# Jordan University of Science and Technology

## Faculty of Engineering

# Department of Chemical Engineering

***Curriculum for the B.Sc. Degree in Chemical Engineering***

2007

## Vision

To stay ahead in chemical engineering education quality and research

## Mission

To Provide students with a high caliber education in the chemical engineering field through a well coordinated, dynamic and practical program with an up-to-date content, professional skills, knowledge, and quality research. The acquired knowledge covers chemical engineering fundamentals and exposure to emerging technologies that prepare graduates for a challenging career in chemical engineering and to be pioneers contributing to the comprehensive sustainable national development plans.

## Department Objectives

The educational objectives of the Chemical Engineering Program at JUST are to produce graduates who:

1. Have a strong foundation of scientific and technical knowledge and are equipped with problem solving, critical-thinking, teamwork, and communication skills that will serve them throughout their future careers.
2. Are prepared for entry into careers in chemical engineering in the various areas including, but not limited to, petrochemical, petroleum refining, biochemical, pharmaceutical, water treatment, desalination, environmental pollution control, mineral processing, advanced materials, and food technologies.
3. Are committed to integrate ethical and social codes, environmental regulations, and safety issues into their professional careers.
4. Have the capability to effectively exercise leadership within a multifaceted scope of technological and economical issues.
5. Have the ability to pursue research and advanced studies in areas such as biochemical engineering, environmental engineering, advanced materials, renewable energy, computer-aided design, process synthesis, process control, and petrochemical engineering.
6. Participate in identifying contemporary challenges and propose a plan of action to tackle them.

## B. Sc. Program Learning Outcomes

Upon completion of the degree program, students will have:

A. An ability to apply knowledge of mathematics, science, and engineering.
B. An ability to design and conduct experiments as well as analyze and interpret data.
C. An ability to design a system, component, or process to meet desired needs.
D. An ability to function on multi-disciplinary teams.
E. An ability to identify, formulate, and solve engineering problems.
F. An understanding of professional and ethical responsibility.
G. An ability to communicate effectively.

H. The broad education to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in life-long learning.
J. Knowledge of contemporary issues.
K. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
L. Recognition of the safety needs, and an ability to adhere to the safety rules and regulations.

**Table 1:** Mapping of ChE Program Objectives and ABET Program Outcomes

| **PROGRAM EDUCATIONAL OBJECTIVES** | **Program/ABET Outcomes** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** |
| 1. Have a strong foundation of scientific and technical knowledge and are equipped with problem solving, critical-thinking, teamwork, and communication skills that will serve them throughout their future careers | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| 2. Are prepared for entry into careers in chemical engineering in the various areas including, but not limited to, petrochemical and petroleum refining, biochemical, pharmaceutical, water treatment, desalination, environmental pollution control, mineral processing, advanced materials, and food technologies | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| 3. Are committed to integrate ethical and social codes, environmental regulations, and safety issues into their professional careers | | | | | | **x** | | **x** | | | | **x** |
| 4. Have the capability to effectively exercise leadership within a multifaceted scope of technological and economical issues | | | | **x** | | **x** | **x** | | | | | |
| 5. Have the ability to pursue research and advanced studies in areas such as Biochemical Engineering, Environmental Engineering, Advanced Materials, Renewable Energy, Computer-Aided Design, Process Synthesis, Process Control, and Petrochemical Engineering | **x** | **x** | **x** | | **x** | | **x** | **x** | **x** | **x** | **x** | **x** |
| 6. Participate in identifying contemporary challenges and propose a plan of action to tackle them | **x** | **x** | **x** | **x** | **x** | | | **x** | | **x** | **x** | **x** |

## Undergraduate Curriculum

## Undergraduate Degree Plan

Before introducing courses and degree requirements it is important to describe the numbering / coding system of courses at JUST.

### Course Coding

The following codes are used to designate courses:

| Department | | | Level/Year | Field | Sequence |
|---|---|---|---|---|---|
| A | B | C | # | # | # |

The Department codes (A, B, C ) are as follows:

| Code | Department |
|---|---|
| AE | Architectural Engineering |
| CE | Civil Engineering |
| ME | Mechanical Engineering |
| EE | Electrical Engineering |

| Code | Department |
|---|---|
| IE | Industrial Engineering |
| **ChE** | **Chemical Engineering** |
| BME | Biomedical Engineering |
| NE | Nuclear Engineering |

### Course Numbering

The Chemical Engineering courses are tabled and numbered in such a manner to recognize each course regarding its subject area, year level, and semester offered. The symbol ChE denotes Chemical Engineering and each number is made of 3 digits; the first digit denotes the year level of the course according to student's study plan as follows:

| First Digit | Level of Course |
|---|---|
| 1 | First year |
| 2 | Second year |
| 3 | Third year |
| 4 | Fourth year |
| 5 | Fifth year. |

The second digit denotes the course field subject as follows:

| Second Number | Specialization |
|---|---|
| 0 | Basics of Chemical Engineering |
| 1 | Engineering Materials |
| 2 | Technology and Applied Chemical Engineering |
| 3 | Chemical Reaction Engineering |
| 4 | Thermal and Fluid Sciences |
| 5 | System Analysis, Modeling and Control |
| 6 | Mass Transfer Operations |
| 7 | Design and Safety |
| 8 | Biochemical and Environmental Engineering |
| 9 | Special Topics, Graduation Projects and Engineering Training |

**Example: ChE 311 means**

| | | | |
|---|---|---|---|
| ChE | 3 | 1 | 1 |
| Department | Level (Third year) | Field (Engineering materials) | Sequence ($1^{st}$ semester) |

The following presents the courses (and their pre/co–requisite) within each of the requirements needed to obtain a B.Sc. in Chemical Engineering.

## B.Sc. Degree (159 Semester Credits)

A Bachelor of Science (B.Sc.) degree in Chemical Engineering at JUST is awarded in accordance with the statute stated by JUST regulations for B.Sc. awarding issued by the Deans' Council based on the 1987 law for awarding scientific degrees and certifications at JUST, and after the successful completion of 159 credit hours, distributed as indicated in Tables 1 and 2.

**Table 1. Distribution of Credit hours**

| Classification | Credit Hours | | |
|---|---|---|---|
| | Compulsory | Elective | Total |
| University Requirements | 16 | 09 | 25 |
| Faculty Requirements | 32 | - | 32 |
| Department Requirements | 87 | 15 | 102 |
| Total | 135 | 24 | 159 |

**Table 2. Classification of Courses**

| Source of Courses | | Credit Hours | Percentage |
|---|---|---|---|
| **Humanities** | Lecture | 24 | 15.1% |
| | Lab | 1 | 0.6% |
| **Basic Sciences** | Lecture | 36 | 22.6% |
| | Lab | 3 | 1.9% |
| **General Engineering** | Lecture | 18 | 11.3% |
| | Lab | 2 | 1.3% |
| **Chemical Engineering** | Lecture | 68 | 42.8% |
| | Lab | 7 | 4.4% |
| **Total** | Lecture | 146 | 91.8% |
| | Lab | 13 | 8.2% |

## University Requirements (25 Credit Hours)

## Compulsory: (16 Credit Hours)

**Table 3. University Compulsory Courses**

| Course No. | Course Title | Cr. Hr. | Lecture | Lab. | Prerequisite or Co-requisite |
|---|---|---|---|---|---|
| Arb 101 | Arabic Language | 3 | 3 | | |
| Arb 103 | Applied Arabic Language Studies | 1 | | 3 | |
| Eng 111 (1) | English Language | 3 | 3 | | Pass Eng 99 |
| Eng 112 | Communication Skills II | 3 | 3 | | Eng 111 |
| CIS 100 (2) | Computer Skills | 3 | 3 | | |
| MS100 (3) | Military Sciences | 3 | 3 | | |
| | **Total** | **16** | | | |

1) A student who passes the English Language Placement Test with a grade > 80% is exempted from both Eng 099 and Eng. 111, while a student who passes the English Placement Test with a grade between 50% and 80% is exempted from Eng 099 only.
2) A student who passes the Computer Skills Placement Test with a grade > 50% is exempted from CIS 100.
3) This course is required from Jordanian students only; graded on Pass/Fail basis. Students graduating from Royal Military faculty and military candidates school and equivalent institutes are exempted from taking this course: Non-Jordanian Arabic Speaking students are required to take a substitute for this course from the elective courses and in this case the grade of this course is included in their grade point average (GPA).

**Notice:** All non Arabic Speaking foreign students in the University are required to study two courses in Arabic language as shown below:

**Table 4. Courses for non Arabic Speaking Students**

| Course No. | Course Title | Cr. Hr. | Lecture | Lab. | Prerequisite or Co-requisite |
|---|---|---|---|---|---|
| Arb101A | Fundamentals of Arabic Language (for non Arabic speaking students as a substitute for the course Arb101 Arabic Language) | 3 | 3 | | |
| Arb103A | Fundamentals of Arabic Language Lab for non Arabic speaking students as a substitute for the course Arb103 ○○○Applied Arabic Language Studies) | 1 | | 3 | |

## Elective: (9 Credit Hours)

The university elective courses are three courses with a total of 9 Cr. Table 5 lists these courses.

**Table 5. University Elective Courses for Engineering Students**

| Course No. | Course title | Cr. Hr. | Lecture | Lab. | Prerequisite or Co-requisite |
|---|---|---|---|---|---|
| ES 103 | Environment Protection (for non Environment Sciences students) | 3 | 3 | 0 | |
| PH 200 | First Aid and Emergency Procedure (for non Medicine, non Nursing, and non Midwifery students) | 3 | 3 | 0 | |
| PH 104 | Community Health and Nutrition (for non Medicine, non Nursing, and non Midwifery students) | 3 | 3 | 0 | |
| PHAR 104 | Drugs and Medical Plants (for non Medicine, and non Pharmacy students)) | 3 | 3 | 0 | |
| NUR 100 | Health Promotion (for non Medicine, non Nursing, and non Midwifery students) | 3 | 3 | 0 | |
| ADS 100 | Oral and Dental Health (for non Dentistry and non Dentistry Sciences students) | 3 | 3 | 0 | |
| PP 200 | Home Gardens (for non Agriculture students) | 3 | 3 | 0 | |
| PP 201 | Bee Keeping (for non Agriculture students) | 3 | 3 | 0 | |
| VM 211 | Animal Health ( for non Veterinary Medicine and non Agriculture students) | 3 | 3 | 0 | |
| VM 212 | Pet Animal Care (for non VM and Agriculture students) | 3 | 3 | 0 | |
| HSS 112 | Hadith Shareef | 3 | 3 | 0 | |
| HSS 113 | Aqideh | 3 | 3 | 0 | |
| HS 114 | Fekeh | 3 | 3 | 0 | |
| HSS 115 | Islam and Recent Problems | 3 | 3 | 0 | |
| HSS 116 | Islamic Economy System | 3 | 3 | 0 | |
| HSS 121 | Principles of Sociology | 3 | 3 | 0 | |
| HSS 126 | Principles of Psychology | 3 | 3 | 0 | |
| HSS 127 | Educational Technology | 3 | 3 | 0 | |
| HSS 128 | National Education | 3 | 3 | 0 | |
| HSS 131 | Islamic Civilization | 3 | 3 | 0 | |
| HSS 132 | The History of the City of Jerusalem | 3 | 3 | 0 | |
| HSS 133 | Civilization and Recent Cultures | 3 | 3 | 0 | |
| HSS 141 | Introduction to Economics (for non CIS students) | 3 | 3 | 0 | |
| HSS 142 | Library and Information Research | 3 | 3 | 0 | |
| HSS 151 | Introduction to Management Sciences (for non CIS students) | 3 | 3 | 0 | |
| HSS 161 | Contemporary Problems | 3 | 3 | 0 | |
| HSS 166 | Man and Science | 3 | 3 | 0 | |
| HSS 182 | Studies on Women | 3 | 3 | 0 | |
| HSS 250 | Music History (in English) | 3 | 3 | 0 | |
| HSS 211 | Introduction to Sociology (in English) | 3 | 3 | 0 | |
| HSS 212 | Arab Society | 3 | 3 | 0 | |
| HSS 213 | Individual and Society | 3 | 3 | 0 | |
| HSS 216 | International Global Issues | 3 | 3 | 0 | |
| HSS 221 | Introduction to Psychology (in English) | 3 | 3 | 0 | |
| HSS 222 | Creativity and Problems Solving | 3 | 3 | 0 | |

| | | | | | |
|---|---|---|---|---|---|
| HSS 224 | Leader ship and Communication Skills | 3 | 3 | 0 | |
| HSS 231 | History of Science in Islam | 3 | 3 | 0 | |
| HSS 241 | Economy in the Third World | 3 | 3 | 0 | |
| HSS 242 | Information and Research | 3 | 3 | 0 | |
| HSS 429 | Behavioral Science and Dealing with Children | 3 | 3 | 0 | |
| PT 100 | Health and Life Styles (for non physical therapy students) | 3 | 3 | 0 | |
| ME 211 | Fundamentals of Automobile Engineering (for non ME students) | 3 | 3 | 0 | |
| NR 200 | Natural Resources and Human Being | 3 | 3 | 0 | |
| NF 177 | Food Preservation (in English) | 3 | 3 | 0 | |

## Faculty Requirements: (32 Credit Hours)

The Faculty of Engineering requirements consist of 32 Credit Hours distributed as follows:

**Table 6. Faculty of Engineering Compulsory Courses**

| Course No. | Course Title | Cr. hr. | Lecture | Lab. | Prerequisite or Co-requisite |
|---|---|---|---|---|---|
| Math101 | Calculus I | 3 | 3 | | ---- |
| Math 102 | Calculus II | 3 | 3 | | Math 101 |
| Math 201 | Intermediate Analysis | 3 | 3 | | Math 102 |
| Math 203 | Ordinary Differential Equations | 3 | 3 | | Math 102 |
| Phys 101 | General Physics I | 3 | 3 | | ---- |
| Phys 102 | General Physics II | 3 | 3 | | Phys 101 |
| Phys 107 | General Physics Lab | 1 | | 3 | Phys 102 Pre or Co |
| Chem 101 | General Chemistry I | 3 | 3 | | ---- |
| Chem 102 | General Chemistry II | 3 | 3 | | Chem 101 |
| Chem 107 | General Chemistry Lab | 1 | | 3 | Chem 102 Pre or Co |
| CS 115 | Programming in C++ Language | 3 | 3 | | CIS 100 |
| EE 202 | Communication Skills for Engineers | 2 | 2 | | 2nd Year Standing |
| ChE 400 | Professional Ethics for Engineers | 1 | 1 | | Completion of 90 Cr. Hr. |
| | **Total** | **32** | | | |

# Department Requirements: (102 Credit Hours)

## I) Department Compulsory Courses: (87 Credit Hours)

Department compulsory courses are 87 credit hours distributed in Tables 7 and 8.

**Table 7: Chemical Engineering compulsory courses (66 credit hours)**

| Course No. | Course Title | Cr. hr. | Lecture | Lab. | Prerequisite or Co-requisite |
|---|---|---|---|---|---|
| ChE 201 | Introduction to Chemical Engineering | 1 | 1 | | Chem 102 |
| ChE 204 | Fundamentals of Chemical Engineering | 3 | 3 | | CS 115, ME 200 or Co & ChE 201 |
| ChE 311 | Materials Science and Engineering | 3 | 3 | | ChE 204 & Chem 212 |
| ChE 340 | Thermodynamics | 3 | 3 | | Math 203 |
| ChE 342 | Chemical Engineering Thermodynamics | 3 | 3 | | ChE 340 |
| ChE 343 | Fluid Mechanics for Chemical Engineers | 3 | 3 | | Math 203 & ChE 340 or Co |
| ChE 344 | Fluid Mechanics Lab. | 1 | | 3 | ChE 343 |
| ChE 346 | Heat Transfer | 3 | 3 | | ChE 343 & EE 305 or Co |
| ChE 362 | Unit Operations | 3 | 3 | | ChE 343 |
| ChE 431 | Chemical Reaction Engineering I | 3 | 3 | | Chem 347 & ChE 342 |
| ChE 432 | Chemical Reaction Engineering II | 3 | 3 | | ChE 431 |
| ChE 441 | Chemical Measurements & Testing Lab | 1 | | 3 | ChE 342 & ChE 346 |
| ChE 442 | Heat & Mass Transfer Lab. | 1 | | 3 | ChE 461 or Co |
| ChE 452 | Applied Mathematics and Modeling for Chemical Engineers | 3 | 3 | | EE 305 & ChE 432 or Co |
| ChE 461 | Mass Transfer | 3 | 3 | | ChE 342 & ChE 346 |
| ChE 464 | Separation Processes | 3 | 3 | | ChE 461 |
| ChE 472 | Equipment Design | 3 | 3 | | ChE 311 & ChE 464 or Co |
| ChE 483 | Introduction to Biochemical Engineering | 3 | 3 | | ChE 431 or Co |
| ChE 490 | Engineering Training | 3 | 3 | | Completion of 117 Cr. Hr. & ChE 400 |
| ChE 535 | Chemical Processing Lab. | 1 | | 3 | ChE 432 |
| ChE 551 | Process Dynamics and Control | 3 | 3 | | ChE 452 |
| ChE 552 | Process Control Lab. | 1 | | 3 | ChE 551 |
| ChE 555 | Computer Applications Lab. For Chemical Engineers | 1 | | 3 | ChE 472 or Co |
| ChE 557 | Instrumental Analysis | 3 | 3 | | ChE 464 or Co |
| ChE 565 | Unit Operations Lab. | 1 | | 3 | ChE 362 & ChE 464 |
| ChE 575 | Plant Design | 3 | 3 | | IE 341 & ChE 472 or Co |
| ChE 591 | Graduation Project I | 1 | | | Completion of 114 Cr. Hr. & ChE 575 or Co |
| ChE 592 | Graduation Project II | 3 | | | ChE 591 |
| | **Total** | **66** | | | |

**Table 8. Compulsory courses from other departments (21 credit hours)**

| Course No. | Course Title | Cr. hr. | Lecture | Lab. | Prerequisite or Co-requisite |
|---|---|---|---|---|---|
| ME 101 | Engineering Workshop | 2 | 1 | 3 | --- |
| ME 101 | Engineering Workshop Lab | 0 | 0 | 0 | --- |
| ME 200 | Engineering Drawing A | 1 | | 3 | CIS 100 |
| EE 303 | Fundamentals of Electrical Engineering | 3 | 3 | | Phys 102 & Math 102 |
| EE 305 | Numerical Methods for Engineers | 3 | 3 | | Math 203 & CS 115 |
| IE 341 | Engineering Economy | 2 | 2 | | Math 201 |
| Chem 211 | Organic Chemistry I | 3 | 3 | | Chem 102 |
| Chem 212 | Organic Chemistry II | 3 | 3 | | Chem 211 |
| Chem 213 | Organic Chemistry Lab. I | 1 | | 3 | Chem 212 or CO |
| Chem 347 | Physical Chemistry II | 3 | 3 | | ChE 340 |
| | **Total** | **21** | | | |

## II) Department Technical Electives: (15 Credit Hours)

The student is advised to select courses (15 Credit Hours) from Tables 9 and 10.

**Table 9. Department technical elective courses**

| Course No. | Course Title | Cr. hr. | Lecture | Lab. | Prerequisite or Co-requisite |
|---|---|---|---|---|---|
| ChE 411 | Corrosion Engineering | 3 | 3 | | ChE 311 |
| ChE 412 | Polymer Science and Technology | 3 | 3 | | Chem 212 & ChE 431 |
| ChE 415 | Ceramics Engineering | 3 | 3 | | ChE 311 |
| ChE 424 | Petroleum Refining Engineering | 3 | 3 | | Chem 212 & ChE 464 |
| ChE 443 | Energy and Analysis of Fossil Fuels | 3 | 3 | | ChE 432 & ChE 461 |
| ChE 450 | Experimental Design and Data Analysis | 3 | 3 | | EE 305 |
| ChE 457 | Introduction to Optimization | 3 | 3 | | EE 305 |
| ChE 484 | Air Pollution | 3 | 3 | | ChE 362 & ChE 461 |
| ChE 518 | Electrochemical Engineering | 3 | 3 | | ChE 431 & ChE 461 |
| ChE 521 | Chemical Industries | 3 | 3 | | ChE 464 or Co |
| ChE 524 | Food Engineering | 3 | 3 | | ChE 362 & ChE 461 |
| ChE 543 | Renewable Energy | 3 | 3 | | ChE 342 & ChE 346 |
| ChE 563 | Mineral Processing | 3 | 3 | | ChE 362 & ChE 461 |
| ChE 566 | Desalination | 3 | 3 | | ChE 461 |
| ChE 568 | Gas Processing and Treatment | 3 | 3 | | ChE 464 or Co |
| ChE 577 | Chemical Process Safety | 3 | 3 | | ChE 575 or Co |
| ChE 581 | Membrane Separation Processes | 3 | 3 | | ChE 461 |
| ChE 583 | Physical and Chemical Water Treatment | 3 | 3 | | ChE 464 or Co |
| ChE 585 | Biochemical Engineering | 3 | 3 | | ChE 461 & ChE 483 |

| | | | | | |
|---|---|---|---|---|---|
| ChE 587 | Biological Water Treatment | 3 | 3 | | ChE 483 |
| ChE 588 | Pharmaceutical Process Engineering | 3 | 3 | | ChE 362 & ChE 464 |
| ChE 590 A | Special Topics A | 3 | 3 | | Department approval |
| ChE 590 B | Special Topics B | 2 | 2 | | Department approval |
| ChE 590 C | Special Topics C | 1 | 1 | | Department approval |

**Table 10. Technical elective courses from other Engineering Departments (Students are allowed to take one course from this list)**

| Course No. | Course Title | Cr. hr. | Lecture | Lab. | Prerequisite or Co-requisite |
|---|---|---|---|---|---|
| ME 528 | Thermal Power Plants | 3 | 3 | | ChE 340 |
| ME 581A | Heating Ventilation and Air Conditioning | 3 | 3 | | 5th year standing |
| ME 582A | Refrigeration | 3 | 3 | | 5th year standing |
| IE 548 | Facilities Planning | 3 | 3 | | 5th year standing |
| IE 556 | Total Quality Management | 3 | 3 | | Completion of 100 Cr. Hr. |
| IE 557 | Introduction to Project Management | 3 | 3 | | 5th year standing |
| IE 574 | Reliability and Maintenance Management | 3 | 3 | | 5th year standing |

# Study Plan for the B.Sc. Degree in Chemical Engineering

## First Year

### First Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| CIS 100 | Computer Skills | 3 | - |
| Eng 111 | English Language | 3 | Pass Eng 99 |
| Phys 101 | General Physics I | 3 | - |
| Chem 101 | General Chemistry I | 3 | - |
| Math 101 | Calculus I | 3 | - |
| | | | |
| | | | |
| **Total** | | **15** | |

### Second Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| Chem 102 | General Chemistry II | 3 | Chem 101 |
| Chem 107 | General Chemistry Lab. | 1 | Chem 102 or Co |
| Phys 102 | General Physics II | 3 | Phys 101 |
| Phys 107 | General Physics Lab | 1 | Phys 102 or Co |
| Math 102 | Calculus II | 3 | Math 101 |
| CS 115 | Programming in C++ | 3 | CIS 100 |
| Eng 112 | Communication Skills II | 3 | Eng 111 |
| **Total** | | **17** | |

## Second Year

### First Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| ChE 201 | Introduction to Chemical Engineering | 1 | Chem 102 |
| Math 201 | Intermediate Analysis | 3 | Math 102 |
| Math 203 | Ordinary Differential Equations | 3 | Math 102 |
| Chem 211 | Organic Chemistry I | 3 | Chem 102 |
| EE 202 | Communication Skills for Engineers | 2 | 2nd year standing |
| Arb 101 | Arabic Language | 3 | - |
| Arb 103 | ○○○Applied Arabic Language Studies | 1 | - |
| **Total** | | **16** | |

### Second Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| ME 101 | Engineering Workshops | 2 | -- |
| ME 200 | Engineering Drawing A | 1 | CIS 100 |
| ChE 204 | Fundamentals of Chemical Engineering | 3 | CS115, ChE 201 & ME 200 or Co |
| Chem 212 | Organic Chemistry II | 3 | Chem 211 |
| Chem 213 | Organic Chemistry Lab. I | 1 | Chem 212 or Co |
| MS 100 | Military Science | 3 | |
| U --- | University Elective | 3 | |
| **Total** | | **16** | |

## Third Year

### First Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| EE 305 | Numerical Methods for Engineers | 3 | Math 203 & CS 115 |
| ChE 311 | Materials Science and Engineering | 3 | ChE 204 & Chem 212 |
| ChE 340 | Thermodynamics | 3 | Math 203 |
| ChE 343 | Fluid Mechanics for Chemical Engineers | 3 | Math 203 & ChE 340 or Co |
| IE 341 | Engineering Economy | 2 | Math 201 |
| U --- | University Elective | 3 | |
| **Total** | | **17** | |

### Second Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| Chem 347 | Physical Chemistry II | 3 | ChE 340 |
| ChE 342 | Chemical Engineering Thermodynamics | 3 | ChE 340 |
| ChE 344 | Fluid Mechanics Lab. | 1 | ChE 343 |
| ChE 346 | Heat Transfer | 3 | ChE 343 & EE 305 or Co |
| ChE 362 | Unit Operations | 3 | ChE 343 |
| EE 303 | Fundamentals of Electrical Engineering | 3 | Phys 102 & Math 102 |
| **Total** | | **16** | |

## Fourth Year

### First Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| ChE 400 | Professional Ethics for Engineers | 1 | Completion of 90 Cr Hrs |
| ChE 431 | Chemical Reaction Engineering I | 3 | ChE 342 & Chem 347 |
| ChE 441 | Chemical Measurements & Testing Lab. | 1 | ChE 342 & ChE 346 |
| ChE 461 | Mass Transfer | 3 | ChE 342 & ChE 346 |
| ChE 483 | Introduction to Biochemical Engineering | 3 | ChE 431 or Co |
| --- --- | Technical Elective | 3 | |
| | | | |
| **Total** | | **14** | |

### Second Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| ChE 432 | Chemical Reaction Engineering II | 3 | ChE 431 |
| ChE 442 | Heat & Mass Transfer Lab. | 1 | ChE 461 or Co |
| ChE 452 | Applied Mathematics & Modeling For Chemical Engineering | 3 | EE 305 & ChE 432 or Co |
| ChE 464 | Separation Processes | 3 | ChE 461 |
| ChE 472 | Equipment Design | 3 | ChE 311 & ChE 464 or Co |
| --- --- | Technical Elective | 3 | |
| | | | |
| **Total** | | **16** | |

## Summer Session

| Course Number | Course Name | Credit Hours | Pre-Requisite |
|---|---|---|---|
| ChE 490 | Engineering Training | 3 | Completion of 117 credit hours + ChE 400 |
| **Total** | | **3** | |

## Fifth Year

### First Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| ChE 535 | Chemical Processing Lab. | 1 | ChE 432 |
| ChE 551 | Process Dynamics & Control | 3 | ChE 452 |
| ChE 555 | Computer Applications Lab. for Chemical Engineering | 1 | ChE 472 or Co |
| ChE 557 | Instrumental Analysis | 3 | ChE 464 or Co |
| ChE 565 | Unit Operation Lab. | 1 | ChE 362 & ChE 464 |
| ChE 575 | Plant Design | 3 | IE 341 & ChE 472 or Co |
| ChE 591 | Graduation Project I | 1 | ChE 575 or Co & Completion of 114 Cr. Hr. |
| --- --- | Technical Elective | 3 | |
| **Total** | | **16** | |

### Second Semester

| Course Number | Course Name | Credit Hours | Pre-Requisite or Co-requisite |
|---|---|---|---|
| ChE 552 | Process Control Lab. | 1 | ChE 551 |
| ChE 592 | Graduation Project II | 3 | ChE 591 |
| --- ---- | Technical Elective | 3 | |
| --- ---- | Technical Elective | 3 | |
| U ---- | University Elective | 3 | |
| | | | |
| | | | |
| | | | |
| **Total** | | **13** | |

**Distribution of credit hours over academic year and semester standing**

| Year standing | First semester | Second semester | Summer semester | Total |
|---|---|---|---|---|
| **First** | 15 | 17 | | 32 |
| **Second** | 16 | 16 | | 32 |
| **Third** | 17 | 16 | | 33 |
| **Forth** | 14 | 16 | 3 | 33 |
| **Fifth** | 16 | 13 | | 29 |

## Course Description

**ChE 201: Introduction to Chemical Engineering (1 Cr. Hr.)**
Careers in Chemical Engineering, units and dimensions, numerical calculations and estimation, process data; representation and analysis, processes and process variables.

**Pre: Chem 102**

**ChE 204: Fundamentals of Chemical Engineering (3 Cr. Hr.)**
Material Balances: fundamentals of material balances, single and multi phase systems. Energy balances for processes; steady and transient, reactive and nonreactive.

**Pre: ChE 201, CS 115, ME 200 or Co**

**ChE 311 Materials Science and Engineering (3 Cr. Hr.)**
Atomic structure and bonding. Crystal structures. Solidification, crystalline imperfections and diffusion in solids. Mechanical properties of metals. Thermal processing of metals. Phase diagrams and engineering alloys. Polymeric ceramic and composite materials. Corrosion and degradation of materials.

**Pre: Chem 212 and ChE 204**

**ChE 340: Thermodynamics (3 Cr. Hr.)**
Forms of energy. Open and closed systems. Work and heat. PVT properties of pure fluids and steam tables**.** First law of thermodynamics. Second law of thermodynamics. entropy concept and third law of thermodynamics (open and closed systems). Analysis of power cycles (power plants and refrigeration)

**Pre: Math 203**

**ChE 342: Chemical Engineering Thermodynamics (3 Cr. Hr.)**
Heat Effects. Phase Rule. Thermodynamic Properties of Gas Mixtures & Liquid Solutions. Vapor-Liquid Equilibria. Liquid-Liquid Equilibria. Chemical Reaction Equilibria.

**Pre: ChE 340**

**ChE 343 Fluid Mechanics for Chemical Engineers (3 Cr. Hr.)**
Fluid Static. Continuity Equation. Energy Equation (Bernoulli's Equation). Flow measuring Devices. Fluid Friction of Flowing Systems. Momentum Balance. Dimensional Analysis. Pumps Types and their Performance Curves.

**Pre: Math 203 & ChE 340 or Co**

**ChE 344 Fluid Mechanics Laboratory (1 Cr. Hr., 3 Hrs. Lab.)**
The following experiments are expected to be performed: Density, viscosity and surface tension measurements, pressure and flow measurements, friction and Reynolds tests, impact of a water jet, center of pressure, pumps' testing.

**Pre: ChE 343**

**ChE 346 Heat Transfer (3 Cr. Hr.)**
Nature and Modes of Heat Transfer. Steady-State Heat Conduction. Unsteady-State Heat Conduction (Lumped Analysis). Principles of Convection. Empirical Relations for Natural and Forced Convection. Introduction to Boiling & Condensation. Heat Exchangers.

**Pre: ChE 343 & EE-305 or Co**

**ChE 362 Unit Operation (3 Cr. Hr.)**

Characterization of solid particles. Storage of solids. Drag and drag coefficients. Flow through beds of solids. Mechanics of particle motion. Settling. Fluidization. Size reduction. Screening. Filtration. Gravity sedmentation processes. Separation by centrifuges. Separation by cyclones. Evaporation.

**Pre: ChE 343**

**ChE: 400 Professional Ethics for Engineers (1 Cr. Hr)**
Awareness on the role of engineers and engineering profession and the ethical issues in the practice of engineering: codes of ethics, safety and liability, professional responsibility to clients and employers, corporate responsibility, legal obligations, conflicts of interest, risk assessment, sustainable development, social and environmental issues, contemporary issues, multidisciplinary teams, and life long learning.

**Pre: Completion of 90 Cr. Hr.**

**ChE 411 Corrosion Engineering (3 Cr. Hr.)**
Electrochemical and metallurgical aspects of corrosion. Forms of corrosion. Modern theory of corrosion and its application. Iron and steel corrosion. Corrosion prevention. Case studies.

**Pre: ChE 311**

**ChE 412 Polymer Science and Technology (3 Cr. Hr.)**
Chemistry and Physics of polymers. Fundamentals of polymer synthesis; addition and condensation polymers. Mechanisms and kinetics of polymerization reactions. Polymerization techniques; suspension and emulsion. Properties of polymeric materials and polymers reinforced by fibers. Polymers manufacturing techniques. Polymer rheology. Methods of polymer fabrication; casting, blow molding, injection molding, extrusion. Polymeric solutions. Degradation.

**Pre: Chem 212 and ChE 431**

**ChE 415 Ceramics Engineering (3 Cr. Hr.)**
Crystalline structure. Phase diagrams. Ceramic materials and properties. Cement, glass, porcelain, bricks and pottery. Ceramic processing: extrusion, pressing, glazing, and finishing processes.

**Pre: ChE 311**

**ChE 424 Petroleum Refining Engineering (3 Cr. Hr.)**
Origin and composition of petroleum. Crude oil analysis and evaluation. Petroleum products and their uses. Refinery structure. Refinery operations and processes: Atmospheric & Vacuum Distillation, Fluid Catalytic Cracking, Platforming, Hydro-desulfurization and Hydrotreating, Chemical treatment, Asphalt production, Lube oils production. Refinery Utilities. Waste Treatment. Standards and Specifications.

**Pre: Chem 212 and ChE 464**

**ChE 431 Chemical Reaction Engineering I (3 Cr. Hr.)**
Mole balances. Kinetics of homogeneous reactions. Analysis of reaction rate data. Design of isothermal reactors (batch, CSTR, and plug flow). Single and multiple ideal reactors. Multiple reactions.

**Pre: Chem 347 and ChE 342**

**ChE 432 Chemical Reaction Engineering II (3 Cr. Hr.)**
Energy balance for ideal reactors. Non-isothermal reactor design. Multiple steady state and stability of CSTR's. Non-ideal reactors and residence time distribution (RTD). Design of heterogeneous reacting systems. Introduction to fluid-fluid reactions.

**Pre: ChE 431**

**ChE 441 Chemical Measurements and Testing Lab. (1 Cr. Hr., 3 Hr. Lab.)**
The following experiments and universal tests in chemical engineering are expected to be performed: Temperature measurement, corrosion testing, petroleum fractions testing, vapor pressure measurement, instrumental analysis techniques: gas chromatography (GC), differential thermal Analysis (DTA), atomic absorption spectrophotometery (AAS), high performance liquid chromatography (HPLC) and fluorescence spectrophotometery

**Pre: ChE 342 & ChE 346**

**ChE 442 Heat & Mass Transfer Lab. (1 Cr. Hr., 3 Hr. Lab.)**
The following experiments are expected to be performed: Heat conduction in solids, free and forced convection, thermal conductivity of liquids and gases, coil, plate, and shell-and-tube heat exchangers, saturation pressure and throttling, vapor-liquid equilibria, mass transfer and diffusion coefficients of liquids and gases, wetted-wall gas absorption.

**Pre: ChE 461 or Co**

**ChE 443 Energy and Anaylsis of Fossil Fuels (3 Cr. Hr.)**
Importance of energy in our life. Impact of energy generation and use on the environment. Fossil fuels and their analysis. Principles of combustion, gasification, and pyrolsysis. Steam and gas generation. Power cycles.

**Pre: ChE 432 and ChE 461**

**ChE 450 Experimental Design and Data Analysis (3 Cr. Hr.)**
Review of Statistical distributions. Simple comparative experiments. Experiments with a single factor. Analysis of variance; randomized blocks, Latin squares, and related designs. Incomplete block designs, Factorial designs, Confounding in factorial designs, Two-level fraction factorial designs, Multi-factor experiment and nested designs.

**Pre: EE 305**

**ChE 452 Applied Mathematics and Modeling for Chemical Engineers (3 Cr. Hr.)**
Mathematical modeling of chemical engineering processes. Solution of mathematical models involving ordinary, differential and algebraic equations. Solution of partial differential equations (PDE's), Fourier half-range cosine and sine expansions. Bessel's function. Generalized Bessel's equation, Sturm-Liouville theorem. Laplace transforms.

**Pre: EE 305 & ChE 432 or Co**

**ChE 457 Introduction to Optimization (3 Cr. Hr.)**
Survey of continuous optimization problems. Unconstrained optimization problems. Introduction to constrained optimization. Solution of constrained optimization problems. Software packages in optimization.

**Pre: EE 305**

**ChE 461 Mass Transfer (3 Cr. Hr.)**
Molecular diffusion. Mass transfer coefficients. Mass transfer across interface. Analogy between momentum, heat and mass transfer. Continuous and stage-wise processes. Equipment for gas-liquid mass transfer operations. Absorption.

**Pre: ChE 342 and ChE 346**

**ChE 464 Separation Processes (3 Cr. Hr.)**
Binary and multi-component distillation, humidification and dehumidification, drying, extraction, and leaching.

**Pre: ChE 461**

**ChE 472 Equipment Design (3 Cr. Hr.)**
Selection of materials of construction. Design of pipes and pumping systems, compressors, tanks, pressure vessels, storage equipment, heat exchangers, and plate and packed towers.

**Pre: ChE 311, ChE 464 or Co**

**ChE 483 Introduction to Biochemical Engineering**
This course provides integration of the principles of chemical engineering, biochemistry, and microbiology with applications to the biochemical processes. Quantitative, problem-solving methods are emphasized. Topics include: cellular biology, polymeric cell compounds, enzyme and microbial kinetics, application of industrial enzymes, and cell growth cycle.

**Pre: ChE 431 or Co**

**ChE 484 Air Pollution (3 Cr. Hr.)**
Introduction to air pollution. Clean air act, quality and emission standards. Criteria pollutants. Air pollution and meteorology. Atmospheric dispersion. Emission control. Effect of pollutants on the global atmosphere. **Pre: ChE 362 and ChE 461**

**ChE 490 Engineering Training (3 Cr. Hr.)**
Practical training for 8 weeks after the completion of 117 credit hours (See Engineering Training Regulations of the College of Engineering).

**Pre: Completion of 117 Cr. Hr. and ChE 400**

**ChE 518 Electrochemical Engineering (3 Cr. Hr.)**
Basics of electrochemistry. Mass transfer in electrochemical systems. Electrochemical applications: batteries, fuel cells, electroplating, electrolytic industries. Metal recovery from electrochemical process wastes.

**Pre: ChE 431 & ChE 461**

**ChE 521 Chemical Industries (3 Cr. Hr.)**
Fundamentals of chemical industries. Study of selected industries such as water treatment; industrial gases; ceramic, cement and glass industries; fertilizers industries; sulfuric acid; phosphoric acid; etc. case studies on industries related to consumer products.

**Pre: ChE 464 or Co**

**ChE 524 Food Engineering (3 Cr. Hr.)**
Rheological properties of food. Phase transitions and transformations in food systems. Food freezing. Food dehydration. Transport phenomena in food systems. Food packaging.

**Pre: ChE 362 and ChE 461**

**ChE 535 Chemical Processing Lab. (1 Cr. Hr., 3 Hr. Lab.)**
The following experiments are expected to be performed: Batch reactor, tubular reactor, CSTR, dynamics of stirred tanks in series, residence time distribution, water treatment, flocculation, oil extraction, and phosphoric acid production.

**Pre: ChE 432**

**ChE 543 Renewable Energy (3 Cr. Hr.)**
Wind, solar, hydraulic, geothermal, tidal power, solid wastes, biofuels, …etc. Nuclear energy. Fuel cells, hybrid systems.

**Pre: ChE 342 and ChE 346**

**ChE 551 Process Dynamics and Control (3 Cr. Hr.)**
Process dynamics in time and Laplace domains. Input/output relationships. Basic components of control systems. Design of single-loop feedback control systems: stability, tuning, and synthesis techniques. Applications to chemical engineering processes.

**Pre: ChE 452**

**ChE 552 Process Control Lab. (1 Cr. Hr., 3 Hr. Lab.)**
The following experiments are expected to be performed: Temperature control, level control, pressure control, flow control, and process module.

**Pre: ChE 551**

**ChE 555 Computer Applications Lab. for Chemical Engineers (1 Cr. Hr., 3 Hr. Lab.)**
Usage of commercial process simulation packages; Aspen, Chemcad, Hysys, or others,

**Pre: ChE 472 or Co**

**ChE 557 Instrumental Analysis (3 CR. Hr.)**
Analytical measurements and measurement systems, separation methods of analysis, spectroscopic methods of analysis, thermal methods of analysis, electrochemical methods of analysis, Mass and NMR spectroscopy, Automated methods of analysis.

**Pre: ChE 464 or Co**

**ChE 563 Mineral Processing (3 Cr. Hr.)**
Classification of ores and metals. Ore preparation. Extraction of metals from ores. Pyrometallurgy and hydrometallurgy. Thermodynamics and kinetics of extractive processes. Metallurgical furnaces. Metal refining.

**Pre: ChE 362 and ChE 461**

**ChE 565 Unit Operations Lab. (1 Cr. Hr., 3 Hr. Lab.)**
The following experiments are expected to be performed: packed and tray distillation, packed-column gas absorption, liquid-liquid extraction, humidification/dehumidification in cooling towers, spray drying, tray drying, evaporation, filtration, fluidization, screen analysis and size reduction.

**Pre: ChE 362 & ChE 464**

**ChE 566 Desalination (3 Cr. Hr.)**
Physical and chemical properties of sea water, scale formation and control. Distillation processes. Membrane processes. Energy consumption in the different desalting systems.

**Pre: ChE 461**

**ChE 568 Gas Processing and Treatment (3 Cr. Hr.)**
Natural and refinery gases. Liquefied petroleum gases. Water-hydrocarbon system, hydrate formation and inhibition. Dehydration and sweetening, sulfur dioxide removal. Conversion of gas impurities. Removal of nitrogen compounds from gas streams. Equipment sizing, selection and design.

**Pre: ChE 464 or Co**

**ChE 575 Plant Design (3 Cr. Hr.)**
Process design development. General plant design considerations: health and safety, environmental factors, plant location and plant layout. Computer aided design. Economic principles including cost estimation. Design optimization. Report writing. Case studies.

**Pre: IE 341, ChE 472 or Co**

**ChE 577 Chemical Process Safety (3 Cr. Hr.)**
Importance of safety in industry. Accident analysis. Hazards of fires, explosions, dust, noise, radiation, electrical current and preventive methods. Hazards of toxic, corrosive, and carcinogenic chemicals and threshold limit values. Risk analysis exceeding the operating conditions. Required safety tools. Case Studies.

**Pre: ChE 575 or Co**

**ChE 581 Membrane Separation Processes (3 CR. Hr.)**
Membranes and module preparation: symmetrical, asymmetrical, ceramic and metal, and liquid membranes. Microfiltration, ultrafiltration, reverse osmosis, gas separation, pervaporation, electrodialysis, facilated transport, membrane distillation.

**Pre: ChE 461**

**ChE 583 Physical and Chemical Water Treatment (3 Cr. Hr.)**
Water quality. Sedimentation, thickening and flotation. Filtration and centrifugation. Adsorption. Membrane separation processes. Chemical equilbria in aqueous systems. Coagulation. Ion exchange. Oxidation and disinfection. **Pre: ChE 464 or Co**

**ChE 585 Biochemical Engineering**: An Integrated approach to the application of engineering principles to biochemical processes. Quantitative, problem-solving methods are emphasized. Topics include: enzyme immobilization, transport phenomena in biological systems, design of bioreactors, sterilization, scale-up of bioreactors, and bioseparation.

**Pre: ChE 461& ChE 483**

**ChE 587 Biological Wastewater Treatment (3 Cr. Hr.)**
Wastewater characterization. Aeration and mass transfer. Biological mechanisms and kinetics. Models for biological reactors. Biological design parameters. Biological nutrient removal (BOD, nitrogen and phosphorous). Activated sludge processes. Anerobic digestion. Fixed-film biological systems. Sludge treatment and disposal. **Pre: ChE 483**

**ChE 588 Pharmaceutical Process Engineering (3 Cr. Hr.)**
Application of transport processes and unit operations in pharmaceutical engineering such as particle size reduction, sieving, blending, drying, granulation, tableting, coating, encapsulation, sterilization. Crystallization processes for concentrated drug solutions and solids.

**Pre: ChE 362 & ChE 464**

**ChE 590A Special Topics A (3 Cr. Hr.)**
Title and course contents of the topic must be approved by the Department's Council and pre-announced by the Department of Chemical Engineering. **Pre: Department Council Approval**

**ChE 590B Special Topics B (2 Cr. Hr.)**
Title and course contents of the topic must be approved by the Department's Council and pre-announced by the Department of Chemical Engineering. **Pre: Department Council Approval**

**ChE 590C Special Topics C (1 Cr. Hr.)**
Title and course contents of the topic must be approved by the Department's Council and pre-announced by the Department of Chemical Engineering. **Pre: Department Council Approval**

**ChE 591 Graduation Project I (1 Cr. Hr.)**
Theoretical and/or experimental investigation of a problem in chemical engineering, or design and development of a chemical process. A student or a group of students undertake an independent project under the supervision of a faculty member. The general objectives are to improve the student's skills and creativity, and to give him/her the experience of problem solving through integration of chemical engineering principles.

**Pre: Completion of 114 Cr. Hr. & ChE 575 or Co**

**ChE 592 Graduation Project II (3 Cr. Hr.)**
Completion of the same project started in CHE 591 with more details, theoretical and/or experimental work, design and calculations. **Pre: ChE 591**