation at High Temperatures 3(3+0)

Oxidation of metals: description of oxidation process and experimental rate laws. Parabolic oxidation. Material transport through scales. Defect structure of oxides. Ionic conduction and semi-conduction. Formation of layered scales. Oxidation of alloys: The Wagner-Hanffee theory. Selective oxidation and diffusion in the underlying alloys. Internal oxidation. Spinel formation. Formation of composite scales. Stress generation and relief in growing oxide scales.

CHE 538: Electrochemical Engineering 3(3+1)

Thermodynamics of electrochemical systems. Electrochemical kinetics of electrode processes. Mass transfer aspects of electrochemical systems. Applications include corrosion, fuel cells, electro deposition, electrolytic hydrogen production, and electrochemical wastewater treatment.

CHE 539: Selected Topics in Materials Engineering 3(3+0)

Advanced topics in selected areas of materials engineering are covered.

CHE 540: Thermal Separation Processes 3(3+0)

Overview of thermal separation processes, especially those used in desalination. Theoretical principles of the process. Principles of desalination system operation, system design, and evaluation of the economics of the process. Physical, physicochemical, and chemical engineering fundamentals of thermal separation processes. Phase equilibrium: vapor–liquid, liquid–liquid, liquid–solid, and gas–solid. Principles and general procedure to design thermal separation process equipment. Mathematical description of heat and mass transfer processes. Thermal separation process modes. Process efficiency. Common interface of thermal desalination with associated power plants in various configurations.

CHE 543: Advanced Chemical Engineering Thermodynamics 3(3+0)

Thermodynamic analysis of processes. Availability concept. Engineering equations of state for PVT properties. Generalized property relations for homogenous phases. Departure functions. Equilibrium and stability in one component systems. Thermodynamic of multicomponent systems. Phase equilibria in mixture by equations of state. Activity models. Vapor–liquid equilibrium. Liquid–liquid equilibrium. Vapor–liquid–liquid equilibrium. Solid–liquid equilibrium. Solid–vapor equilibrium. Equilibrium adsorption of gases and solids. Osmotic equilibrium. Chemical reaction equilibria. Association and solvation

CHE 544: Advanced Reaction Engineering 3(3+0)
External and internal resistances (non-isothermal pellets). Fixed bed reactors (isothermal and non-isothermal). Fluidized bed reactors (isothermal and nonisothermal). Other types of multiphase reactors. Polymerization reactors and multiplicity of steady states.

CHE 545: Advanced Transport Phenomena 1 3(3+0)
Transport in laminar flow, turbulent flow, two phases, and large flow systems. Transport by radiation.

CHE 546: Advanced Transport Phenomena 2 3(3+0)
Advanced topics in momentum, mass, and heat transfer.

CHE 547: Advanced Separation Processes 3(3+0)
Theory and computational approach in the design of multi-component separation processes. Energy requirement. Capacity and efficiency of contacting devices: single stage and cascaded absorption. Adsorption. Extraction. Distillation. Filtration. Ion exchange. Crystallization processes. Low-temperature distillation and partial condensation.

CHE 548: Multiphase Flow 3(3+0)
Analysis of two-phase flows of gases, liquids, and solids. Single-particle and multi-particle systems. Fluidized beds. Bubble beds. Drop beds. Slug flow. Annular flow.

CHE 549: Combustion Engineering and Furnaces 3(3+0)
Introduction to combustion. Natural gas and liquid petroleum fuels. Energy balance equations. Turbulence characteristics. Chemical and thermal equilibrium. Flame temperatures. Models of combustion processes including reacting flow systems. Energy and efficiency calculations. Radiation. Furnace and combustion chamber design. Combustion processes pertinent to Saudi Arabia: desalination, power generation, building material industries.

CHE 550: Catalysis in Chemical Reactors 3(3+0)
Characterization and selection. Catalyst definition and properties. Catalyst characterization techniques and equipment. Analysis of heterogeneous reactions. Supported catalysts. Diffusion in porous catalysts. Catalyst deactivation. Advanced topics on external and internal resistance.

CHE 552: Petrochemical Processes 3(3+1)
Overview of the petrochemical processes and their importance. Feedstocks from oil and natural gas for petrochemical processes. Examples of key petrochemical processes such as steam reforming plants, olefin plants, aromatic plants, ammonia, urea, fertilizer, methanol, and polymerization plants, etc. Application of software packages.

CHE 553: Advanced Petroleum Refining Engineering 3(3+1)

Chemical conversion processes. Mechanism of thermal and catalytic conversion processes. Important industrial conversion processes. Polymerization and alkylation. Production and purification of petroleum products. Design of fractional distillation of complex mixtures. Design of pipe-still heaters. Design of important reactors used in petroleum refiners. Synthesis and analysis of refineries. Application of software packages.

CHE 554: Polymer Science and Engineering **3(3+0)**

Structure of polymer and their properties. Kinetics and mechanisms of polymer formation. Polymers reology. Manufacturing and processing techniques.

CHE 555: Oil and Natural Gas Economics **3(2+2)**

Oil and gas industry from an economic perspective. International industry structure. Oil and gas industry in KSA. The economics of investment. Discounted cash-flow analysis. Cost–benefit analysis. Internal rate of return. Oil and gas markets. Supply and demand determining prices and output. Hotelling: Principle. The operation of cartels. Dealing with risks in oil and gas markets. Open access to natural gas pipelines. Natural monopoly theory. National competition policy. Gas market regulation. Taxation of the oil and gas industry. Concept of economic rent. Impact and multiplier analysis. Balance of payments and exchange rate effects. Application of software packages. Government policy and the oil and gas industry. The greenhouse gas issue.

CHE 556: Chemical Engineering Application in Waste Treatment **3(3+0)**

Control of gaseous pollutants: conversion methods, thermal and catalytic processes. Absorption, adsorption condensation, control of SO2 emission, and control of NOx emission. Wastewater treatment: Objectives and regulations, classification and application of wastewater treatment methods, physical and chemical treatment processes, neutralization, coagulation and flocculation, sedimentation, ion exchange, and electrodialysis. Solid waste: Definitions, characterization, engineered systems for solid waste handling and disposal, ultimate disposal, hazardous waste treatment technologies.

CHE 557: Air pollution Engineering **3(3+0)**

Identification of air pollutants both gaseous and particulate. Physical and chemical mechanisms for their formation. Design of existing technologies used to control emissions. Effect of meteorology on air quality.

CHE 558: Chemical Plant Management **3(3+1)**

System approach to the firm: as a technological system, as a resource flow system, and as information-processing and decision-making system. Principles of decision making and problem solving in an industrial environment. Brief description of linear programming applications. Application of software packages. Administrative structures and problems of the firm. Organization theories and achievement of objectives. Efficient use of resources and energy. The firm and technical change, Research and developement.

CHE 559: Process Safety and Occupational Health **3(3+0)**

Understanding, mitigating, and eliminating risks associated with handling hazardous materials. Applications to various chemical and petrochemical industries. Wastewater emissions, air emissions, and other wastes. Transportation of hazardous materials. Spill prevention. Environmental regulation. Methods to determine exposure, radiation, and environmental risk assessments. Methods to control processes with flammable materials or potential runaway reactions. Safety standards and code requirements. Emergency response plans. Hazard detection, reporting, and abating. Occupational health. Supervisor/management roles and responsibilities. Compensation costs/lost time injuries.

CHE 560: Selected Topics in Chemical and Petrochemical Industries 3(3+0)
Advanced topics in selected areas of chemical and petrochemical processes.

CHE 561: Fundamentals of Polymer Engineering 3(3+0)
Physical and mathematical principles required to understand and solve engineering problems encountered with polymeric materials. Fundamentals of polymerization and polymer synthesis. Details of polymerization mechanisms, structure–property relationships, fundamentals of processing, and characterization of high polymers. Overview of different polymer processing techniques commonly used in KSA.

CHE 562: Polymer Reaction Engineering 3(3+0)
Engineering principles applied to the analysis and design of polymerization processes. Mathematical modeling of polymerization kinetics, ideal polymerization reactors, heat and mass transfer, reactor dynamics and optimization, and mixing effects. Case studies of important industrial processes.

CHE 563: Polymer Properties and Rheology 3(3+0)
Overview of polymer chemical composition, microstructure, thermal and mechanical properties, rheology, and principles of polymer material selection. Description of the physical, thermal, mechanical, and rheological properties of polymeric materials relevant to their processing behavior. Techniques for predicting the engineering and physical properties of polymers from their molecular structures. Definition and measurement of the material functions of complex fluids, continuum mechanics of stress and deformation, and constitutive equations derived from both continuum and molecular theories.

CHE 564: Polymer Processing 3(3+0)
Review of the basic transport phenomena equations: mass, momentum, and energy. Analysis of various processing operations for the manufacture of polymeric articles, with particular emphasis on extrusion, injection molding, blow molding, thermoforming, compression molding, and stretch blow. Discussion on plastic recycling issues. Effects of additives on polymer processing.

CHE 565: Polymer Characterization and Synthesis Laboratory 3(1+2)

Characterization of polymers, including spectroscopic (Raman, infrared), mechanical (tensile, dynamic, mechanical, rheological), microscopic (electron microscopy), physiochemical (intrinsic viscosity, differential scanning, calorimetry, gel permeation chromatography), and scattering (light, x-rays). Preparation of the most important types of polymers. Radical, cationic,and anionic polymerization, copolymerization, Ziegler–Natta polymerization, step growth polymerization, suspension and emulsion polymerization, group transfer polymerization, and metathesis polymerization. Additional polymer characterization and synthesis methods.

CHE 566: Polymer Degradation **3(3+0)**

Thermal, chemical, and photo stability of polymers, swelling, and dissolution. Chain scission and bond rupture by oxygen, ozone, and other oxidizing substances. Thermal degradation at elevated temperature. Radiation damage caused by electron beams, x-rays, UV, and others. Weathering of polymers upon exposure to outdoor conditions. Polymer degradation prevention and control.

CHE 567: Micromechanics **3(3+0)**

Effects of microstructure on the mechanics of polymeric media: deformation modes, yield, rubber toughening, alloys and blends, and fatigue and fracture of highly filled systems. Effect of fillers and strengthening additives on the micromechanics of polymers.

CHE 568: Polymer Surfaces and Adsorption **3(3+0)**

Discussion on theoretical and experimental methods providing insights into the polymer interfacial phenomena. Theoretical: surface dynamics, Gibbs isotherm, and gradient squares. Experimental: infrared rays, spectroscopic methods, contact angles, etc.

CHE 569: Advanced Topics in Polymer Engineering **3(3+0)**

Advanced subjects in polymer engineering related to current needs.

CHE 570: Modeling and Simulation in Polymer Synthesis and Processing **3(3+0)**

Modeling techniques used in commercial software in the polymer synthesis and processing industry. Developing simulation tools for specialized polymer Different numerical methods to simulate flow, heat transfer, and structural development in polymer synthesis and processing operations.

CHE 571: Non-Newtonian Flow and Heat Transfer in Polymers **3(3+0)**

Introduction to non-Newtonian behavior in polymers, laminar flow for polymers, laminar and turbulent heat transfer in polymers, mixing and heat transfer, heat transfer in polymer processing, and viscoelastic fluids.

CHE 572: Membrane Separation Processes **3(3+1)**

Theories of membrane separation processes with special emphasis on the processes used in desalination and water treatment. Qualitative and quantitative description of membrane

separation processes including reverse osmosis, nanofiltration, ultrafiltration, and membrane distillation. Synthetic membranes: types, mechanisms of separation, and applications. Membrane selectivity to solutes. Solubility of permeates in polymeric membranes. Transport phenomena in membrane systems. Modeling and design of membrane modules and membrane separation processes. Membrane fouling: types, mechanisms, prevention/reduction methods, and treatment.

CHE 573: Water Treatment Engineering 3(3+0)

Classification and significance of impurities in water: suspended and dissolved solids, organic and inorganic, trace contaminants, and pathogens. Methods for removing suspended solids: screening and grit removal, sedimentation, and filtration. Modern screening designs: bar racks, fine screens, rotating drums, and moving belts. Chemical dosing: precipitation for water softening and other applications; coagulation and flocculation processes, including basic concepts from colloid science; and disinfection. Physical processes: adsorption and ion exchange, primary sedimentation. Filtration, flotation, sludge-dewatering systems. Chemical processes: oxidation of trace organics by ozone, hydrogen peroxide, and other oxidants, photochemical methods, disinfection, ion exchange, and softening. Use of polyelectrolytes for flocculation and sludge conditioning.

CHE 574: Water Quality 3(3+1)

Water sources and use. Characteristics of water: water analysis, physical parameters, chemical and bacteriological parameters. Modeling of common water quality parameters such as dissolved oxygen, temperature, suspended solids, algae, nutrients, coliforms, and toxins. Techniques for assessing the physical, chemical, and biological characteristics of waters. Emphasis on understanding the effects of water quality on the treatment processes.

CHE 575: Selected Topics in Desalination and Water Treatment 3(3+0)

Advanced topics in selected areas of desalination and water treatment processes.

CHE 577: Computer-Aided Process Design 3(2+2)

Techniques of computer-aided process modeling and design using commercial simulators. Principles of flow-sheet simulation. Steady-state simulation. Simulation of a new grassroot chemical plant. Simulation of an existing chemical plant. Revamping and retrofit simulation. Parametric studies. Dynamic simulation. Applications to chemical, petrochemical, biochemical, waste treatment, and other processes of current interest.

CHE 578: Process Identification 3(3+0)

Development and formulation of process models. Linear regression models (e.g., ARX, ARMAX, Output–Error, Box–Jenkins). Incorporation of process knowledge. System identification. (Problem definition. Experimental design. Model set parameterization. Criterion identification. Least-square and maximum likelihood methods. Recursive computations). Model validation. Closed loop identification. Real plant considerations.) Applications to chemical, biochemical, waste treatment, and other processes of current interest.

CHE 579: Process Synthesis **3(2+2)**

Heuristics for process synthesis. Development and evaluation of process flowsheet. Establishing design criteria. Synthesis for separation trains. Heat and power integration. Equipment selection and design. Process sensitivity analysis. Process economic analysis and evaluation. Applications to chemical, petrochemical, biological, water treatment, and other processes of current interest. Application of software packages.

CHE 580: Process Integration **3(2+2)**

Fundamentals of pinch analysis. Energy targets, composite curves, and problem table algorithm. Grand composite curves. Multiple-utility targeting. Trade-off between energy and capital costs. Heat exchanger area targets. Grid diagram. Flow-sheet data extraction. Pinch design method. Heat exchanger network design for maximum energy recovery. Energy relaxation. Optimum heat exchanger network design. Threshold problems. Mixing and splitting junctions. Retrofit applications in chemical and petrochemical plants. Application of software packages.

CHE 581: Process Optimization **3(2+2)**

Nature and organization of optimization problems. Developing models for optimization. Formulation of the objective function. Optimization theory and methods. Optimization for unconstrained functions. Linear programming. Nonlinear optimization with constraints. Mixed-integer programming. Dynamic programming. Applications to chemical, petrochemical, biochemical, waste treatment, and other processes of current interest. Application of software packages.

CHE 582: Computational Fluid Dynamics **3(2+2)**

Introduction to CFD. Governing equations and assumptions. Turbulence modeling. Numerical methods: finite differences, finite volumes, explicit algorithms, implicit algorithms, numerical boundary conditions, methods of line, etc. CFD packages. Applications: turbulent flow and reactions, mass transfer and reaction in catalyst particles, mixing in a stirred tank reactor, multiphase flow, etc.

CHE 583: Nonlinear Analysis of Dynamical Processes **3(3+1)**

Bifurcation and stability theory of solutions to nonlinear algebraic equations. Numerical methods for the analysis of static and dynamic behavior of initial value ordinary differential equations. Applications to chemical, petrochemical, biochemical, waste treatment, and other processes of current interest. Application of software packages.

CHE 584: Advanced Control for Industrial Processess **3(3+0)**

Robust process control. Model predictive control: single and multi-variable. Applications to chemical, petrochemical, biochemical, waste treatment, and other processes of current interest.

CHE 585: Modern Control Theory **3(3+0)**

State space representation. Laplace transformation of multivariable systems. Controllability. Observability. Stability. Interaction measures. Linear feedback control. State estimation. Optimal control.

CHE 586: Assessment of Benefits of Advanced Control Systems **3(3+0)**

Conducting a process control technology audit. Estimating control function benefits. Developing a strategic automation plan. Quantifying quality control's intangible benefits. Improving return on advanced controls. Avoiding advanced control project mistakes. Online optimization. Performance monitoring techniques. On-line data reconciliation.

CHE 587: Data Acquisition and Digital Control in Laboratory Experiments **3(2+2)**

Principles of data acquisition. Computer interface (digital-to-analog conversion and analog-to-digital conversion). Computer operator interface. Data collection, trending, and processing. Plant experimentation and testing procedures. Data analysis and model development. Inferential control. Introduction to DCS systems.

CHE 588: Selected Topics in Process Synthesis and Control **3(3+0)**

Advanced topics in selected areas of process synthesis and control.

CHE 590: Biochemical Engineering **3(3+0)**

Biochemical fundamentals. Basic microbiology and biochemistry. Biochemical reaction mechanisms, kinetics, and rate processes. Enzyme and microbial kinetics. Various fermentors for enzyme and pure cultures. Sterilization. Recovery and purification processes. Bioprocess economics.

CHE 591: Bioseparation Engineering **3(3+0)**

Separation technology in biological processes. Cell separation process. Recovery of intracellular and extracellular products. Technology in liquid– solid, liquid mixture, and gas mixture separation. Membrane technology in bioseparation.

CHE 592: Enzyme Engineering **3(3+0)**

Chemistry and structure of enzymes. Enzyme kinetics and mechanisms of enzyme action. Enzyme regulation and production. Extraction and purification of enzyme. Technique of immobilization. Characteristics of immobilized enzymes and enzyme reactors. Application of enzymes in industries.

CHE 593: Bioremediation **3(3+0)**

Fundamentals of bioremediation. Advantages and disadvantages of bioremediation compared with non-biological processes. Factors affecting choice of in situ or ex situ processes. Assessment of biodegradability. Factors affecting microbial activity. Examples of biodegradation of specific contaminants (e.g., fuels, aromatic and polyaromatic hydrocarbons, etc.).

CHE 594: Bioreaction Engineering **3(3+0)**
Analysis of microbial kinetics for bioreactor design. Design and analysis of batch, continuous, and multiphase bioreactors. Effect of the rheology of fermentation broths on mass transfer, mixing, power requirement, etc. Scaleup.

CHE 595: Selected Topics in Bioprocess Engineering **3(3+0)**
Advanced topics in selected areas of bioprocess engineering.

CHE 597: Advanced Topics in Chemical Engineering **3(3+0)**
Topics of current interest in the field of chemical engineering.

CHE 598: Project 1 **3(3+0)**

CHE 599: Project 2 **3(3+0)**

CHE 600: Thesis **3(3+0)**

GE 501: Simulation of Engineering Systems on Computer **3(3+0)**
Introduction to process modeling. Lumped and distributed parameter systems. Equation of change. Numerical simulation of chemical processes described by differential equations: initial, boundary, and partial differential equations.

MATH 506: Ordinary and Partial Differential Equations **3(3+0)**
Initial and boundary value problems in ordinary differential equations. Numerical solutions. Elliptic, hyperbolic, and parabolic partial differential equations. Initial and boundary value problems for second-order partial differential equations. Numerical solutions.

ME 556: Alloy Theory **3(3+0)**
Solidification processes. Nucleation and growth phenomena in alloys. Plane front solidification of single- and poly-phased alloys. Solid-state transformation characteristics of alloys. Processing and properties of alloy systems.

CHEM 581 Polymer Solutions **3(2+1)**
Study of polymer solutions and their thermodynamic properties (e.g., vapor pressure, osmotic pressure, swelling pressure, thermodynamic criterion of solubility, entropy of mixing, and internal energy. Thermodynamics of highly elastic and glassy polymer solutions. Thermodynamics of copolymer solution with emphasis on various applications. Practical measurements of particular thermodynamic properties of polymer solutions

7.3. Ph.D. Program

The Ph.D. program in Chemical Engineering was approved in 1417 H (1997 G). The program aims to meet the needs of the Kingdom for qualified individuals with a highly specialized degree. Graduates are expected to lead in research and development. The program also aims to strengthen the links between the university and the industry through Ph.D. research in specific industrial problems. It also aims to develop and conduct fundamental chemical engineering research. The Ph.D. program has four main specialization (options):

1. Transport Phenomena
2. Process Control
3. Chemical Industries
4. Material Engineering

7.3.1. Program Objectives And Outcomes

The graduates are expected to lead in research and development. The program aims also at strengthening the links between the university and the industry through Ph.D. research in specific industrial problems.

7.3.2. Program Study Plan

7.3.2.1. Course requirements

The study for the Ph.D. degree in Chemical Engineering requires the student to complete 18 credit units from the graduate courses listed in Table (3), together with successful completion of the comprehensive examination. The student is also required to conduct an original and novel scientific research and write a thesis on one Chemical Engineering topic. The student is required to take six compulsory units (CHE 602 and CHE 618) and 12 units chosen from one of the four departmental specializations (options).

7.3.2.2. Compulsory Ph.D. Courses

CHE 602	Advanced Reaction Engineering (2)
CHE 618	Unsteady State Transport Phenomena

7.3.2.3. Material Engineering Option

CHE 604	Advanced Numerical Techniques
CHE 605	Properties of Gases and Liquids
CHE 607	Advanced Electrochemical Engineering
CHE 611	Advanced Separation Processes
CHE 631	Advanced Extractive Metallurgy
CHE 632	Advanced Physical Metallurgy (1)
CHE 633	Composite Materials
CHE 634	Advanced Physical Metallurgy (2)

CHE 635	Hot Corrosion Engineering
CHE 636	Corrosion Control
CHE 643	Advances in Polymerization
CHE 654	Selected Topics in Chemical Engineering
CHEM 621	Structure Analysis
CHEM 631	Advanced Physical Chemistry

7.3.2.4. Control and System Engineering Option

CHE 603	Complex Dynamics and Chaos
CHE 604	Advanced Computational Techniques
CHE 621	Computer-Aided Design for Chemical Industries
CHE 622	Simulation of Chemical Processes
CHE 623	Computer-Aided Control of Chemical Plants
CHE 624	Digital Control of Experiments
CHE 625	Artificial Intelligence in Chemical Industries
CHE 626	Chemical Processes
CHE 627	Advanced Control of Processes
CHE 654	Selected Topics in Chemical Engineering
EE 656	Nonlinear Control Systems
EE 657	Stochastic Control Systems

7.3.2.5. Transport Phenomena Option

CHE 601	Statistical Thermodynamics
CHE 604	Advanced Computational Techniques
CHE 605	Properties of Gases and Liquids
CHE 608	Chemical Engineering Experimentation
CHE 611	Advanced Separation Processes
CHE 612	Multiphase Flow
CHE 614	Advanced Heat Transfer (2)
CHE 615	Combustion Engineering
CHE 617	Advanced Topics in Diffusion
CHE 654	Selected Topics in Chemical Engineering

7.3.2.6. Chemical Industries Option

CHE 604	Advanced Computational Techniques
CHE 605	Properties of Gases and Liquids
CHE 606	Topics in Biomedical Engineering
CHE 607	Advanced Electrochemical Engineering
CHE 611	Advanced Separation Processes
CHE 613	Biochemical Engineering

CHE 616	Chemical Engineering Applications in Electronics
CHE 626	Chemical Processes
CHE 636	Corrosion Control
CHE 641	Advanced Petroleum Refining (2)
CHE 642	Design of Chemical Industrial Systems
CHE 643	Advances in Polymerization
CHE 654	Selected Topics in Chemical Engineering
CHEM 621	Structure Analysis
CHEM 631	Advanced Physical Chemistry

7.3.2.7. Ph.D. Course Descriptions

CHE 601: Statistical Thermodynamics

Modern techniques for the investigation of fluid properties from statistical mechanics point of view. Studies on liquid state, hard spheres, soft spheres, Lennard–Jones fluids, perturbation theory, adsorption on solid surfaces, electrolyte solution, molten salts, and transport properties. Computer applications on the above topics.

CHE 602: Advanced Chemical Reaction Engineering II

Physical phenomena in reaction engineering. Dynamic behavior of catalyst pellets. Dynamic behavior of chemical multiphase reactors. Bio-kinetics and bioreactors. Non-ideal flow reactors. Advanced polymerization reactors.

CHE 603: Complex dynamics and chaos in chemical and biochemical systems.

Introduction to the bifurcation theory, sources of instabilities in chemical and biochemical systems. Identification of stable and unstable regions. Practical implications of bifurcation and instabilities. Introduction to chaos, strange attractors, and fractal structures.

CHE 604: Advanced Computational Techniques in Chemical Engineering

Stability theory for first-order ordinary differential equations. Continuity techniques for bifurcation analysis. Series solutions and special functions. Nonlinear boundary value problems. Formulation of parabolic, elliptic, and hyperbolic partial differential equations (PDE). Solutions for PDE by using finite difference and collocation techniques. Applications to chemical and biochemical systems.

CHE 605: Properties of Gases and Liquids

Introduction to physical property estimation, experimental data validation, consistency tests, pure component constants, various estimation procedures for the properties of pure compounds and mixtures of gases and liquids, PVT, and other thermodynamic properties, mixing rules, and their effects on mixture properties, group contribution methods in property estimation, and linear and nonlinear regression in property estimation. Computer applications on the above topics.

CHE 606: Topics in Biomedical Engineering

Review of the human anatomy and physiology. Application of the principles of heat, mass, and momentum transfer laws to human systems, artificial organs, and life support systems. Modeling and simulation of the respiratory, circulatory, gastroenterology, and nephrology systems.

CHE 607: Advanced Electrochemical Engineering

Review of the main concepts in electrochemical engineering. Thermodynamics of electrochemical systems and kinetics of electrode processes. Electrolytic mass transfer, current, and potential distribution functions. Applications of electrochemical engineering in corrosion. Batteries, fuel cells, and electrolytic hydrogen production. Electro-catalysis and electro-synthesis. Applications of electrochemical engineering in environment control and water treatment.

CHE 608: Chemical Engineering Experimentation

Main statistical characteristics of random variables. Parameters of the distribution function. Analysis of variance. Correlation and regression analysis. Experimental factorial design. Empirical modeling.

CHE 611: Advanced Separation Processes

Relatively new separation technologies, gas and liquid chromatography, electrophoresis, membrane processes, and pressure swing adsorption.

CHE 612: Multiphase Flow with Phase Change

Fluid dynamics of multiphase flow. Thermodynamic characteristics of multiphase systems, interphase heat transfer, and instability of two-phase flow.

CHE 613: Biochemical Engineering

Advances in processes involving biochemical reactions. Enzyme deactivation and immobilization. Cell culture technology. Biosensors. Downstream processes of bio-products. Modeling and simulation of bioprocesses. Applications of biochemical engineering in waste treatment.

CHE 614: Advanced Heat Transfer II

Design of heat exchangers. Heat pumps. Heat pipes. Optimization techniques in heat equipment selection and design. Problems encountered in the operation of heat transfer equipment (fouling, corrosion, etc.).

CHE 615: Combustion Engineering

Introduction to combustion. Emphasis on natural gas and liquid petroleum fuels. Energy balance equations, species, and turbulence characteristics. Chemical and thermal equilibrium. Flame temperatures. Chemical kinetics. Combustion physics. Reactors. Ignition phenomena:

auto-ignition and forced ignition, flame speed, stability, hydrocarbon flammability limits, and detonation phenomena. Models of combustion processes including reacting flow systems. Energy and efficiency calculations, radiation, furnace and combustion chamber design. Combustion processes pertinent to KSA: desalination, fuels, power generation, building material industries. Safety and environmental issues.

CHE 616: Chemical Engineering Applications in Electronic Industry

Introduction to microelectronic processing, chlorosilanes from metallurgicalgrade silicon, bulk crystal growth from melts, chemical vapor deposition (CVD), low-pressure chemical vapor deposition (LCVD), thermal laserassisted CVD, photochemical CVD, CVD in optical fiber fabrication, glow discharge (plasma) characteristics, plasma reactors, liquid-phase epitaxy (LPE), physical vapor deposition (PVD), and catalytic and non-catalytic etching. Oxidation of silicon.

CHE 617: Advanced Topics in Diffusion

Diffusion for multi-component systems in solids and membrane. Steady-state diffusion with homogeneous and/or heterogeneous chemical reaction. Dispersion in different flow regions. Measurements of diffusion coefficients. Unsteady-state diffusion without and with chemical reactions.

CHE 618: Unsteady-State Transport Processes

General unsteady-state transport equations for mass, heat, and momentum transfer with and without generation in the system. Solutions for the unsteadystate transport equations by using analytical, graphical, and numerical methods. Application to actual industrial cases.

CHE 621: Computer-Aided Design for Chemical Industries

Principles of developing advanced user-friendly software packages for the design of industrial reactors, distillation columns, absorption towers, heat exchangers, etc.

CHE 622: Simulation of Chemical Processes

Steady-state simulation of chemical processes Decomposition of recycle streams. Dynamic simulation of chemical processes. Practice in the simulation of industrial units and processes.

CHE 623: Digital Computer Control of Chemical Plants

Digital computer control loops and technology. Discrete time systems. Z transforms. Approximation of continuous-time systems. Discrete-time response of dynamic systems. Digital implementation of control algorithms, hardware, sampling, noise filtering. Design of digital controllers, discrete pole placement controller, discrete optimal controller. Process identification by using least-square methods. Introduction to adaptive control.

CHE 624: Data Acquisition and Digital Control in Laboratory Experiments

Principles of data acquisition, computer interface (digital-to-analog conversion and analog-to-digital conversion), and computer operator interface. Data collection, trending, and processing.

Plant experimentation and testing procedures. Analysis using statistical tools. Developing and validating empirical dynamic models. Inferential control. Introduction to DCS systems. Fault detection and performance monitoring.

CHE 625: Neural Networks in Chemical Processes

Definitions and conventions of neural network theory. Leaning methods. Neural network structures (topography): single layer, multilayer, layers, models of neurons. Using neural networks for empirical dynamic modeling, control of chemical processes, artificial intelligence in chemical processes, and creating an expert system for design, plant diagnosis, and safety.

CHE 626: Process Synthesis

Input–output structure of a flow sheet, recycle structure of the flow sheet. Sequencing of separation systems. Heat exchanger network design. Integrated design of chemical plants. Process optimization and computer-aided process design.

CHE 627: Advanced Chemical Process Control II

Direct synthesis and time-delay compensation. Selected topics on one or two of the following advanced control strategies: statistical process control, fuzzy logic control, internal model control, supervisory control (real-time optimization), linear multivariable control, nonlinear multivariable control, adaptive control, distributed parameter control systems, and model predictive control.

CHE 631: Advanced Extractive Metallurgy

Advanced theory and practice of mineral dressing. Mineral dressing in relation to mineral resources and economics of the society. Quality control on ore dressing. Design of mineral-dressing systems and dust control. Advanced study of reaction rate theories as applied to the solid-state and multiphase reactions of chemical metallurgy, fuel, and refractories. Ion exchange theories and their application in hydrometallurgy, electrolysis, and electro-extraction of metals and metal refining.

CHE 632: Advanced Physical Metallurgy I

The free electron theory of metals. The zone theory of metals, magnetism, and electrical conductivity. Dislocation and mechanical properties of metals. Dislocation interactions and properties of dislocation arrays. X-ray diffraction as applied to the study of metals and alloys. Interpretation of multi-component phase diagrams for metal systems. Physical and chemical metallurgy of primary metals in the nuclear field. Graphite and other non-metallic, fuel elements, container materials and moderators, radiation damage, and liquid metals.

CHE 633: Composite Materials

Nature and scope of composite materials. Development of composites. Structure and properties of composites, stress–strain relations, toughness, and impact strength. Fracture and transport properties of composites. Fabrication of composites. Optimal design and application of composites.

CHE 634: Advanced Physical Metallurgy II

Metallurgical defects encountered in metal-forming production and testing of powdered metals and their uses. Raw materials and forming methods of ceramic products. Microstructure and mechanical properties of powder materials. Theory and technique of rolling; deep drawing, extension drawing, and rod and wire drawing. Fundamentals of the plastic deformation of metals. Metallurgical welding. Physical metallurgy and mechanical properties of weld metal and thermally altered metals. Joining methods in relation to composition, microstructure, and mechanical properties.

CHE 635: Hot Corrosion Engineering

Oxidation and sulfidation at high temperature. Effect of salt on hot corrosion. Thermodynamics of hot corrosion reactions. Kinetics and reaction rate expressions for hot corrosion processes. The behavior of superalloys in complex atmospheres (O_2, SO_2, H_2S, $NaSO_4$, etc.). Methods of measuring hot corrosion rates. Recent trends in hot corrosion control.

CHE 636: Corrosion Control and Monitoring

Electrochemical theory of wet corrosion. Corrosion of polymers and ceramics. Principles of corrosion protection. Corrosion protection methods. Design principles and applications of cathodic protection systems. Evaluation of various techniques of corrosion control. Corrosion testing in laboratory and field. Corrosion monitoring.

CHE 641: Advanced Petroleum Refining Engineering II

Design methods and procedures of the following units: hydrotreating, hydrocracking, fluid catalytic cracking, and catalytic reforming.

CHE 642: Petrochemical System Design

Description and evaluation of processes designed to manufacture petrochemicals. Sources, availability, and characterization of feedstocks. Process design procedure.

CHE 643: Advanced Topics in Polymerization

Mathematical modeling and reactor design for polymerization processes including step growth and chain growth mechanisms. Topics cover polycondensation and free-radical processes in various reacting media and reactor configuration (emulsion, suspension, solution polymerization, etc.). Catalytic olefin polymerization.

CHE 654: Selected Topics in Chemical Engineering

Selected advanced topics of recent progress in subjects related to chemical engineering

8. DEPARTMENT LABORATORIES

8.1. Student Laboratories

The Chemical Engineering department has four main undergraduate laboratories where students can practice and integrate all of their knowledge from the undergraduate courses into realistic applications. These laboratories are as follows:

8.1.1. Unit operation laboratory

In this laboratory, students are introduced to and trained on different laboratory-scale chemical processes such as distillation, drying, cooling tower, liquid-phase chemical reactors (batch, continuous, tubular), and heat exchanger. The students also learn about many chemical and physical phenomena such as diffusion of liquids and gases, thermal conductivity, solid handling, fluidization, and filtration.

8.1.2. Petroleum refining laboratory

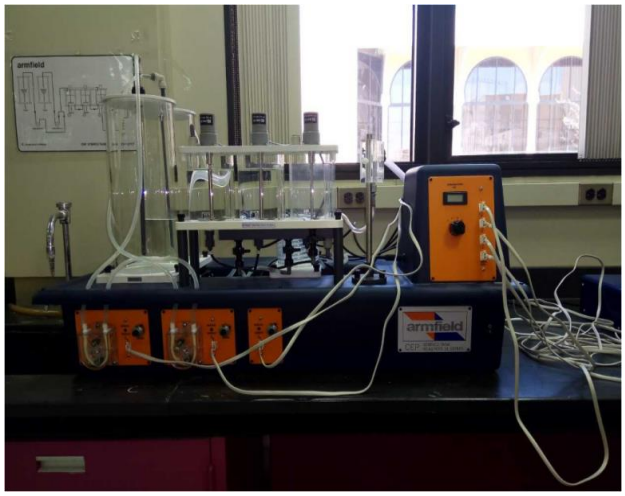
In this laboratory, students are trained on the distillation of crude oil and learn how to estimate oil properties such as pour and cloud point, melting point of wax, specific gravity and viscosity of oil, and flash and fire points by open-cup method. The training also includes water and sediment removal by centrifuge.

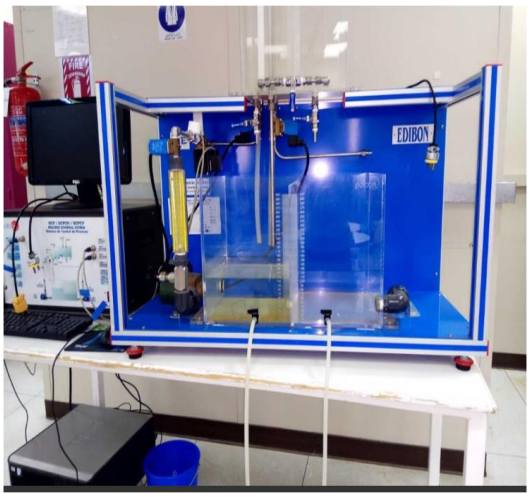
8.1.3. Material science laboratory

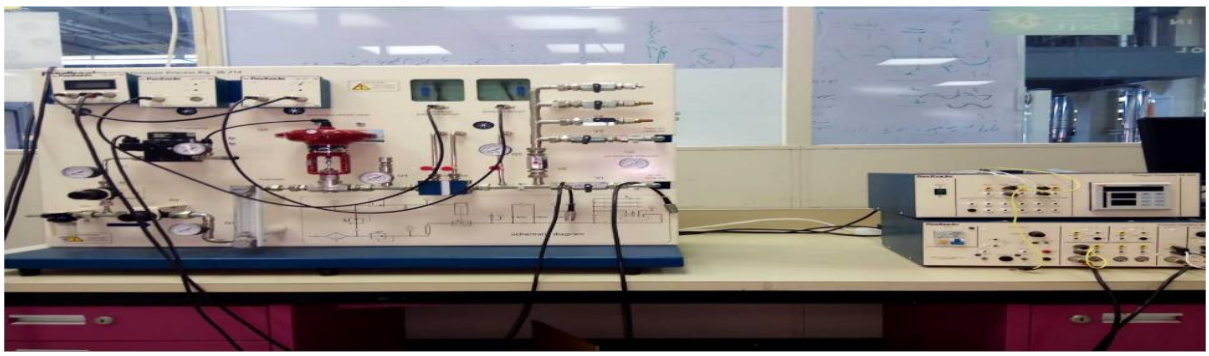
In this laboratory, students learn how to study and analyze the surface and structure of various types of minerals.

8.1.4. Process control laboratory

This laboratory contains several equipment, which are used to introduce the student to process dynamics in open- and closed-loop modes, instrumentation, and control valves. The students are also trained on how to tune the conventional PID controller.







8.2. Research Laboratories

The Chemical Engineering department has the following research laboratories:

1. Phosphate manufacturing and processing laboratory

2. Electrochemistry and hydrogen production laboratory

3. Heat transfer and scale and fouling laboratory

4. Catalysis and characterization laboratory

5. Catalytic chemical reaction laboratory

6. Mass transfer enhancement laboratory

7. Advanced process control application laboratory

8. Hydrodynamics of gas-lift reactor laboratory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In addition, the department has the following characterization and analytical equipment:

1	Scanning electron microscopy (SEM)
2	Transmission electron microscopy (TEM)
3	X-ray diffraction (XRD) system
4	X-ray fluorescence (XRF) system
5	Energy dispersive X-ray (EDX) system
6	Thermogravimetric and differential thermal analyzer (TGA/DTA)
7	Differential scanning calorimeter (DSC)
8	Surface area analyzer (BET)
9	Temperature-programmed reduction /desorption (*TPR*/TPO/*TPD*)system
10	Fourier transform infrared spectrometer (FTIR)
11	UV–vis spectrometer
12	High-performance liquid chromatography (HPLC)
13	Gas chromatography (GC)
14	Gas chromatograph–mass spectrometer (GC-MS)
15	Heterogeneous catalysis reactor
16	CHN analyzer
17	Tensile test equipment
18	Applied corrosion monitoring
19	Particle size NanoPlus
20	Sonicator bath
21	Thermal imaging camera
22	Izod impact tester
23	Fluid bed dryer
24	Hot-stage Hall effect measurement system

9. RESEARCH CAPABILITIES

9.1. Catalysis and Reactor Engineering

Catalysis and Reactor Engineering	
Description	Professional investigations and design of single-phase and multiphase reactors. Reaction kinetics including petrochemicals, polymers, etc. Catalysis and catalyst development including preparation, characterization, and testing. Modeling and simulation of chemical and petrochemical reactors.
Faculty Expertise	Dr. Yusuf alZeghyer, Dr. Saeed AlZahrani, Dr. Ahmed Abasaeed, Dr. Mohamed Abashar, Dr. Fahad AlMubaddel, Dr. Waheed Almasry

9.2. Process Dynamics, Optimization, and Control

Process Dynamics, Optimization, and Control	
Description	Professional investigation of chemical process dynamics behavior, nonlinearity, and stability. Control structure design. Control tuning. Control performance assessment. Process modeling and identification. Polymerization reactor dynamics and control. Modeling and simulation of process dynamics.
Faculty Expertise	Dr. Emad Ali, Dr. Khalid alHumaizi, Dr. AbdelHamid Ajbar, Dr. Mohamed Abashar

9.3. Powder Technology and Hydrodynamic of Multiphase Processes

Powder Technology and Hydrodynamic of Multiphase Processes	
Description	Professional investigation of the hydrodynamic characteristics and mass transfer enhancement of multiphase reactors. Electro capacitance tomography, fluidization, and fluidized bed engineering. Flow in porous media. Nanomaterial handling.
Faculty Expertise	Dr. Mohammad Asif, Dr. Waheed AlMasry, Dr. AbdelHamid Ajbar, Dr. Emad Ali, Dr. Fahad AlMubaddel

9.4. Renewable Energy and Hydrogen Production

Renewable Energy and Hydrogen Production	
Description	Professional investigation of alternative energy resources such as solar energy, fuel cells, biofuel, and hydrogen production. Design and testing fuel cells. Fuel progressing, hydrogen production, and storage. Advanced modeling and design analysis tools
Faculty Expertise	Dr. Anis Fakeeha, Dr. Mohammad Abashar, Dr. Ahmed Abasaeed

9.5. Chemical and Biochemical Processes

Chemical and Biochemical Processes	
Description	Professional investigation of chemical industries, flow sheeting, process development and alternatives, economic and feasibility studies. Ore and mineral extraction and processing. Natural gas processing. Biochemical and biomedical processes design and technology. Food processing.
Faculty Expertise	Dr. Mourad Bumaza, Dr. Jehad Saleh, Dr. Muhannad Elharbawi, Dr. Mohamed Hadj-Kali, Dr. Ahmed Abasaeed,

9.6. Material Science and Engineering

Material Science and Engineering	
Description	Professional investigation of industrial and building material properties. Material structure and enhancement. Corrosion detection and control. Electrochemical engineering application. Advanced material characterization and application.
Faculty Expertise	Dr. Mansour alHazaa, Dr. Maher alOdan Dr. Mansour alHoshan, Dr. Othman Alothma

9.7. Polymer Science and Engineering

Polymer Science and Engineering	
Description	Provides professional research and consultations in the different aspects of polymer engineering. Some of these aspects are property characterization, process optimization, failure prevention and analysis, material selection, environmental effects, material improvements, production, and many other aspects of polymer engineering.
Faculty Expertise	Dr. Abdulaziz Alghyamah, Dr. Othman AlOthman, Dr. Saeed AlZahrani, Dr. Ahmed Abasaeed

9.8. Process Synthesis and Integration

Process Synthesis and Integration	
Description	Professional investigation of process flow sheet optimization. Process flow sheet integration and intensification. Process technologies and synthesis. Hybrid systems. Membrane Reactors. Membrane technology. Economic evaluation and profitability analysis
Faculty Expertise	Dr. AbdulRahman AlRabiah, Dr. Abdulaziz alMutlaq

10. DEPARTMENT COMMITEES

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