UNDERGRADUATE STUDENT GUIDE

THE DEPARTMENT OF CHEMICAL ENGINEERING
COLLEGE OF ENGINEERING
UNIVERSITY OF UTAH

Geoff Silcox
Associate Chair
50 S Central Campus Drive RM 3290 MEB
University of Utah, Salt Lake City, UT 84112-9203
Tel. 801-581-8820
E-mail: geoff@che.utah.edu

Catalog Year 2007-2008

Table of Contents

I. What is Chemical Engineering?

A chemical engineer applies chemical and engineering knowledge to several fields—environmental protection, pollution prevention, biotechnology, electronics, chemistry, petroleum, medicine, and law. Chemical engineers are involved in research, development (taking a process from bench scale to full scale), design and evaluation (how should the process work), plant design (how should the chemical plant be built), plant operation, sales, management, and academics.

Chemical engineers are responsible for making the probable possible. They have developed the synthetic rubber used for tires, translated laboratory breakthroughs in the drug industry to large-scale, low-cost production facilities, and changed daily life with the development of plastics and synthetic fabrics. Chemical engineers in the fertilizer industry are helping in the fight against world hunger. The chemical engineer is flexible, and possesses a fundamental background and a highly developed ability to analyze and solve new problems. This training and knowledge enable the chemical engineer to enter entirely new areas of research and development with success. The chemical engineering profession is moving into several exciting nontraditional areas that require engineers to have an even broader background in chemistry, mathematics, physics, and biology. These areas include biotechnology and biomedicine; electronic, photo optic, and recording materials and devices; and microstructured materials such as ceramics, polymers, and composites. Each of these specialties utilize chemical engineering principles and expertise to provide better health, improve the environment, develop more efficient chemical production methods, and fabricate exciting new materials.

Every chemical engineer is an environmental engineer. Our graduates regularly deal with the environmental consequences of the production and use of chemical, biological, forest and food products, and of fuels and power. Many chemical engineers work in environmental control agencies and in consulting and control firms. While a degree in Environmental Engineering at the University of Utah is offered only at the graduate (master's and Ph.D.) level (http://www.eegp.utah.edu/ or contact the Environmental Engineering Program Office, 581-6931), interested Chemical Engineering undergraduates may choose to specialize in this area and satisfy their B.S. Chemical Engineering elective requirements by taking fundamental courses in environmental engineering (see the section below on Technical Electives).

Unlimited opportunities for development of interests in either scientific or applied pursuits are offered in the chemical engineering field. Chemical engineers are vital players in improving our standard of living and initiating social change. Employment opportunities for our graduates are excellent, and salaries are among the highest for B.S. engineers.

II. Welcome and General Information

It is our pleasure to welcome you to the University of Utah and to our department. We hope that your first year will be an exciting and rewarding experience for you. This guide is designed to answer most of your questions regarding the policies and procedures of the University and the Department. We also recommend that you make an appointment with a student advisor in our department so that you can plan your education and understand the requirements in Chemical Engineering. Our student advisors are listed below.

	Advisor	**Telephone**	**E-mail**
Primary Advisor	Jenny Jones	585-7175	jones.jenny@eng.utah.edu
Auxiliary Advisor	Geoff Silcox	581-8820	geoff@che.utah.edu

You can also find answers using the web sites listed below.

University of Utah	http://www.utah.edu
College of Engineering	http://www.coe.utah.edu
Department of Chemical Engineering	http://www.che.utah.edu

Our Department, which is located at the north end of campus in the Merrill Engineering Building (MEB), is one of several chemical engineering programs in the Intermountain West. **The Bachelor of Science degree in chemical engineering in our department is accredited by the Accreditation Board for Engineering and Technology (ABET) with the concurrence of the American Institute of Chemical Engineers.** There are many opportunities for the undergraduate student to interact directly with the faculty, both inside and outside of class. The department's faculty have diverse research interests, are internationally known for their engineering and scientific contributions, and many have extensive industrial experience. In addition, several members of the faculty have received the University's Distinguished Teaching Award.

Research is an important part of the department and offers the undergraduate student an opportunity to work individually with a professor on a specific engineering problem. This can be done as either a B.S. Senior Thesis or as part of the University's Undergraduate Research Program. Much of the research that is carried out in the department reflects the strengths of the broader industrial and academic community in Utah. Interests include combustion, polymer science, fluid flow, solid waste incineration, and biotechnology.

The department participates in several university research centers that enable students to collaborate with other students and professors throughout campus on interdisciplinary problems.

Mission

The mission of the Department of Chemical Engineering is to cultivate an environment through teaching, research, and service that foster the technical, critical thinking, and communication skills necessary for students and faculty to contribute to the engineering profession and to the well-being of society.

Objectives

1. Graduates will be able to analyze problems, design experiments, obtain solutions, evaluate information, and communicate results both individually and as part of a team.
2. Graduates will continue to broaden their education outside engineering and will engage in life-long learning.
3. Graduates will continue to learn about fundamental and current issues in chemical engineering and will use this knowledge to improve society and strengthen their profession.
4. Graduates will practice their profession with honesty, integrity and a strong engineering and work ethic.

III. Admission Policy

All students are admitted to Chemical Engineering with pre-chemical engineering status and are encouraged to meet with a departmental advisor to review program requirements and to ensure understanding of what is needed to make satisfactory progress toward degree completion. Initial meetings with an advisor often occur as part of the University's orientation program. The program requirements are summarized in our Undergraduate Handbook that is available on the web (http://www.che.utah.edu/%7Egeoff/FROSHGUIDE00c.pdf) and in hardcopy.

After completion of first year courses, students apply for ***Intermediate Status*** via online application. Intermediate Status is required before students can apply for ***Major Status***. Major Status is required before students take their third and fourth year engineering classes.

INTERMEDIATE STATUS

A student may apply for intermediate status after the following courses have been completed:

- CHEM 1210 and 1215 (General Chemistry I and lab)
- MATH 1210 (Calculus I)

In addition, applicants must have completed or be currently enrolled in the following courses.

- CHEM 1220 and 1225 (General Chemistry II and lab)
- MATH 1220 (Calculus II)
- CH EN 1703 (Intro. to Engineering Computing) or CPSC 1000
- CH EN 4753 or 4755 (Undergraduate Seminar)
- PHYS 2210 (Physics for Scientists and Engineers I)
- WRTG 2010 (lower-division writing requirement)

Effective 2008 February 15, admission to intermediate status requires an overall GPA of at least 2.5 in the above courses, with no individual grade below a C- being accepted. The department may count AP credit for some of these courses if appropriate scores are obtained (see Section V). Transfer students who wish to be admitted to intermediate status must complete a Transfer Agreement (http://www.che.utah.edu/~geoff/transfer_agre.xls) and meet with an advisor before they can apply. The advisor must approve all of the transfer credit by signing the Transfer Agreement.

You must apply for intermediate status online at http://www.che.utah.edu/undergraduate/applications/index.html. In order for your application to be approved, you must also meet with one of the department's undergraduate advisors.

MAJOR STATUS

In order to be admitted to major status, students must have been admitted to intermediate status. Effective 2008 February 1, admission to major status requires an overall GPA of 2.5, with no individual grade below a C- being accepted, in the following required chemical engineering course work:

- CH EN 2703 (Numerical Methods)
- CH EN 2300 (Thermodynamics I)
- CH EN 2800 (Process Engineering)

You must apply for major status online at http://www.che.utah.edu/undergraduate/applications/index.html.

Please note that degree candidates in Chemical Engineering must have a minimum cumulative GPA of 2.0 in required chemical engineering courses. Transfer GPA is not combined with U of U GPA for this 2.0 requirement. All required courses must be taken for a letter grade.

Students who complete their sophomore year at the U of U will normally apply for major status at the end of that year, by which time they will have completed the required courses. Transfer students who wish to be admitted to major status must first complete a Transfer Agreement (http://www.che.utah.edu/~geoff/transfer_agre.xls) and meet with an advisor before they can apply. The advisor must approve all of the transfer credit by signing the Transfer Agreement.

IV. Degree Requirements

In order for a student to obtain a B.S. degree in chemical engineering from our department he or she must satisfy both the University-wide degree requirements ***and*** the Departmental degree requirements. The University of Utah degree requirements are stated in the *General Catalog*. Many of these requirements are fulfilled through the department requirements. The department requirements are listed below and many of these are explained in detail in the following sections.

1. Completion of the course requirements listed under the departmental program of study below that includes the minimum number of undergraduate Seminar courses (4) and the required technical elective credits (18).
2. A minimum of 122 semester hours is required for a bachelor's degree of which 40 must be 3000 level or above. The program of study for a B.S. degree in Chemical Engineering requires 130 semester hours with well over 40 semester hours in the 3000 level or above category.
3. Satisfactorily completing the General Education and Bachelor's Degree Requirements for the University. The University has a Lower Division Writing requirement that is normally filled by completing Writing 2010 with a grade of C- or better, and an Upper-Division Communications/Writing requirement, which is normally filled by completing CH EN 4905. The Quantitative Reasoning requirement (QA and QB) can be satisfied with Calculus. The two B.S. Quantitative Intensive classes (QI) are normally filled by completing the required Chemical Engineering and Chemistry classes. Students are responsible for fulfilling the Diversity requirement, the American Institutions requirements, the Intellectual Explorations requirements, and the International Requirement. Chemical Engineering students can fulfill a General Education Humanities Exploration requirement and a technical elective requirement by completing PHIL 4540, Engineering, Ethics, and Society. There are three classes that will fulfill both the International Requirement and a technical elective requirement.
4. Meeting the University's residency requirement, that is, of the total hours for graduation, at least 30 must be earned in courses taken in residence at the University (correspondence courses, courses earned by exam or petition do not count). Twenty of the student's last 30 hours must be earned in residence at the University.
5. Degree candidates must have a minimum cumulative GPA of 2.0 in required chemical engineering courses. Transfer GPA is not combined with U of U GPA for this requirement. All required courses must be taken for letter grades.
6. Students must pass the morning (general engineering) and afternoon (chemical engineering) sessions of the Fundamentals of Engineering (FE) Exam (formerly the Engineering-In-Training Exam) which is administered by the State and which is nationally composed and graded. This exam is given twice yearly and should be taken at the earliest possible date in the senior year. Students who do not pass the FE exam after two attempts are permitted to petition the Undergraduate Committee for an exception to policy.

Departmental Program of Study

The Departmental Four Year Program of Study is listed on page 8. Although some students are able to complete the necessary course work in four years, most of our students do not, primarily because of other commitments, such as family and work. We have included a Five Year Program as a guide for those students on page 9. To avoid unnecessary loss of time, the student should make sure the prerequisites indicated under course descriptions in the University General Catalog are completed prior to the time the courses are taken. Courses taken without the stated prerequisites may not meet graduation requirements.

FOUR-YEAR PROGRAM IN CHEMICAL ENGINEERING (Catalogue Year 07-08)

FIRST YEAR

FALL SEMESTER	SPRING SEMESTER
MATH 1210 or 1270 Calculus I[1] (4)	MATH 1220 or 1280 Calculus II[1] (4)
CHEM 1210 General Chemistry I (4)	CHEM 1220 General Chemistry II[2] (4)
CHEM 1215 General Chemistry Lab I (1)	CHEM 1225 General Chemistry Lab II (1)
WRTG 2010 Intermediate Writing (3)	PHYS 2210 Physics (4)
CH EN 1703 Intro to Eng Computing (2)	CH EN 4755 Undergraduate Seminar (0.5)
General Education (3)	General Education (3)
TOTAL HOURS: 17	TOTAL HOURS: 16.5

SECOND YEAR

FALL SEMESTER	SPRING SEMESTER
MATH 2250 ODEs and Linear Algebra (3)	MATH Technical Elective[3] (Math) (2 to 4)
ME EN 1300 Statics and Strength of Matls (4)	CH EN 2703 Numerical Methods (2)
PHYS 2220 Physics (4)	CH EN 2800 Fund. of Process Engineering (3)
PHYS 1809 General Physics Laboratory (1)	CHEM 2310 Organic Chemistry I[4] (4)
CH EN 2300 Thermodynamics I (2)	CHEM 2315 Organic Chemistry lab I[4] (1)
General Education (3)	CH EN 4755 Undergraduate Seminar (0.5)
	General Education (3)
TOTAL HOURS: 17	TOTAL HOURS: 17.5

THIRD YEAR

FALL SEMESTER	SPRING SEMESTER
CHEM 3060 Physical Chemistry I (4)	CH EN 3603 Mass Transfer & Separations (3)
CH EN 3353 Fluid Mechanics (3)	CH EN 3553 Chemical Reaction Eng (3)
CH EN 3453 Heat Transfer (3)	CH EN 5103 Biochemical Engineering (3)
CH EN 3853 Chemical Eng Thermo (3)	Technical Electives[3] (3)
CH EN 4753 Undergraduate Seminar (0.5)	General Education/Bachelor Degree Requir. (3)
Technical Elective[3] (3)	
TOTAL HOURS: 16.5	TOTAL HOURS: 15

FOURTH YEAR

FALL SEMESTER	SPRING SEMESTER
CH EN 4903 Projects Laboratory I (4)	CH EN 4905 Projects Laboratory II[5] (3)
CH EN 4253 Process Design I (3)	CH EN 5253 Process Design II (3)
CH EN 4203 Process Control (3)	Technical Elective[3] (5)
CH EN 4753 Undergraduate Seminar (0.5)	General Education (3)
Technical Elective[3] (3)	
General Education (3)	TOTAL HOURS: 14
TOTAL HOURS: 16.5	

GRAND TOTAL HOURS: 130

1. Students with adequate math preparation are encouraged to take the MATH 1270 and 1280, Accelerated Engineering Calculus series, in place of MATH 1210 and 1220. Students who take 1210/1220 are encouraged to take MATH 2210 as a technical elective.
2. Students who qualify should take CHEM 1221, Honors General Chemistry II and CHEM 1241, Honors General Chemistry Lab II, instead of CHEM 1220, General Chemistry II, and CHEM 1225, General Chemistry Lab II.
3. A total of 18 credit hours of technical elective courses are required.
4. Students who qualify should take CHEM 2311, Honors Organic Chemistry I, instead of CHEM 2310.
5. CH EN 4905 fulfills the Upper-division Writing/Communication requirement.

FIVE-YEAR PROGRAM IN CHEMICAL ENGINEERING (Catalogue Year 07-08)

FIRST YEAR

FALL SEMESTER	SPRING SEMESTER
MATH 1210 or 1270 Calculus I[1] (4)	MATH 1220 or 1280 Calculus II[1] (4)
CHEM 1210 General Chemistry I (4)	CHEM 1220 General Chemistry II[2] (4)
CHEM 1215 General Chemistry Lab I (1)	CHEM 1225 General Chemistry Lab II (1)
WRTG 2010 Intermediate Writing (3)	PHYS 2210 Physics (4)
CH EN 1703 Intro to Eng Computing (2)	CH EN 4755 Undergraduate Seminar (0.5)
TOTAL HOURS: 14	TOTAL HOURS: 13.5

SECOND YEAR

FALL SEMESTER	SPRING SEMESTER
MATH 2250 ODEs and Linear Algebra (3)	CH EN 2703 Numerical Methods (2)
ME EN 1300 Statics and Strength of Matls (4)	CH EN 2800 Fund. of Process Engineering (3)
PHYS 2220 Physics (4)	CHEM 2310 Organic Chemistry I[3] (4)
PHYS 1809 General Physics Laboratory (1)	CHEM 2315 Organic Chemistry lab I[3] (1)
CH EN 2300 Thermodynamics I (2)	CH EN 4755 Undergraduate Seminar (0.5)
	General Education (3)
TOTAL HOURS: 14	TOTAL HOURS: 13.5

THIRD YEAR

FALL SEMESTER	SPRING SEMESTER
CHEM 3060 Physical Chemistry I (4)	MATH Technical Elective[4] (Math) (2-4)
CH EN 3353 Fluid Mechanics (3)	General Education/Bachelor Degree Requir. (6)
General Education (3)	Technical Elective[4] (6)
CH EN 3853 Chemical Eng Thermo (3)	
TOTAL HOURS: 13	TOTAL HOURS: 16

FOURTH YEAR

FALL SEMESTER	SPRING SEMESTER
CH EN 3453 Heat Transfer (3)	CH EN 3553 Chemical Reaction Eng (3)
Technical Elective[4] (6)	CH EN 3603 Mass Transfer & Separations (3)
CH EN 4753 Undergraduate Seminar (0.5)	CH EN 5103 Biochemical Engineering (3)
General Education (3)	General Education (3)
TOTAL HOURS: 12.5	TOTAL HOURS: 12

FIFTH YEAR

FALL SEMESTER	SPRING SEMESTER
CH EN 4903 Projects Laboratory I (4)	CH EN 4905 Projects Laboratory II[5] (3)
CH EN 4203 Process Control (3)	CH EN 5253 Process Design II (3)
CH EN 4253 Process Design I (3)	Technical Elective[4] (2)
CH EN 4753 Undergraduate Seminar (0.5)	General Education (3)
TOTAL HOURS: 10.5[6]	TOTAL HOURS: 11
	GRAND TOTAL HOURS: 130

1. Students with adequate math preparation are encouraged to take the MATH 1270 and 1280, Accelerated Engineering Calculus series, in place of MATH 1210 and 1220. Students who take 1210/1220 are encouraged to take MATH 2210 as a technical elective.
2. Students who qualify should take CHEM 1221, Honors General Chemistry II and CHEM 1241, Honors General Chemistry Lab II, instead of CHEM 1220, General Chemistry II, and CHEM 1225, General Chemistry Lab II.
3. Students who qualify should take CHEM 2311, Honors Organic Chemistry I, instead of CHEM 2310.
4. A total of 18 credit hours of technical elective courses are required.
5. CH EN 4905 fulfills the Upper-division Writing/Communication requirement.
6. Note that a student must take at least 12 credit hours to be considered a full-time student, a requirement for scholarship recipients. You may have to take an additional course to bring your total credit hours up to 12 for this semester.

Some factors to be considered in planning your course work are

- Most courses have prerequisites. Figure 1 shows how the required courses in the four-year program of study depend on each other. The Department's policy on prerequisites is given on page 21 of this guide.
- Chemistry 1220 and 1225, Chemical Engineering 2300 and Physics 2210 are prerequisites to Chemical Engineering 2800.
- Chemistry 3060 is a prerequisites or co-requisites to junior-year chemical engineering course work.
- Upper-division (3000 and above) chemical engineering courses are offered only once each year and are restricted to students who have satisfied the prerequisites.
- Students who do not achieve a grade of C or better in prerequisite courses seldom develop satisfactorily in the subsequent courses.

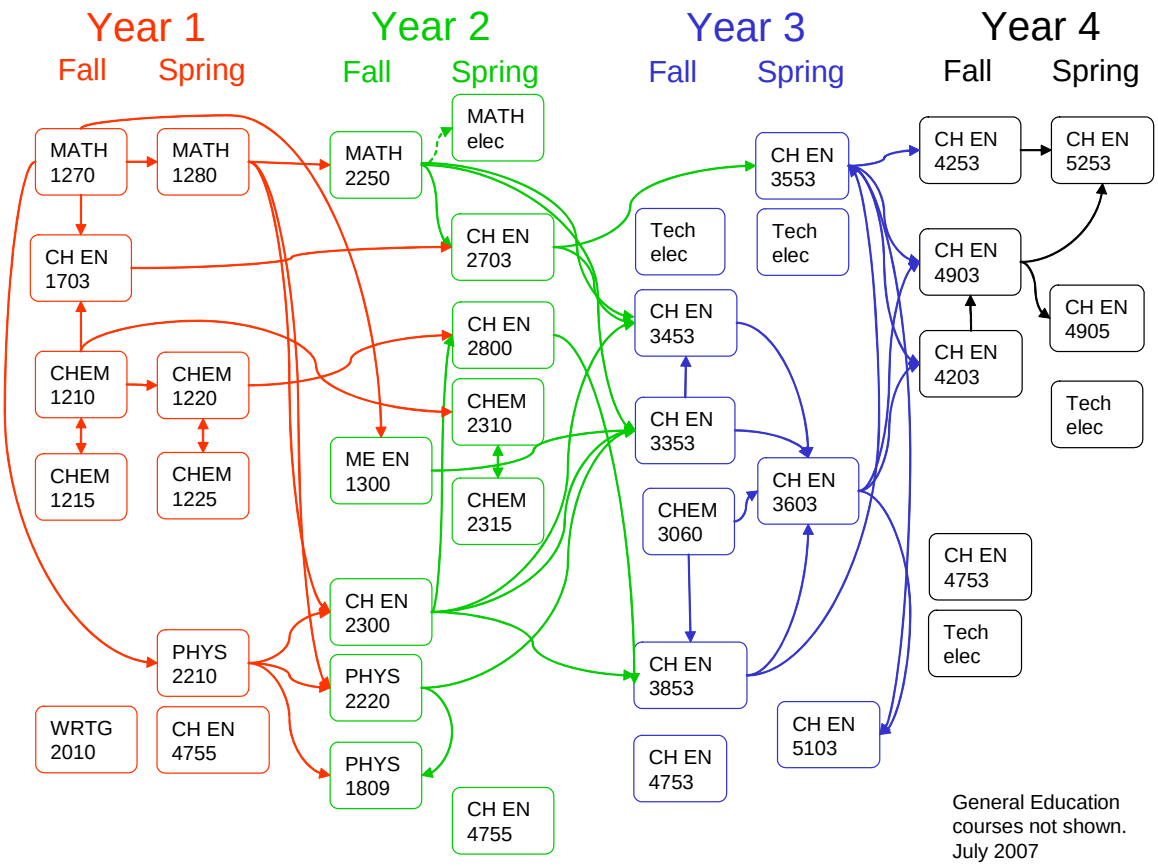

Figure 1. Flow chart showing how the required courses depend on each other. Arrows indicate the existence of a co-requisite or prerequisite.

Undergraduate Seminar

All chemical engineering candidates must take at least 2.0 credit hours of undergraduate seminar (CH EN 4753, 4755 - 0.5 credit hours each) during their tenure.

This seminar course, which is offered every semester for 0.5 credit hours, meets once a week and is designed to discuss topics in chemical engineering. It is usually organized by undergraduate students and provides useful information about the chemical engineering profession, employment opportunities, student organizations, as well as conducting tours in the area. Students are encouraged to sign up for the appropriate course each semester if it doesn't conflict with other courses.

Technical Electives (effective 1 March 2007)

Bachelor's degree candidates must complete18 hours of approved technical electives. At least two of the 18 hours must be an upper division math class taught by the math department (MATH) and at least nine of the 18 hours must be upper division chemical engineering classes (CH EN). Table I lists the approved classes for technical electives. More than one math class can be taken. **Although not required, students may choose to take most of their electives in one particular emphasis area**. Approved courses, listed by emphasis areas, are given in Table II. A brief description of the various emphasis areas is given in Table III. A student needs to petition the faculty, through the undergraduate committee, if she or he wants to use a course not listed in Tables I and II as a technical elective. Students are responsible for completing any prerequisites or co-requisites for technical elective classes.

Table I. Approved classes for technical electives.
At least two elective hours must be upper division math.

Course	Title	Semester Hours	Prerequisite(s)
MATH 3070	Applied Statistics I	4	MATH 1220 or 1270
MATH 3080	Applied Statistics II	3	MATH 3070
MATH 3090	Design of Experiments	3	MATH 3070
MATH 3150	Partial Differential Equations	2	MATH 2250 and either 1280 or 2210
MATH 3160	Complex Variables	2	MATH 2250
MATH 5600	Survey of Numerical Analysis	4	MATH 2210, either MATH 2250 or 2270
MATH 5620	Intro to Numerical Analysis II	4	MATH 5610

At least nine hours must be upper division Chemical Engineering classes

Course	Title	Semester Hours	Prerequisite(s)
CH EN 4973	Undergraduate Thesis	1 - 3	Instructors consent
CH EN 4975	Chemical Engineering Clinic	1 – 3	
CH EN 4977	Coop	1 – 3	Instructors consent Up to 3 hours as upper division CH EN
CH EN 5104	Biochemical Engineering Lab	1	Co-requisite CH EN 5103
CH EN 5153	Fundamentals of Combustion	3	Instructors consent
CH EN 5203	State Space Methods	3	CH EN 4203
CH EN 5303	Environmental Appl. of Chem. Eng.	3	Instructors consent
CH EN 5305	Air Pollution Control Engineering	3	Major status
CH EN 5353	Computational Fluid Dynamics	3	CH EN 2703 and 3353
CH EN 5553	Introduction to Catalysis	3	CH EN 3553
CH EN 5655	Silicon Chip Processing	3	CH EN 3553 and 3603 (or co-requisite)
CH EN 5657	Nuclear Engineering I with Laboratory	4	MATH 2250 and PHYS 2210
CH EN 5950	Independent Study	1 – 5	Instructors consent
CH EN 5960	Special Topics	1 – 5	Instructors consent Must petition to be accepted as tech. elective credit

Other approved technical elective classes

Course	Title	Semester Hours	Prerequisite(s)
BIOEN 5030	From Biology to Engineering	2	
BIOEN 5090	Biophysical Chemistry	3	
BIOL 2020	Principles of Cell Biology	3	BIOL 1210 and 2010, CHEM 1210
BIOL 2030	Genetics	3	BIOL 2020
BIOL 3510	Biological Chemistry I	3	BIOL 2020 and 2030, CHEM 2320
BIOL 3520	Biological Chem II	3	BIOL 3510

BIOL 5495	Biophysical Ecology	4	MATH 1220, PHYS 2210, CHEM 1220, BIOL 2010(may be waived) *Class includes lecture and lab*
CHEM 2320	Organic Chemistry II	4	CHEM 2310 *May take CHEM 2320 or 2321, not both*
CHEM 2321	Honors Organic Chemistry II	4	CHEM 2311 *May take CHEM 2320 or 2321, not both*
CHEM 2325	Organic Chemistry Laboratory II	1	Co-requisite CHEM 2320 or 2321
CHEM 3070	Physical Chemistry II	4	MATH 2210, PHYS 2220 and CHEM 1220 or 1221
CHEM 3100	Inorganic Chemistry	5	CHEM 1220
CHEM 5720	Adv. Physical Chemistry Lab	2	CHEM 3060
CHEM 5730	Adv. Inorganic Chemistry Lab	2	
CH EN 4977*	COOP	1 – 3	Instructors consent *Up to 3 hours as upper division CH EN**
CVEEN 3610	Intro. to Environ. Engineering I	3	CHEM 1220, PHYS 2210, MATH 2250
CVEEN 5605	Environmental II	3	CVEEN 3610
CVEEN 5710	Applied Nuclear Eng. w/Lab	4	CVEEN 5700 or CH EN 5657
CVEEN 5720	Health Physics	3	CVEEN 5700 or CH EN 5657
CVEEN 5730	Survey of Nuclear Power	2	Intermediate engineering status
ECON 3500	International Economics	3	ECON 2010 and 2020 (or ECON 1010 and instructor's consent) Fulfills IR
GEO 5350	Groundwater	3	
MATH 2210	Calculus III	3	MATH 1220 *(can not be used if student completed MATH 1260 or 1280)*
ME EN 5000	Engineering Law and Contracts	3	Instructor consent
MET E 5260	Physical Metallurgy I	3	
METEO 5210	Physical Meteorology	3	Instructor consent
MGT 3410	Business Law: The Commercial Env.	3	
MGT 3500	Principles of Management	3	
MGT 3680	Human Behavior in Organizations	3	

MGT 3700	Fundamentals of Entrepreneurship	3	
MGT 4560	Small Business Management	3	
MGT 4900	International Management	3	Fulfills IR
MGT 5510	Human Resource Management	3	
MGT 5770	Business Plan Development	3	
MGT 5780	New Venture Implementation	3	
MKTG 4840	International Marketing	3	MKTG 3010. Fulfills IR.
MSE 3210	Electronic Properties of Solids	3	PHYS 3740, CHEM 1220 or Instructor Consent
MSE 3310	Introduction to Ceramics	3	
MSE 3410	Introduction to Polymers	3	
MSE 5040	Intro. to Modern Biomaterials	4	
MSE 5471	Polymer Processing	4	
MSE 5473	Polymer Synthesis & Characterization	3	
MSE 5475	Introduction to Composites	3	
PHIL 4540	Engineering, Ethics, and Society	3	*Counts as both a technical elective and a general education course.*
PHYS 2215	Physics Lab for Scientists & Eng. I	1	PHYS 2210
PHYS 2225	Physics Lab for Scientists & Eng. II	1	PHYS 2210 and 2215 *Both PHYS 2215 & 2225 can be used as substitute for PHYS 1809*
PHYS 3610	Electronics I	3	
PHYS 3620	Electronics II	3	
PHYS 3740	Intro. to Quantum Theory & Relativity	3	
PHYS 3760	Principles of Thermo. & Mech.	3	
POL S 3320	Intro. to Public Policy and Analysis	3	
POL S 4790	The United States Constitution	3	*May take POL S 4790 or 5211, not both*
POL S 5211	Constitutional Law	3	*May take POL S 4790 or 5211, not both*
POL S 5322	Environ. Policy	3	*May take POL S 5322 or URBPL 5350, not both*

URBPL 5350	Public Lands and Environ. Policy	3	*May take POL S 5322 or URBPL 5350, not both*
URBPL 5360	Environ. Planning Law & Policy	3	

*Students who register for CH EN 4977 are eligible to receive up to three credit hours for each semester that they work in industry, for a maximum of six semester hours. Of these six hours, a maximum of three can count toward their departmental technical elective requirement. Students who receive more than three credits are still required to complete at least six technical elective hours in CH EN courses other than 4977. Students can apply CH EN 4977 credits that are in excess of three hours toward non-departmental technical elective requirements.

Table II. List of Approved Courses for Technical Electives by Area

Area	Recommended Courses	Additional Approved Courses
Process Control	CH EN 5203	CH EN 4973, 4975, 4977, PHYS 2215, 2225, 3610, 3620 MATH 3070, 3080, 3150, 5600
Fuels	CH EN 5153, 5303	CH EN 4973, 4975, 4977, 5203, 5305, 5553, MATH 3150
Applied Mathematics and Physical Sciences	BIOL 2020 CHEM 2320, 2325, 3100, 5720, 5730 PHYS 3610, 3620, 3740, 3760	CH EN 4973, 4975, 4977, 5203, 5353 MATH 3070, 3080, 3090, 3150, 3160, 5620
Biochemical Engineering and Living Systems	CH EN 5104 BIOL 2020	BIOEN 5030, 5090, BIOL 2030, 3215, 3510, 3520 CHEM 2320, 2325, 3100 CH EN 4973, 4975, 4977 MATH 3150 MSE 5040 PHYS 3610,3620
Environmental Engineering	CH EN 5303, 5305	BIOL 2020 CH EN 4973, 4975, 4977, 5104 CVEEN 3610, 5605 GEO 5350 MATH 3150, 3070 METEO 5210 PHYS 3610, 3620
Management, Policy, and Law	CH EN 5303, 5305	CH EN 4973, 4975, 4977 ECON 3500 MATH 3070, 3150, 3160 ME EN 5000 MGT 3410, 3500, 3700,3680, 4560, 4900, 5510, 5770, 5780 MKTG 4840 PHIL 4540$^{\theta}$ PHYS 3610,3620 POL S 3320, 4790*, 5211*, 5322** URBPL 5360, 5350**
Materials and Nuclear	CH EN 5657 MSE 3210, 3410	CH EN 4973, 4975, 4977, 5655 CVEEN 5710, 5720, 5730 MATH 3070, 3150, 3160 MET E 5260 MSE 3310, 5471, 5473, 5475 PHYS 3610, 3620

* Students may take one of POL S 4790 or 5211 not both.
** Students may take one of POL S 5322 or URBPL 5350, not both.
$^{\theta}$ PHIL 4540 counts as both a technical elective and a general education course.

Table III. BRIEF DESCRIPTION OF THE VARIOUS AREAS FOR TECHNICAL ELECTIVES WITHIN THE DEPARTMENT OF CHEMICAL ENGINEERING

Applied Math and Physical Sciences:

The Applied Mathematics and Physical Sciences option is intended to provide students with deep understanding in fundamental sciences; mathematics, physics, chemistry and biology. Students intending to pursue graduate school options may want to consider courses in mathematics to buildup their applied mathematics background. Students wanting to go to medical school may want to consider additional courses in biology and biological chemistry. Students wanting to complete the science and math series required of them in the basic curriculum may also choose this area.

Biochemical Engineering and Living Systems:

With recent developments in biotechnology and genetics, it is apparent that chemical engineers will be needed in the future to design and develop systems that will produce biochemical/biomedical products more efficiently and economically. The objective of this emphasis area is to give the student an opportunity to learn more about biological systems and how chemical engineering principles are applied in biotechnology. Applications range from the biomedical field to bioprocessing to bioremediation. The required and recommended courses, CH EN 5103 and 5104, give the student an introduction to biochemical engineering and include a laboratory where the student will perform biological and biochemical experiments. Biology 2020 is strongly recommended to provide background on cell structure and other biological basics and is a prerequisite to CH EN 5103.

Environmental Engineering:

The courses listed for this area were selected for students with a strong interest in the environmental area. The courses are designed to give the student more, in depth, information on the wide-range of environmental subjects. Topics covered include environmental aspects of fuels, air pollution, bioremediation, groundwater flow as well as introductory courses in environmental engineering.

Fuels:

The combination of courses in the Fuels Emphasis was selected for students who have a scientific curiosity and interest in the application of chemical engineering fundamentals to the discovery, production, conversion, and utilization of fuels. This emphasis area is intended to bring together the principles of science and engineering in an application related to the practical study of fuels. Thermodynamics, Process Design, Kinetics, and Analytical and Organic Chemistry are fundamental to this group of courses.

Management, Policy, and Law:

Engineers frequently encounter challenges in scientific, legal, administrative, and public policy areas. The logical problem solving skills inherent in engineering lend themselves to good approaches to management, policy, and law. This option allows the student to build the skills necessary to develop and manage their own projects. Specifically, this curriculum includes course work in strategic planning, statistical quality control, and financial modeling. The suggested curriculum also includes classes that explore public policy, law, engineering ethics, and the allocation of human resources. Engineering students who complete this option will enter their first job knowing that it takes more than just science and mathematics to complete successfully any project.

Materials and Nuclear:

The Materials and Nuclear option provides students interested in engineering and/or nuclear materials an opportunity to explore these important areas of chemical engineering. Courses expose students to the fundamentals of materials properties as well as engineering application of materials, including metals, ceramics, polymers, electronic, and composite materials. Emphasis is placed on chemical engineering aspects of materials processing as well as materials properties and selection for applications in chemical engineering.

Process Control:

Today, process engineers have software and hardware capabilities to implement multivariable model-based control, and to build accurate empirical and semi-empirical models, perform process optimization, fault detection, process monitoring, etc. The limiting factor in a wide-spread application of the advanced process control and data analysis methods is the limited set of skills obtained by chemical engineering within the traditional chemical engineering education. This emphasis area is aimed at developing a guideline on the sequence of elective classes for the students who wish to obtain a more in-depth knowledge of Process Control and related fields.

Fundamentals of Engineering (FE) Exam

All chemical engineering students must pass the morning and afternoon sessions of the Fundamentals of Engineering (FE) exam (formerly the Engineering-In-Training Exam) which is administered by the State. The FE is nationally composed and graded. The morning session includes general topics that are common to all engineering disciplines and the afternoon session focuses on topics that are specific to chemical engineering. The exam is given twice yearly and should be taken at the earliest possible date in the senior year. Information about the exam and registration can be found at http://www.ncees.org. The College and the Department usually conduct a "Fundamentals of Engineering Review Series" of lectures early fall semester. Please contact the Department office, 3290 Merrill Engineering Building, 581-6915, for more information.

Students who do not pass the FE exam after two attempts are permitted to petition the Undergraduate Committee for an exception to policy.

V. Advanced Placement (AP) Credit

Students who take Advanced Placement (AP) courses in high school may receive college credit for certain University courses if they receive a certain minimum score on the AP exam. However the department will only accept credit that appears on your University of Utah transcript showing the tests taken and the test scores. Thus, depending on your scores, several of your first year chemistry, math, and physics courses could be waived. The College recently instituted new guidelines for AP credit. The table on page 19 outlines which courses would be waived by our department and the minimum score required. Keep in mind that it is more important that you understand the subject matter than it is to waive the class, since subsequent courses will rely on this material. The table below also assigns an equivalent grade for each score that will be used in our department to determine your GPA for admission to intermediate status. If, for any reason, you decide to take a class for which you have received AP credit, we will use the grade you received in class instead of the equivalent AP grade.

Advanced Placement Credit Information for Chemical Engineering students (effective August 2007)

Subject/AP Score	University of Utah Equivalent Courses	Equivalent Grade[4]
Chemistry		
5	CHEM 1210,1220[1]	A/A
4	CHEM 1210,1220[1]	B+/B-
Calculus[2, 3]		
5(AB)	MATH 1210	A
4(AB)	MATH 1210	B-
5(BC)	MATH 1210, 1220	A/A
4(BC)	MATH 1210, 1220	B+/B-
Physics C Test (Mechanics)		
5	PHYS 2210	A
4	PHYS 2210	B
Physics C Test (E & M)		
5	PHYS 2220	A
4	PHYS 2220	B
English		
5	WRTG 2010	A
4	WRTG 2010	B
Computer Science A (1999 and after)		
5	CP SC 1000/2010	A/A
4	CP SC 1000/2010	B/no credit
Computer Science AB (1999 and after)		
5	CP SC 1000/2010/2020	A/A/A
4	CP SC 1000/2010/2020	A-/B+/B-

1. Only the chemistry course is waived. Students must still take the corresponding laboratory associated with these courses, CHEM 1215 and 1225, unless they have already taken the equivalent AP chemistry laboratories with Professor Ragsdale in the Chemistry department at the University of Utah.
2. If you have not taken a math course recently, you should take the online test at http://www.math.utah.edu/online/1210. A strong foundation in math is necessary for many engineering courses.
3. Math 1210 or 1270 is a prerequisite to Physics 2210.
4. These grades will only be used to determine acceptance into intermediate status. The U grants hours of credit, not grades, for AP scores of 3 or higher. Submit a request for evaluation to the Admissions Office to have your credits recorded.

VI. Honors in Engineering Program

The Honors in Engineering Program in the College of Engineering is designed to provide a challenging, individualized educational experience to high achieving students and to promote life-long learning throughout their careers. The objective is to challenge top students by offering them access to more advanced levels of study, to facilitate the fullest possible use of their creative abilities, to encourage a sustained interest in advanced education and basic research, as well as to foster leadership and fellowship within the engineering community. Honors in Engineering is an undergraduate student honors program that is an option and not mandatory. Students can also receive Departmental Honors and/or University Honors in addition to Honors in Engineering.

For more information, including requirements and admission criteria, please refer to http://www.coe.utah.edu/current/UG/Honors_in_Engineering.

VI. Transfer Students

Students planning to transfer to the department from other colleges and universities should contact the transfer student adviser, Prof. Geoff Silcox, 3290 MEB, 801-581-8820, geoff@che.utah.edu.

Transfer students who wish to be admitted to major status must complete a Transfer Agreement (http://www.che.utah.edu/undergraduate/documents/transfer_agre.xls) and meet with an advisor before they can be admitted. The advisor must approve all of the transfer credit by signing the Transfer Agreement.

VII. COOP Program

The Cooperative Education Program (Coop) seeks to provide students with practical experience to complement class-oriented learning. The industrial exposure that participants obtain is beneficial to students who hope to work in industry. In many cases, Coop experiences will occur at locations removed from campus with a strong possibility of being out of state. These opportunities are available with employers who have agreed to participate with the University of Utah.

Participants have generally completed (or will shortly complete) their sophomore-level courses and are selected by potential employers from a pool of applicants. The process of recruitment, interviewing, and selection is typically handled by Career Services.

Once employed in a Coop, students request admittance into CH EN 4977. This course may be used for technical elective credit. Students working part-time for an engineering employer during a semester may also apply for admittance to CH EN 4977, and receive from 1 to 3 hours credit for their work experience. CH EN can be repeated for credit for a total of up to 6 hours. To receive credit, the student will be required to produce a 15-20 page report each time they register for CH EN 4977. The report will describe the engineering activities and work performed, and must meet acceptable academic standards of grammar and detail.

Students who register for CH EN 4977 have the opportunity of receiving up to three credit hours for each semester that they work in industry, for a maximum of six semester hours. Of these six hours, a maximum of three can count toward their departmental technical elective requirement. Students who receive more than three credits for CH EN 4977 are still required to complete at least six technical elective hours in CH EN courses other than 4977. Students can apply CH EN 4977 credits that are in excess of three hours toward non-departmental technical elective requirements.

Participation in some Coop Programs will alter the suggested departmental program of study. Students will alternate semesters between engineering employment and on-campus study. Coop participants must commit to their employer and to the department, that they will fulfill their employment obligations and complete full-time study while on-campus *without outside employment*. All students return to the University campus full time for their senior-level courses.

For deadlines and procedures, contact Lisa Christensen (Lchrist@sa.utah.edu, 585-5065) in Career Services (http://careers.utah.edu/). All materials are processed through Career Services. For current Coop opportunities, contact Dr. Terry Ring (ring@eng.utah.edu, 585-5705). Coop opportunities are posted on the Chemical Engineering internship and coop board as they arise.

If you will be missing a semester or more of classes due to Coop, please speak with Jenny Jones, Department Academic Advisor (jones.jenny@eng.utah.edu, 585-7175) or Geoff Silcox, Associate Chair (geoff@che.utah.edu, 581-8820) before the semester begins.

VIII. Policy on Repeating Courses

College of Engineering policy states that engineering students can only repeat a course once. Courses from which students have withdrawn are counted under this policy. Please contact Jenny Jones or Geoff Silcox if you plan to repeat a course more than once.

IX. Departmental Scholarships

The Department has a number of scholarships that are available to undergraduate students (http://www.che.utah.edu/undergraduate/scholarships.html). Application forms are available on the website. The department offers many scholarships for incoming and continuing students that are available from funds raised from industry or our alumni. In addition, there are a wide variety of University scholarships that are also available to incoming Chemical Engineering students from the Financial Aid & Scholarship Office, such as the Presidential or Honors-at-Entrance scholarships. Contact the Financial Aid & Scholarship Office, 105 SSB, 581-6211, for more information and application forms. The College of Engineering has a number of scholarships that are available to Chemical Engineering students; they can be contacted at 581-6911 or http://www.coe.utah.edu.

A number of loans are available through the College of Engineering - http://www.coe.utah.edu/current/FA_Scholarship/Loans.

X. LEAP and E-LEAP Programs

Engineering-LEAP (E-LEAP) is a year long, small class called a "seminar," focusing on the theme of community building in American and in global settings, and the ethical standards of engineering. This seminar keeps students together with one professor and classmates, while fulfilling the University's diversity requirement and two general education requirements—one in Humanities and one in Social Science. In the first semester, students engage in a discussion about the American community experience as revealed through American autobiography and fiction. In the second semester, students build on the first semester concepts to consider the role of the engineer as a technical expert in contributing to community decision-making. In addition to its academic content, E-LEAP seminar emphasizes college writing, critical reading, group work, presentation skills, and library research strategies appropriate for engineering majors. Throughout the year, students network with College of Engineering faculty and advisors as well as the LEAP professor and a student advisor to learn more about careers in engineering. They also attend lectures and events about innovations in the engineering field. For more information contact the LEAP office at (801) 581-3811.

XI. Student Organizations

While your course work should be your top priority, participating in various student organizations and activities on campus can enhance your education at the University of Utah. This will enable you to interact with your colleagues outside of class and in an informal manner as well as acquaint you with all the supporting services the University and the College has to offer. The following table lists a few of the U of U student chapters you may want to consider.

Organization	Location, Tel. Number	Contact
American Institute of Chemical Engineers (AIChE)	3290H MEB 581-4460	Prof. Edward Trujillo
Society of Women Engineers (SWE)	206 Kennecott Building 581-8954	Ms. Deidre Schoenfeld
Society of Hispanic Professional Engineers - (SHPE)	206 Kennecott Building 581-8954	Ms. Deidre Schoenfeld
Program for Diversity in Engineering (PDE)	206 Kennecott Building 581-8954	Ms. Deidre Schoenfeld
American Indian Science and Engineering Society (AISES) -	206 Kennecott Building 581-8954	Ms. Deidre Schoenfeld
Society of Ethnic Student Engineers (SESE)	206 Kennecott Building 581-8954	Ms. Deidre Schoenfeld

XII. Policy on Prerequisites

1. It is the responsibility of the student to make sure that they have satisfied the co-requisites and prerequisites for all courses for which they register.

2. If a student determines that they have not met the prerequisites, they will schedule a meeting with an advisor in the department to discuss their situation. This meeting will take place the semester before they hope to attend the course in question.
3. In general, a student will not be allowed to register for a class unless they have completed the prerequisites.
4. The instructor is the ultimate authority who will decide whether to grant an exception and allow a student to register for their course without having completed the prerequisites.

XIII. Combined BS/MS Program

The Department offers a combined BS/MS degree program for undergraduate students interested in research. This program is designed to foster undergraduate research and to accelerate progress toward the Master of Science degree. Students in the combined program should begin their research while in the undergraduate portion of the program and may expect to complete the combined degree after five years with the simultaneous conferral of the Bachelor of Science and Master of Science degrees. This is one year less than a traditional sequential BS - MS program as described in the General Catalog. The BS degree portion of the combined degree requires the completion of 124 semester credit hours. The MS degree requires the completion of 30 additional hours. The standard BS degree requires 130 hours.

Students are encouraged to begin research in the summer following their junior year and often receive financial support. Most BS/MS students are also eligible for the University of Utah Tuition Benefit Program, once they are classified as graduate students.

The shift from undergraduate to graduate status occurs after completion of required undergraduate Chemical Engineering classes. Students wishing to exit the combined program can apply qualifying coursework toward the traditional BS and MS degree requirements without penalty. No student will be awarded a separate MS degree without satisfying all requirements for the BS degree.

SUGGESTED COMBINED BS/MS PROGRAM IN CHEMICAL ENGINEERING
(Catalogue Year 07-08)

FIRST YEAR

FALL SEMESTER	SPRING SEMESTER	SUMMER SEMESTER
MATH 1210 or 1270 Calculus I[1] (4)	MATH 1220 or 1280 Calculus II[1] (4)	
CHEM 1210 General Chem I (4)	CHEM 1220 General Chem II[2] (4)	
CHEM 1215 Gen Chem Lab I (1)	CHEM 1225 Gen Chem Lab II (1)	
WRTG 2010 Intermed Writing (3)	PHYS 2210 Physics (4)	
CH EN 1703 Intro to Eng Comp (2)	CH EN 4755 UG Seminar (0.5)	
General Education (3)	General Education (3)	
TOTAL HOURS: 17	TOTAL HOURS: 16.5	

SECOND YEAR

FALL SEMESTER	SPRING SEMESTER	SUMMER SEMESTER
MATH 2250 ODEs and LA (3)	MATH Technical Elective[3] (2 to 4)	

ME EN 1300 Statics, Strength (4)
PHYS 2220 Physics (4)
PHYS 1809 Gen Physics Lab (1)
CH EN 2300 Thermo I (2)
General Education (3)

TOTAL HOURS: 17

CH EN 2703 Numerical Methods (2)
CH EN 2800 Process Eng (3)
CHEM 2310 Organic Chem I[4] (4)
CHEM 2315 Organic Chem lab I[4] (1)
CH EN 4755 UG Seminar (0.5)
General Education (3)

TOTAL HOURS: 17.5

THIRD YEAR

FALL SEMESTER
CHEM 3060 Physical Chem I (4)
CH EN 3353 Fluid Mechanics (3)
CH EN 3453 Heat Transfer (3)
CH EN 3853 Chemical Eng Thermodynamics (3)
CH EN 4753 UG Seminar (0.5)

TOTAL HOURS: 13.5

SPRING SEMESTER
CH EN 3603 Mass Transfer and Separations (3)
CH EN 3553 Chemical Reaction Engineering (3)
CH EN 5103 Biochemical Eng (3)
Technical Elective[3] (3)
General Ed/Bachelor Degree Req (3)

TOTAL HOURS: 15

SUMMER SEMESTER
Students are encouraged to begin working on Master's Thesis Research.

FOURTH YEAR

FALL SEMESTER
CH EN 4903 Projects Lab I (4)
CH EN 4253 Process Design I (3)
CH EN 4203 Process Control (3)
CH EN 4753 UG Seminar (0.5)
General Education (3)

TOTAL HOURS: 13.5

SPRING SEMESTER
CH EN 4905 Projects Lab II[5] (3)
CH EN 5253 Process Design II (3)
Technical Elective[3] (5)
General Education (3)

TOTAL HOURS: 14

TOTAL UNDERGRAD HOURS: 124

SUMMER SEMESTER
CH EN 6973 Thesis Research: Master's (3)

FIFTH YEAR

FALL SEMESTER
CH EN 6353 Fluid Mechanics (3)
CH EN 6553 Chemical Reaction Engineering (3)
CH EN 6853 Thermodynamics (3)
Elective (3)[6]
CH EN 7753 Grad Seminar (1)

TOTAL HOURS: 13

SPRING SEMESTER
CH EN 6453 Heat Transfer (3)
CH EN 6603 Multicomponent Mass Transfer (3)
Elective (3)[6]
CH EN 7755 Grad Seminar (1)
CH EN 6973 Thesis Research: Master's (1)

TOTAL HOURS: 11

TOTAL GRADUATE HOURS: 30

SUMMER SEMESTER
CH EN 6973 Thesis Research: Master's (3)

1. Students with adequate math preparation are encouraged to take the MATH 1270 and 1280, Accelerated Engineering Calculus series, in place of MATH 1210 and 1220. Students who take 1210/1220 are encouraged to take MATH 2210 as a technical elective.
2. Students who qualify should take CHEM 1221, Honors General Chemistry II and CHEM 1241, Honors General Chemistry Lab II, instead of CHEM 1220, General Chemistry II, and CHEM 1225, General Chemistry Lab II.
3. A total of 12 credit hours of technical elective courses are required as part of the BS portion of the program. At least two of those hours must be in an approved mathematic course and at least 6 must be in approved CH EN courses. See the Technical Electives Section of this handbook for a list of approved courses.
4. Students who qualify should take CHEM 2311, Honors Organic Chemistry I, instead of CHEM 2310.
5. CH EN 4905 fulfills the Upper Division Writing/Communication requirements.
6. BS/MS students may take their graduate electives earlier in their program of study, if their schedule permits it.

APPLICATION / ADMISSION PROCEDURES

Undergraduate students must apply to the combined BS/MS program by April 1st of the year in which they are enrolled in CH EN 3603, Mass Transfer and Separations. The department will notify the student if they are admitted by May 1st. Entrance criteria for the combined BS/MS program are consistent with criteria for the traditional MS program. An undergraduate GPA of at least 3.0, based on all undergraduate work or work completed during the last two years of study, whichever is higher, is required. Students must be supported by a faculty member who will be the research advisor for a master's thesis. The faculty member must be able to support the student as a Research Assistant for the graduate portion of this program.
To apply for admission to the BS/MS program, submit the following three items:

1. A completed Chemical Engineering BS/MS application. This application can be found at http://www.che.utah.edu/undergraduate/applications/index.html.
2. A letter of support from the faculty member who will be your research advisor for your master's thesis. The letter must include a commitment from the faculty member to support you as a Research Assistant for the graduate portion of this program.
3. A current Degree Audit Report (DARS).

Mail or deliver all materials to:

Jenny Jones, Academic Advisor
University of Utah Chemical Engineering Department
50 S Central Campus Drive RM 3290 MEB
Salt Lake City, Utah 84112-9203

Once admitted, the student must complete a University of Utah Graduate School application and will need to pay the appropriate fee. Students should apply to the Graduate School to be admitted the summer following the semester in which the student completes Projects Lab II and Process Design II. Students should comply with Admissions Office deadlines.

Admitted students must submit a BS/MS program of study to the department during the fall semester that their fourth year. Students must follow all guidelines for the Masters of Science program that are listed within the Graduate Handbook.

XIV. Undergraduate Courses offered in the Department (CH EN)

1001 Sustainable Energy (3) Taught Fall. Fulfills Science Foundation.
Energy is discussed with regard to its forms, production, distribution, conversion, and usage. The impact of energy on quality of life, health, ecology, and climate is considered. Case studies of energy production, usage, and integration with existing energy systems are presented. Alternative technologies are explored: solar thermal energy, solar photovoltaics, biopower, biofuels, tidal power, wave energy, geothermal energy, and wind energy. Conventional sources of power are also discussed.

1703 Introduction to Engineering Computing (2) Taught Fall. Co-requisites or Prerequisites: MATH 1210 and CHEM 1210.
An introduction to the solution of engineering problems using Excel spreadsheets and MATLAB. Excel topics include basic spreadsheet use, plotting, solvers, macros, and introduction to VBA programming. MATLAB topics include basic usage, vector and matrix operations, user-defined functions, and structured programming.

2300 Thermodynamics I (2) Taught Fall, Spring, and Summer. Cross listed as ME EN 2300. Meets with ME EN 2300. Prerequisites: MATH 1220 and PHYS 2210.
Thermodynamic properties, open and closed systems, equations of state, heat and work, first law of thermodynamics, second law of thermodynamics, Carnot cycle, introduction to power and refrigeration cycles.

2703 Numerical Methods Applications in Chemical Engineering (2) Taught Spring and Summer. Prerequisite: MATH 2250. Recommended Prerequisite: CH EN 1703.
Applications of numerical methods to interpolation, differentiation, integration, and the solution of systems of linear, nonlinear, and differential equations in chemical engineering.

2800 Fundamentals of Process Engineering (3) Taught Spring and Summer. Prerequisites: CHEM 1220 and CH EN 2300.
Material and energy balances, process engineering applications, degrees of freedom, fundamentals of multi-component phase equilibria, numerical and graphical calculations, and the use of modern computing tools in process-engineering calculations.

3353 Fluid Mechanics (3) Taught Fall. Prerequisite: CH EN 2300, MATH 2250, PHYS 2220 and Major standing. Recommended Prerequisite: ME EN 1300.
Fluid statics; application of conservation of mass, energy, and momentum to basic fluid mechanics problems; introduction to compressible flow, potential flow, boundary layer and dimensional analysis.

3453 Heat Transfer (3) Taught Fall. Prerequisite: MATH 2250, CH EN 2703 and 2300 and Major standing. Co-requisite: CH EN 3353.
Basic mechanisms of heat transfer, conduction, radiation, convection; heat transfer with change of phase; design of heat exchangers. Introduction to complex problems involving all three modes of heat transfer (conduction, convection, and radiation).

3553 Chemical Reaction Engineering (3) Taught Spring. Prerequisite: CH EN 2703 and 3853 and Major standing. Fulfills Quantitative Intensive BS Course. Reaction-rate equations, adiabatic reactions, back-mixed and plug-flow reactors, heterogeneous reactions, heterogeneous catalysis, reactor design.

3603 Mass Transfer and Separations (3) Taught Spring. Prerequisite: CH EN 3353, 3453, 3853 and CHEM 3060 and Major standing. Fulfills Quantitative Intensive BS Course.

Molecular and turbulent diffusion; conservation, phase equilibria and rate-processes concepts in diffusional operations design, including simultaneous heat and mass transfer. Gas absorption, distillation, extraction, membranes, adsorption, and drying.

3853 Chemical Engineering Thermodynamics (3) Taught Fall. Prerequisite: CH EN 2300, 2800 and Major standing. Co-requisite: CHEM 3060. Fulfills Quantitative Intensive BS Course.
Principles of physical and chemical equilibria with illustrative applications in chemical process industries.

4203 Process Dynamics and Control (3) Taught Fall. Prerequisite: CH EN 3553 and 3603, Major standing.
Introduction to practical and theoretical aspects of process control, process dynamics, empirical model identification and feedback control of single-input, single-output processes; PID algorithm, tuning of the PID controller, stability analysis, time and frequency domain design methods, digital implementation of process control, control system performance and limitations, and trade-offs in controller design. Enhancements to single-loop PID control; cascade control, feed-forward control, level and inventory control, and model predictive control.

4253 Process Design (3) Taught Fall. Prerequisite: CH EN 3553 and 3603, Major standing.
Process design and engineering; process synthesis, mathematical modeling of process equipment units, system calculational strategy, economic evaluation and optimization, process simulation.

4753 Undergraduate Seminar (0.5) Taught Fall.
Graded CR/NC principally on attendance. Four semesters minimum required for graduation. Topics in the arts, humanities, and social sciences. Field trips to industrial facilities. Serves as forum for activities of University student chapter of American Institute of Chemical Engineers.

4755 Undergraduate Seminar (0.5) Taught Spring.
Graded CR/NC principally on attendance. Four semesters minimum required for graduation. Topics in engineering, science, the arts, humanities, and social sciences. Field trips to industrial facilities. Serves as forum for activities of University student chapter of American Institute of Chemical Engineers.

4903 Projects Laboratory I (4) Taught Fall. Laboratory. Prerequisites: CH EN 3553, 3603, Major standing. Co-requisite: CH EN 4203.
Provides the opportunity to analyze and optimize processes and products by several means: experimentation, simulation, instrumentation, and control. Hands-on experience with real systems is emphasized as are communication skills and teamwork.

4905 Projects Laboratory II (2) Taught Spring. Laboratory. Prerequisite: CH EN 4903. Fulfills Intensive Writing/Communication.

Continuation of CH EN 4903.

4973 Undergraduate Thesis (1 to 3) Taught Fall and Spring. Thesis Research. Completed thesis may comprise from two to three credit hours work. Original research or design in a selected field of chemical engineering. Directed by a faculty member.

4975 Chemical Engineering Clinic (1 to 3) Taught Fall and Spring. Clinical. Original engineering project selected with approval of external sponsor and instructor.

4977 Cooperative Education Work Period (1 to 3) Taught Fall and Spring. Activity. Students register for this course each semester in which they officially participate in a full-time cooperative work experience. Can be repeated for credit for up to 6 hours.

4999 Honors Thesis/Project (3) Taught Fall and Spring. Honors Thesis Project. Fulfills Intensive Writing/Communication.
Restricted to students in the Honors Program working on an honors degree.

5103 Biochemical Engineering (3) Taught Spring. Service Learning course. Cross listed as CVEEN 5603. Co-requisites: for CH EN students - CH EN 3553 and 3603; for CVEEN students - CVEEN 3610. Recommended prerequisites or co-requisites are BIOL 2020 - Principles of Cell Biology; and CH EN 5104.
Introductory course in biochemical engineering and bioprocessing. Cell biology, enzyme kinetics, bioreactors, bioseparations and bioprocessing in relation to the medical, pharmaceutical, environmental, and biochemical industries.

5104 Biochemical Engineering Laboratory (1) Taught Spring. Cross listed as CVEEN 5604. Laboratory. Co-requisite: CH EN 5103.
Laboratory course demonstrating the principles of fermentation, filtration, centrifugation, chromatography, and other biochemical principles. Meets with CVEEN 5604.

5153 Fundamentals of Combustion (3) Taught Fall (even numbered years).
Prerequisite: Instructor's consent.
A broad introduction to combustion including stoichiometry, equilibrium, mixing, heat transfer, kinetics, heterogeneous combustion, flames, confined flames, and practical applications. Extensive use is made of computer programs for calculation of equilibrium, kinetics, and confined flames. Factors affecting pollutant formation and control are emphasized.

5203 State Space Methods (3) Taught Spring. Cross listed as ME EN 5210.
Prerequisite: CH EN 4203 or ME EN 3210 or equivalent.
Introduction to modeling of multivariable systems in state space form. System analysis including stability, observability and controllability. Control system design using pole placement and linear quadratic regulator theory. Observer design..

5253 Process Design II (3) Taught Spring. Prerequisite: CH EN 4253 and 4903, Major standing.

Computer-aided process design and simulation; solution of complex recycle processes and modeling of process equipment. Comprehensive design project leading to preparation of process design and economic evaluation report.

5303 Environmental Applications of Chemical Engineering (3) Taught Fall. Prerequisite: Instructor's consent.
The nature of pollutants, their sources, and existing and evolving strategies for their abatement and control. Environmental considerations in the production, transportation, and processing aspects of coal and petroleum. Topics include air pollution, surface water pollution and subsurface pollution analysis. Public-domain software will be used to study realistic environmental problems.

5305 Air Pollution Control Engineering (3) Taught Spring. Recommended Prerequisite: Intermediate Status in an Engineering discipline or Senior standing in science.
Air-pollution emission sources, behavior of pollutants in the atmosphere, theory and practice of control of particulate and gaseous air pollutants at their sources.

5353 Computational Fluid Dynamics (3) Taught Fall (odd numbered years). Cross listed as ME EN 5720.Meets with ME EN 5720. Prerequisite: (ME EN 2040 and 3700) or (CH EN 2703 and 3353) and ME EN/CH EN status or junior standing.
Survey of approaches including time accurate and steady-state methods, explicit and implicit techniques, Eulerian and Lagrangian methods, laminar and turbulent flow, compressible and incompressible approaches, projection methods, stability considerations, etc. Applications of CFD to mixing, heat transfer and reaction.

5553 Introduction to Catalysis (2) Taught Spring (even numbered years). Prerequisite: CH EN 3553.
Basic principles, adsorption, isotherms, catalyst geometry, surface reactions, kinetics and mechanisms, selective and polyfunctional catalysts, geometric and electronic theories, examples of industrial applications.

5555 Environmental Engineering Seminar (0.5) Taught Fall and Spring. Cross listed as GG 5555, CVEEN 5555, MET E 5555, MG EN 5555.
Provides students the opportunity to meet with and learn from environmental engineering practitioners and researchers during a series of informal lectures and discussions.

5655 Silicon Chip Processing (3) Taught Spring, odd years. Prerequisite: CH EN 3553 and 3603 as pre- or co-requisites.
This course gives chemical engineers (1) an overview of semiconductor materials and their properties; (2) the basics of device physics, structure, and electrical properties; (3) the vocabulary of the industry; and (4) the ability to translate the chemical engineering fundamentals learned in mass transfer, heat transfer, and reaction kinetics to problems in semiconductor processing. The processing steps that are emphasized include crystal growth, diffusion, implantation, photolithography with emphasis on light induced reaction

in photo-resists, deposition methodologies with emphasis on chemical vapor deposition, and chemical-mechanical polishing. In addition to teaching quantitative approaches to process analysis, this course focuses on how defects are minimized.

5657 Nuclear Engineering I with Laboratory (4) Taught Fall. Cross-listed as CVEEN 5700. Prerequisites: MATH 2250 and PHYS 2210.
Fundamentals of nuclear engineering and science; nuclear reactions, radioactive decay, neutron diffusion, kinetics, energy removal, shielding, health physics, and system design. Includes laboratory.

5950 Independent Study (1 to 5) Taught Fall and Spring. Independent Study. Prerequisite: Instructor's consent.
Independent-study projects such as participation in organized student paper competition.

5960 Special Topics (1 to 5) Taught Fall and Spring. Special Topics. Prerequisite: Instructor's consent.
Application of engineering to societal problems. Tutorial courses. Offered as opportunities arise.