CLEMSON

CHEMICAL AND BIOMOLECULAR ENGINEERING

UNDERGRADUATE STUDENT HANDBOOK

2017-2018

Department of Chemical and Biomolecular Engineering
Clemson University
Clemson, South Carolina 29634–0909
(864) 656–3055

Student _____

Advisor _____

This handbook is available on the ChBE website:

http://www.clemson.edu/cecas/departments/chbe/documents/undergrad_handbook.pdf

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INTRODUCTION

It is important that you acquaint yourself with the information in this handbook, which has been prepared to inform Chemical Engineering students about their program of study, and about the Chemical & Biomolecular Engineering Department. Most of the information presented is available in the Undergraduate Announcements or other sources, but it has been collected here for your convenience. If you have questions about anything regarding the curriculum, the department, or the chemical engineering profession, please talk to your advisor.

DEPARTMENTAL DIRECTORY

DEPARTMENTAL OFFICE:	127 Earle Hall (864) 656-3055 www.clemson.edu/chbe
DEPARTMENT CHAIR:	Dr. David Bruce 127 Earle Hall dbruce@clemson.edu
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UNDERGRADUATE ADVISORS:	Each student is assigned an advisor upon entering the ChBE program. See the Undergraduate Student Services Coordinator for your assigned advisor.

SELECTED INDEX – UNDERGRADUATE ANNOUNCEMENTS

Page references below are from the latest Clemson University Announcements. In general students are subject to the rules and regulations in place during the year in which they entered the University and to the curriculum requirements of the year of their most recent change of major. University Announcements from prior years can be found online at: **http://www.registrar.clemson.edu/html/catalog.htm**

To access the **academic calendar**, please go to this link:

http://www.registrar.clemson.edu/html/Acad_Cal.htm

CHEMICAL ENGINEERING PROGRAM

What is chemical engineering?
Chemical engineering is based on the sciences of chemistry, biology, physics and mathematics. The curriculum at Clemson emphasizes a broad range of fundamental principles in science and engineering as well as communication skills and humanities and social sciences. As a result, our graduates are sought avidly by industries in many areas of technology such as energy and fuels, commodity chemicals, specialty chemicals, pharmaceuticals, biotechnology, electronic and photonic devices, food and consumer goods, advanced materials, pulp and paper, and design engineering. Chemical engineers contribute to the prevention and remediation of environmental pollution, and many are involved in the application of engineering technology to the solution of medical and health-related problems.

Intended Student Outcomes: What will I learn in the Clemson BSChE Program?
Our undergraduate program consists of a blend of classroom instruction, laboratory practice, and project work designed to insure that students achieve the following **Student Outcomes** by the time they graduate:

a. Ability to apply knowledge of mathematics, science, and engineering
b. Ability to design and conduct experiments, as well as analyze and interpret data
c. Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. Ability to function on a multidisciplinary team
e. Ability to identify, formulate, and solve engineering problems
f. Understanding of professional and ethical responsibility
g. Ability to communicate effectively
h. Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. Recognition of the need for and the ability to engage in lifelong learning
j. Knowledge of contemporary issues
k. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Program Educational Objectives: What can I achieve as a result of my Clemson education?
The objective of Clemson University's Bachelor of Science Program in Chemical Engineering is that our graduates will experience careers characterized by the following attributes:

- Successfully practice chemical engineering and provide leadership in industry, government organizations, or higher education.
- Pursue further education in chemical engineering, other engineering or science disciplines, medicine, law, or business.
- Generate, disseminate, and apply chemical engineering knowledge to solve contemporary challenges.

Because of the broad, fundamental background, chemical engineering graduates are prepared for a wide variety of career paths. They can work in the operation and management of production facilities, conceptual engineering and design of new plants, technical marketing and sales, basic research and development, and a variety of other activities. The careers of many Clemson chemical engineers have led to top executive positions in established companies or to entrepreneurship in their own companies.

By the judicious choice of electives a Clemson chemical engineering student can tailor his/her education to a specific career objective. Many students use their electives and an Emphasis Area or Minor to prepare for a technical specialization such as energy, environmental control, or polymer processing. Others gravitate toward an emphasis in business. Some students prepare for entry into a graduate program in engineering or for advanced professional study in medicine, dentistry, or law.

CHEMICAL ENGINEERING CURRICULUM 2017-18

Freshman Year

Fall Semester		Spring Semester	
ENGR 1050 Engr Disciplines & Skills I	1	CHE 1300 Intro to Chemical Eng.	3
ENGR 1060 Engr Disciplines & Skills II	1	CH 1020 General Chemistry	4
CH 1010 General Chemistry	4	MATH 1080 Calc of One Variable II	4
ENGL 1030 Accelerated Composition	3	PHYS 1220 Physics with Calculus I	3
MATH 1060 Calculus of One Variable I	4	Arts and Humanities/Social Science[1]	3
Arts and Humanities/Social Science[1]	3	*Semester Totals:*	*17*
Semester Totals:	*16*		

Optional Summer Semester

CHE 1300 Intro to Chemical Eng. (online) 3

Sophomore Year

CHE 2110 Mass and Energy Balances	4	CHE 2200 Chem Engr Thermodynamics I	3
CH 2230 Organic Chemistry	3	CHE 2300 Fluids/Heat Transfer	4
MATH 2060 Calc of Several Variables	4	CH 2240 Organic Chemistry	3
PHYS 2210 Physics with Calculus II	3	CH 2290 Organic Chemistry Lab	1
Arts and Humanities/Social Science[1]	3	MATH 2080 Intro to Ord Diff Eqns	4
Semester Totals:	*17*	*Semester Totals:*	*15*

Junior Year

CHE 3210 Chem Eng Thermodynamics II	3	CHE 3070 Unit Operations Lab I	3
CHE 3300 Mass Transfer/Separations	4	CHE 3190 Engineering Materials	3
STAT 4110 Statistical Methods	3	CH 3320 Physical Chemistry	3
CH 3390 Physical Chemistry Lab	1	CH 3400 Physical Chemistry Lab	1
ECE 2070 Basic Electrical Engr	2	BMOL 4250 Biomolecular Engr	3
ECE 2080 Electrical Engr Lab I	1	Arts and Humanities/Social Science[1]	3
Emphasis Area[2]	3	*Semester Totals:*	*16*
Semester Totals:	*17*		

Optional Summer Semester

CHE 3070 Unit Operations Lab I	3
CHE 3210 Chem Eng Thermodynamics II	3
CHE 3300 Mass Transfer/Separations	4

Senior Year

CHE 4070 Unit Operations Lab II	3	CHE 3530 Process Dynamics/Control	3
CHE 4310 Chemical Process Design I	3	CHE 4330 Process Design II	3
CHE 4430 Safety, Env. & Prof. Prac. I	2	CHE 4440 Safety, Env. & Proc. Prac. II	1
CHE 4500 Chemical Reaction Engr	3	BMOL 4290 Bioprocess Engineering	3
Arts and Humanities/Social Science	3	Arts and Humanities/Social Science[1]	3
Emphasis Area[2]	3	Emphasis Area[2]	3
Semester Totals:	*17*	*Semester Totals:*	*16*

Total: 131 Hours

Notes:

[1] See Policy on Social Sciences and Humanities for Engineering Curricula. Six of these credit hours must also satisfy the Cross-Cultural Awareness and Science and Technology in Society Requirements.

[2] See advisor for details. Nine credit hours devoted to completion of an emphasis area or approved minor is required. Emphasis areas are these: Applied Engineering, Mathematics & Science; Biomolecular Science & Engineering; Polymeric Materials; Energy Studies; Environmental Engineering & Science; Business Management. Emphasis area courses may not be used to satisfy other CHE degree requirements.

Note: No student may exceed two attempts, including a *W*, to complete successfully any CHE course.

Emphasis Areas and the Biomolecular Concentration

The Chemical Engineering curriculum includes Emphasis Areas to allow students flexibility in selecting courses and planning their future careers. Students in this curriculum must declare an area of interest and plan a sequence of Emphasis Area courses in the fall semester of the sophomore year. These initial plans can be modified later in consultation with an academic advisor. Before graduation each student in the regular Chemical Engineering curriculum must complete 9 credit hours of approved courses in one of the following Emphasis Areas:

- Applied Engineering, Mathematics, and Science
- Biomolecular Science and Engineering
- Business Management
- Energy Studies
- Environmental Engineering and Science
- Polymeric Materials

Alternatively, students in the Chemical Engineering curriculum may apply the 9-hours set aside for completion of an Emphasis Area toward the completion of any minor or second major offered by Clemson, except the Chemistry Minor and the Cluster Minor. (You can earn a minor in Chemistry if you wish, but you will also have to complete an Emphasis Area.) Minor requirements are set by the department granting the minor. Details of each minor are available in the Undergraduate Announcements. Students who enter the program having already earned a baccalaureate degree from an accredited institution may apply 9 approved hours of required junior or senior-level courses from the previous degree program to satisfy the Emphasis Area requirement.

Students also have the option of earning a Bachelor of Science degree in Chemical Engineering with a Biomolecular Concentration. The concentration is a modified version of the BSChE curriculum that devotes 22 credit hours of work to a stronger emphasis in biomolecular engineering and science.

REQUIREMENTS FOR EMPHASIS AREAS

Important note to students: It is **your responsibility** to insure that the Emphasis Area courses you select will be offered when you want to take them **and** that you will meet the prerequisites and other registration criteria stipulated by the offering department. Course schedules change frequently, and many of the Emphasis Area courses have prerequisites that are not part of the ChE curriculum. The Undergraduate Announcements lists prerequisites for every course offered by Clemson. For your convenience, a list of prerequisites for Emphasis Area courses are also provided below, following the course listings. This list is not guaranteed to be complete or up to date. In some cases a department may waive a prerequisite or accept a reasonable alternative for a well-qualified student. If you believe that you have reasonable alternatives to the listed prerequisites, then you should request a prerequisite waiver from the offering department. In other cases, even though you have the prerequisites, you may be unable to get into a course due to other registration restrictions such as space limitations, majors who are given priority, or the course is not offered on a regular schedule. **The department that offers a particular course is the only reliable source** that can tell you when a course will be offered and what requirements must be met prior to registration. Plan ahead and contact the offering department if there is any doubt about the availability of courses you select. It is highly advisable to plan ahead and coordinate the emphasis area prerequisites with your General Education requirements. For example, if you are considering the

Business Management Emphasis Area, it would be advisable to take ECON 2110 for your Social Science requirement.

Note also that not all courses listed in the Emphasis Areas have 3 credits. Therefore, depending on the set of courses you select, you might need to complete more than 3 courses to satisfy the 9 credit hour minimum.

a) Applied Engineering, Mathematics, and Science Emphasis Area

Students must complete 1-3 engineering course(s), 0-2 mathematics course(s), and 0-1 science course from the lists below. Students who qualify for admission to the Combined BS/MS Program can also use graduate level courses that apply toward the MS degree in Chemical Engineering to satisfy requirements in this Emphasis Area. See the ChE Graduate Coordinator for details.

Options for Engineering Course(s):

CHE 4010 (Transport Phenomena)
CHE 4140 (Green Engineering)
CE 2010 (Statics)
IE 3600 (Industrial Applications of Probability and Statistics)
IE 3610 (Industrial Quality Control)
IE 4620 (Six Sigma Quality)
ME 2040 (Mechanics of Materials)

NOTE: Students who complete IE 3600, IE 3610, and IE 4620 will be granted a Six Sigma Certificate by the Industrial Engineering Department.

Options for Mathematics Course(s):

MATH 4340 (Advanced Engineering Mathematics)
MATH 4500 (Introduction to Mathematical Models)

Options for Science Course:

CH 3130 (Quantitative Analysis, 3150 or 3170 lab must be taken concurrently)
CH 4020 (Inorganic Chemistry)
CH 4110 (Instrumental Analysis)
CH 4130 (Chemistry of Aqueous Systems)
CH 4210 (Advanced Organic Chemistry)
CH 4270/4271 (Organic Spectroscopy)
CH 4350 (Atomic and Molecular Structure)
PHYS 2220 (Physics with Calculus III)
PHYS 4200 (Atmospheric Physics)
PHYS 4320 (Optics)
PHYS 4410 (Electromagnetics I)
PHYS 4450 (Solid State Physics)

b) Biomolecular Science and Engineering Emphasis Area

Students must complete 1-2 science course(s) and 1-2 engineering course(s) from the lists below.

Options for Science Courses:

BIOL 4340 (Biological Chemistry Laboratory Techniques)

BCHM 3050 (Biochemistry)
BCHM 4310 (Physical Approach to Biochemistry)
BCHM 4330 (General Biochemistry Lab)
BCHM 4060 (Physiological Chemistry)
BCHM 4360 (Nucleic Acid and Protein Biosynthesis)
CH 3600 (Biological Chemistry)
CH 4040 (Bioinorganic Chemistry)
CH 4140 (Bioanalytical Chemistry)
CH 4250 (Medicinal Chemistry)
GEN 3120 (Molecular Genetics)
GEN 4400 (Bioinformatics)
MICRO 3050 (General Microbiology)
MICRO 4070/4071 (Food and Dairy Microbiology)
MICRO 4130/4131 (Industrial Microbiology)
PHYS 4170 (Introduction to Biophysics)

Options for Engineering Courses:
BIOE 3020 (Biomaterials)
BIOE 4010 (Bioengineering Design Theory)
BIOE 4020 (Biocompatibility)
BIOE 4400 (Biopharmaceutical Engineering)
BIOE 4480 (Tissue Engineering)
BIOE 4490 (Drug Delivery)
BMOL 4260 (Biosensors and Bioelectronics)
BMOL 4270 (Membranes for Biotechnology and Biomedicine)
BE 4280 (Biochemical Engineering)

c) Business Management Emphasis Area
Students must take MGT 2010 (Principles of Management) plus two other courses from the list below.

Options for Courses:
ACCT 2010 (Financial Accounting Concepts)
ELE 3010 (Introduction to Entrepreneurship)
ELE 4000 (Technology Entrepreneurship)
ELE 4010 (Executive Leadership and Entrepreneurship II)
ECON 3060 or MGT 3060 (Managerial Economics)
ECON 3100 (International Economy)
ECON 3210 or ELE 3210 (Economics of Innovation)
MKT 3140 (New Venture Creation I)
MGT 3150 or ELE 3150 (New Venture Creation II)
MGT 3900 (Operations Management)
MGT 4110 (Project Management)
MGT 4230 (International Business Management)

d) Energy Studies Emphasis Area
Students must complete 9 credit hours from the following options.

Options for Courses:

AGRB 4570 or ECON 4570 (Natural Resource Use, Technology, and Policy)
BE 4400/4401 or CE 4400/4401 (Renewable Energy Resource Engineering)
CE 4370 (Sustainable Energy)
CE 4430 (Water Resources Engineering)
CE 4910 (Energy Related)
CHE 4140 (Green Engineering)
CHE 4150 (Alternative Energy)
ECE 4200 (Renewable Energy Penetration on the Power Grid)
ECE 4570 or ME 4570 (Fundamentals of Wind Power)
ECE 4610 (Fundamentals of Solar Power)
ECE 4710 (Electric Vehicles and Energy Storage)
EES 3100 (Nuclear Engineering)
EES 4100 (Environmental Radiation Protection)
EES 4120 (Nuclear Fuel Cycle and Radioactive Waste Management)
GEOL 4090/4091 (Environmental and Exploration Geophysics)
ME 4200 (Energy Sources and Their Utilization)
ME 4220 (Design of Gas Turbines)
ME 4260 (Nuclear Energy)

e) Environmental Engineering and Science Emphasis Area

Students must complete 1 science or policy course and 2 engineering courses from the lists below. Students who qualify for admission to the Combined BS/MS Program can also use graduate level courses that apply toward the MS or MENGR degree in Environmental Engineering and Science to satisfy requirements in this Emphasis Area. See the EE&S Graduate Coordinator for details.

Options for Science/Policy Course:

CH 4130 (Chemistry of Aqueous Systems)
CH 4110 (Instrumental Analysis)
ENR 3120 (Environmental Risks and Society)
ENSP 4000 (Studies in Environmental Science)
PHYS 2450 (Physics of Global Climate Change)
PHYS 4200 (Atmospheric Physics)

Options for Engineering Courses:

CHE 4010 or BMOL 4030 (Transport Phenomena)
CHE 4140 (Green Engineering)
CHE 4150 (Alternative Energy)
EES 4010 (Environmental Engineering)
EES 4020 (Water and Waste Treatment)
EES 4100 (Environmental Radiation Protection)
EES 4110 (Ionizing Radiation Detection and Measurement)
EES 4300 (Air Pollution Engineering)
EES 4800 (Environmental Risk Assessment)
EES 4850 (Hazardous Waste Management)
EES 4860 (Environmental Sustainability)

BE 4240 (Ecological Engineering)
BE 4400/4401 or CE 4400/4401 (Sustainable Energy Engineering)
ETOX 4210 (Chemical Source and Fate in the Environment)
ETOX 4460 (Soil and Water Quality Fundamentals)

f) Polymeric Materials Emphasis Area

Students must complete the required 9 hours by selecting courses from the following options.

Options for Courses:

BIOE 3020/3021 (Biomaterials)
CH 4510 (Frontiers in Polymer Chemistry)
CHE 4130 (Polymer Composite Engineering)
CHE 4450 (Special Topics, Polymer related)
MSE 4150 (Intro to Polymer Science and Engineering)
or CHE 4120 (Polymer Engineering)
MSE 4610/4611 (Polymer and Fiber Materials III)
PKSC 4160/4161 (Application of Polymers in Packaging)

g) Selected Minor in lieu of an Emphasis Area

Students may use the 9 hours devoted to the Emphasis Area requirement to select and complete any Minor, with the exception of the Chemistry Minor or the Cluster Minor. See the Undergraduate Announcements for requirements in the Minor of your choice.

Students who earn a second baccalaureate degree from Clemson or another accredited institution may apply 9 hours of required junior or senior-level courses from the other degree program to satisfy the Emphasis Area requirement.

Pre-requisites for Emphasis Area Courses

<u>Warning</u>: Pre-requisites listed below are not guaranteed to be correct. To be certain that you can get into a course, you must verify pre-requisites in the University Announcements and check course scheduling and enrollment restrictions with the department that offers the course.

a) Applied Engineering, Mathematics, and Science

Options for Engineering Course(s):

Course:	Pre-requisites:
CHE 4010	CHE 3300, MATH 2080
CHE 4140	CHE 2200, 2300
CE 2010	PHYS 1220, MATH 2060 (or concurrent enrollment)
IE 3600	MATH 2060
IE 3610	IE 3600
IE 4620	STAT 4110 or CHE 3070
ME 2040	MATH 2080, ME 2220, MSE 2100

Options for Mathematics Course(s):

Course:	Pre-requisites:
MATH 4340	MATH 2080
MATH 4500	MATH 3600 or 3650 and MATH 3020 or STAT 2300 or STAT 3090

Options for Science Course:

Course:	Pre-requisites:
CH 3130	CH 3150 or 3170 (Concurrent)
CH 4020	CH 3310, 3320
CH 4110	CH 3310, 3320
CH 4130	CH 1020 or 1060
CH 4210	CH 2240
CH 4270/1	One year each of organic & physical chemistry
CH 4350	CH 3320
PHYS 2220	PHYS 2210
PHYS 4200	MATH 1080, PHYS 2080 or 2210
PHYS 4320	PHYS 2210
PHYS 4410	PHYS 2210 and MATH 2080
PHYS 4450	PHYS 2210

Biomolecular Science and Engineering

Options for Science Course(s):

Course:	Pre-requisites:
BCHM 3050	BIOL 1030 or BIOL1100; Co-req CH 2230
BCHM 4060	BCHM 305 or CH2230
BCHM 4310	BCHM 3010 or consent of instructor; Co-req: CH 3300 or CH 3310
BCHM 4330	Concurrent enrollment in BCHM 4230 or 4310
BCHM 4360	BCHM 3010 and GEN 3020
BIOL 4340	BCHM 3050

CH 3600	CH 2230
CH 4040	BCHM 3010 or CH 2050
CH 4140	CH 3130, CH 4110
CH 4250	CH 2240
GEN 3020	BIOL 1100
GEN 4400	BCHM 3050 or GEN 3020
MICR 3050/1	BIOL1100/1110 or BIOL 1030/1040/1050/1060, CH 1010, 1020
MICR 4070/1	BCHM 3050 or CH 2230, MICRO 3050
PHYS 4170	MATH 2060, PHYS 2210, or consent of instructor

Options for Engineering Course(s):

Course:	Pre-requisites:
BIOE 3020/1	BIOE 2010, MSE 2100, CH 2230, CH 2270
BIOE 4010	BIOE 3020 or consent of instructor
BIOE 4020/1	BIOE 3020 and BIOL 4610 or consent of instructor
BIOE 4400	BCHM 3050
BIOE 4480	BIOE 3020, BIOL 3150, and BIOL 4610
BIOE 4490	BIOE 3020
BMOL 4030	CHE 3300, MATH 2080
BMOL 4260	CHE 3300, and BIOCH 3010 or 3050, or consent of instructor
BMOL 4270	CHE 3300 or equivalent or consent of instructor
CHE/BE 4280	Co-req CHE 3300 , CHE 4500

Business Management

Course:	Pre-requisites:
MGT 2010	none
ACCT 2010	none
ELE 3010	MGT 2010
ELE 4000	Junior standing in engineering
ELE 4010	ELE 3010
ECON 3060	ECON 2110
ECON 3100	ECON 2110 and 2120
ECON 3210	ECON 3060 or 3140
MKT 3140	Junior standing
MGT 3150	ELE 3010
MGT 3900	STAT 3090 or equivalent and MGT 2180 or equivalent
MGT 4110	STAT 3090 or equivalent
MGT 4230	Junior Standing

Energy Studies

Course:	Pre-requisites:
AGRB/ECON 4570	MATH 1060, ECON 2110, and AGRB 3570 or ECON 3140
BE/CE 4400/1	Junior standing in engineering
CE 4370	CE 3310

CE 4430	CE 3410 (Fluid Mechanics)
CE 4910	Consent of instructor; priority to CE majors
CHE 4140	CHE 2110, MATH 1080
CHE 4150	CHE 2200, CHE 2300
ECE 4200	ECE 2070
ECE/ME 4570	ECE 2070
ECE 4610	ECE 3200
ECE 4710	ECE 3200
EES 3100	MATH 2080
EES 4100	PHYS 2210
EES 4120	EES 4100
GEOL 4090/4091	Junior standing
ME 4200	ME 3030, 3040 or consent of instructor: priority to ME majors
ME 4220	ME 3080 (Fluid Mechanics)
ME 4260	CHE 3210

Environmental Engineering and Science

Options for Science/Policy Course:

Course:	Pre-requisites:
CH 4130	CH 1020 or CH 1060
CH 4110	CH 3310, CH 3320
ENR 3120	Junior standing
ENSP 4000	ENSP 2000 or EES 2020 or consent of instructor
PHYS 2450	None
PHYS 4200	MATH 1080, PHYS 2080 or PHYS 2210

Options for Engineering Course(s):

Course:	Pre-requisites:
BE 4240	None
BE 4400/1	Junior standing in engineering
CHE 4010	CHE 3300, MATH 2080 (same for BMOLE 4030)
CHE 4140	CHE 2110, MATH 1080
CHE 4150	CHE 2200, CHE 2300
EES 4010	CHE 2300, MATH 2060
EES 4020	EES 2020 or 4010
EES 4100	PHYS 2210
EES 4110/1	EES 4100 or consent of instructor
EES 4300	EES 2020 or 4010
EES 4800	EES 2020 or 4010, MATH 2080
EES 4850	EES 2020 or 4010 and CH 2230
EES 4860	Junior standing in engineering
ETOX4210	CH 2230, CH 2270, and CH 3130
ETOX4460	CH 2240

Polymeric Materials

Course:	Pre-requisite:
BIOE 3020/1	BIOE 2010, MSE 2100, and CH 2230/2270
CH 4510	CH 2230, 2240, MSE 4150
CHE 4120	CH 2240, 3320
CHE 4130	CH 2240 and CHE 4120 or MSE 4150
CHE 4450	Consent of instructor
MSE 4150	CH 2240
MSE 4610/1	none
PKSC 4160/1	CH 2230, consent of instructor

HEMICAL ENGINEERING CURRICULUM 2017-18 with BIOMOLECULAR ENG. CONCENTRATION

Freshman Year

Fall Semester		Spring Semester	
ENGR 1050 Engr Disciplines & Skills I	1	CHE 1300 Intro to Chemical Eng.	3
ENGR 1060 Engr Disciplines & Skills II	1	CH 1020 General Chemistry	4
CH 1010 General Chemistry	4	MATH 1080 Calc of One Variable II	4
ENGL 1030 Accelerated Composition	3	PHYS 1220 Physics with Calculus I	3
MATH 1060 Calculus of One Variable I	4	Arts and Humanities/Social Science[1]	3
Arts and Humanities/Social Science[1]	3	*Semester Totals:*	*17*
Semester Totals:	*16*		

Optional Summer Semester

CHE 1300 Intro to Chemical Eng. (online) 3

Sophomore Year

CHE 2110 Mass and Energy Balances	4	CHE 2200 Chem Engr Thermodynamics I	3
CH 2230 Organic Chemistry	3	CHE 2300 Fluids/Heat Transfer	4
MATH 2060 Calc of Several Variables	4	CH 2240 Organic Chemistry	3
BIOL 1100 Prncpls of Biology (w/Lab)	5	CH 2290 Organic Chemistry Lab	1
Arts and Humanities/Social Science[1]	3	MATH 2080 Intro to Ord Diff Eqns	4
Semester Totals:	*19*	*Semester Totals:*	*15*

Junior Year

CHE 3210 Chem Eng Thermodynamics II	3	CHE 3070 Unit Operations Lab I	3
CHE 3300 Mass Transfer/Separations	4	CHE 3190 Engineering Materials	3
PHYS 2210 Physics with Calculus II	3	BIOL 4340 Biochemistry Lab	2
Biochemistry Requirement[2]	3	BMOL 4250 Biomolecular Engr	3
STAT 4110 Statistical Methods	3	BIOE 3020 Biomaterials	3
Semester Totals:	*16*	Arts and Humanities/Social Science[1]	3
		Semester Totals:	*17*

Optional Summer Semester

CHE 3070 Unit Operations Lab I	3
CHE 3210 Chem Eng Thermodynamics II	3
CHE 3300 Mass Transfer/Separations	4

Senior Year

CHE 4070 Unit Operations Lab II	3	CHE 3530 Process Dynamics/Control	3
CHE 4310 Chemical Process Design I	3	CHE 4330 Process Design II	3
CHE 4430 Safety, Env. & Prof. Prac. I	2	CHE 4440 Safety, Env. & Proc. Prac. II	1
CHE 4500 Chemical Reaction Engr	3	BMOL 4290 Bioprocess Engineering	3
BCHM 4310 Physical Biochemistry	3	Arts and Humanities/Social Science[1]	3
Arts and Humanities/Social Science[1]	3	Engineering Requirement[3]	3
Semester Totals:	*17*	*Semester Totals:*	*16*

Total: 133 Hours

Notes:

[1] See Policy on Social Sciences and Humanities for Engineering Curricula. Six of these credit hours must also satisfy the Cross-Cultural Awareness and Science and Technology in Society Requirements.

[2] Select from BCHM 3010, BCHM 3050, BCHM 4230, or CH 3600

[3] Select from CHE 4010 or BMOL 4030, BMOL 4270, BE 4280 or 4350, BIO 4400, 4490 or 4760, or MICR 4130

Note: No student may exceed two attempts, including a *W*, to complete successfully any CHE course.

ChE Emphasis Area/Minor/Concentration Selection Form

(Submit a paper copy of this form to your CHE 2110 instructor when requested. Keep a copy for yourself. You may change your selections by submitting a new form to your academic advisor. Use this template or get a blank form from the ChE Student Services Coordinator. It is **your** responsibility to insure that you meet these requirements by your intended graduation date. **Check course pre-requisites and scheduling.**

Date:

Name:

CU student ID:

Selected emphasis area:

- ☐ Applied Engineering, Mathematics, and Science
- ☐ Biomolecular Science and Engineering
- ☐ Business Management
- ☐ Environmental Engineering
- ☐ Polymeric Materials
- ☐ Energy Studies

☐ Biomolecular Engineering Concentration

☐ Minor in _____ (any minor but Chemistry or Cluster Minor)

List proposed electives that will satisfy your Emphasis Area, BMOL concentration, or minor requirements:

Course	Course Title	Semester Scheduled

Student signature _____ Date _____

Advisor signature _____ Date _____

ChE Emphasis Area/Minor/Concentration Verification Form

(Complete this form and have your academic advisor sign it when you register for your final semester. Submit the signed copy to the instructor in CHE 4440)

Date:

Name:

CU student ID:

Selected emphasis area:

- ☐ Applied Engineering, Mathematics, and Science
- ☐ Biomolecular Science and Engineering
- ☐ Business Management
- ☐ Environmental Engineering
- ☐ Polymeric Materials
- ☐ Energy Studies

☐ Biomolecular Engineering Concentration

☐ Minor in _____ (any minor but Chemistry or Cluster Minor)

List electives used to satisfy your selected emphasis area, minor, or BMOL concentration, requirements:

Course	Course Title	Semester taken

Student signature _____ Date _____

Advisor signature _____ Date _____

Chemical Engineering Curriculum:
Contributions to the Achievement of Student Outcomes

CRITERON 1. Course	Student Outcome										
	a	b	c	d	e	f	g	h	i	j	k
CH 1010/1020/2230/2240/2290/ 3320/3390/3400	A	B		B				A			
MATH 1060/1080/2060/2080; STAT 4110	A	B			B			A			B
PHYS 1220/2210; ECE 2070/2080	A			B				A			B
BMOL 4250/4290	A	B	B		B						B
ENGL 1030, Arts/Human/Social Sci						B	A	A	A	B	
ENGR 1050/1060 Engr. Disc. & Skills	B	B	B	B	B	B	B				B
CHE 1300 Intro to Chemical Engineering	B	B			B						B
CHE 2110 Mass and Energy Balances	A	B	B		A	B					B
CHE 2200 Chemical Engr Thermo I	A				A						B
CHE 2300 Fluids/Heat Transfer	A		B		A						B
CHE 3070 Unit Operations Lab I	A	A	B	A	A	B	A				B
CHE 3190 Engineering Materials	A		B		A					B	B
CHE 3210 Chemical Engr Thermo II	A				A						B
CHE 3300 Mass Transfer/Separations	A		B		A						B
CHE 3530 Proc. Dynamics & Control	A		B		A						B
CHE 4070 Unit Operations Lab II	A	A	A	A	A	B	A		B		A
CHE 4310 Process Design I	A		A		A	A			B	B	A
CHE 4330 Process Design II	A	A	A	A	A	A	A		B	A	A
CHE 4430 Safety, Envr, Prof. Practice I	B				B	A		B	B	B	B
CHE 4440 Safety, Envr, Prof. Practice II	B			B		A	A	B	A	A	
CHE 4500 Kinetics & Reactor Design	A		B		A						B
Emphasis Area or Minor								B	B	B	

A -- denotes a primary contributor B -- denotes a secondary contributor

a. Ability to apply knowledge of math, engineering, and science
b. Ability to design and conduct experiments, and to analyze and interpret data
c. Ability to design a system, component, or process to meet needs within realistic constraints
d. Ability to function on a multidisciplinary team
e. Ability to identify, formulate, and solve engineering problems
f. Understanding of professional and ethical responsibility
g. Ability to communicate effectively both orally and in writing
h. Breadth of education beyond engineering
i. Recognition of the need for and an ability to engage in lifelong learning
j. Knowledge of contemporary issues
k. Ability to apply engineering tools, skills, and techniques

BMOL Concentration:
Contributions to the Achievement of Student Outcomes

CRITERON 2. Course	Student Outcome										
	a	b	c	d	e	f	g	h	i	j	k
CH 1010/1020/2230/2240/2290 BIOL 1100	A	B		B				A			
MATH 1060/1080/2060/2080; STAT 4110	A	B			B			A			B
PHYS 1220/2210	A							A			B
Biochemistry Req.; BCHM 4310; BIOL 4340	A			B				A			
ENGL 1030, Arts/Human/Social Sci						B	A	A	A	B	
ENGR 1050/1060 Engr. Disc. & Skills	B	B	B	B	B	B	B				B
CHE 1300 Intro to Chemical Engineering	B	B			B						B
CHE 2110 Mass and Energy Balances	A	B	B		A	B					B
CHE 2200 Chemical Engr Thermo I	A				A						B
CHE 2300 Fluids/Heat Transfer	A		B		A						B
CHE 3070 Unit Operations Lab I	A	A	B	A	A	B	A				B
CHE 3190 Engineering Materials	A		B		A					B	B
CHE 3210 Chemical Engr Thermo II	A				A						B
CHE 3300 Mass Transfer/Separations	A		B		A						B
CHE 3530 Proc. Dynamics & Control	A		B		A						B
CHE 4070 Unit Operations Lab II	A	A	A	A	A	B	A		B		A
CHE 4310 Process Design I	A		A		A	A			B	B	A
CHE 4330 Process Design II	A	A	A	A	A	A	A		B	A	A
CHE 4430 Safety, Envr, Prof. Practice I	B				B	A		B	B	B	B
CHE 4440 Safety, Envr, Prof. Practice II	B			B		A	A	B	A	A	
CHE 4500 Kinetics & Reactor Design	A		B		A						B
BIOE 3020; BMOL 4250/4290; Engr Req	A	B	B		B						B

A -- denotes a primary contributor B -- denotes a secondary contributor

a. Ability to apply knowledge of math, engineering, and science
b. Ability to design and conduct experiments, and to analyze and interpret data
c. Ability to design a system, component, or process to meet needs within realistic constraints
d. Ability to function on a multidisciplinary team
e. Ability to identify, formulate, and solve engineering problems
f. Understanding of professional and ethical responsibility
g. Ability to communicate effectively both orally and in writing
h. Breadth of education beyond engineering
i. Recognition of the need for and an ability to engage in lifelong learning
j. Knowledge of contemporary issues
k. Ability to apply engineering tools, skills, and techniques

DEPARTMENTAL POLICIES

CHBE UNDERGRADUATE PREREQUISITE POLICY

Prerequisites to chemical engineering courses are established by the faculty to ensure that students are properly prepared for the courses in the curriculum. The objectives are to prevent students from doing serious harm to their own academic records by attempting courses they are not prepared for, to insure that students are able to do their fair share of team work, and to ensure that the pace and scope of courses are not impeded by poorly prepared students.

Generally, the faculty are reluctant to waive prerequisites, but mitigating circumstances sometimes arise. Any student who wishes to enroll in a course for which they do not meet all prerequisites must submit a written request in the form of a memo document via email to the ChBE Departmental Undergraduate Coordinator or the ChBE Student Services Coordinator. The memo should contain an explanation of the circumstances, be addressed to the Undergraduate Curriculum Committee, contain any supporting documentation, and be received no later than 2 days before the start of classes. Earlier submittal is encouraged.

When the Undergraduate Committee deliberates such requests, the primary factors considered are the reasons for the prerequisite deficiency and the student's academic record to date, with particular emphasis on engineering GPR and prior performance in chemical engineering courses. Students who enroll in a course without meeting all prerequisites or receiving a written faculty waiver will be dropped from the course.

Things for students to consider regarding Prerequisite Waivers

- DO NOT DROP OR STOP ATTENDING A CLASS WITHOUT CONSULTING YOUR ADVISOR.
- Waivers are not automatically or routinely granted.
- The chemical engineering curriculum is highly structured, with many courses being prerequisites to others.
- Many classes are offered only once a year. Before you drop any course, you must consider the consequences to your academic schedule and progress toward graduation.

FOR MORE INFORMATION, SEE YOUR ADVISOR AND THE PREREQUISITE GUIDE IN THIS HANDBOOK.

GUIDE TO COURSE PREREQUISITES

To use this guide, find the "KEY COURSE" of interest in the center column. Key courses are listed in order of the semester in which they are normally taken. The left column gives prerequisites for the key course, and the right column lists subsequent courses which require the key course as a prerequisite. You should double check this guide with the current edition of Undergraduate Announcements if you decide to deviate from the prescribed curriculum time line.

Chemical Engineering Curriculum

Prerequisites →	* Key Course *□→	Prerequisite for
CMPT score of 60 or higher; or CH 1040 or MATH 1050; or MATH 1010 or MATH 1020 or MATH 1030 with a C or better	**CH 1010**	CH 1020, CHE 1300
Score of 80 or better on the CMPT	**MATH 1060**	MATH 1080, CHE 1300 (coreq)
Satisfactory score on Placement test	**ENGL 1030**	
Score of 65 or better on the CMPT	**ENGR 1020**	CHE 1300
CH 1010 with C or better	**CH 1020**	CHE 2110, CH 2230,
MATH 1060 or MATH 1070	**MATH 1080**	MATH 2060, PHYS 2210, CHE 2110
MATH 1060 or MATH 1070	**PHYS 1220**	CH 2110, PHYS 2210, CHE 1300 (coreq)
CH 1010, ENGR 1020, MATH 1060 (coreq), PHYS 1220 (coreq)	**CHE 1300**	CHE 2110
CH 1020	**CH 2230**	CH 2240, CH 2290, CHE 3190 (coreq), BCHM 3050
MATH 1080 or MATH 1110	**MATH 2060**	MATH 2080, CHE 2200, ECE 3070, CHE 2300 (coreq)
CH 1020, MATH 1080, PHYS 1220, CHE 1300	**CHE 2110**	CHE 2200, 2300, 3190
MATH 1080 or MATH 1110	**PHYS 2210**	ECE 3070
CH 2230	**CH 2240**	
CH 2230	**CH 2290**	
MATH 2060	**MATH 2080**	CHE 3210, 3530
CHE 2110, MATH 2060	**CH E 2200**	CHE 3210, CHE 3070, CH 3320, CH 3390, CHE 2300 (coreq), CHE 3190 (coreq)
CHE 2110, CHE 2200 (coreq), MATH 2060 (coreq)	**CHE 2300**	CHE 3300, CHE 3070, BMOL 4250, CHE 3190 (coreq)
CHE 2110, CHE 2230 (coreq), CHE 2200 (coreq)	**CHE 3190**	
CHE 2200, CHE 2300	**CH 3070**	CHE 4070, 4310
MATH 2060	**STAT 4110**	
MATH 2060 and PHYS 2210	**ECE 2070**	ECE 2080

ECE 2070	**ECE 2080**	
CH 3310 or CHE 2200	**CH 3390**	
CHE 2300	**BMOL 4250**	
CHE 2200, MATH 2080	**CHE 3210**	CHE 4500,CHE 4310, CHE 3300 (coreq)
CHE 2300, CHE 3210 (coreq)	**CHE 3300**	CHE 3530, 4070, 4310, 4330, 4430, 4500, BMOL 4290
CH 3310 or CHE 2200	**CH 3320**	CHE 4500, CH 3400 (coreq)
CH 3320 (coreq)	**CH 3400**	
CHE 3070, CHE 3300	**CHE 4070**	CHE 4330
CHE 3070, CHE 3210, CHE 3300, CHE 4500 (coreq)	**CHE 4310**	CHE 4430 (coreq), CHE 4330
CHE 4310 (coreq)	**CHE 4430**	CHE 4440
CHE 3300, CHE 3210, CH 3320	**CHE 4500**	CHE 4310 (coreq), CHE 4330
MATH 2080, CHE 2300 and CHE 3300 (coreq)	**CHE 3530**	
CHE 3300, 4070, 4310, 4500	**CHE 4330**	
CHE 4430, CHE 4330 (coreq)	**CHE 4440**	
CHE 3300, CHE 4500.	**BMOL 4290**	

NOTE: The College of Engineering, Computing and Applied Science requires a cumulative 2.0 GPR for registration in any engineering course numbered 300 or higher.

Chemical Engineering, Biomolecular Engineering Concentration

Prerequisites →	* Key Course *□→	Prerequisite for
CMPT score of 60 or higher; or CH 1040 or MATH 1050; or MATH 1010 or MATH 1020 or MATH 1030 with a C or better	**CH 1010**	CH 1020, CHE 1300
Score of 80 or better on the CMPT	**MATH 1060**	MATH 1080, CHE 1300 (coreq)
Satisfactory score on Placement test	**ENGL 1030**	
Score of 65 or better on the CMPT	**ENGR 1020**	CHE 1300
CH 1010 with C or better	**CH 1020**	CHE 2110, CH 2230,
MATH 1060 or MATH 1070	**MATH 1080**	MATH 2060, PHYS 2210, CHE 2110
MATH 1060 or MATH 1070	**PHYS 1220**	CH 2110, PHYS 2210, CHE 1300 (coreq)
CH 1010, ENGR 1020, MATH 1060 (coreq), PHYS 1220 (coreq)	**CHE 1300**	CHE 2110
CH 1020	**CH 2230**	CH 2240, CH 2290, CHE 3190 (coreq), BCHM 3050
MATH 1080 or MATH 1110	**MATH 2060**	MATH 2080, CHE 2200, ECE 3070, CHE 2300 (coreq)
CH 1020, MATH 1080, PHYS 1220, CHE 1300	**CHE 2110**	CHE 2200, 2300, 3190
MATH 1080 or MATH 1110	**PHYS 2210**	ECE 3070
CH 2230	**CH 2240**	
CH 2230	**CH 2290**	
MATH 2060	**MATH 2080**	CHE 3210, 3530
CHE 2110, MATH 2060	**CH E 2200**	CHE 3210, CHE 3070, CH 3320, CH 3390, CHE 2300 (coreq), CHE 3190 (coreq)
CHE 2110, CHE 2200 (coreq), MATH 2060 (coreq)	**CHE 2300**	CHE 3300, CHE 3070, BMOL 4250, CHE 3190 (coreq)
CHE 2110, CHE 2230 (coreq), CHE 2200 (coreq)	**CHE 3190**	
CHE 2200, CHE 2300	**CH 3070**	CHE 4070, 4310
	BIOL 1100	CH 1010 (coreq)
MATH 2060	**STAT 4110**	
CHE 2300	**BMOL 4250**	
BIOE 2010 and MSE 2100; and either both CH 2010 and CH 2020, or both CH 2230 and CH 2270 or consent of instructor [Note: Having CH 2230 will meet this req.]	**BIOE 3020**	

CH 2230 (coreq) CH 2230, BCHM 3050 (coreq)	**BCHM 3050** **BIOL 4340**	BIOL 4340 (coreq), BCHM 4310
CHE 2200, MATH 2080 CHE 2300, CHE 3210 (coreq) BCHM 3050 with C or better or consent of instructor, physical chemistry (coreq). [Note: CHE 2200 will meet the PCHEM req.]	**CHE 3210** **CHE 3300** **BCHM 4310**	CHE 4500,CHE 4310, CHE 3300 (coreq) CHE 3530, 4070, 4310, 4330, 4430, 4500, BMOL 4290
CHE 3070, CHE 3300 CHE 3070, CHE 3210, CHE 3300, CHE 4500 (coreq) CHE 4310 (coreq) CHE 3300, CHE 3210, CH 3320	**CHE 4070** **CHE 4310** **CHE 4430** **CHE 4500**	CHE 4330 CHE 4430 (coreq), CHE 4330 CHE 4440 CHE 4310 (coreq), CHE 4330
MATH 2080, CHE 2300 and CHE 3300 (coreq) CHE 3300, 4070, 4310, 4500 CHE 4430, CHE 4330 (coreq) CHE 3300, CHE 4500.	**CHE 3530** **CHE 4330** **CHE 4440** **BMOL 4290**	

COURSE SUBSTITUTIONS AND COURSES TAKEN ELSEWHERE

Substitution for Required Courses

The Faculty of Chemical & Biomolecular Engineering has designed the curriculum carefully to ensure that our graduates are well prepared to undertake their professional careers, and to ensure that all accreditation requirements and university requirements are met. Thus, substitution for a required course in the curriculum is not approved without close scrutiny. Nevertheless, there are occasionally circumstances in which such substitution is justified, and will be permitted with the necessary approvals. Such circumstances include substitution of an equivalent or higher level course in the same subject matter or substitution that permits a student to take advantage of a change made in a later curriculum. In all cases, the proposed substitution must be such that it does not cause any violation of accreditation or university requirements. The form entitled "Request Substitution for a Required Course" is available in the ChBE Department office (127 Earle Hall).

Courses Taken Elsewhere

In the summer, or during terms away from campus (e.g., on co-op or study abroad), it is sometimes advantageous for students to take one or more courses at another institution. For such course transfers to be accepted, the department that offers the equivalent course at Clemson must certify its equivalency. Thus, for example, the Chemistry Department must certify an organic chemistry course as equivalent to CH 2230 or 2240 at Clemson for it to be accepted in our curriculum. This certification should be obtained in advance of taking the course. Many courses offered at nearby schools have already been certified and included on the University's Transfer Credit Equivalency List (TCEL) so that their approval requires only verification that they are on the list and the signature of your advisor. The relevant form, "Request for Approval of Work to Be Taken Elsewhere," is available in the ChBE Department office (127 Earle Hall).

There are several university policies concerning course transfer; some of these are listed on the following page. Additionally, three notes on course transfer are called especially to your attention:

1. You must earn at least a grade C for any transfer to be accepted.

2. Transfer of any chemical engineering course not on the University's Transfer Credit Equivalency List (TCEL) requires signatures of your academic advisor and the Chemical Engineering Department Chair.

3. No more than 13 hours of chemical engineering credits from another university will be accepted for required course credits at Clemson.

See http://virtual.clemson.edu/groups/tcel/ for transfer evaluation equivalency information for specific colleges and universities.

CHEMICAL ENGINEERING DEPARTMENTAL ACADEMIC ADVISING

Prior to registering for each semester, it is the student's responsibility to seek out their academic advisor to consult on their academic status and progress towards graduation. Advising is required before a student can be cleared to register for a particular term. Prior to an advising meeting, students must abide by the guidelines set forth by the department or assigned advisor, which will be communicated. This will likely entail creating an individualized curriculum map (as detailed in this handbook) for a student's particular degree plan and academic year that dictates what degree requirements have been completed, what courses are planned for the upcoming semester, and a plan of courses to complete the degree. In preparation for advising, students should consult the resources available, which include but are not limited to the Departmental Handbook, University Announcements for your curriculum year, iROAR/Degree Works, etc.

The role of advisors is to confirm that your plan of courses is appropriate and you are on a correct path towards graduation. A student's advising appointment is an opportunity to ask questions regarding the Chemical Engineering curriculum and requirements for completing the Chemical Engineering degree. Students may also take this opportunity to ask their advisor about other questions regarding other opportunities in the department (eg. research, co-op, internship, study abroad, graduate school, etc.). Some questions may be more appropriate for or redirected to the Undergraduate Student Services Administrative Assistant or the Departmental Undergraduate Coordinator.

Students should consult their advisor before making other decisions regarding their academic progress. Examples of these may include:

- Dropping a required CHE course after the drop date, which could have implications with prerequisites or the departmental two strike policy. Students may not attempt any CHE course more than two times, which includes a W.
- Use of academic forgiveness. Academic forgiveness can be used at any point but is irreversible. Students may prefer to save their academic forgiveness to apply towards courses with more credit hours or for engineering courses that contribute to the College 2.0 engineering GPA requirement for graduation.

CHEMICAL ENGINEERING DEPARTMENTAL APPEAL PROCESS

In the event that a student believes extenuating circumstances exist that have directly or indirectly resulted in a student's inability to meet any of the chemical engineering degree requirements, the student may submit a formal appeal to the Departmental Curriculum Committee for evaluation. The appeal should be made in the form of a written memo document and submitted via email to the Departmental Undergraduate Coordinator or the Student Services Coordinator. The memo should contain an explanation of the circumstances, be addressed to the Undergraduate Curriculum Committee, and include by attachment any supporting documentation. For example, in the event of an unforeseen personal tragedy, a letter from a medical doctor or registered grief counselor may be

included as an attachment. All submitted documentation will be held confidential within the department.

All appeals will be evaluated by the Departmental Curriculum Committee and the Department Chair. For cases requiring further deliberation, the Departmental Curriculum Committee will gain insight from other members of the Departmental Faculty.

UNIVERSITY GENERAL EDUCATION REQUIREMENTS

Information about General Education requirements can be found in the Undergraduate Announcements at http://www.registrar.clemson.edu/html/catalog.htm/ Each undergraduate student must fulfill the General Education requirements stipulated in the Undergraduate Announcements in the year of initial enrollment at Clemson or in the year of re-enrollment if the student withdraws from the university and returns. Any exception to curricular or general education requirements must the approved via the course substitution procedure.

Specific notes on General Education for Chemical Engineering students

- Students who complete the Chemical Engineering curriculum automatically satisfy the following General Education coursework requirements.
  - I.A Communication
  - I.B Mathematical, Scientific, and Technological Literacy
  - II.A Academic and Professional Development
  - II.B Distributed Competencies
- It is possible to satisfy all General Education A&H/SS/STS/CCA requirements of the University (II.C-F) by taking four courses. However, the Chemical Engineering curriculum requires 18 credits of A&H/SS/STS/CCA, or six courses at least.
- A worksheet and guide to the completion of A&H/SS/STS/CCA General Education requirements in Chemical Engineering are available on the two pages following this one. Copies can also be obtained in the ChBE Department office.
- Do not assume that completing a course on the list of approved STS or CCA courses means that it also satisfies a Social Science or A&H requirement. If you look closely, you will find that some of the STS and CCA courses listed in the Undergraduate Announcements count only as STS or CCA credit, not as Social Science or A&H credit.
- Chemical Engineering students may **not** take CH 1050 or CH 1060 to satisfy the STS requirement.

Arts & Humanities, Social Sciences, Cross-Cultural Awareness and Science & Technology in Society Worksheet for ChEs

All ChE students must complete a minimum of six courses (18 hours) in the arts & humanities (A&H) and social sciences (SS). Within these 18 hours, students must complete the Clemson General Education requirements, which include 3 hours of literature arts and humanities, 3 hours of non-literature arts and humanities, 3 hours in each of two different social sciences, 3 hours involving science and technology in society (STS), and 3 hours of cross-cultural awareness (CCA) coursework. Careful selection of these courses is important because some courses can satisfy more than one General Education requirement. If you choose carefully, you can allow yourself more flexibility to take courses of interest to you. If you do not choose correctly, you might have to take additional classes to meet all the requirements. You are strongly encouraged to seek an advisor's help if you have questions or need help in planning your choices.

Arts & Humanities

1._____
3 hour Literature Requirement

2._____
3 hour Non-literature Arts & Humanities
Meets STS? Y N Meets CCA? Y N

Social Sciences

3._____ **<**2 different fields**>** **4.**_____
3 hours 3 hours
Meets STS? Y N Meets CCA? Y N Meets STS? Y N Meets CCA? Y N

Arts & Humanities or Social Sciences

5._____ **6.**_____

3 hours A&H or SS ***** *3 hours A&H or SS* *****
Meets STS? Y N Meets CCA? Y N Meets STS? Y N Meets CCA? Y N

Courses that fulfill: **CCA** _____ **STS** _____

*****Certain A&H/SS courses not included in the Clemson General Education requirements may be taken by engineering students to fulfill the 5th and 6th courses required in ChE. See "Additional Engineering A&H/SS Course Choices**"** on the bottom of the attached sheet for these additional options.

Students are encouraged to verify any information they use from this list by consulting the official Clemson Undergraduate Announcements. **Courses are occasionally added and deleted**, but you cannot lose credit if a course is deleted after you have taken it.

Arts and Humanities

Literature--3 credits

Any 2000-level ENGL literature course (ENGL 2020, 2120, 2130, 2140, 2150), CHIN 4010, FR 3000, 3040, GER 2600, 3060, 3600, 3610, HON 1900, 2210, ITAL 3010, 3020, JAPN 4010, 4060, RUSS 3600, 3610, SPAN 3110, 3130

Non-Literature--3 credits

AAH 1010, 2100[2], ART 3750, ASL 3050[2], CAAH 2010, CHIN (PHIL), 3120, (PHIL) 3130, 4990, COMM 3030, 3080, 3090, 4020, ENGL (GW), 3010, 3550, 3570, (LANG) 4540, FR 3070, GW (ENGL) 3010, 4050, GER, 3400, HON 1910, 2010[1], 2030, 2100, 2220, HUM 3010, 3020, 3060, 3090[2], JAPN 3070, 3080, LANG 3400, 3420, 3560, (ENGL) 4540, LARC 1160[1], MUSC 2100[2], 3080, 3090, 3110, 3120, 3130, 3140[2], 3170, 3610, 3620, 3630, 3640, 3690, 3700, 3710, 3720, PHIL 1010, 1020, 1030, 1240[1], 2100[1], (CHIN) 3120, (CHIN) 3130, 3160, 3170, 3180, 3230, 3240[1], 3250, 3260[1], 3270, 3440, 3450[1], REL 1010[2], 1020[2], 3010, 3020, 3030, 3060, 3070, 3120, 3130, 3150, RUSS 3400, SPAN 3070, 3080, STS 1010[1], 1020[1], 2150[1], 3010[1], 3030[1], THEA 2100, 2790, 3080, 3090, 3150, 3160, 3170, WS 3010

Social Sciences

Selected from two different fields--6 credits (APEC and ECON are considered the same field)

ANTH 2010[2], APEC 2020, 2570, ECON 2000, 2110, 2120, GEOG 1010, 1030[2], 1060, HIST 1010, 1020, 1220[1], 1240[1], 1720[2], 1730[2], 1930[2], HON 1920, 2020, 2200, PAS 3010[2], POSC 1010, 1020[2], 1030, 1040[2], PSYC 2010, 2500[2], 2750[1], RS 3010, SOC 2010, 2020

Cross-Cultural Awareness

AAH 1020, 2100, ASL 3050, ANTH 2010, APEC 2050[1], CAAH 2010, GEOG 1030, HIST 1720, 1730, 1930, HON 1930, 2090, HUM 3090, IS 1010, 2100, LANG 2500, 2540, MUSC 2100, 3140, PAS 3010, POSC 1020, 1040, PSYC 2500, REL 1010, 1020, WS 1030, or through a University approved cross-cultural experience

Science and Technology in Society

AGED (EDF) 4800, APEC 2050[2], (ECON) 4570, AVS 3150, 4150, BIOL 2000, 2010, 2030, 2040, 2100, 2110, 2200, 4730, CH 1050, 1060, COMM 1070, 3070, CTE 1150, 2210, ECE 1010, ECON 3190, (APEC) 4570, EDF (AGED) 4800, ENR 3120, (FOR) 4160, ENSP (GEOL) 1250, 2000, (PES) 3150, 4000, ENGL 3490, ENT 2000, FDSC 2140, FOR (ENR) 4160, GEOL 1120, 1200, (ENSP) 1250, 2700, 3000, HCG (NURS) 3330, HIST 1220, 1240, 3210, 3230, 3920, 4240, 4910, HLTH
4310, HON 1940, 2010, 2060, IE 4880, LARC 1160, MKT 4450, MSE 1010, MUSC 3180, NURS 1400, (HCG) 3330, NUTR 2030, 2100, PES (ENSP) 3150, PHIL 1240, 2100, 3240, 3260, 3280, 3400, 3450, PHYS 2450, PKSC 3680, PLPA 2130, PRTM 2110, PSYC 2750, RS (SOC) 4010, SOC (RS) 4010, 4030, STAT 2220, STS 1010, 1020, 1200, 1710, 2150, 2160, 3010, 3030, 4980, 4990

*Additional Engineering A&H/SS Course Choices (for 5th and 6th courses only)

AAH 1000-4999, APEC 1000-2999, ANTH 1000-4999, ARAB 1000-4999, ART 1000-4999, ASL 1000-4999, CAAH 2010, CHIN 1000-4999, COMM 1000-4999 (except 1500, 2500), DANC 1000-4999, EAS 1230, ECON 1000-4999, ENGL 2000-4999 (except 2170, 3040, 3100, 3120, 3140, 3150, 3160, 3330), FR 1000-4999, GEOG 1000-4999, GER 1000-4999, GW 1000-4999, HIST 1000-4999, HON 1900, 1910, 1920, 2010, 2020, 2030, 2100, 2200, 2210, 2220, HUM 1000-4999, IS 2100, ITAL 1000-4999, JAPN 1000-4999, LANG 1000-4999, LAW 1000-4999, MUSC 1000-4999, PA 1000-4999, PAS 1000-4999, PHIL 1000-4999, PORT 1000-4999, POSC 1000-4999, PSYC 1000-4999, REL 1000-4999, RS 1000-4999, RUSS 1000-4999, SOC 1000-4999, SPAN 1000-4999, STS 1010, 1020, 3030, THEA 1000-4999, WS 1000-4999

Superscripts
1. This course also satisfies the STS requirement.
2. This course also satisfies the CCA requirement.

COOPERATIVE EDUCATION and INTERNSHIPS

How Cooperative Education and Internships Work

The Cooperative Education Program enables students to alternate semesters of work and study in order to gain a year or more of practical experience in their chosen field while earning their academic degree. About half of Clemson Chemical Engineering majors participate in the Co-op Program. Cooperative Education, as the term implies, represents a partnership between the University and participating industry, business and government organizations. Co-op is not a summer job program. At least three work periods are required to obtain the minimum 12 months of experience needed to earn the Cooperative Education Certificate, which is awarded with the degree at graduation. Chemical Engineering students actually have the opportunity to work more than three periods as shown on the suggested co-op schedules A and B that follow this page. These schedules are designed to ensure that students who choose to co-op will enter the program with a solid foundation of engineering skills and will be prepared to do progressively more meaningful and productive work in each co-op session.

Internships provide similar experience with industry, business, and government organizations but are limited to a single term and particularly over a summer term. Many students will prefer an internship opportunity based on the ability to gain multiple internship opportunities with different organizations, the fact that it does not delay graduation, or based upon the availability of positions offered by different organizations. Some companies may only provide opportunities for internships or Co-ops. The internship program does not have an extended contract with the student and University but students may have the opportunity to complete multiple internship rotations if desired. Some students will opt to participate in both co-op and internships before they graduate.

Advantages for Students

Students who elect to participate in the co-op and internship programs realize several benefits:

1. Co-op and internships provide valuable on-the-job learning experiences that cannot be acquired in the classroom.
2. Co-op and internships provide students opportunities to evaluate their initial career path choice.
3. Often students are offered permanent employment with their co-op or internship employer after graduation.
4. Career-related, on-the-job experiences enhance classroom academic work through increased motivation and conceptual understanding.
5. Co-op and internships provide students additional opportunities to develop professionally with respect to confidence, maturity, responsibility, and skill in human relations.
6. Co-op and internships allow students to earn substantial wages and salary that can be used to finance a portion of college expenses.
7. More and more employers are requiring that new hires have prior relevant work experience.

Eligibility and Participation

All Clemson students must complete at least 27 semester hours with a minimum 2.45 GPA before beginning their first co-op work term. Some employers require more semester hours completed and higher grade points than these criteria. Transfer students may begin work after their first semester at Clemson University, provided that they meet the other requirements. The ChE program is designed to start following completion of the Sophomore Year courses. The Cooperative Education Program is limited to undergraduate students.

Internships are less restrictive and are available to undergraduate and graduate students. Eligibility for internships is dictated by the internship position advertised by the sponsoring organization.

Special Notes:

1. If you have a scholarship and you co-op, be sure to talk with the Financial Aid Office about how your scholarship should be administered. Some scholarships require that you complete a minimum number of hours in a 12-month period, and this can influence your course scheduling. See your advisor if you need to depart from the suggested schedule.

2. Pay careful attention to the suggested schedule you choose to follow and consult with your academic advisor each semester. This will ensure that you can get the courses you need when you plan to take them and that you will have all the prerequisites for each course.

Additional Information

The first step towards identifying a co-op or internship opportunity should be to visit the Michelin Career Services Center in Suite 316, Hendrix Student Center; phone (864) 656-0440. Many helpful resources are available through their website: https://career.sites.clemson.edu/contact.php#coop The co-op office can be reached at Suite 316, Hendrix Student Center; phone (864) 656-3150. The internship office can be reached at Suite 314, Hendrix Student Center; phone (864) 656-2160

For departmental specific advising, please see one of the ChE co-op advisors (Drs. Bruce, Norfolk, Kitchens, Thies). The AIChE Student Organization and other ChE students can also be an excellent resource regarding co-op and internship opportunities.

CHEMICAL ENGINEERING CURRICULUM CO-OP "A"

Freshman Year

ENGR 1020 Engr Disciplines & Skills	2	CHE 1300 Chemical Engineering Tools	3
MATH 1060 Calculus of One Variable I	4	CH 1020 General Chemistry	4
CH 1010 General Chemistry	4	MATH 1080 Calc of One Variable II	4
ENGL 1030 Accelerated Composition	3	PHYS 1220 Physics with Calculus I	3
Arts and Humanities/Social Science[1]	3	Arts and Humanities/Social Science[1]	3
Semester Totals:	*16*		*17*

Sophomore Year

CHE 2110 Intro to Chem Engineering	4	CHE 2200 Chem Engr Thermodynamics I	3
CH 2230 Organic Chemistry	3	CHE 2300 Fluids/Heat Transfer	4
MATH 2060 Calc of Several Variables	4	CH 2240 Organic Chemistry	3
PHYS 2210 Physics with Calculus II	3	CH 2290 Organic Chemistry Lab	1
Arts and Humanities/Social Science[1]	3	MATH 2080 Intro to Ord Diff Eqns	4
Semester Totals:	*17*		*15*

Summer Semester CO-OP (1)

Junior Year (2 Years)

CHE 3210 Chem Eng Thermodynamics II	3	CO-OP Semester (2)	**
CHE 3300 Mass Transfer/Separations	4		
STAT 4110 Statistical Methods	3		
CH 3390 Physical Chemistry Lab	1	CHE 3070 Unit Operations Lab I	3
ECE 2070 Basic Electrical Engr	2	CHE 3190 Engineering Materials	3
ECE 2080 Electrical Engr Lab I	1	CH 3320 Physical Chemistry	3
Emphasis Area[2]	3	CH 3400 Physical Chemistry Lab	1
Semester Total:	*17*	BMOL 4250 Biomolecular Engr	3
		Arts and Humanities/Social Science[1]	3
CO-OP Semester (3)	**	*Semester Total:*	*16*

Senior Year

CHE 4070 Unit Operations Lab II	3	CHE 3530 Process Dynamics/Control	3
CHE 4310 Chemical Process Design I	3	CHE 4330 Process Design II	3
CHE 4430 Safety, Env. & Prof. Prac. I	2	CHE 4440 Safety, Env. & Prof. Prac. II	1
CHE 4500 Chemical Reaction Engr	3	BMOL 4290 Bioprocess Engineering	3
Arts and Humanities/Social Science[1]	3	Arts and Humanities/Social Science[1]	3
Emphasis Area[2]	3	Emphasis Area[2]	3
Semester Totals:	*17*		*16*

Total = 131 hrs.

Notes

[1] See Policy on Social Sciences and Humanities for Engineering Curricula. Six of these credit hours must also satisfy the Cross-Cultural Awareness and Science and Technology in Society Requirements.

[2] See advisor for details. Nine credit hours devoted to completion of an emphasis area or approved minor is required. Emphasis areas are these: Applied Engineering, Mathematics & Science; Biomolecular Science & Engineering; Polymeric Materials; Energy Studies; Environmental Engineering & Science; Business Management.

Note: No student may exceed two attempts, including a *W*, to complete successfully any CHE course.

CHEMICAL ENGINEERING CURRICULUM CO-OP "B"

Freshman Year

ENGR 1020 Engr Disciplines & Skills	2	CHE 1300 Chemical Engineering Tools	3
MATH 1060 Calculus of One Variable I	4	CH 1020 General Chemistry	4
CH 1010 General Chemistry	4	MATH 1080 Calc of One Variable II	4
ENGL 1030 Accelerated Composition	3	PHYS 1220 Physics with Calculus I	3
Arts and Humanities/Social Science[1]	3	Arts and Humanities/Social Science[1]	3
Semester Totals:	*16*		*17*

Sophomore Year

CHE 2110 Intro to Chem Engineering	4	CHE 2200 Chem Engr Thermodynamics I	3
CH 2230 Organic Chemistry	3	CHE 2300 Fluids/Heat Transfer	4
MATH 2060 Calc of Several Variables	4	CH 2240 Organic Chemistry	3
PHYS 2210 Physics with Calculus II	3	CH 2290 Organic Chemistry Lab	1
Arts and Humanities/Social Science[1]	3	MATH 2080 Intro to Ord Diff Eqns	4
Semester Totals:	*17*		*15*

Junior Year (2 Years)

CO-OP Semester (1)	**	CHE 3070 Unit Operations Lab I	3
		CHE 3190 Engineering Materials	3
CHE 3210 Chem Eng Thermodynamics II	3	CH 3320 Physical Chemistry	3
CHE 3300 Mass Transfer/Separations	4	CH 3400 Physical Chemistry Lab	1
STAT 4110 Statistical Methods	3	BMOL 4250 Biomolecular Engr	3
CH 3390 Physical Chemistry Lab	1	Arts and Humanities/Social Science[1]	3
ECE 2070 Basic Electrical Engr	2	*Semester Total:*	*16*
ECE 2080 Electrical Engr Lab I	1		
Emphasis Area[2]	3	CO-OP Semester (3)	**
Semester Total:	*17*		

Summer Semester CO-OP (2)

Senior Year

CHE 4070 Unit Operations Lab II	3	CHE 3530 Process Dynamics/Control	3
CHE 4310 Chemical Process Design I	3	CHE 4330 Process Design II	3
CHE 4430 Safety, Env. & Prof. Prac. I	2	CHE 4440 Safety, Env. & Prof. Prac. II	1
CHE 4500 Chemical Reaction Engr	3	BMOL 4290 Bioprocess Engineering	3
Arts and Humanities/Social Science[1]	3	Arts and Humanities/Social Science[1]	3
Emphasis Area[2]	3	Emphasis Area[2]	3
Semester Totals:	*17*		*16*

Total = 131 hrs.

Notes

[1] See Policy on Social Sciences and Humanities for Engineering Curricula. Six of these credit hours must also satisfy the Cross-Cultural Awareness and Science and Technology in Society Requirements.

[2] See advisor for details. Nine credit hours devoted to completion of an emphasis area or approved minor is required. Emphasis areas are these: Applied Engineering, Mathematics & Science; Biomolecular Science & Engineering; Polymeric Materials; Energy Studies; Environmental Engineering & Science; Business Management.

Note: No student may exceed two attempts, including a *W*, to complete successfully any CHE course.

CHEMICAL ENGINEERING CURRICULUM CO-OP "A" with BIOMOLECULAR ENGINEERING CONCENTRATION

Freshman Year

ENGR 1020 Engr Disciplines & Skills	2	CHE 1300 Intro. To Chemical Eng.	3
MATH 1060 Calculus of One Variable I	4	CH 1020 General Chemistry	4
CH 1010 General Chemistry	4	MATH 1080 Calc of One Variable II	4
ENGL 1030 English Composition	3	PHYS 1220 Physics with Calculus I	3
Arts and Humanities/Social Science[1]	3	Arts and Humanities/Social Science[1]	3
Semester Totals:	*16*		*17*

Sophomore Year

CHE 2110 Intro to Chem Engineering	4	CHE 2200 Chem Engr Thermodynamics I	3
CH 2230 Organic Chemistry	3	CHE 2300 Fluids/Heat Transfer	4
MATH 2060 Calc of Several Variables	4	CH 2240 Organic Chemistry	3
BIOL 1100 Prncpls of Biology (w/Lab)	5	CH 2290 Organic Chemistry Lab	1
Arts and Humanities/Social Science[1]	3	MATH 2080 Intro Ordinary Diff Eqns	4
Semester Totals:	*19*		*15*

Summer Semester CO-OP (1)

Junior Year (2 Years)

CHE 3210 Chem E. Thermodynamics II	3	CO-OP Semester (2)	**
CHE 3300 Mass Transfer/Separations	4		
PHYS 2210 Physics with Calculus II	3	CHE 3070 Unit Operations Lab I	3
Biochemistry requirement[2]	3	CHE 3190 Engineering Materials	3
STAT 4110 Statistical Methods	3	BIOL 4340 Biochemistry Lab	2
		BMOL 4250 Biomolecular Engr	3
Semester Total:	*16*	BIOE 3020 Biomaterials	3
		Arts and Humanities/Social Science[1]	3
CO-OP Semester (3)	**	*Semester Total:*	*17*

Senior Year

CHE 4070 Unit Operations Lab II	3	CHE 3530 Process Dynamics/Control	3
CHE 4310 Chemical Process Design I	3	CHE 4330 Process Design II	3
CHE 4430 Safety, Env. & Prof. Prac. I	2	CHE 4440 Safety, Env. & Prof. Prac. II	1
CHE 4500 Chemical Reaction Engr	3	BMOL 4290 Bioprocess Engineering	3
BCHM 4310 Physical Biochemistry	3	Arts and Humanities/Social Science[1]	3
Arts and Humanities/Social Science[1]	3	Engineering Requirement[3]	3
Semester Totals:	*17*		*16*

Total = 133 hrs.

Notes

[1] See Policy on Social Sciences and Humanities for Engineering Curricula. Six of these credit hours must also satisfy the Cross-Cultural Awareness and Science and Technology in Society Requirements.

[2] Select from BCHM 3010, BCHM 3050, BCHM 4230, or CH 3600.

[3] Select from CHE 4010 or BMOL 4030, BMOL 4270, BE 4280, BE 4350, BIOE 4400, BIOE 4490, BIOE 4760, MICR 4130

Note: No student may exceed two attempts, including a *W*, to complete successfully any CHE course.

CHEMICAL ENGINEERING CURRICULUM CO-OP "B" with BIOMOLECULAR ENGINEERING CONCENTRATION

Freshman Year

ENGR 1020 Engr Disciplines & Skills	2	CHE 1300 Intro. To Chemical Eng.	3
MATH 1060 Calculus of One Variable I	4	CH 1020 General Chemistry	4
CH 1010 General Chemistry	4	MATH 1080 Calc of One Variable II	4
ENGL 1030 English Composition	3	PHYS 1220 Physics with Calculus I	3
Arts and Humanities/Social Science[1]	3	Arts and Humanities/Social Science[1]	3
Semester Totals:	*16*		*17*

Sophomore Year

CHE 2110 Intro to Chem Engineering	4	CHE 2200 Chem Engr Thermodynamics I	3
CH 2230 Organic Chemistry	3	CHE 2300 Fluids/Heat Transfer	4
MATH 2060 Calc of Several Variables	4	CH 2240 Organic Chemistry	3
BIOL 1100 Prncpls of Biology (w/Lab)	5	CH 2290 Organic Chemistry Lab	1
Arts and Humanities/Social Science[1]	3	MATH 2080 Intro Ordinary Diff Eqns	4
Semester Totals:	*19*		*15*

Junior Year (2 Years)

CO-OP Semester (1)	**	CHE 3070 Unit Operations Lab I	3
		CHE 3190 Engineering Materials	3
CHE 3210 Chem E. Thermodynamics II	3	BIOL 4340 Biochemistry Lab	2
CHE 3300 Mass Transfer/Separations	4	BMOL 4250 Biomolecular Engr	3
PHYS 2210 Physics with Calculus II	3	BIOE 3020 Biomaterials	3
Biochemistry requirement[2]	3	Arts and Humanities/Social Science[1]	3
STAT 4110 Statistical Methods	3	*Semester Total:*	*17*
Semester Total:	*16*	CO-OP Semester (2)	**

Summer Semester CO-OP (3)

Senior Year

CHE 4070 Unit Operations Lab II	3	CHE 3530 Process Dynamics/Control	3
CHE 4310 Chemical Process Design I	3	CHE 4330 Process Design II	3
CHE 4430 Safety, Env. & Prof. Prac. I	2	CHE 4440 Safety, Env. & Prof. Prac. II	1
CHE 4500 Chemical Reaction Engr	3	BMOL 4290 Bioprocess Engineering	3
BCHM 4310 Physical Biochemistry	3	Arts and Humanities/Social Science[1]	3
Arts and Humanities/Social Science[1]	3	Engineering Requirement[3]	3
Semester Totals:	*17*		*16*

Total = 133 hrs.

Notes

[1] See Policy on Social Sciences and Humanities for Engineering Curricula. Six of these credit hours must also satisfy the Cross-Cultural Awareness and Science and Technology in Society Requirements.

[2] Select from BCHM 3010, BCHM 3050, BCHM 4230, or CH 3600.

[3] Select from CHE 4010 or BMOL 4030, BMOL 4270, BE 4280, BE 4350, BIOE 4400, BIOE 4490, BIOE 4760, MICR 4130

Note: No student may exceed two attempts, including a *W*, to complete successfully any CHE course.

THE HONORS PROGRAM (Calhoun Honors College)

The Honors Program of Clemson University is known as Calhoun Honors College, and students enrolled in honors work are called Calhoun Scholars. To enter or to remain in Calhoun Honors College a student must have a cumulative grade-point ratio of 3.4. Admission to Calhoun Honors College for incoming freshmen is by invitation, based primarily on SAT scores and high school academic records. Calhoun College is operated under the guidelines of the Honors Program Committee, a group comprised of faculty members from each college, and chaired by the Director of the Honors Program. The Calhoun Honors College Student Handbook is available in the Honors Program Office, 105 Tillman Hall.

Students graduating with Senior Departmental Honors will receive the Senior Departmental Honors Medallion at an honors ceremony shortly before graduation. The medallion is worn during the graduate exercises. Students' diplomas also reflect the honors graduation designation.

SENIOR DEPARTMENTAL HONORS PROGRAM

Department of Chemical & Biomolecular Engineering

Administration

The Senior Departmental Honors Program is administered by the Honors Program Committee. The Honors Coordinator who chairs this committee is appointed by the Department Chair. Members of the committee include all faculty who are currently advising honors students. If necessary, additional faculty are appointed by the Department Chair so that there are at least three committee members.

Admission

Students who wish to participate in the Senior Departmental Honors Program must meet the eligibility requirements set by Calhoun College and the ChBE Department, which include:

- Students applying for admission to the Senior Departmental Honors Program must have completed or be about to complete the sophomore courses of the chemical engineering curriculum and must have at least three (and preferably four) semesters remaining to complete their degree program.

- To enter and to remain in the Senior Departmental Honors Program a student must have a cumulative grade-point ratio of 3.4.

- To enter the program students must have a minimum cumulative GPR of 3.0 in chemical engineering courses. They must maintain this standard (exclusive of grades earned in CHE 3950, 4950, and 4970) to graduate with Senior Departmental Honors.

- The faculty intends for the Honors Program to be an enriching experience beyond that normally provided for undergraduate students. Therefore, Chemical Engineering honors courses will not be used to replace any courses required for earning the B.S. degree in Chemical Engineering.

- Students in the program must earn at least a B in one honors course in Chemical Engineering each semester of the junior and senior years (or, equivalently, a Pass in CHE 3000). The program is a research-focused effort centered around four courses, for a total of 8 hours of honors credit. The courses are described below. The exact timing of these courses is flexible, at the discretion of the Honors Program Committee and the student's research advisor. During the last half of the spring semester of their senior year, senior honors students will make oral presentation on their work.

Chemical & Biomolecular Engineering Honors Courses

(1) *CHE 3000, Honors Seminar* (1 hour credit, P/F). New honors students will take this course during the fall semester of the junior year. The purpose is to provide opportunities for students to learn about research projects. Honors students will attend the weekly graduate seminar, and interested faculty may also present separate talks describing projects to honors students. Students will be given the opportunity to earn credit for CHE 3000 during a spring semester if their schedules preclude enrollment in the fall.

Student Responsibilities: Honors student attendance at each seminar will be mandatory. Students accumulating more than one unexcused absence will receive an F in 3000 and will be dismissed from the program.

No later than two weeks before the end of the semester, each honors student will identify three projects for which they would like to work and will submit the selected list to the Honors Program Coordinator.

(2) *CHE 3950 and 4950, Honors Research* (3 hours credit, each graded). During the spring semester, junior year, and fall, senior year, students will perform their research under the guidance of faculty advisors. Each student is expected to work 10 hours per week on the project. With the concurrence of a faculty advisor, co-op students may substitute 3 hours of CHE 4910 (Special Projects) earned over the course of an entire summer (2 hours for one session and 1 hour for the other) for CHE 3950 or CHE 4950.

Student Responsibilities: Two weeks before the end of the first research term, students enrolled in CHE 3950 will submit to the Honors Program Committee a written report of progress on the project. In general, this report should be 10 to 15 pages long plus appropriate appendices.

During the last half of the second research term, each student enrolled in CHE 4950 will arrange with the Honors Program Coordinator to present a talk at the Honors Seminar. Two weeks before the end of the second research term, each student will submit to the Honors Program Committee a thesis outline.

(3) *CHE 4970, Honors Thesis* (1 hour credit, graded). During the spring of the senior year each Honors student will write a thesis. A complete draft of the thesis will be submitted to the faculty advisor no later than March 15. Generally, the body of the thesis will constitute no more than 50 type-written pages (excluding appendices), and it will follow a format established by the Honors Program Committee. This draft will be critiqued by the faculty advisor and revised by the student for final submittal to the Honors Program Coordinator no later than April 15.

UNDERGRADUATE RESEARCH OPPORTUNITIES

The faculty in the Department of Chemical and Biomolecular Engineering conduct research in many exciting areas. The faculty listing that appears later in this handbook indicates the broad range of research activities available. These research projects often offer the opportunity for undergraduates to participate in one of several ways:

(a) Part-time work as a Laboratory Assistant during the academic year

(b) Part-time or full time work as a Lab Assistant during the summer

(c) Summer Research Fellowships

(d) Creative inquiry course credit through CHE 1990, 2990, 3990, 4990

(e) Research for course credit through CHE 4910/4910.

(f) Participation in the Departmental Honors Program.

Undergraduates have made meaningful contributions to our research in the past, and many students have begun to work as Lab Assistants as early as their sophomore year. It is an excellent way to earn money or academic credits. You can also get insight into whether you may be interested in graduate study after your B.S. since most research jobs in industry and government require advanced degrees. Finally, whether or not you continue to do research in graduate school or in industry, research experience as an undergraduate is a plus when seeking employment after graduation.

If you are interested in becoming involved, talk directly to a faculty member whose research area you think looks interesting.

<u>Note</u>: Students will not be provided an opportunity to enroll in CHE 4910 as a means to raise a low engineering grade point average.

GRADUATE STUDY IN CHEMICAL ENGINEERING

What is graduate school?

You may attend graduate school in chemical engineering to earn an M.S. degree, a Ph.D. degree, or both. The M.S. degree typically requires 2 years, while the Ph.D. degree typically requires 4-5 years beyond the B.S. degree. You will take advanced courses during the first one or two years, and then will focus on a thesis research project in a research area of your interest.

Who should attend graduate school?

If you are in the top one-third or one-fourth of your class, then you should seriously consider attending graduate school. For research and development, technical work, or teaching, a graduate degree is a definite advantage, if not a requirement. If your GPR is greater than 3.5/4.0, then your chances of being accepted into a Ph.D. program with financial aid are excellent. If your GPR is between 3.0/4.0 and 3.5/4.0, then you can probably gain admission to graduate school with financial aid, but your choices may be more limited.

Why does one attend graduate school?

If you are like many others, you may be tired of taking courses and living the student lifestyle when your undergraduate program is completed. It may at first seem out of the question to go through four more years of school in order to obtain a Ph.D. degree. However, there are three very important reasons for doing so:

- Graduate school is challenging and fun - Most of your graduate courses will be in areas that interest you and will offer considerable interaction with the professor and the other students. Moreover, the majority of your time spent on a Ph.D. degree will be in research on a challenging problem that is of interest to you. You will have opportunity to develop close-knit relationships with other members of your entering class and research group.

- Graduate school is a wise investment - Although there is a short-term financial sacrifice in not taking a professional job with a B.S. degree, those who obtain advanced degrees generally receive higher starting salaries and come out ahead financially in the long-term. More important, though, is the job satisfaction that is made possible with an advanced degree. There are many exciting areas that are opening up to chemical engineers, including biotechnology, electronic devices, advanced materials, novel energy processing, and hazardous waste management. Advanced knowledge is needed to work in these so-called "frontiers of chemical engineering." In addition, a Ph.D. degree may be a distinct advantage for upper-level management jobs and is a requirement for an academic position.

- Graduate students are paid to go to school - Most full-time graduate students have their tuition paid and they receive a stipend that is sufficient to live on. Many fellowships also exist that pay even higher stipends.

When is the best time to attend graduate school?

It is generally best to attend graduate school shortly after completing a B.S. degree. A small percentage of graduate students work a few years in industry first and then return to school with a clearer vision of how an advanced degree can improve career opportunities. However, the interruption of a career in this way is difficult and requires some sacrifice.

Where does one attend graduate school?

First, we do recommend that you consider going to a different school than Clemson. It is important that you apply to schools that have active research programs in one or more areas that interest you. Directories, such as the "Graduate Education Issue" published each Fall by Chemical Engineering Education (an ASEE journal) and the *AIChE Graduate School Directory* published each year, give information on faculty, students, research grants, and research publications. Discuss your desire to attend graduate school with faculty members at Clemson. Ask them for advice on schools that are well-suited for you and that have faculty members with active research programs in areas that interest you.

Of course, Clemson has active research programs in several areas, and a strong graduate program of study. We have found that Clemson undergraduates are some of our best graduate students, and certainly encourage you to consider study here.

How does one apply for graduate school?

First, talk to the Department Graduate Coordinator. If you are interested in applying at Clemson, they can supply you with the necessary forms. They can also counsel you on other graduate schools to consider, and suggest other Clemson faculty to talk with about particular research areas. In general though, early in the fall term of your senior year you should write a brief letter addressed to the Graduate Coordinator of each department that you are interested in, requesting information (graduate brochure) and application materials. It is probably best to apply to only a few schools that you are seriously interested in. The applications should be submitted in the fall, or early in the winter.

When a school accepts you for graduate study, it will specify a decision date. An important element in making your decision will be the financial aid available. If you are interested in a Ph.D. and have good qualifications, then most schools will offer you a fellowship, teaching assistantship, or research assistantship that will cover tuition and provide a monthly stipend that is adequate for living expenses. Also, it is a good idea to visit the one or two schools that you are most interested in. Often, the school will pay for part of your visit.

What is the combined BS/MS plan?

Undergraduate Chemical Engineering majors who have completed at least 90 credit hours with a grade point ratio of 3.4 can begin work toward an MS (Master of Science) in Chemical Engineering or an MS or MENGR (Master of Engineering) in Environmental Engineering and Science by selecting approved graduate courses for their emphasis area. See details in the Emphasis Area descriptions for Advanced Engineering, Math, and Science and Environmental Engineering and Science.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS STUDENT CHAPTER

It is traditional that professionals band together to promote their profession and to disseminate professional information. Medical doctors join the American Medical Association, lawyers belong to the American Bar Association, and chemical engineers affiliate themselves with the American Institute of Chemical Engineers (AIChE). As a chemical engineering student at Clemson you are invited to join our outstanding Student Chapter of the American Institute of Chemical Engineers (AIChE), which has won the National Award of Excellence over 10 times in its history.

The Student Chapter of AICHE is active at the national, regional, and local levels. At the national level, there are many benefits for the Chem E student. Recently, joining the national organization has been FREE! Upon joining the national organization, each student may receive the following:

- free online access to Perry's Chemical Engineer's Handbook
- subscription to the National AICH E Student magazine, Chapter One
- subscription to the regular members monthly magazine, Chemical Engineering Progress
- chance to apply for a Visa card which is affiliated with the AIChE
- Hertz Rent-A-Car Discount Card
- a volume from the AICH E modular instruction series
- chance to win AICH E scholarships
- chance to compete in National AICH E Student Design Competition
- employment services during senior year (including list of potential employees nationwide)

In addition, each year a national convention is held, and Clemson usually sends 2-4 representatives.

At the regional level, a student convention is held each year at one of the member universities. The Southern Region, of which Clemson is a member, includes the University of Puerto Rico as well as universities in the states of Kentucky, Virginia, Tennessee, North Carolina, South Carolina, Louisiana, Mississippi, Alabama, Georgia and Florida. At the Regional Convention held each year at one of the member universities, we socialize with Chem Es from other schools, visit chemical plants, and hold a technical paper contest.

The AIChE Student Chapter is most active at the local level. Each year the Clemson student organization hosts many professional development events designed to acquaint students with types of situations that they can expect to find themselves in after graduation. This is accomplished through guest speakers (usually about 8 per year), plant trips, and two dinners with chemical engineers who work in the area and are members of Greenville's Western Section. The AIChE Student Chapter also sponsors social events to help students get to know each other and the faculty on a personal basis. Traditionally these include a Welcome Back Picnic in August, a Shrimp Boil later in the fall, and a Pig Roast in the spring.

In summary, there are many excellent reasons to join AIChE. As a freshman or sophomore, it is often difficult to know whether the major you have chosen is really right for you. By joining AIChE, you can get exposure to the wide variety of jobs that will be available to you after graduation, and thus feel certain that you have chosen the right path. Membership dues are inexpensive. For more information, contact one of the chapter officers listed on the Clemson AIChE website (www.ces.clemson.edu/chemeng/AIChE/index.html).

OTHER IMPORTANT INFORMATION AND ADVICE FOR CHEMICAL ENGINEERING STUDENTS

Why Are You In College?

You are here for one overriding reason, and that is to learn. You will and should do other things while here. You will meet a lot of people, make new friends and have a lot of fun. You should participate in some extra-curricula activities, take time out for personal participation sports (golf, tennis, etc) and allow some time to simply have fun. However, all of these activities are secondary to your main purpose - learning the subject matter and intellectual discipline of your future profession. Keep that in mind.

Professionalism

The work of a professional person differs from that of others in the crafts and trades industry by virtue of the fact that it is intellectual and of a non-routine nature. In general a professional works with their brain and a craftsman with their hands. Your future employer will be interested in having you solve "new" problems. If all the problems had been solved, there would be no need for engineers. Your future work will be non-routine and non-repetitive; new, unusual, and challenging problems will be the rule rather than the exception. The reason for our emphasis on understanding basic concepts should now be apparent. You will find that in chemical engineering education we stick to concepts and fundamentals, and that we will not teach you, except incidentally, how to make any specific product such as nylon, sulfuric acid, rocket fuel, etc. Processes for making things change almost daily, but the fundamentals on which processes are created endure.

How To Study

Many students fail in college because they don't know how to study; and indeed, many students have never had to study. To succeed in college, particularly in engineering, you must develop good study habits and stick to them. There are many approaches to this; for further help, see the Counseling & Psychological Services Center (656-2451), or ask your advisor for help.

To illustrate one method of study, let us assume that you are studying for an engineering course.

1. Find a quiet place to study. If your dorm or apartment is not suitable, go to the University Library or one of the academic buildings such as Earle Hall. Have a reasonable size desk and a straight chair. Sit with your feet on the floor, not on the desk.

2. Check your assignment or estimate how many pages of text the professor will cover in the next class. As you read the material, make yourself a set of notes on the material. Derive and understand the key equations in your notes, always bearing in mind the individual assumptions and previous equations used in the derivation; the final result is often not as important as the concepts it embodies. Although writing down a derivation that is in the book may seem unnecessary, most people learn much better by virtue of this "active" studying rather than simply "passively" reading the material.

3. Don't be afraid to underline or highlight important passages in a book, or to make notes in the margin. When you run across something that you don't understand or are unsure of, make a note in the margin. These notes form the basis for questions at the next lecture.

4. At the lecture, make a new set of notes. An effective professor will give you more on a subject than is in your text and will bring out variations on the text material. Be sure to ask questions on points that are not clear to you.

5. The night after a lecture you should combine the two sets of notes you have taken into a final set. By this time you will have covered the material three times and if you have been diligent in note taking and listening to the lecturer, you should have a solid understanding of the material. You will usually have an opportunity to test your knowledge by working homework problems. If you do not have a firm grasp on the material, seek help from your instructor at your earliest opportunity.

6. Never depend on "cramming" for a quiz or examination. If you follow this recommended reviewing, your quizzes will be easy.

Understanding Concepts

In four years of college the faculty can only hope to sharpen your thinking processes along the lines of your chosen field of study. You are not here to be taught "how" to do something, but rather you are here to absorb the concepts of "why" things happen the way they do. You should strive to gain an understanding of overall concepts; for example, in chemistry you will be taught the molar concept for calculating yields from chemical reactions, and in the calculus you will be taught the concept of a differential operator. If you firmly grasp the concepts, you will be able to apply them in other classes, and in your future profession long after the present-day "hows" are obsolete.

Keep Your Books

Don't succumb to the temptation to sell your books at the end of a semester for a little ready cash. Keep your books, especially the technical ones, for they will form the basis of your professional library after graduation. As a professional engineer you will live with books and you never know which one you may have to consult. Be smart; keep your books.

Scholastic Regulations

Become familiar with the Scholastic Regulations of Clemson University as written in the University Announcements. The University accepts no excuses for ignorance of these regulations. Be sure that you know to compute your overall GPR and your engineering GPR, and be sure that you know the prerequisites for the courses you must take.

If You Fall Behind In A Course

If you become aware that you are falling behind in a course, you should immediately see your instructor for advice on catching up. All faculty members maintain office hours so as to be available to students, but you must take the initiative to ask for help. Please discard any thoughts that you may have retained from high school regarding "playing up" to a teacher. You are now in a professional course of study and you have a responsibility to yourself to get the best education you possibly can. Don't worry an instructor with trivial things, but don't hesitate to ask if you need help in a course. You will surely fall behind in the course if you "cut class" or sleep in class. You (or your parents or your scholarship provider) are paying at least $616 (in-state) to $1,600 (out-of-state) for each credit hour of class you have scheduled or about $41 to $106 for each hour of class time. You might consider whether or not you can afford to throw away money like that.

Your Advisor

Each chemical engineering student is assigned to a chemical engineering faculty advisor. Get to know your advisor and don't hesitate to ask him or her for help with scheduling, studying, career plans, or anything else related to chemical engineering. Each semester during registration, you must make out a schedule of courses that you want to take in the following semester, and this schedule must be approved by your advisor.

DOS

1. THINK! Gather needed information and make your own decisions.
2. Be active in your education; i.e. participate.
3. Memorize really important principles (there aren't that many).
4. Learn to separate important principles from less important details.
5. Learn to distinguish between causes and effects.
6. Read written instructions carefully and interpret them logically.
7. Look for analogies and use them to interpret new ideas.
8. Use knowledge and methods from previous courses and experiences.
9. Try to connect textbook and lecture material with "the real world".
10. Develop systematic procedures to solve problems.
11. Learn to analyze data for consistency, reliability, and meaning.
12. Learn to ascribe physical meaning to equations.
13. Learn to use fundamental logic to reach a conclusion.
14. Try to judge the reasonableness of your answers.
15. Learn to write coherent paragraphs.
16. Present your work in a neat and orderly fashion.
17. Exercise and stay healthy.
18. Anticipate the consequences of your actions and realize that you alone are responsible for them
19. Do everything you do ethically and with respect for others.

DON'TS

1. Accept all authoritative statements as truths. No one has all the answers.
2. Expect instructors to give cookbook procedures for everything.
3. Copy homework.
4. Expect to find all the answers in a book.
5. Expect all problems to have closed-form solutions; some require iteration, i.e., trial & error.
6. Expect all problems to have a single solution (or any solution).
7. Expect quizzes to be just like old homework problems.
8. Submit reports that look good but contain nonsense.

CHEMICAL ENGINEERING FACULTY

Marc R. Birtwistle, Associate Professor, PhD. -- University of Delaware (2008). Cancer systems biology and pharmacology

Mark A. Blenner, Assistant Professor, Ph.D. – Columbia University (2009): Synthetic biology, metabolic engineering, and protein engineering with emphasis on production of sustainable biochemicals, therapeutics, and biosensors using yeast.

David A. Bruce, Professor and Chair, Ph.D. - Georgia Institute of Technology (1994): Catalyst development for the petrochemical and pharmaceutical industries and molecular modeling, chiral zeolites, mesophase materials and polymeric templating.

Eric M. Davis, Assistant Professor, Ph.D. – Drexel University (2013): Polymer Membranes, Transport Phenomena, Poromechanics

Rachel B. Getman, Associate Professor, Ph.D. – University of Notre Dame (2009): Simulation and design of catalysts for energy applications.

Douglas E. Hirt, Professor and Associate Dean for Research, Ph.D. - Princeton University (1989): Polymer films, additive diffusion, interfacial phenomena, mass transfer modeling, polymer thermodynamics, surface chemistry.

Scott M. Husson, Professor, Ph.D. – University of California, Berkeley (1998): Bioseparations and Advanced Separation Materials.

Jessica M. Kelly, Assistant Professor, Ph.D. – Auburn University (2017): Drug delivery and advanced materials with a focus on application in treatment of neurodegenerative disease and other brain disorders.

Christopher L. Kitchens, Associate Professor, Ph.D. – Auburn University (2004): Advanced materials for sustainability and nanotechnology applications; structure-activity relationships, materials from renewable resources, catalysis, drug delivery, thermodynamics and green chemistry

Christopher W. Norfolk, Lecturer, Ph.D. – University of Notre Dame (2005): RiSE Faculty Fellow. Composite materials, defense industry, prosthetic technology.

Amod A. Ogale, Professor, Ph.D. - University of Delaware (1986): Director, Center for Advanced Engineering Fibers and Films. Polymer processing; composite formation, characterization; experimental and modeling issues related to advanced engineering fibers and films.

Mark. E. Roberts, Associate Professor, Ph.D. – Stanford University (2008): Organic and nano-materials; electrical energy storage; chemical and biological sensors.

Sapna Sarupria, Assistant Professor, Ph.D. - Rensselaer Polytechnic Institute (2009): Computational studies of kinetic processes with relevance to bioengineering, energy, and the environment.

Joseph K. Scott, Assistant Professor, Ph.D. - Massachusetts Institute of Technology (2012): Process Systems Engineering, Renewable Energy Systems, Dynamic Simulation and Optimization, Global Optimization, Fault Detection and Fault-Tolerant Control

Mark C. Thies, Professor, Ph.D. - University of Delaware (1985): Thermodynamics and supercritical fluids, separation processes, materials processing, phase behavior of complex mixtures, environmental applications.