Jordan University of Science and Technology

Faculty of Engineering

Department of Chemical Engineering

Curriculum for the Bachelor of Science Degree in Chemical Engineering

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2019

Important Contacts

Jordan University of Science and Technology

P.O. Box: 3030 Irbid 22110 Jordan

Tel: (962) 2-7201000

Fax: (962) 2-7095141

E-mail: prsdy@just.edu.jo

Faculty of Engineering

Tel: (962) 2-7201000 Ext. 22525

Fax: (962) 2-7201074

E-mail: eng@just.edu.jo

Department of Chemical Engineering

Tel: (962) 2-7201000 Ext: 22380

Fax: (962) 2-7201074

E-mail: chemeng@just.edu.jo

Deanship of Students affairs

Tel: (962) 2-7201000 Ext: 22543

Fax: (962) 2-7201043

E-mail: studentaffairs@just.edu.jo

Admission and registration unit

Tel: (962) 2-7201000 Ext: 27174

Fax: (962) 2-7095145

E-mail: register@just.edu.jo

International Students Office

Tel: (962) 2-7201000 Ext: 23040

Fax: (962) 2-7201025

E-mail: iso@just.edu.jo

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.

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 experienced 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.

Student Outcomes:

Upon completion of the degree program, students will have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Curriculum for the Bachelor of Science Degree in Chemical Engineering

Numbering and coding system of the curriculum courses.

Course Coding

The following codes are used to designate courses:

Department			Level/year	Course Topic	Academic Semester
A	B	C	x	Y	z

The Faculty of Engineering Departments codes (A, B, C) are as follows:

Code	Department	Code	Department
AE	Aeronautical Engineering	EE	Electrical Engineering
BME	Biomedical Engineering	IE	Industrial Engineering
ChE	**Chemical Engineering**	ME	Mechanical Engineering
CE	Civil 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 or level, and semester offered.
- The symbol (ChE xyz) denotes Chemical Engineering and (xyz) is a 3-digits number.

A. The first digit (x) denotes the year level of the course according to student's study plan as follows:

Code	Level/year
1	First year
2	Second year
3	Third year
4	Fourth year
5	Fifth year

B. The second digit (y) denotes the field of the course 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

C. The third digit (z) denotes sequence of the semester

Example: ChE 345 (Heat Transfer) means

ChE	3	4	5
Chemical Engineering	Level (Third year)	Field (Thermal and Fluid Sciences)	Sequence (1st Semester)

Curriculum

A Bachelor of Science (B.Sc.) degree in Chemical Engineering at JUST is awarded in accordance with the statute stated by JUST regulations (adjusted) 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 160 credit hours, distributed as indicated in the following table.

Distribution of Credit hours

Classification	Credit hours		
	Compulsory	Elective	Total
University Requirements	16	9	25
Faculty Requirements	32	-	32
Department Requirements	88	15	103
Total	136	24	160

A. University Requirements (25 Credit Hours)

Students are required to study a total of 25 credit hours (16 compulsory and 9 electives), as follows:

1. Compulsory University Requirements (16 Credit Hours)

Course No.	Course title	Credit hours	Theoretical	Practical
MS 100 (1)	Military sciences	3	3	-
ARA 101	Arabic language	3	3	-
HSS 110	Social responsibility	3	3	-
HSS119(2)	Entrepreneurship and Innovation	2	2	-
LG 112	English language 2	3	3	-
HSS129	General skills	2	2	-

(1) This course is required from Jordanian students only; non-Jordanian students can take a substitute for this course from the university elective courses.
(2) Faculty of Engineering students must take "HSS119A" Introduction to Engineering Innovation and Entrepreneurship instead of "HSS119" Entrepreneurship and Innovation.

Note: All non-Arabic speaking students in the university are required to study the following courses:

Course No.	Course title	Credit hours	Theoretical	Practical
ARB 101A	Fundamentals of Arabic Language for non-Arabic speaking students (as a substitute for the course ARB 101)	3	3	-
HSS 110A	Social responsibility (in English) (as a substitute for the course HSS 110)	3	3	3

2. Elective courses (9 credit hours)

A total of 9 credit hours is required.

B. Faculty Requirements: (32 credit hours) distributed as follows:

Course No.	Course title	Credit hours	Theoretical	Practical	Prerequisite or co-requisite
Math 101	Calculus 1	3	3	-	-
Math 102	Calculus 2	3	3	-	Math 101
Math 201	Intermediate Analysis	3	3	-	Math 102
Math 203	Ordinary Differential Equations I	3	3	-	Math 102
Phys 101	General Physics 1	3	3	-	-
Phys 102	General Physics 2	3	3	-	Phys 101
Phys 107	General Physics Lab	1	-	1	Pre/Co Phys 102
CHEM 101	General Chemistry 1	3	3	-	-
CHEM 102	General Chemistry 2	3	3	-	CHEM 101
CHEM 107	General Chemistry Lab	1	-	1	Pre/Co CHEM 102
NE 100*	Introduction to Engineering	1	1	-	-
NE 114	Programming for Engineers	3	2	2	-
ME 100	Engineering Workshops	1	-	1	-
ME 200	Engineering Drawing - A	1	-	1	-
Total		**32**	**27**	**6**	

***Online course**

C. Department requirements: (103 Credit Hours) distributed as follows:

1. Department Compulsory Courses (88 credit hours) distributed as follows:

I. Chemical Engineering Compulsory Courses (78 credit hours)

Course No.	Course title	Credit hours	Theoretical	Practical	Prerequisite
ChE 102	Introduction to Chemical Engineering	1	1	0	CHEM 102 (or Co)
ChE 202	Numerical Methods for Chemical Engineers	3	3	0	Math 201, Math 203(Passing), NE 114
ChE 203	Fundamentals of Chemical Engineering	4	3	1	CHEM 102, ChE 102 (Passing)
ChE 242	Engineering Thermodynamics	3	3	0	ChE 203
ChE 244	Fluid Mechanics for Chemical Engineers	3	3	0	ChE 203 (Passing)
ChE 303*	Communication Skills for Engineers	2	2	0	**LG 112**
ChE 311	Materials Science and Engineering	3	3	0	CHEM 347
ChE 332	Chemical Reaction Engineering I	3	3	0	ChE 202, CHEM 347,
ChE 341	Chemical Engineering Thermodynamics	3	3	0	ChE 242 (Passing)
ChE 345	Heat Transfer	3	3	0	ChE 244 (Passing), ChE 202 (or Co)
ChE 347	Fluid Mechanics Lab.	1	0	1	ChE 244
ChE 362	Unit Operations	3	3	0	ChE 345
ChE 364	Mass Transfer	3	3	0	ChE 341, ChE 345
ChE 401	Engineering Economy	2	2	0	ChE 362
ChE 422*	Chemical industries	3	3	0	ChE 463
ChE 433	Chemical Reaction Engineering II	3	3	0	ChE 332 (Passing)

Course No.	Course title	Credit hours	Theoretical	Practical	Prerequisite
ChE 436	Chemical Reaction and Processing Lab.	1	0	1	ChE 433 (or Co)
ChE 445	Heat & Mass Transfer Lab.	1	0	1	ChE 347, ChE 364
ChE 452	Applied Mathematics and Modeling for Chemical Engineers	3	3	0	ChE 433 (or Co)
ChE 454	Computer Applications Lab. For Chemical Engineers	1	0	1	ChE 471 (or Co)
ChE 456	Instrumental Analysis	3	3	0	ChE 463
ChE 462	Extractive Metallurgy	3	3	0	ChE 312, ChE 362
ChE 463	Separation Processes	3	3	0	ChE 364
ChE 471	Equipment Design	3	3	0	ChE 312, ChE 463 (or Co)
ChE 490[1]	Engineering Training	3	0	3	Completion of 117 Cr. Hr.
ChE 551	Process Dynamics and Control	3	3	0	ChE 452
ChE 552	Process Control Lab.	1	0	1	ChE 551
ChE 565	Unit Operations Lab.	1	0	1	ChE 362, ChE 463, ChE 445
ChE 575	Plant Design	3	3	0	ChE 401, ChE 471
ChE 578	Chemical Process Safety	2	2	0	ChE 575 (or Co)
ChE 591	Graduation Project I	1	1	0	Completion of 117 Cr. Hr., ChE 575 (or Co)
ChE 592	Graduation Project II	3	3	0	ChE 490, ChE 591
TOTAL		**78**	**68**	**10**	

* May be delivered as an online course.

[1] 8 weeks of practical training in a by-Faculty accredited institution pertaining to chemical engineering

II. Compulsory Courses from Other Departments (10 credit hours):

Course No.	Course title	Credit hours	Theoretical	Practical	Prerequisite
EE 303	Principles of Electrical Engineering	3	3	0	Phys 102, Math 102
CHEM 217	Organic Chemistry	3	3	0	CHEM 102
CHEM 218	Organic Chemistry Practical	1	0	1	CHEM 217 (or Co)
CHEM 347	Physical Chemistry II	3	3	0	ChE 242
TOTAL		**10**	**9**	**1**	

2. Department Technical Electives (15 credit hours):

The student is advised to select courses (15 Credit Hours) from the following tables:

I. Chemical Engineering Technical Elective Courses

Course No.	Course title	Credit hours	Theoretical	Practical	Prerequisite
ChE 411	Corrosion Engineering	3	3	0	ChE 312
ChE 412	Polymer Science and Technology	3	3	0	CHEM 217, ChE 332
ChE 415	Ceramics Engineering	3	3	0	ChE 312
ChE 424	Petroleum Refining Engineering	3	3	0	CHEM 217, ChE 463
ChE 426	Food Engineering	3	3	0	ChE 362, ChE 364
ChE 450	Experimental Design and Data Analysis	3	3	0	ChE 202

ChE 457	Introduction to Optimization	3	3	0	ChE 202
ChE 484	Air Pollution	3	3	0	ChE 362, ChE 364
ChE 518	Electrochemical Engineering	3	3	0	ChE 332, ChE 364
ChE 528	Pharmaceutical Process Engineering	3	3	0	ChE 463
ChE 543	Renewable Energy	3	3	0	ChE 341, ChE 345
ChE 545	Energy and Analysis of Fossil Fuels	3	3	0	ChE 433, ChE 364
ChE 546	Oil Shale Technology	3	3	0	ChE 362
ChE 562	Hydrometallurgy	3	3	0	ChE 362
ChE 566	Desalination	3	3	0	ChE 364
ChE 568	Gas Processing and Treatment	3	3	0	ChE 463 (or Co)
ChE 581	Membrane Separation Processes	3	3	0	ChE 364
ChE 583	Physical and Chemical Water Treatment	3	3	0	ChE 463 (or Co)
ChE 585	Biochemical Engineering	3	3	0	ChE 332, ChE 364
ChE 587	Biological Wastewater Treatment	3	3	0	ChE 362
ChE 590 A	Special Topics A	3	3	0	Completion of 100 Cr. Hr.
ChE 590 B	Special Topics B	2	2	0	Completion of 100 Cr. Hr.
ChE 590 C	Special Topics C	1	1	0	Completion of 100 Cr. Hr.

* May be delivered as an online course.

I. Technical Elective Courses from other Engineering Departments
(Students are allowed to take one course from this list)

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
ME 528	Thermal Power Plants	3	3	0	ChE 341
ME 581	Heating, Ventilation and Air Conditioning	3	3	0	Completion of 100 Cr. Hr.
ME 582	Refrigeration	3	3	0	Completion of 100 Cr. Hr.
IE 545	Project Management	3	3	0	Completion of 100 Cr. Hr.
IE 547	Facilities Planning	3	3	0	Completion of 100 Cr. Hr.
IE 556	Total Quality Management	3	3	0	Completion of 100 Cr. Hr.
IE 560	Reliability and Maintenance Management	3	3	0	Completion of 100 Cr. Hr.

Study Plan

First Year (Preparatory Year for the College of Engineering)											
First semester						Second semester					
Course No.	Course Name	Credit Hours	Weekly hours		Prerequisite	Course No.	Course Name	Credit Hours	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
ME 100	Engineering Workshops	1	-	3	-	ME 200	Engineering Drawing A	1	-	3	-
HSS 119 A	Introduction to Engineering Innovation and Entrepreneurship	2	2	-	-	ARB 101	Arabic Language	3	3	-	-
MATH 101	Calculus 1	3	3	-	-	MATH 102	Calculus 2	3	3	-	MATH 101
PHYS 101	General physics 1	3	3	-	-	CHEM 102	General Chemistry 2	3	3	-	CHEM 101
CHEM 101	General Chemistry 1	3	3	-	-	CHEM 107	General Chemistry lab.	1	-	3	CHEM 102 (or Co.)
NE 114	Programming For Engineers	3	2	2	-	PHYS 102	General Physics 2	3	3	-	PHYS 101
NE 100	Introduction to Engineering	1	1	-	-	PHYS 107	General Physics lab.	1	-	3	PHYS 102 (or Co.)
						ChE 201	Introduction to Chemical Engineering	1	1	-	CHEM 102 (or Co)
Total		**16**	**14**	**5**		**Total**		**16**	**13**	**9**	

SECOND YEAR											
First semester						Second semester					
Course No.	Course name	Total Credits	Weekly hours		Prerequisite	Course No.	Course name	Total Credits	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
ChE 203	Fundamentals of Chemical Engineering	4	3	2	CHEM 102 (Passing), ChE 102	ChE 202	Numerical Methods for Chemical Engineers	3	3	-	MATH 201, MATH 203 (Passing), NE 114
MATH 201	Intermediate Analysis	3	3	-	MATH 102	ChE 242	Engineering Thermodynamics	3	3	-	ChE 203
MATH 203	Ordinary Differential Equations	3	3	-	MATH 102	ChE 244	Fluid Mechanics for Chemical Engineers	3	3	-	ChE 203 (Passing)
CHEM 217	Organic Chemistry	3	3	-	CHEM 102	CHEM 218	Organic Chemistry Practical	1	-	3	CHEM 217 (or Co)
LG 112	English Language 2	3	3	-	Pass ENG 99 or pass the displacement exam with grade greater than 50%	HSS 110	Social Responsibility	3	2	1	-
						HSS 129	General Skills	2	2	-	LG 112
Total		**16**	**15**	**2**		**Total**		**15**	**13**	**4**	

THIRD YEAR											
First semester						Second semester					
Course No.	Course name	Total credit	Weekly hours		Prerequisite	Course No.	Course name	Total credit	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
CHEM 347	Physical Chemistry II	3	3	-	ChE 242	ChE 312	Materials Science and Engineering	3	3	-	CHEM 347
ChE 303*	Communication Skills for Engineers	2	2	-	LG 112	ChE 332	Chemical Reaction Engineering I	3	3	-	ChE 202, CHEM 347, ChE 341
ChE 341	Chemical Engineering Thermodynamics	3	3	-	ChE 242 (Passing)	ChE 362	Unit Operations	3	3	-	ChE 345
ChE 345	Heat Transfer	3	3	-	ChE 244 (Passing), ChE 202 (Or Co)	ChE 364	Mass Transfer	3	3	-	ChE 341, ChE 345
ChE 347	Fluid Mechanics Lab.	1	-	3	ChE 244	-	University Elective 1	3	3	-	-
EE 303	Principles of Electrical Engineering	3	3	-	Phys 102, MATH 102	MS 100	Military Sciences	3	3	-	-
Total		**15**	**14**	**3**		**Total**		**18**	**18**	**0**	

* May be delivered as an online course.

FOURTH YEAR											
First semester						Second semester					
Course No.	Course name	Total credits	Weekly hours		Prerequisite	Course No.	Course name	Total credits	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
ChE 401	Engineering Economy	2	2	-	ChE 362	ChE 422*	Chemical Industries	3	3	-	ChE 463
ChE 433	Chemical Reaction Engineering II	3	3	-	ChE 332 (Passing)	ChE 436	Chemical Reaction and Processing Lab.	1	-	3	ChE 433 (or Co)
ChE 445	Heat & Mass Transfer Lab.	1	-	3	ChE 347, ChE 364	ChE 452	Applied Mathematics & Modeling For Chemical Engineers	3	3	-	ChE 202, ChE 433 (or Co)
ChE 463	Separation Processes	3	3	-	ChE 364	ChE 454	Computer Applications Lab. for Chemical Engineering	1	-	3	ChE 471(or Co)
ChE 471	Equipment Design	3	3	-	ChE 312, ChE 463 (or Co)	ChE 456	Instrumental Analysis	3	3	-	ChE 463
-	Technical Elective 1	3	3	-	-	ChE 462	Extractive Metallurgy	3	3	-	ChE 312, ChE 362
-	University Elective 2	3	3	-	-	-	Technical Elective 2	3	3	-	-
Total		**18**	**17**	**3**		**Total**		**17**	**15**	**6**	

* May be delivered as an online course.

SUMMER SEMESTER					
Course No.	Course name	Total credit	Weekly hours		Prerequisite
			Lecture	Lab	
ChE 490	Engineering Training	3	-	-	Completion of 117 Credit Hours
Total		**3**		-	

FIFTH YEAR											
First semester						Second semester					
Course No.	Course name	Total credit	Weekly hours		Prerequisite	Course No.	Course name	Total credit	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
ChE 551	Process Dynamics & Control	3	3	-	ChE 452	ChE 552	Process Control Lab.	1	-	3	ChE 551
ChE 565	Unit Operation Lab.	1	-	3	ChE 362, ChE 445, ChE 463	ChE 578	Chemical Process Safety	2	2	-	ChE 575 (or Co)
ChE 575	Plant Design	3	3		ChE 401, ChE 471	ChE 592	Graduation Project II	3	-	-	ChE 490, ChE 591
ChE 591	Graduation Project I	1	-	-	ChE 575 (or Co) Completion of 117 Cr. Hr.	-	Technical Elective 4	3	3	-	-
-	Technical Elective 3	3	3	-	-	-	Technical Elective 5	3	3	-	-
-	University Elective 3	3	3	-	-						
Total		**14**	**12**	**3**		**Total**		**12**	**8**	**3**	

Course Catalogue

ChE 102 Introduction to Chemical Engineering (1 Cr. Hr.) (Prerequisite: CHEM 102 or Co)
The scope of Chemical Engineering, chemical processes, problem solving and team work, ethical considerations (academic integrity and professional ethics), units and dimensions, data analysis, manipulation and representation, applications of spreadsheets.

ChE 202 Numerical Methods for Chemical Engineers (3 Cr. Hr.) (Prerequisite: MATH 201, MATH 203 (Passing), NE 114)
Introduction to numerical solution, approximations, rounding, and errors, solving non-linear equations, solving system of linear and nonlinear equations, least-squares curve fitting, polynomial interpolation, splines interpolation, numerical differentiation, numerical integration, solving differential equations (ODE's and PDE's), computer applications (MATLAB and spreadsheets).

ChE 203 Fundamentals of Chemical Engineering (4 Cr. Hr.) (Prerequisite: ChE 102, CHEM102 (Passing))
The role of chemical processing, material balances (non-reactive and reactive processes), physical properties estimation, multiphase systems, energy balances (non-reactive and reactive processes), balances on transient processes.

ChE 242 Engineering Thermodynamics (3 Cr. Hr.) (Prerequisite: ChE 203)
Forms of energy and their conversion, open and closed systems, work and heat, PVT properties of pure fluids, steam tables**,** first law of thermodynamics, second law of thermodynamics, entropy concept and zeroth law of thermodynamics, third law of thermodynamics (open and closed systems), analysis of power cycles (steam power plants and refrigeration).

ChE 244 Fluid Mechanics for Chemical Engineers (3 Cr. Hr.) (ChE 203 (Passing))
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.

ChE 303* Communication Skills for Engineers (2 Cr. Hr.) (Prerequisite: LG 112)
Managing technical data and writing for the workplace, memorandums, letters, applications, and research projects, building presentation skills through several individual and team presentations, focusing on style of delivery, and interaction with audience, job interview skills.

ChE 312 Materials Science and Engineering (3 Cr. Hr.) (Prerequisite: CHEM 347)
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.

ChE 332 Chemical Reaction Engineering I (3 Cr. Hr.) (Prerequisite: ChE 202, CHEM 347, ChE 341)
Kinetics of homogeneous reactions, mole balance, design of isothermal reactors (batch, CSTR, PBR, and plug flow), single and multiple ideal reactors, non-elementary homogeneous reactions, multiple reactions, collection and analysis of reaction rate data.

ChE 341 Chemical Engineering Thermodynamics (3 Cr. Hr.) (Prerequisite: ChE 242 (Passing))
Heat Effects, phase rule, thermodynamic properties of pure compounds, gas mixtures & Liquid Solutions, Kay's rule, vapor-liquid equilibria. liquid-liquid equilibria, chemical reaction equilibria.

ChE 345 Heat Transfer (3 Cr. Hr.) (Prerequisite: ChE 244 (Passing), ChE 202 or Co)
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.

ChE 347 Fluid Mechanics Lab. (1 Cr. Hr., 3 Hrs. Lab.) (Prerequisite: ChE 244)
Density, viscosity and surface tension measurements, pressure and flow measurements, friction and Reynolds tests, impact of a water jet, center of pressure, pumps' testing.

ChE 362 Unit Operations (3 Cr. Hr.) (Prerequisite: ChE 345 (or Co))
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 sedimentation processes, separation by centrifuges, separation by cyclones, evaporation.

ChE 364 Mass Transfer (3 Cr. Hr.) (Prerequisite: ChE 345, ChE 341)
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.

ChE 401 Engineering Economy (2 Cr. Hr.) (Prerequisite: ChE 362)
Economic concepts, supply and demand relations, interest and investment costs, taxes, insurance, depreciation, inflation, cash flow, profitability measures, estimation of unit operation and production cost, feasibility studies, etc.

ChE 411 Corrosion Engineering (3 Cr. Hr.) (Prerequisite: ChE 312)
Electrochemical and metallurgical aspects of corrosion, Forms of corrosion, modern theory of corrosion and its application, iron and steel corrosion, corrosion prevention, case studies.

ChE 412 Polymer Science and Technology (3 Cr. Hr.) (Prerequisite: CHEM 217, ChE 332)
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.

ChE 415 Ceramics Engineering (3 Cr. Hr.) (Prerequisite: ChE 312)
Crystalline structure, phase diagrams, ceramic materials and properties, cement, glass, porcelain, bricks and pottery, ceramic processing, extrusion, pressing, glazing, and finishing processes.

ChE 422* Chemical Industries (3 Cr. Hr.) (Prerequisite: ChE 463)
Fundamentals of chemical and metallurgical 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.

ChE 424 Petroleum Refining Engineering (3 Cr. Hr.) (Prerequisite: CHEM 217, ChE 463)
Origin and composition of petroleum, crude oil analysis and evaluation, petroleum products and their uses, refinery structure, refinery operations and processes, atmospheric and vacuum distillation, fluid catalytic cracking, platforming, hydro-desulfurization and hydrotreating, chemical treatment, asphalt production, lube oils production, refinery utilities, waste treatment, standards and specifications.

ChE 426 Food Engineering (3 Cr. Hr.) (Prerequisite: ChE 362, ChE 364)
Rheological properties of food, phase transitions and transformations in food systems, food freezing, food dehydration, transport phenomena in food systems, food packaging.

ChE 433 Chemical Reaction Engineering II (3 Cr. Hr.) (Prerequisite: ChE 332 Passing)
Energy balance for ideal reactors, non-isothermal reactor design, stability of CSTR's, non-ideal reactors and residence time distribution, catalytic reaction mechanism, design of catalytic reactors, deactivation of catalyst.

ChE 436 Chemical Reaction and Processing Lab. (1 Cr. Hr., 3 Hr. Lab.) (Prerequisite: ChE 433)
Batch reactor, tubular reactor, CSTR, dynamics of stirred tanks in series, residence time distribution, water treatment, flocculation, oil extraction, and phosphoric acid production.

ChE 446 Heat & Mass Transfer Lab. (1 Cr. Hr., 3 Hr. Lab.) (Prerequisite: ChE 347, ChE 364)
Temperature measurements, heat conduction in solids, free and forced convection, thermal conductivity of liquids and gases, shell-and-tube heat exchangers, saturation pressure and throttling, mass transfer and diffusion coefficients of liquids and gases, wetted-wall gas absorption (convective mas transfer).

ChE 450 Experimental Design and Data Analysis (3 Cr. Hr.) (Prerequisite: ChE 202)
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.

ChE 452 Applied Mathematics and Modeling for Chemical Engineers (3 Cr. Hr.) (Prerequisite: ChE 433 (or Co), ChE 202)
Introduction to mathematical modeling, modeling steady state processes, degree of freedom analysis, heat integration, solution techniques for ODE's, distributed models development, Laplace transformation, modeling dynamic behavior of processes, computer applications for model analysis.

ChE 454 Computer Applications Lab. for Chemical Engineers (1 Cr. Hr., 3 Hr. Lab.) (Prerequisite: ChE 471 or Co)
Introduction to process simulation, the Aspen one packages, Aspen Plus user interface, physical and thermodynamic properties, pressure changer units, heat exchangers, flow sheet analysis, reactions and reactors, equilibrium separation processes.

ChE 456 Instrumental Analysis (3 CR. Hr.) (Prerequisite: ChE 463)
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.

ChE 457 Introduction to Optimization (3 Cr. Hr.) (Prerequisite: ChE 202)
Survey of continuous optimization problems, unconstrained optimization problems, introduction to constrained optimization, solution of constrained optimization problems, software packages in optimization.

ChE 462 Extractive Metallurgy (3 Cr. Hr.) (Prerequisite: ChE 312 and ChE 362)
Scope of extractive metallurgy, chemistry of metals, classification of metals, Classification of ores and ore preparation, extraction of metals from ores, pyrometallurgy (copper and iron) and hydrometallurgy (Cu, Al, Au, and U), unit operations and technology aspects, thermodynamics and kinetics of extractive processes.

ChE 463 Separation Processes (3 Cr. Hr.) (Prerequisite: ChE 364)
Binary and multi-component distillation, humidification and dehumidification, drying, extraction, and leaching.

ChE 472 Equipment Design (3 Cr. Hr.) (Prerequisite: ChE 312, ChE 463 (or Co))
Selection of materials of construction, design of pipes and pumping systems, compressors, tanks, pressure vessels, storage equipment, heat exchangers, and plate and packed towers.

ChE 484 Air Pollution (3 Cr. Hr.) (Prerequisite: ChE 362, ChE 364)
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.

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

ChE 518 Electrochemical Engineering (3 Cr. Hr.) (Prerequisite: ChE 332, ChE 364)
Basics of electrochemistry, mass transfer in electrochemical systems, electrochemical applications, batteries, fuel cells, electroplating, electrolytic industries, metal recovery from electrochemical process wastes.

ChE 528 Pharmaceutical Process Engineering (3 Cr. Hr.) (Prerequisite: ChE 463)
Industrial processes in the pharmaceutical industry, manufacture of conventional solid and liquid dosage forms, mixing, granulation, tableting, coating, encapsulation, and crystallization.

ChE 543 Renewable Energy (3 Cr. Hr.) (Prerequisite: ChE 341, ChE 345)
Wind, solar, hydraulic, geothermal, tidal power, solid wastes, biofuels, etc., nuclear energy, fuel cells, hybrid systems.

ChE 545 Energy and Analysis of Fossil Fuels (3 Cr. Hr.) (Prerequisite: ChE 364, ChE 433)
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 pyrolysis, steam and gas generation, power cycles.

ChE 546: Oil Shale Technology (3 Cr. Hr.) (Prerequisite: ChE 362)
Formation of oil shale–geological background, distribution and reserves of oil shale in the world and in Jordan, oil shale composition and methods of characterization and analysis, oil shale as an energy source, methods of oil shale utilization for energy production (pyrolysis, gasification, combustion and solvent extraction), industrial processes for oil shale utilization, environmental issues of oil shale technology, effluent gases, wastewater and solid residue.

ChE 551 Process Dynamics and Control (3 Cr. Hr.) (Prerequisite: ChE 452)
Introduction to practical and theoretical aspects of process control, process modeling, transfer functions, MATLAB, dynamics of open-loop systems, feedback control system, instruments of control system, control laws (P, PI, PD and PID), block diagrams, dynamics of closed-loop systems, stability analysis, root-locus analysis, tuning of controllers, frequency analysis, Bode stability, cascade control, feed-forward control, other control schemes.

ChE 552 Process Control Lab. (1 Cr. Hr., 3 Hr. Lab.) (Prerequisite: ChE 551)
Temperature control, level control, pressure control, flow control, and process module.

ChE 562: Hydrometallurgy (3 Cr. Hr.) (Prerequisite: ChE 462)
The chemistry and engineering aspects of hydrometallurgical unit processes - leaching, separation, extraction and recovery, extraction techniques will include the oxidative and non-oxidative leaching of minerals, purification and recovery of metals by precipitation, ion exchange and solvent extraction, recovery of metals by reduction and electrowinning, chemistry, design and operation of some common hydrometallurgical processes.

ChE 565 Unit Operations Lab. (1 Cr. Hr., 3 Hr. Lab.) (Prerequisite: ChE 362, ChE 463)
Packed and tray distillation, packed-column gas absorption, liquid-liquid extraction, humidification/dehumidification in cooling towers, spray drying, tray drying, evaporation, fluidization, screen analysis and size reduction.

ChE 566 Desalination (3 Cr. Hr.) (Prerequisite: ChE 364)
Physical and chemical properties of sea water, scale formation and control, distillation processes, membrane processes, energy consumption in the different desalting systems.

ChE 568 Gas Processing and Treatment (3 Cr. Hr.) (Prerequisite: ChE 463 (or Co))
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.

ChE 575 Plant Design (3 Cr. Hr.) (Prerequisite: ChE 401, ChE 471)
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, codes of ethics, case studies.

ChE 578 Chemical Process Safety (2 Cr. Hr.) (Prerequisite: ChE 575 (or Co))
Safety in the industry, accident analysis, toxicology, industrial hygiene, chemicals release source models, toxic release and dispersion models, fires and explosions, design to prevent fires and accidents, reliefs and relief sizing, hazards identification, risk assessment.

ChE 581 Membrane Separation Processes (3 CR. Hr.) (Prerequisite: ChE 364)
Membranes and module preparation: symmetrical, asymmetrical, ceramic and metal, and liquid membranes, microfiltration, ultrafiltration, reverse osmosis, gas separation, pervaporation, electrodialysis, enhanced transport, membrane distillation.

ChE 583 Physical and Chemical Water Treatment (3 Cr. Hr.) (Prerequisite: ChE 463 (or Co))
Water quality, sedimentation, thickening and flotation, filtration and centrifugation, adsorption, membrane separation processes, chemical equilibria in aqueous systems, coagulation, ion exchange, oxidation and disinfection.

ChE 585 Biochemical Engineering: (3 Cr. Hr.) (Prerequisite: ChE 332, ChE 364)
Introduction to microbiology and biochemistry, enzyme engineering, enzyme kinetics, biomass production in cell cultures, preparation of cell culture media, fermentation systems, sterilization, agitation and aeration, design and scale-up of biochemical reactors, industrial bioseparation processes.

ChE 587 Biological Wastewater Treatment (3 Cr. Hr.) (Prerequisite: ChE 362)
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.

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

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

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

ChE 591 Graduation Project I (1 Cr. Hr.) (Prerequisite: Completion of 117 Cr. Hr. and ChE 575 (or Co))
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.

ChE 592 Graduation Project II (3 Cr. Hr.) (Prerequisite: ChE 490, ChE 591)
Completion of the same project started in CHE 591 with more details, theoretical and/or experimental work, design and calculations.

* May be delivered as an online course.