UNDERGRADUATE STUDENT

HANDBOOK

2008-2009

Department of Chemical and Biomolecular Engineering
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http://www.ces.clemson.edu/chemeng/

Updated June 2008

Student _____

Advisor _____

A more recent version of this handbook may be available on our website at:

www.ces.clemson.edu/chemeng/current_undergraduate_students.html

CH E students should keep a record of courses taken on these pages.

Bring your handbook with you whenever you see your advisor.

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INTRODUCTION

This handbook 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 has been collected here for your convenience.

It is important that you acquaint yourself immediately with the information in this handbook. If you have any questions about the information in this handbook or anything else regarding the Chemical Engineering Program or profession, please talk to your advisor.

DEPARTMENTAL DIRECTORY

DEPARTMENTAL OFFICE: 127 Earle Hall	TELEPHONE: (864) 656-3055 WEBSITE: www.ces.clemson.edu/chemeng/	
DEPARTMENT CHAIR:	Dr. James Goodwin, Jr. 127 Earle Hall jgoodwi@clemson.edu	
UNDERGRADUATE COORDINATOR:	Dr. Scott Husson 126 Earle Hall shusson@clemson.edu	
STUDENT SERVICES COORDINATOR:	Joy Rodatz 127 Earle Hall jrodatz@clemson.edu	
BUDGET OFFICER:	Diane Jackson 9 Earle Hall jdhmoor@clemson.edu	
MARKETING DIRECTOR:	Donna Kilbourne 127 Earle Hall dkilbou@clemson.edu	
LAB EQUIPMENT/SAFETY SPECIALISTS:	William Coburn G12 Earle Hall wcoburn@clemson.edu	Mike Wilbanks G12 Earle Hall mikew@clemson.edu
UNDERGRADUATE ADVISORS:	Each student is assigned an advisor upon entering the CH E program. See student services coordinator for your assigned advisor.	
Co-Op Advisors	Dr. David Bruce 211 Earle Hall dbruce@clemson.edu	Dr. Charles Gooding 209 Earle Hall chgdng@clemson.edu
	Dr. Douglas Hirt 16 Earle Hall hirtd@clemson.edu	Dr. Mark Thies 221 Earle Hall mcths@clemson.edu

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(Page number references are from Clemson University Announcements, 2008-2009)

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If you entered Clemson prior to Fall 2008, then you can find the announcements for your curriculum year online. Note: you will follow the requirements in effect on the date of your enrollment.

Current catalog plus catalogs from:
2007 - 2008
2006 - 2007
2005 - 2006
2004 - 2005
2003 - 2004
2002 - 2003
2001 - 2002
2000 - 2001
Can be found online at:
http://www.registrar.clemson.edu/html/catalog.htm

CHEMICAL ENGINEERING PROGRAM

Bachelor of Science

Chemical engineering is based on the sciences of chemistry, biology, physics and mathematics. The curriculum emphasizes a broad range of fundamental principles in science and engineering as well as communication skills and humanities. As a result, graduates are sought avidly by industries in many areas of technology such as energy and fuels, specialty chemicals, biotechnology, electronic and photonic devices, food and consumer goods, pharmaceuticals, advanced materials, pulp and paper, and aerospace, just to name a few. Chemical engineers work on environmental pollution prevention and remediation and lead the way in applying engineering technology to the solution of medical and health-related problems.

Because of the broad, fundamental background, a chemical engineering graduate is prepared for a wide variety of career paths. Chemical engineers can work in basic research and development, engineering design of new plants, operations and management of production facilities, or technical marketing and sales. The careers of many chemical engineers lead to top executive positions in their companies. By the judicious choice of electives made with the help of an advisor, a chemical engineering student may tailor his education to a specific career objective. Many students use electives to prepare for entry into professional schools, such as medicine, dentistry, law, or business, or for specialization in technical areas such as environmental control or polymer processing. The Department of Chemical & Biomolecular Engineering offers advanced study leading to the Doctor of Philosophy degree or Master of Science degree.

The curricula at Clemson include classroom and laboratory instruction and emphasize broadly applicable fundamental principles and current technology to prepare graduates for professional practice and professional growth. Graduates will have careers characterized by success in chemical engineering practice, postgraduate education, or other areas such as medicine and law that make use of engineering skills; demonstrated success in the design of chemical processes and/or identification, formulation, and solution of chemical engineering problems; ethical behavior in all endeavors; demonstrated effectiveness in teamwork, communication, and service to society through their professional contributions; demonstrated technical and/or managerial leadership; and demonstrated commitment to lifelong learning.

The Chemical Engineering curriculum and the Biomolecular Engineering concentration at Clemson are shown next, followed by a matrix that indicates how each chemical engineering course contributes to objectives established by the department.

For students who follow the Chemical Engineering Curriculum with Emphasis Areas, the Emphasis Area Verification form is given after that curriculum. This form must be completed and signed by your advisor prior to graduation.

For students who follow the Chemical Engineering - Biomolecular Engineering Concentration curriculum, the curriculum map follows the emphasis area course list.

CHEMICAL ENGINEERING CURRICULUM (W/CHECKLIST)

(For class entering Clemson University Fall 2008 and after. If you entered Clemson prior to Fall 2008, then see the curriculum map in the UG announcements for the year that you entered.)

Freshman Year

_____	CES 102	Engineering Disciplines & Skills	2	_____	CH 102	General Chemistry	4
_____	CH 101	General Chemistry	4	_____	CH E 130	Chemical Engineering Tools	3
_____	ENGL 103	English Composition	3	_____	MTHSC 108	Calculus of One Variable II	4
_____	MTHSC 106	Calculus of One Variable I	4	_____	PHYS 122	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

_____	CH 223	Organic Chemistry	3	_____	CH 224	Organic Chemistry	3
_____	CH E 211	Intro. to Chemical Engineering	4	_____	CH 229	Organic Chemistry Lab.	1
_____	MTHSC 206	Calculus of Several Variables	4	_____	CH E 220	Chemical Engr. Thermodynamics I	3
_____	PHYS 221	Physics with Calculus II	3	_____	CH E 230	Fluids/Heat Transfer	4
_____	Arts and Humanities/Social Science[1]		3	_____	MTHSC 208	Intro. to Ord. Diff. Equations	4
		Semester Totals:	***17***				***15***

Junior Year

_____	Biochemistry Option[2]		3	_____	CH 332	Physical Chemistry	3
_____	CH 339	Physical Chemistry Lab.	1	_____	CH 340	Physical Chemistry Lab.	1
_____	CH E 307	Unit Operations Lab. I	3	_____	CH E 321	Chemical Engr. Thermodynamics II	3
_____	CH E 319	Engineering Materials	3	_____	CH E 330	Mass Transfer & Separ. Proc.	4
_____	ECE 307	Basic Electrical Engineering	2	_____	Arts and Humanities/Social Science[1]		3
_____	ECE 309	Electrical Engineering Lab	1	_____	Emphasis Area[3]		3
_____	Arts and Humanities/Social Science[1]		3				
		Semester Totals:	***16***				***17***

Senior Year

_____	CH E 407	Unit Operations Lab. II	3	_____	CH E 353	Process Dynamics and Control	3
_____	CH E 431	Chemical Process Design I	3	_____	CH E 433	Process Design II	3
_____	CH E 443	Chem. Engr. Senior Seminar I	1	_____	CH E 444	Chem. Engr. Senior Seminar II	1
_____	CH E 450	Chemical Reaction Engineering	3	_____	MICRO 413	Industrial Microbiology	3
_____	Arts and Humanities/Social Science[1]		3	_____	Emphasis Area[3]		3
_____	Emphasis Area[3]		3				
		Semester Totals:	***16***				***13***

Total = 127 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 BIOCH 301, BIOCH 305, BIOCH 423

[3] 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 and Science; Biomolecular Science and Engineering; Business Management; Energy Studies; Environmental Engineering; Polymeric Materials.

Note: No student may exceed a maximum of two attempts, including a *W*, to complete successfully any CH E course.

Chemical Engineering Emphasis Area Selection/Verification Form

(Form to accompany Degree Certification Form submitted at the beginning of the semester before graduation)

Date:

Name:

CU student ID:

Selected emphasis area:

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

List of Courses Proposed or Satisfying Emphasis Area Requirement:

Course	Course Title	Semester Completed
Course	Course Title	Semester Completed
Course	Course Title	Semester Completed

- ☐ Minor (except the Chemistry or Cluster minors)

If you checked the Minor box, then write in the minor that you have completed

- ☐ Biomolecular Engineering Concentration (BMOLE) (18 credits)

Required signatures:

Student signature	Date
Advisor signature	Date

Return this form to:

Ms. Joy Rodatz (JRODATZ@exchange.clemson.edu), Student Services Coordinator, 127 Earle Hall, Clemson, SC 29634. (FORM MUST BE FINALIZED AND SUBMITTED TO THE OFFICE AT THE BEGINNING OF THE SEMESTER THAT YOU PLAN TO GRADUATE)

Emphasis Areas

In response to the national trend of greater diversity in areas of employment for chemical engineers and the desires of our undergraduates for more flexibility in the curriculum, the Department has incorporated Emphasis Areas into the curriculum. The goal of the Emphasis Area requirement is to provide students with in-depth study in an additional area. Students must declare an Emphasis Area and complete a minimum of 9 hours in that Emphasis Area. Students may select any one of the following Emphasis Areas:

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

Alternatively, students may elect to use the 9-hours set aside for completion of an Emphasis Area toward the completion of any Minor, except the Chemistry Minor and the Cluster Minor.

EMPHASIS AREA REQUIREMENTS (REV. 04/2008)

Notes:

1. All emphasis areas require a minimum of 9 credits. Not all courses listed below have 3 credits. Therefore, depending on the set of courses that you select, you may need to complete more than 3 courses to satisfy the 9 credit hour minimum.
2. Not all courses are taught every semester, and some times may conflict with required courses. It is your responsibility to plan ahead given these constraints.
3. Some courses have prerequisites that you may also need to satisfy. Plan ahead!

a) Applied Engineering, Mathematics, and Science

Students will complete 9 credits by taking 1-3 engineering course(s), 0-2 mathematics course(s), and 0-1 science course from the following lists:

Options for Engineering Course(s):

CH E 401 (Transport Phenomena)
CME 402 (Solid State Materials)
CME 424 (Optical Materials)
EM 201 (Statics)
IE 462 (Six Sigma Quality)
ME 302 (Mechanics of Materials)
ME 430 (Mechanics of Composite Materials)
ME 432 (Advanced Strength of Materials)

Options for Mathematics Course(s):

MTHSC 302 (Statistics for Science and Engineering) or EX STAT 411 (Statistical Methods for Process Development and Control)
MTHSC 434 (Advanced Engineering Mathematics)
MTHSC 450 (Introduction to Mathematical Models)

Options for Science Course:

CH 313/315 (Quantitative Analysis)

CH 402 (Inorganic Chemistry)
CH 411 (Instrumental Analysis)
CH 413 (Chemistry of Aqueous Systems)
CH 421 (Advanced Organic Chemistry)
CH 427 (Organic Spectroscopy)
CH 435 (Atomic and Molecular Structure)
PHYS 222 (Physics with Calculus III)
PHYS 420 (Atmospheric Physics)
PHYS 432 (Optics)
PHYS 441 (Electromagnetics I)
PHYS 452 (Nuclear and Particle Physics)
PHYS 465 (Thermodynamics and Statistical Mechanics)

b) Biomolecular Science and Engineering

Students will complete 9 credits by taking 1-2 science course(s) and 1-2 engineering courses from the following lists:

Options for Science Courses:

BIOCH 302 (Molecular Biology Laboratory)
BIOCH 431 (Physical Approach to Biochemistry)
BIOCH 433 (General Biochemistry Lab)
BIOCH 406 (Physiological Chemistry)
BIOCH 436 (Nucleic Acid and Protein Biosynthesis)
CH 404 (Bioinorganic Chemistry)
CH 414 (Bioanalytical Chemistry)
CH 425 (Medicinal Chemistry)
GEN 416 (Recombinant DNA)
GEN 418 (Biotechnology I: Nucleic Acid Techniques)
MICRO 305 (General Microbiology)
MICRO 407 (Food and Dairy Microbiology)
MICRO 417 (Molecular Mechanisms of Carcinogenesis and Aging)

Options for Engineering Courses:

BIOE 302 (Biomaterials)
BIOE 401 (Biomedical Design)
BIOE 402 (Biocompatibility)
BIOE 448 (Tissue Engineering)
BMOLE 403 (Biotransport)
BMOLE 423 (Bioseparations)
BMOLE 425 (Biomolecular Engineering)
BMOLE 426 (Biosensors and Bioelectronics)
BMOLE 427 (Membranes for Biotechnol. Biomed.)
CH E 428 (Biochemical Engineering)
PHYS 417 (Introduction to Biophysics)

c) Business Management

9 credit hours are required. Students must take MGT 201 (Principles of Management) plus two other courses from the following list:

Options for Courses:

ELE 301 (Executive Leadership and Entrepreneurship I)
ELE 400 (Technology Entrepreneurship)
ELE 401 (Executive Leadership and Entrepreneurship II)
ECON 306 (Managerial Economics)
ECON 310 (International Economy) **cannot be used to double-count for emphasis area credit and Social Science credit*
ECON 321 (Economics of Innovation)
MKT 314 (New Venture Creation I)
MGT 315 (New Venture Creation II)
MGT 390 (Operations Management)
MGT 411 (Project Management)
MKT 426 (Business-to-Business Marketing)

d) Energy Studies

Students will complete the required 9 hours by selecting courses from the following options:

Options for Courses:

APEC 457 (Natural Resource Economic Theory and Policy)
BE 440 (Renewable Energy Resource Engineering)
CME 433 (Combustion Systems and Environmental Emissions)
ME 420 (Energy Sources and Their Utilization)

e) Environmental Engineering

Students will complete 9 hours by taking 1 science/policy and 2 engineering courses from the following lists:

Options for Science/Policy Courses:

CH 413 (Chemistry of Aqueous Systems)
CH 411 (Instrumental Analysis)
PHYS 420 (Atmospheric Physics)

Options for Engineering Courses:

BE 440 (Renewable Energy Resource Engineering)
CH E 401 (Transport Phenomena)
EE&S 401 (Environmental Engineering)
EE&S 402 (Water and Waste Treatment)
EE&S 410 (Environmental Radiation Protection)
EE&S 411 (Ionizing Radiation Detection and Measurement)
EE&S 430 (Air Pollution Engineering)
EE&S 480 (Environmental Risk Assessment)
EE&S 485 (Hazardous Waste Management)
EE&S 486 (Pollution Prevention and Industrial Ecology)

f) Polymeric Materials

Students will complete the required 9 hours by selecting courses from the following options:

Options for Courses:

BIOE 302 (Biomaterials)
CH 451 (Frontiers in Polymer Chemistry)
CH E 401 (Transport Phenomena)
CH E 445 (Special Topics, Polymer related)
PFC 415 (Intro to Polymer Science and Engineering) *or* CH E 412 (Polymer Engineering)
PFC 417 (Polymer and Fiber Laboratory)
PKGSC 416 (Application of Polymers in Packaging) [Needs consent of instructor for registration]

g) Selected Minor

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.

BIOMOLECULAR ENGINEERING CONCENTRATION (W/CHECKLIST)

(for students who enter Chemical Engineering Fall 2008 and after. If you entered Clemson prior to Fall 2008, then see the curriculum map in the UG announcements for the year that you entered.)

Freshman Year

_____	CES 102	Engineering Disciplines & Skills	2	_____	CH 102	General Chemistry	4
_____	CH 101	General Chemistry	4	_____	CH E 130	Chemical Engineering Tools	3
_____	ENGL 103	English Composition	3	_____	MTHSC 108	Calculus of One Variable II	4
_____	MTHSC 106	Calculus of One Variable I	4	_____	PHYS 122	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

_____	CH 223	Organic Chemistry	3	_____	BIOCH 301	General Biochemistry	3
_____	CH E 211	Intro. to Chemical Engineering	4	_____	BIOCH 302	Molecular Biology Lab	1
_____	MTHSC 206	Calculus of Several Variables	4	_____	CH 224	Organic Chemistry	3
_____	PHYS 221	Physics with Calculus II	3	_____	CH 229	Organic Chemistry Lab.	1
_____	Arts and Humanities/Social Science[1]		3	_____	CH E 220	Chemical Engr. Thermodynamics I	3
				_____	CH E 230	Fluids/Heat Transfer	4
		Semester Totals:	***17***				***15***

Junior Year

_____	BIOL 103	General Biology I	3	_____	BIOE 302	Biomaterials	3
_____	BIOL 105	General Biology Lab I	1	_____	CH E 321	Chemical Engr. Thermodynamics II	3
_____	CH E 307	Unit Operations Lab. I	3	_____	CH E 330	Mass Transfer & Separ. Proc.	4
_____	CH E 319	Engineering Materials	3	_____	Arts and Humanities/Social Science[1]		3
_____	MTHSC 208	Intro. to Ord. Diff. Equations	4	_____	ENGINEERING REQUIREMENT[2]		3
_____	Arts and Humanities/Social Science[1]		3				
		Semester Totals:	***17***				***16***

Senior Year

_____	BIOCH 431	Physical Approach to Bioch.	3	_____	CH E 353	Process Dynamics and Control	3
_____	BMOLE 403	Biotransport Phenomena	3	_____	CH E 433	Process Design II	3
_____	CH E 407	Unit Operations Lab. II	3	_____	CH E 444	Chem. Engr. Senior Seminar II	1
_____	CH E 431	Chemical Process Design I	3	_____	MICRO 413	Industrial Microbiology	3
_____	CH E 443	Chem. Engr. Senior Seminar I	1	_____	Arts and Humanities/Social Science[1]		3
_____	CH E 450	Chemical Reaction Engineering	3	_____	ENGINEERING REQUIREMENT[2]		3
		Semester Totals:	***16***				***16***

Total = 130 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 BMOLE 423, BMOLE 425, BMOLE 426, BMOLE 427, BE 428

Note: No student may exceed a maximum of two attempts, including a *W*, to complete successfully any CH E course.

Curriculum Analysis Matrix (Fall 2005 & thereafter)

Course	Outcome										
	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
CH 101/102/223/224/229/332/ 339/340	A						B				
MTHSC 106/108/206/208	A										
PHYS 122/221; ECE 307/309	A										B
BIOCH OPTION; MICRO 413	A										
ENGL 103 & Humanities/Social Sci.						B	A	B	A	B	
CES 102 Engr. Disciplines and Skills	B	A		B	B	B	B				A
CH E 130 Chemical Engineering Tools	B	B					B				A
CH E 211 Intro. to Chemical Engr	A	B	B		A						B
CH E 220 Chemical Engr Thermo I	A			B	A						B
CH E 230 Fluids/Heat Transfer	A		B	B	A	B			B	B	A
CH E 307 Unit Operations Lab I	B	A	B	A	B		A				B
CH E 330 Mass Transfer & Separations	A		B	B	A	B			B	B	A
CH E 319 Engineering Materials	A		B		A						B
CH E 321 Chemical Engr Thermo II	A		B		A						B
CH E 353 Proc. Dynamics and Control	A	A	B		A				B	B	A
CH E 407 Unit Operations Lab II	A	A	A	B	A	B	A	B	B	A	A
CH E 431 Process Design I	A	A	A	B	A	B	B	B	B	B	A
CH E 433 Process Design II	A	A	A	B	A	B	B	B	B	B	A
CH E 443 CH E Seminar I						B			B		
CH E 444 CH E Senior Seminar II				B		B	A	A	B	A	
CH E 450 Kinetics and Reactor Design	A	A	A		A	B	B		B	B	A

A -- denotes a primary goal B -- denotes a secondary goal

3a Ability to apply knowledge of mathematics, science, and engineering

3b Ability to design and conduct experiments, as well as analyze and interpret data

3c 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

3d Ability to function on a multidisciplinary team

3e Ability to identify, formulate, and solve engineering problems

3f	Understanding of professional and ethical responsibility
3g	Ability to communicate effectively
3h	Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
3i	Recognition of the need for and an ability to engage in lifelong learning
3j	Knowledge of contemporary issues
3k	Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

CHEMICAL & BIOMOLECULAR ENGINEERING 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 cannot handle, to insure that students are able to do their fair share of group work, and to ensure that the pace of courses and the work of the faculty are not impeded by poorly prepared students.

Generally the faculty is reluctant to waive prerequisites, but mitigating circumstances sometimes arise. Any student who wishes to enroll in a course for which he or she does not meet all prerequisites must submit a written request, addressed to the Undergraduate Curriculum Committee, and delivered to the departmental office or Undergraduate Coordinator not later than 2 weeks before the start of the appropriate semester or summer session. Students who fail a prerequisite in the semester or session immediately preceding the one in question will be granted an extension until the day of walk-through (late) registration to submit their written request.

The primary factors in the deliberations of the faculty will be 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.

STUDENTS ARE CAUTIONED THAT THE CHEMICAL ENGINEERING CURRICULUM IS HIGHLY STRUCTURED, WITH MANY COURSES BEING PREREQUISITES TO OTHERS.

BEFORE YOU DROP ANY COURSE, YOU SHOULD CONSIDER THE CONSEQUENCES TO YOUR ACADEMIC SCHEDULE AND PROGRESS TOWARD GRADUATION.

***DO NOT DROP A CLASS WITHOUT CONSULTING YOUR ADVISOR*.**

FOR MORE INFORMATION SEE YOUR ADVISOR AND THE PREREQUISITES GUIDE THAT FOLLOWS.

GUIDE TO COURSE PREREQUISITES

To use this guide, find the "KEY COURSE" of interest in the center column. Then, the left column gives prerequisites for that 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
MTHSC 101, 102, 103, or 105 or CMPT score of 3 or higher (prereq or coreq)	**CH 101**	CH 102
MTHSC 103 or 105 or satisfactory score on Placement test	**MTHSC 106**	MTHSC 108
Satisfactory score on Placement test	**ENGL 103**	
MTHSC 103, 105, 106 or higher	**CES 102**	CH E 130
CH 101 with C or better	**CH 102**	CH E 211, CH 223,
MTHSC 106	**MTHSC 108**	MTHSC 206, PHYS 122 CH E 130 (coreq), CH E 211
MTHSC 108 (coreq)	**PHYS 122**	CH E 211, PHYS 221, CH E 130 (coreq)
CES 102, MTHSC 108 (coreq), PHYS 122 (coreq)	**CH E 130**	CH E 211
CH 102	**CH 223**	CH 224, CH 229, CH E 319 (coreq), BIOCH option
MTHSC 108	**MTHSC 206**	MTHSC 208, CH E 220, ECE 307, CH E 230 (coreq)
CH 102, CH E 130 or Engr 130, PHYS 122, MTHSC 108	**CH E 211**	CH E 220, 230, 319
PHYS 122	**PHYS 221**	ECE 307
CH 223	**CH 224**	
CH 223	**CH 229**	
MTHSC 206	**MTHSC 208**	CH E 321, 353
CH E 211, MTHSC 206	**CH E 220**	CH E 321, CH E 307, CH 339 (coreq), CH E 230 (coreq), CH E 319 (coreq)
CH E 211, CH E 220 (coreq), MTHSC 206 (coreq)	**CH E 230**	CH E 330, CH E 307
CH E 211, CH 223 (coreq), CH E 220 (coreq)	**CH E 319**	
CH E 220, CH E 230	**CH E 307**	CH E 407, 431
MTHSC 206, PHYS 221, ECE 309 (coreq)	**ECE 307**	
ECE 307 (coreq)	**ECE 309**	
CH 331 or CH E 220 (coreq)	**CH 339**	

CH 223	**BIOCH option**	
CH E 220, MTHSC 208	**CH E 321**	CH E 450,CH E 431, CH E 330 (coreq)
CH E 230, CH E 321(coreq)	**CH E 330**	CH E 353, 407, 431, 433, 443, 450
CH 331 or consent of instructor	**CH 332**	CH E 450, CH 340 (coreq)
CH 332 (coreq)	**CH 340**	
CH E 307, CH E 330	**CH E 407**	CH E 433
CH E 307, CH E 321, CH E 330, CH E 450 (coreq)	**CH E 431**	CH E 443 (coreq), CH E 433
CH E 330, senior standing CH E, CH E 431 (coreq)	**CH E 443**	CH E 444
CH E 330, CH E 321, CH 332	**CH E 450**	CH E 433
MTHSC 208, CH E 230, CH E 330	**CH E 353**	
CH E 330, 407, 431,450	**CH E 433**	
CH E 443, CH E 433 (coreq)	**CH E 444**	
CH Es have consent of instructor	**MICRO 413**	

NOTE: The College of Engineering and 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
MTHSC 101, 102, 103, or 105 or CMPT score of 3 or higher (prereq or coreq)	**CH 101**	CH 102
MTHSC 103 or 105 or satisfactory score on Placement test	**MTHSC 106**	MTHSC 108
Satisfactory score on Placement test	**ENGL 103**	
MTHSC 103, 105, 106 or higher	**CES 102**	CH E 130
CH 101 with C or better	**CH 102**	CH E 211, CH 223,
MTHSC 106	**MTHSC 108**	MTHSC 206, PHYS 122 CH E 130 (coreq), CH E 211
MTHSC 108 (coreq)	**PHYS 122**	CH E 211, PHYS 221, CH E 130 (coreq)
CES 102, MTHSC 108 (coreq), PHYS 122 (coreq)	**CH E 130**	CH E 211
CH 102	**CH 223**	CH 224, CH 229, CH E 319 (coreq), BIOCH 301, BIOCH 302, BIO E 302
MTHSC 108	**MTHSC 206**	MTHSC 208, CH E 220, ECE 307, CH E 230 (coreq)

CH 102, CH E 130 or Engr 130, PHYS 122, MTHSC 108	**CH E 211**	CH E 220, 230, 319
PHYS 122	**PHYS 221**	ECE 307
CH 223	**CH 224**	
CH 223	**CH 229**	
MTHSC 206	**MTHSC 208**	CH E 321, 353, BMOLE 403
CH E 211, MTHSC 206	**CH E 220**	CH E 321, CH E 307, CH 339 (coreq), CH E 230 (coreq), CH E 319 (coreq), BIOCH 431
CH E 211, CH E 220 (coreq), MTHSC 206 (coreq)	**CH E 230**	CH E 330, CH E 307
CH E 211, CH 223 (coreq), CH E 220 (coreq)	**CH E 319**	
CH E 220, CH E 230	**CH E 307**	CH E 407, 431
	BIOL 103	BIOL 105 (coreq)
BIOL 103 (coreq)	**BIOL 105**	
BIO E 301, CME 210, CH 201, or consent of instructor [Note: Having CH 223 will meet this req.]	**BIO E 302**	
CH 223	**BIOCH 301**	BIOCH 302 (coreq), BIOCH 431
CH 223, BIOCH 301 (coreq)	**BIOCH 302**	
CH E 220, MTHSC 208	**CH E 321**	CH E 450,CH E 431, CH E 330 (coreq)
CH E 230, CH E 321(coreq)	**CH E 330**	CH E 353, 407, 431, 433, 443, 450, BMOLE 403
BIOCH 301 with C or better or consent of instructor, physical chemistry (coreq). [Note: CH E 220 will meet the PCHEM req.]	**BIOCH 431**	
CH E 330, MTHSC 208	**BMOLE 403**	
CH E 307, CH E 330	**CH E 407**	CH E 433
CH E 307, CH E 321, CH E 330, CH E 450 (coreq)	**CH E 431**	CH E 443 (coreq), CH E 433
CH E 330, senior standing CH E, CH E 431 (coreq)	**CH E 443**	CH E 444
CH E 330, CH E 321, CH 332	**CH E 450**	CH E 433
MTHSC 208, CH E 230, CH E 330	**CH E 353**	
CH E 330, 407, 431,450	**CH E 433**	
CH E 443, CH E 433 (coreq)	**CH E 444**	
CH Es have consent of instructor	**MICRO 413**	

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

COURSE SUBSTITUTIONS AND COURSES TAKEN ELSEWHERE

Substitution for Required Courses

The Faculty of Chemical & Biomolecular Engineering has designed the curriculum carefully so as 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; substitution that permits a student to take advantage of a change made in a later curriculum; or, when taking the required course would delay graduation significantly. 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 from the Office of Student Records (104 Sikes Hall).

Courses Taken Elsewhere

In the summer, or during terms away from campus (e.g., on co-op work assignment), 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 223 or 224 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 Office of Student Records (104 Sikes 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.

University General Education Requirements

An undergraduate student must fulfill the general education requirements in the catalog in effect at the time of enrollment. A student who withdraws from the University and subsequently returns will be required to satisfy the general education requirements. Any variation in curricular or general education requirements shall be considered under the substitution procedure.

Information about General Education requirements, as well as updated course listings, can also be found in a printed copy of the latest Undergraduate Announcements and in the online version of the Undergraduate Announcements at **http://www.registrar.clemson.edu/html/catalog.htm**

Specific Notes on General Education as They Pertain to Chemical Engineering

- All CH E students must place material in an electronic General Education portfolio to document their work on general education competencies. Information and instructions are available at *MyCLE*.clemson.edu.
- CH E students automatically satisfy all requirements for the following General Education Sections by completion of courses in the curriculum.
    - II. Communication
    - III. Academic and Professional Development
    - IV. Mathematical, Scientific, and Technological Literacy
    - IX. Distributed Competencies
- CH E students may **not** take CH 105 or CH 106 to satisfy the STS requirement.
- Do not assume that completing a course in 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.
- It is possible to satisfy all General Education A&H/SS/STS/CCA requirements by taking four courses (see worksheet below). However, CH E requires 18 credits of A&H/SS/STS/CCA. An approved list of additional courses for the 5th and 6th courses can be found at http://www.ces.clemson.edu/main/students/undergrad/hSS_policy05-06.htm

The next page gives a worksheet to guide you on the completion of A&H/SS/STS/CCA General Education requirements.

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

All CH E students must complete a total of six courses (18 hours) in A&H and SS. Within these 18 hours, students must complete the General Education requirements which include 3 hours of literature, 3 hours in A&H other than literature, 3 hours in each of <u>two different</u> SS fields, 3 hours involving STS, and 3 hours of CCA coursework. Careful selection of these courses is important because some courses can satisfy more than one General Education requirement (e.g., both a SS and an STS). If you choose carefully, you can allow yourself more flexibility to take courses of interest to you. You are strongly encouraged to seek an advisor's help if you have questions or need help in planning your choices.

See the undergraduate announcements for your enrollment year for choices in the various categories, and fill in this worksheet to ensure that you fulfill all of the A&H, SS, CCA, and STS requirements to graduate.

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 <u>or</u> Social Sciences

5._____
3 hours A&H or SS *****

6._____
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 General Education requirements may be taken to fulfill the 5th and 6th courses required in CH E. **An approved list of additional courses for the 5th and 6th courses can be found at <u>www.ces.clemson.edu/main/students/undergrad/hSS_policy05-06.htm</u>.** A copy of this list, titled "Additional Engineering A&H/SS Course Choices" is given on the next page, as it appeared at the time of printing of this handbook.

** Many (but not all) university-approved study abroad programs also satisfy the CCA requirement. See your advisor.

*** CH E students may <u>not</u> take CH 105 or CH 106 to satisfy STS credit.

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

AAH 102, ANTH 301, 320, CHS H201[1], ECON 301, 302, 307, 308, 309, 310, 314, 315, 324, ENGL 350, 351, 353, 356, 357, 380, 385, 386, GEOG 301, 302, 303, 305, 306, 330, HIST 436 or any 300-level course, IS 210[2], PO SC 302, 361, 381, 480, PSYCH 306, 308, 320, 330, 333, 340, 344, 345, 352, 355, 364, 368, 370, 375, REL 308, 310, RS 459, SOC 235, 310, 311, 330, 331, 350, 356, 371, 390, 392, 393, 394, 396, 397, 494, and **ANY** CHIN, FR, GER, ITAL, JAPN, PORT, RUSS, or SPAN course that is not in the student's native language.

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

COOPERATIVE EDUCATION

Imagine the enviable position of receiving a degree from Clemson University and being able to enter your profession with a year or more of relevant experience in hand. The Cooperative Education Program enables students to alternate semesters of work and study in order to gain practical experience in their chosen field while pursuing their educational goals. A basic goal of the program is to help bridge the gap between the academic community and the world of work. 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 various participating industry, business and government organizations. It is not a summer job program.

How Cooperative Education Works

At least three work periods are required to obtain the minimum 12 months of experience needed to qualify for the Cooperative Education Certificate, awarded with the degree at graduation. Chemical Engineering students actually have the opportunity to work up to five periods as shown on the suggested co-op schedules A and B that follow this page.

Advantages for Students

Students who elect to participate in the co-op program realize several substantial benefits:

1. Cooperative Education provides valuable on-the-job learning experiences that cannot be acquired in the classroom.
2. Students have the opportunity to evaluate more realistically their initial choice of career study.
3. Students often are offered permanent employment with their co-op employer after graduation.
4. Career-related, on-the-job experiences often enhance classroom academic work through increased motivation and conceptual understanding.
5. Increased opportunities to develop professionally with respect to confidence, maturity, responsibility, and skill in human relations.
6. The program allows students to earn a salary that may be used to finance a substantial portion of college expenses.
7. More and more employers are requiring that new hires have prior relevant work experience.

Eligibility and Participation

Students should complete at least 27 semester hours with a minimum 2.45 GPA before beginning their first 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. The Cooperative Education Program is limited to undergraduate students.

Additional Information

For further information see one of the CH E co-op advisors (listed on page 3) or contact the co-op office at 321 Brackett Hall; phone (864) 656-3150.

Special Note:

If you have a scholarship and you decide to co-op, be sure to talk with the Financial Aid Office about how your scholarship should be administered.

CO-OP SCHEDULES

The Department of Chemical and Biomolecular Engineering offers two co-op schedules, A and B. These schedules are designed to ensure that students who choose to co-op will enter the program with a good foundation of engineering skills and will be prepared to do progressively more meaningful and productive work in each co-op session.

Advice for all co-op students. 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.

If you decide to co-op, then you should ask to be reassigned to one of the co-op advisors (pg. 3).

CHEMICAL ENGINEERING CURRICULUM

(for students who entered Clemson during the 2008-2009 academic year)

SUGGESTED SCHEDULE "A" FOR CO-OP STUDENTS

Freshman Year

Fall		**Spring**		**Summer**
CES 102	2	CH 102	4	
CH 101	4	CH E 130	3	
ENGL 103	3	MTHSC 108	4	
MTHSC 106	4	PHYS 122	3	
A&H/SS #1	3	A&H/SS #2	3	

Sophomore Year

CH 223	3	CH 224	3	Co-op Work 1
CH E 211	4	CH 229	1	
MTHSC 206	4	CH E 220	3	
PHYS 221	3	CH E 230	4	
A&H/SS #3	3	MTHSC 208	4	

Junior Year '1'

BIOCH Option	3	Co-op Work 2		A&H/SS #6	3
CH 339	1			ECE 307	2
CH E 307	3			ECE 309	1
CH E 319	3				
A&H/SS #4	3				
A&H/SS #5	3				

Junior Year '2'

Co-op Work 3		CH 332	3	Additional co-op work
		CH 340	1	*or* another internship
		CH E 321	3	*or* summer abroad
		CH E 330	4	*or* whatever
		Emphasis Area	3	

Senior Year

CH E 407	3	CH E 353	3
CH E 431	3	CH E 433	3
CH E 443	1	CH E 444	1
CH E 450	3	MICRO 413	3
Emphasis Area	3	Emphasis Area	3

SUGGESTED SCHEDULE "B" FOR CO-OP STUDENTS

Freshman Year

Fall		Spring		Summer	
CES 102	2	CH 102	4		
CH 101	4	CH E 130	3		
ENGL 103	3	MTHSC 108	4		
MTHSC 106	4	PHYS 122	3		
A&H/SS #1	3	A&H/SS #2	3		

Sophomore Year

CH 223	3	CH 224	3	A&H/SS #4	3
CH E 211	4	CH 229	1	ECE 307	2
MTHSC 206	4	CH E 220	3	ECE 309	1
PHYS 221	3	CH E 230	4		
A&H/SS #3	3	MTHSC 208	4		

Junior Year '1'

Co-op Work 1		BIOCH Option	3	Co-op Work 2	
		CH 332	3		
		CH 340	1		
		CH E 321	3		
		CH E 330	4		

Junior Year '2'

CH 339	1	Co-op Work 3		Additional co-op work	
CH E 307	3			*or* another internship	
CH E 319	3			*or* summer abroad	
A&H/SS #5	3			*or* whatever	
A&H/SS #6	3				
Emphasis Area	3				

Senior Year

CH E 407	3	CH E 353	3
CH E 431	3	CH E 433	3
CH E 443	1	CH E 444	1
CH E 450	3	MICRO 413	3
Emphasis Area	3	Emphasis Area	3

2008-2009 BIOMOLECULAR ENGINEERING CONCENTRATION

(for students who entered Clemson during the 2008-2009 academic year)

SUGGESTED SCHEDULE "A" FOR CO-OP STUDENTS

Freshman Year

Fall		**Spring**		**Summer**
CES 102	2	CH 102	4	
CH 101	4	CH E 130	3	
ENGL 103	3	MTHSC 108	4	
MTHSC 106	4	PHYS 122	3	
A&H/SS #1	3	A&H/SS #2	3	

Sophomore Year

CH 223	3	BIOCH 301	3	Co-op Work 1
CH E 211	4	BIOCH 302	1	
MTHSC 206	4	CH 224	3	
PHYS 221	3	CH 229	1	
A&H/SS #3	3	CH E 220	3	
		CH E 230	4	

Junior Year '1'

BIOL103	3	Co-op Work 2		Additional co-op work
BIOL 105	1			*or* another internship
CH E 307	3			*or* summer abroad
CH E 319	3			*or* whatever
MTHSC 208	4			
A&H/SS #4	3			

Junior Year '2'

Co-op Work 3		BIO E 302	3	Additional co-op work
		CH E 321	3	*or* another internship
		CH E 330	4	*or* summer abroad
		A&H/SS #5	3	*or* whatever
		Engr. Req. 1	3	

Senior Year

BIOCH 431	3	CH E 353	3
BMOLE 403	3	CH E 433	3
CH E 407	3	CH E 444	1
CH E 431	3	MICRO 413	3
CH E 443	1	A&H/SS #6	3
CH E 450	3	Engr. Req. 2	3

SUGGESTED SCHEDULE "B" FOR CO-OP STUDENTS

Freshman Year

Fall		**Spring**		**Summer**
CES 102	2	CH 102	4	
CH 101	4	CH E 130	3	
ENGL 103	3	MTHSC 108	4	
MTHSC 106	4	PHYS 122	3	
A&H/SS #1	3	A&H/SS #2	3	

Sophomore Year

CH 223	3	BIOCH 301	3	BIOL 103	3
CH E 211	4	BIOCH 302	1	BIOL 105	1
MTHSC 206	4	CH 224	3	MTHSC 208	4
PHYS 221	3	CH 229	1		
A&H/SS #3	3	CH E 220	3		
		CH E 230	4		

Junior Year '1'

Co-op Work 1		BIO E 302	3	Co-op Work 2
		CH E 321	3	
		CH E 330	4	
		A&H/SS #4	3	
		Engr. Req. 1	3	

Junior Year '2'

BIOCH 431	3	Co-op Work 3		Additional co-op work
CH E 307	3			*or* another internship
CH E 319	3			*or* summer abroad
A&H/SS #5	3			*or* whatever
A&H/SS #6	3			

Senior Year

BMOLE 403	3	CH E 353	3
CH E 407	3	CH E 433	3
CH E 431	3	CH E 444	1
CH E 443	1	MICRO 413	3
CH E 450	3	Engr. Req. 2	3

HONORS PROGRAM
(Calhoun 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 guideline 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 a faculty committee, the Honors Program Committee. The chairman of this committee is the department's Honors Coordinator, who is appointed by the chairman of the department. Members of the committee include all faculty who are serving as advisors to honors students. If necessary, additional faculty are appointed by the Department Chairman so that there are at least three committee members.

Admission

- Students wishing to participate in the Senior Departmental Honors Program must meet the eligibility requirements set by Calhoun College and the Department of Chemical & Biomolecular Engineering. These include:

- Students must have completed (or be about to complete) the sophomore courses of the chemical engineering curriculum.

- Students must have upon admission and must maintain a minimum cumulative GPR of 3.4.

- Students applying for admission to the Senior Departmental Honors Program must have at least three (and preferably four) semesters remaining to complete their degree program.

- Chemical Engineering students must have a minimum cumulative GPR of 3.0 in chemical engineering courses to enter the program and must maintain this standard (exclusive of grades earned in CH E 395, 495, and 497) to graduate with Senior Departmental Honors.

- The student 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 CH E H300). The department's 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 present talks on their work

- The Chemical & Biomolecular Engineering 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 other than free electives.

Chemical & Biomolecular Engineering Honors Courses
(1) *CH E H300, 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 CH E H300 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 H300 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 on which he or she would like to work and will submit the selected list to the Honors Program Coordinator.

(2) *CH E H395 and H495, 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 CH E H 491 (Special Projects) earned over the course of an entire summer (2 hours for one session and 1 hour for the other) for CH E H 395 or CH E H 495.

Student Responsibilities: Two weeks before the end of the first research term, students enrolled in CH E H395 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 CH E H495 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) *CH E H497, 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 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 CH E 199, 299, 399, 499
(e) Research for course credit through CH E 491/H491.
(f) Participation in the Departmental Honors Program.

Undergraduates have made some very 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 an 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.

Note: A student must have grades of C or better in chemical engineering courses in order to enroll in CH E 491.

GRADUATE STUDY IN CHEMICAL ENGINEERING

What, Who, Why, When, Where and How

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 *AICH E 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 our Graduate Coordinator. If you are interested in applying at Clemson, he can supply you with the necessary forms. He 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.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS
STUDENT CHAPTER

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. We feel that this group plays an important part in your education about the Chemical Engineering profession.

The Student Division 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 Student Chapter AICH E is most active at the local level. Each year the Clemson students organize many events designed to acquaint the student with types of situations in which he can expect to find himself after graduation. This is accomplished through guest speakers (usually about 8 per year), plant trips, and two dinners with area practicing Chemical Engineers who are members of Greenville's Western Section. In addition, to help our students to get to know each other (and their professors) on a personal basis, the Clemson Chapter sponsors several social "get-togethers", including a Shrimp Boil, a Pig Roast, and a Welcome Back Picnic.

Recently, our chapter has begun to develop a Chem E car for the regional competition.

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. Dues are inexpensive for Chapter membership. For more information, contact one of the chapter officers listed on the Clemson AIChE website (www.ces.clemson.edu/chemeng/AIChE/index.html).

INFORMATION AND ADVICE FOR NEW CHEMICAL ENGINEERING STUDENTS

All college students receive more advice than they think is necessary, and by this time you may feel that you have heard too much. In spite of this, the chemical engineering faculty wants to make sure that you are aware of certain things; hence this section.

Why Are You In College?

You are here for one overriding reason, and that is to learn. We realize that 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 "goof off". 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.

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 seen 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. A good 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 course if you "cut class" or sleep in class. You (or your parents) are paying at least $15.00 for each hour of class you have scheduled. You might consider whether or not you can afford to throw away money like that.

Your Advisor

Each of you has been assigned to a chemical engineering faculty member who will act as your counselor and class advisor for as long as you are enrolled in chemical engineering. Get to know your advisor and don't hesitate to ask for advice. 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.

Professionalism

The work of a professional person differs from that of others in the crafts and trades by virtue of the fact that it is intellectual and of a non-routine nature. Very crudely put, the professional works with his brain and the craftsman with his 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.

The American Institute of Chemical Engineers

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). On this campus we have a student chapter of AIChE, and you are invited (and encouraged) to join. Further information on the AICH E Student Chapter can be found in a separate section of this handbook.

DO'S AND DON'TS TO BE A SUCCESSFUL CHEMICAL ENGINEERING STUDENT

DOS

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

DON'TS

1. Accept all authoritative statements as truths.
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 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.

TALK IS CHEAP, ADVICE IS FREE, BUT WHAT I HAVE TO SAY IS WORTH THE PRICE

Jeffrey S. Harding
N. A. Penta Engineering
Charlotte, North Carolina
Chapter One, S12 (January 1994)

I graduated with a B.S. in chemical engineering in 1982 and I'm proud to say that I have absolutely no regrets about my college experience. Well, maybe just a few. All right, if you're going to drag it out of me, I've got a truckload of 'em! So here's some friendly advice, so you won't end up with all these pent-up regrets like me.

First of all, let me say that most of my regrets deal with omissions rather than commissions. That is I regret the things I didn't do, as opposed to those I did. (And let me state categorically, for the record, that I wouldn't in a million years change my major!) However, as I look back upon my college career, I now see many missed opportunities to learn and grow. So here, for your benefit, are eight suggestions to avoid regrets in your chemical engineering college career.

1. Join AICH E - The chemical engineering profession is the best fraternity going, both now and when you leave school. Join your student chapter and become active. There are often regional activities which will allow you to meet CH E students from other schools. It's never too early to start networking. And, when you graduate, maintain your AICH E membership. There are many benefits, not the least of which is the low-cost insurance programs. And, insurance is something you have to have when you become "responsible".

2. Get summer job experience in chemical engineering - When you go to interview for that first job, the interviewer is likely to ask you, "What would you like to do after you graduate?" (It's one of those trick questions.) Your response needs to be a little more specific than, "Well, er, um, I'd like to get a job." Summer experience teaches you things, like what a flange is, and how you tell if a valve is open or closed. It also gives you a feel for what the working world is like. Most importantly, it gives you an idea of the different types of job assignments available. Think you might like R&D? Want to be a design engineer? Without any exposure to these environments, it's really hard to say. While a summer job may not clue you in as to what type of job you definitely want, it may show you the type you don't want, and prevent you from making a mistake later. And besides, it won't hurt to have those summer jobs listed on your resume.

3. Take the EIT while you're in school - The EIT or Engineering-In-Training test (also known as the Fundamentals of Engineering test) is the first of two tests you must pass to become a licensed or registered Professional Engineer (P.E.) in most states. It is very broad, covering the fundamentals of all of the engineering disciplines.

Even if you have never thought about becoming a P.E., or won't ever need to, or even if you've never heard of it before, take the EIT during your junior or senior year! By that time you will have probably had the basic courses from the other engineering disciplines and can take the test with little or no review. But if you don't take it while you're in school, and you wait say, oh about six years (like someone I know), you will spend countless hours reviewing and preparing for it.

Once you have passed the EIT, the test your must pass to become registered is solely in your discipline, and is therefore, in my opinion, much easier to prepare for.

4. Consider an advanced degree - You should at least consider the option of getting an advanced degree. Although it may be hard for you to tell what you want to do with your career at this point, and even harder to convince yourself you need another year or two of school, it is far easier to go on for an advanced degree right after graduation than it is later. Getting an advanced degree might allow you to specialize a bit more, or to start at a slightly higher level when you take a job. It's not for everyone, but don't close the door on a possible opportunity without at least considering it.

5. Make your electives count - Electives in your curriculum are a wonderful thing in that they allow you to exercise choice. So make them count. You might even consider a minor to go with your chemical engineering major.

If they are available, take some electives in your department. They will allow you to explore some areas that the core courses may not. For example, some departments offer courses in environmental engineering, bioengineering, polymers and advanced materials, pulp and paper, process control, etc. Or, take some business electives. One of the hardest lessons many engineers have to learn when they get out in the "real world" is that every company is a business, that must be economically viable. The technical stuff may be fun, but we won't have the opportunity to have that fun if we're not making a profit.

And, although most curricula require humanities, take some even if yours doesn't. There are a lot of valuable lessons to be learned from history. And a lot of insight to be gained from psychology.

Taking this advice may be tougher on your schedule and your GPA than taking "crip" courses, but you will probably have an easier time explaining them to an interviewer than I did explaining that I look Dairy Science 101 because they gave us free chocolate milk after every class!

6. Find a mentor - I'm not talking about someone who can help you with your homework. A mentor is someone who can show you the ropes, someone who will share the benefit of his/her experiences with you. A mentor can tell you things like don't schedule kinetics and thermo in the same semester, or that, yes, you can survive organic, or no, don't wear your Grateful Dead t-shirt to that interview.

Even more important than mentoring you about school, you may be able to learn some about what comes after college. Never underestimate what you can learn from just talking to someone who's been there.

For some students, this person could be a faculty member or department advisor. For others, it may be an upperclass student from your hometown, or someone you meet at AICH E student chapter or local section meetings.

7. Take full advantage of the college experience - Going to college presents us with a tremendous opportunity to grow and broaden ourselves. You may never again have such an opportunity, so make the most of it. Don't just go to the sporting events, go to student plays and special events on campus, see a foreign film or an art exhibition. It's a great big world out there, and university life is a great way to sample it by simply opening your dorm room door and walking across campus. (OK, it's a little tougher if you're a commuter. Then you have to find a parking space.)

Please don't be afraid of a challenge. Challenge yourself and set realistic goals. Take thermo under the toughest professor in the department and strive for your best grade. Setting and meeting goals now is great training for the future.

And for Pete's sake, don't be afraid to ask questions. The only stupid question is the one not asked. Ask questions in all your classes. The answers you get may give your a different perspective on things, or a better understanding of the subject. All this broadening and experience stuff is important, because there is this stereotype out there of what engineers are like. We're supposedly a bunch of technocrats who can't communicate, and who wear horn-rimmed glasses, pocket protectors, and calculators on our belts. It's up to all of us to dispel that myth. (I've got everybody fooled - I got contacts!) Being well-rounded, open-minded, and able to express yourself is incredibly important, both on and off the job.

8. Take care of your body - Start some kind of program now to stay in shape. As a chemical engineer, you may make your living with your brain, but you will look better, feel better, and think better if you are in shape.

Now, you might ask, what's the point of all this? Short-term, many of these things, such as AIChE, summer job experience, the EIT, an advanced degree, and your electives, will look good on your resume. It's become a very competitive world, and every little edge helps when you go to interview for that first job (preferably not in your Grateful Dead t-shirt).

The other items, such as challenging yourself, broadening yourself, asking questions, and taking care of yourself, are all simply good life habits to develop. They will increase your maturity, poise, and confidence. And that will not only help you in those first interviews, but in the future as well.

Besides, if you don't follow this advice, you just might live to regret it.

A native of Reading, Pennsylvania, Jeffrey S. Harding is a 1982 summa cum laude graduate of Clemson University, where he received a BS in chemical engineering. He worked for Exxon Chemicals in Baytown, Texas, from 1982 to 1987, then, after moving to Matthews, North Carolina, spent four years with a small engineering design company before joining N.A. Penta Engineering in nearby Charlotte as a chief process engineer. Involved in AICH E since his Clemson days, he is currently a member of the Central Carolina section, which he chaired for the 1990-91 term. He is a registered professional engineering in North and South Carolina.

CHEMICAL ENGINEERING FACULTY

David A. Bruce, Associate Professor; 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.

Charles H. Gooding, Professor; Ph.D. - North Carolina State University (1979): Chemical process design, analysis, and control.

James G. Goodwin, Jr., Professor and Chair; Ph.D. – University of Michigan (1976): Heterogeneous catalysis, kinetics, in-situ characterization of surface reaction properties, catalyst formulation, catalyst deactivation, adsorption.

Anthony Guiseppi-Elie, Dow Chemical Professor, Sc.D. - Massachusetts Institute of Technology (1983): Director, Center for Bioelectronics, Biosensors and Biochips. Implantable biosensors, cancer genetics, unit-ops-on-a-chip, bioelectrochemistry, cell based biosensors, bio-smart polymers.

Esin Gulari, Dean of the College of Engineering & Science, Ph.D. - : Materials Processing, Supercritical Fluids, and Polymer Nanocomposites

Graham M. Harrison, Associate Professor; Ph.D. – University of California, Santa Barbara (1997): Non-Newtonian fluid mechanics, optical and mechanical techniques for experimental characterization of polymers, molecular-based constitutive equations.

Douglas E. Hirt, Professor; Ph.D. - Princeton University (1989): Director, Center for Advanced Engineering Fibers and Films. Polymer films, additive diffusion, interfacial phenomena, mass transfer modeling, polymer thermodynamics, surface chemistry.

Scott M. Husson, Associate Professor; Ph.D. - University of California, Berkeley (1998): Bioseparation materials synthesis, surface engineering by self-assembly and surface-confined polymerization, membrane bioseparations.

Christopher Kitchens, Assistant Professor; Ph.D. - Auburn University (2004): Advanced materials for renewable energy, Nanotechnology, Structure-activity relationships, Cellulose Biomaterials, Neutron Scattering, Thermodynamics and Green Chemistry

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

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.