

Concentration in Bioengineering - Chemical Engineering Program Guide 03/10/05

There are three basic components to earning a concentration in bioengineering:

- A. two courses that are part of the standard curriculum
- B. focused selection of chemical engineering electives and jr / sr clinic projects
- C. one more bioengineering-related non-chemical engineering course

These three components will guide you towards the 18 s.h. of courses required for the bioengineering concentration. The most challenging aspect will be completing component C.

The curriculum listed below guides you through components A and B of this process. Standard courses that count towards the bioengineering concentration and courses that require a focused selection of electives are highlighted in **Bold**.

Bear in mind that only one of your jr / sr clinic projects must be bioengineering-related.

CHEMICAL ENGINEERING CURRICULUM - Class of 2007

Sep-03

FIRST YEAR

Composition I 1501.111	3	Calculus II 1701.131	4
		Comp Sci & Prog or 0704.103 or ⁴ Intro to Programming 0701.102	3
Calculus I 1701.130	4	Fresh. Engineering Clinic II 0901.102	2
Advanced College Chemistry I 1906.105	4	Physics I 1902.200	4
Fresh. Engineering Clinic I 0901.101	2	General Education	3
General Education	3		
Total	16	Total	16

SECOND YEAR

Principles Chemical Processes I 0906.201	2	Math for Engineering Anal II 1701.236	4
Math for Engineering Anal I 1701.235	4	Principles Chemical Processes II 0906.302	2
Biological Systems & Appl 0401.210	4	Fluid Mechanics I 0901.341	2
Advanced College Chemistry II 1906.106	4	Soph. Engineering Clinic II 0901.202	4
Soph. Engineering Clinic I 0901.201	4	Organic Chemistry I 1907.200	4
Total	18	Total	16

THIRD YEAR

Microeconomics 2204.102	3	General Education	3
Process Fluid Transport 0906.309	2	Chem. Engineering Thermo. 0906.310	3
Heat Transfer Processes 0906.311	2	Junior Engineering Clinic II³ 0901.302	2
Equilibrium Staged Operations 0906.312	2	Chemical Reaction Engineering 0906.316	4
Material Science 0901.281	2	Separation Processes 0906.314	4
Physical Chemistry I 1908.400	3		
Junior Engineering Clinic I³ 0901.301	2	Total	16
Total	16		

FOURTH YEAR

Transport Phenomena 0906.402	3	Process Dynamics & Control 0906.405	3
Approved Chem. Eng. Elec. I² 0906.XXX	3	Unit Operations Lab II 0906.404	2
Senior Engineering Clinic I³ 0901.401	2	Approved Chem. Eng. Elec. II² 0906.XXX	3
Chem. Process Component Design 0906.401	4	Senior Engineering Clinic II³ 0901.402	2
Unit Operations Lab I 0906.403	2	Approved Chemistry Elective¹	3
General Education	3	Chemical Plant Design 0906.406	3
Total	17	Total	16

TOTAL 131

Notes:

1. Required/Approved Courses taken to satisfy ABET category of "Advanced Chemistry" May be exchanged with ChE Elective in Fall.

Course must come from a list of approved courses provided by the Ch.E. Chair.

2. Required/Approved courses taken to satisfy Chemical Engineering ABET categories/ AIChE electives.

Courses must be taken from a list of approved courses provided by the Ch.E. Chair.

One of these courses must have substantial advanced chemistry content.

Technical electives may be taken in either semester of Senior year.

3. Junior/Senior Clinics are a project-based experience

Projects must be approved by a ChE Projects Committee and are writing intensive (WI) courses.

Component A consists of two courses that are already required for the standard chemical engineering degree. You must take Biological Systems and Applications (0401.201) and you must take an advanced chemistry elective. Biological Systems and Applications is typically taken in the fall of your sophomore year. The advanced chemistry elective is typically taken in the spring of your senior year, although sometimes this can be taken in the fall of your senior year. The advanced chemistry elective need not have a bioengineering component, but selecting a course that does include a bioengineering component is encouraged.

Component B consists of a focused selection of chemical engineering electives and jr / sr clinic projects. One semester of jr / sr clinic must be spent on a bioengineering related project. This project can be from any engineering discipline, as long as it has a substantial bioengineering component. Your selection of senior year electives must also be focused on bioengineering electives within the chemical engineering department. Your schedule has space for one chemical engineering elective in the fall of your senior year and one in the spring of your senior year. To earn a concentration in bioengineering, these electives must be from the approved list of bioengineering electives within chemical engineering.

Component C consists of one bioengineering-related course outside of chemical engineering. This course must be from the list of approved electives in biology, chemistry, and other engineering disciplines, and you must determine how this will fit into your schedule. The most likely mechanism is for you to complete your general education requirements early, and then fill this open space in your schedule with an approved elective. Currently, general education blocks appear in the curriculum during both semesters of the freshman year, spring of the junior year, and fall of the senior year.

Concentration in Bioengineering – Civil & Environmental Engineering
 Program Guide
 04/26/05

There are three basic components to earning a concentration in bioengineering:

- A. two courses that are part of the standard curriculum
- B. focused selection of civil/environmental engineering electives and jr / sr clinic projects
- C. one more bioengineering-related non-civil/environmental engineering course

These three components will guide you towards the 18 s.h. of courses required for the bioengineering concentration. The most challenging aspect will be completing component C.

The curriculum listed below guides you through components A and B of this process. Standard courses that count towards the bioengineering concentration and courses that require a focused selection of electives are highlighted in **Bold**. Bear in mind that only one or two of your jr / sr clinic projects must be bioengineering-related.

Current Curriculum - Civil & Environmental Engineering

First Year

Fall Courses	Credit Hours	Spring Courses	Credit Hours
Composition I	3	Computer Science & Programming	4
Freshman Engineering Clinic I	2	Freshman Engineering Clinic II	2
Calculus I	4	Calculus II	4
General Education Course	3	General Education Course	3
Advanced College Chemistry I	4	Physics I	4
Total Hours	16	Total Hours	17

Second Year

Fall Courses	Credit Hours	Spring Courses	Credit Hours
Sophomore Engineering Clinic I	4	Sophomore Engineering Clinic II	4
Math for Eng. Analysis I	4	Math for Eng. Analysis II	4
Advanced College Chemistry II	4	Surveying and Engineering Graphics	3
Statics	2	Statistics I	3
Dynamics	2	Solid Mechanics	2
Total Hours	16	Total Hours	16

Third Year

Fall Courses	Credit Hours	Spring Courses	Credit Hours
Junior Engineering Clinic I	2	Junior Engineering Clinic II	2
Structural Analysis and Design	3	Analysis and Design of Steel Frames	3
Environmental Engineering I	3	Environmental Engineering II	3
Fluid Mechanics I	2	Water Resources Engineering	4
Material Science	2	Transportation Engineering	3
Civil Engineering Materials	2	Geotechnical Engineering	3
Civil Engineering Systems	3		
Total Hours	16	Total Hours	17

Fourth Year

Fall Courses	Credit Hours	Spring Courses	Credit Hours
Senior Engineering Clinic I	2	Senior Engineering Clinic II	2
Civil Engineering Design Project I	2	Civil Engineering Design Project II	2
Civil Engineering Practice	1	CEE Elective	3
Microeconomics	3	CEE Elective	3
CEE Elective	3	Technical Elective	3
CEE Elective	3	General Education Course	3
General Education Course	3		
Total Hours	17	Total Hours	16

Total Hours: 131

Component A consists of two courses that are already required for the standard civil and environmental engineering degree. You must take Environmental Engineering I and II (0908.311 and 0908.312).

Component B consists of a focused selection of civil and environmental engineering electives and jr / sr clinic projects. Two of your CEE Electives must be focused on bioengineering electives within the civil and environmental engineering department. Please note that two of your CEE Electives must also fulfill your requirement of taking a second course in at least two of the following, geotechnical, transportation, or water resources. As there are four CEE electives, this should be easy to accomplish. If your component C course (see below) is 4 semester credit hours, one semester of jr / sr clinic must be spent on a bioengineering related project. Otherwise, an additional semester of jr / sr clinic must be taken that is at least half-bioengineering related. The jr / sr clinic(s) can be from any engineering discipline.

Component C consists of one bioengineering-related course outside of civil and environmental engineering. This course must be from the list of approved electives in biology, chemistry, and other engineering disciplines, and you must determine how this will fit into your schedule. This course can also be counted at the senior technical elective, or may be an additional course. Prerequisites may make it difficult to take some of the courses listed in this document.

Concentration in Bioengineering – Electrical & Computer Engineering Program Guide

The ECE department's BME concentration is designed to be as flexible as possible, while ensuring a meaningful depth and breadth in bioengineering.

1. All ECE students are required to take two core science classes (from an approved list of science classes) outside of Engineering. The list currently includes the following courses. Therefore, students who wish to concentrate on BME are advised to take one of these courses towards their regular science requirements.

Biological Systems and Applications
Biology I

2. Students need minimum of 8 credits from an approved list of Biological Science Electives. Approved list of electives will be reviewed on a yearly basis depending on the courses offered on campus. In general, these courses are from the Anatomy / Physiology bank or from the Cellular, Molecular Biology bank of the Biology program, or from the Chemistry / Biochemistry program. The students are responsible for either obtaining the prerequisites, or making the necessary arrangements with the professor. The courses listed in (1) do count towards this requirement. In general, students need to satisfy this requirement during their sophomore or junior year.

3. No fewer than 4, no more than 8 credits of Junior / Senior clinic must come from BME related projects. Note that each Ju/Se clinic in ECE is 2 credits. Therefore, 2 ~ 4 semesters of clinic experience must come from BME related projects. Every semester, there are a number of projects that are BME related. Those projects that qualify for this category will be announced every semester.

4. Minimum of 3 credits (one course) from an approved list of Bio-related ECE electives. The list currently includes Principles of Biomedical Systems and Devices (0909.404) and Introduction to Biosensors (0909.476). Additional courses will be added to this bank. Note that every semester the ECE department offers electives under the title "Special Topics in ECE" (0909.403.xx). Some of these classes are BME related and will count towards this requirement. Special Topics courses that qualify for BME concentration will be announced every semester. This course will be taken during the senior year.

5. Minimum of 3 credits from an approved list of Bio-related non-ECE engineering electives. Any course that is on the approved list of other engineering departments' BME bank will count towards this requirement. This course will also be taken during the senior year.

Students are encouraged to discuss their intentions on Bioengineering specialization as early as possible with the BME advisor in the ECE department. Currently, Dr. Robi Polikar is the ECE department's BME advisor. He will be able to advise and guide students on which courses and in what sequence to take for a meaningful and rewarding BME experience.

Concentration in Bioengineering - Mechanical Engineering Program Guide
03/10/05

There are two basic components to earning a concentration in bioengineering for mechanical engineering:

- A. a focused selection of mechanical engineering, non-mechanical engineering and science electives and jr / sr clinic projects that are part of the standard curriculum
- B. one more bioengineering-related non-mechanical engineering course

This document will guide you towards the minimum of 20 s.h. of courses required for the bioengineering concentration. The most challenging aspect will be completing component B.

The curriculum listed below guides you through component A of this process. A focused selection of electives (both within Mechanical Engineering, as well as outside of ME) that are part of the standard courses and also count towards the bioengineering concentration are highlighted in **Bold**. Bear in mind that only one of your jr / sr clinic projects must be bioengineering-related. Courses that are typically taken elsewhere in the curriculum are in *Italic*.

First Year

Course	c.h.	Course	c.h.
<u>Composition I (1501.111)</u>	3	<u>Computer Sci. & Prog. (0704.103)</u>	4
<u>Freshman Engineering Clinic I (0901.101)</u>	2	<u>Freshman Engineering Clinic II (0901.102)</u>	2
<u>Calculus I (1701.130)</u>	4	<u>Calculus II (1701.131)</u>	4
General Education	3	General Education	3
<u>Adv. College Chemistry I (1906.105)</u>	4	<u>Physics I (1902.200)</u>	4
Total Hours:	16	Total Hours:	17

Second Year

Course	c.h.	Course	c.h.
<u>Sophomore Engineering Clinic I (0901.201)</u>	4	<u>Sophomore Engineering Clinic II (0901.202)</u>	4
<u>Math for Eng. Analysis I (1701.235)</u>	4	<u>Math for Eng. Analysis II (1701.236)</u>	4
<u>Physics II (1902.201)</u>	4	<u>Material Science (0901.281)</u>	2
<u>Statics (0901.271)</u>	2	<u>Manufacturing Processes (0901.282)</u>	2
<u>Solid Mechanics (0901.272)</u>	2	<u>Dynamics (0901.291)</u>	2
		<u>Machine Design (0910.241)</u>	2
Total Hours	16	Total Hours	16

Third Year

Course	c.h.	Course	c.h.
<u>Junior Engineering Clinic I (0901.301)</u>	2	<u>Junior Engineering Clinic II (0901.302)</u>	2
<u>Bioengineering Elective (ME)</u>	3	<u>Bioengineering Elective (ME)</u>	3
<u>Engineering Thermodynamics I (0910.311)</u>	2	<u>Fluid Mechanics I (0901.341)</u>	2
<u>Engineering Thermodynamics II (0910.312)</u>	2	<u>Fluid Mechanics II (0910.313)</u>	2
<u>Mechanical Design & Synthesis (0910.341)</u>	4	<u>Vibrations (0910.201)</u>	2
<u>Networks I (0909.201)</u>	2	<u>Transfer Processes I-Heat (0906.311)</u>	2
		<u>Electronics I (0909.311)</u>	2
Total Hours	15	Total Hours	15

Fourth Year

Course	c.h.	Course	c.h.
<u>Senior Engineering Clinic I (0901.401)</u>	2	<u>Senior Engineering Clinic II (0901.402)</u>	2
<u>Mechanical System Dynamics & Control (0910.343)</u>	3	<u>Microscale Systems (0910.403)</u>	2
Approved Biological Science Elective	3-4	<u>Bioengineering Elective (non-ME)</u>	3
<u>Bioengineering Elective (ME)</u>	3	General Education Course	3
<u>Approved Major Elective 1</u>	3	General Education Course	3
<u>Microeconomics (2204.102)</u>	3	<u>Quality and Reliab. in Des. & Mfg. (0910.342)</u>	3
Total Hours	17	Total Hours	16

Component A consists of a focused selection of three mechanical engineering electives (9 s.h.), one non-mechanical engineering elective (3 s.h.), one science elective (3-4 s.h.) and one jr / sr clinic project (2 s.h.) that are required for the standard mechanical engineering degree. One semester of jr / sr clinic must be spent on a bioengineering related project. This project can be from any engineering discipline, as long as it has a substantial bioengineering component. Your selection of junior and senior year electives must also be focused on bioengineering electives. Three of the four mechanical engineering electives must be from the approved list of bioengineering electives within mechanical engineering. Of the four mechanical engineering electives (three of which are bioengineering related) you must ensure that you meet the mechanical engineering degree requirement that two fulfill the thermal-fluid sciences stem and two fulfill the mechanical systems stem. For the concentration, the technical elective in the standard curriculum is a non-ME engineering course that must be replaced with one of the non-ME bioengineering electives below. Also for the concentration, you must take an approved biological science elective in place of the standard math/science elective.

Component B consists of one additional bioengineering-related course (3-4 s.h.) outside of mechanical engineering. This course must be from the list of approved electives in biology, chemistry, and other engineering disciplines. You must determine how this will fit into your schedule. The most likely mechanism is for you to complete your general education requirements early, and then fill this open space in your schedule with an approved elective. Currently, general education blocks appear in the curriculum during both semesters of the freshman year and in the spring of the senior year.

Chemical Engineering

Bioprocess Engineering (3 s.h.) 0906.462

prerequisites = Chemistry I (Lecture and Lab) = 1906.100 or Advanced College Chemistry I = 1906.105, Calculus II = 1701.130

Principles of Biomedical Engineering (3 s.h.) 0906.472

prerequisites = 1906.100 or 1906.105, 1701.131

Principles of Bioseparation Processes (3 s.h.) 0906.476

prerequisite = Separation Processes = 0906.314

Principles of Food Engineering (3 s.h.) 0906.482

prerequisites = 1906.100 or 1906.105, 1701.131

Principles of Engineering Exercise Physiology (4 s.h.) 0906.483

prerequisites = 1906.100 or 1906.105, Math for Engineering Analysis = 1701.236

Fundamentals of Controlled Release (3 s.h.) 0906.484

Prerequisites: 1906.100 or 1906.105, 701.131.

Membrane Processes (3 s.h.) 0906.486

Prerequisites: 1906.100 or 1906.105, 1701.131.

Civil Engineering

Environmental Engineering I (0908.311) 3 s.h.

Prerequisites: 1907.300, must be taken with Corequisite [0901.341](#)

Environmental Engineering II (0908.312) 3 s.h.

Prerequisites: 0908.311 or permission of instructor

Site Remediation Engineering Principles (0908.422) 3 s.h.

Prerequisites: Senior standing or permission of instructor

Pollutant Fate and Transport Principles (0908.432) 3 s.h.

Prerequisites: Senior standing or permission of instructor

Principles of Integrated Solid Waste Management (0908.433) 3 s.h.

Prerequisites: Senior standing or permission of instructor

Electrical Engineering

Principles of Biomedical Systems and Devices (0909.404) 3 s.h.

Prerequisite: 0909.311, 0909.321

Mechanical Engineering

Introduction to Biomechanics (0910.470) 3 s.h.

Prerequisite: Dynamics (0901.291)

Introduction to Biofluids (0910.471) 3 s.h.

Prerequisite: Fluid Mechanics I (0901.341).

Introduction to Biomaterials (0910.472) 3 s.h.

Prerequisite: Materials Science (0901.281).

Introduction to Crash Safety Engineering (0910.475) 3 s.h.
Prerequisite: 0901.291

Biological Sciences

Biological Systems & Applications (0401.210)
Pre-requisites: Advanced Chemistry I

Work Physiology (0410.350)
Prerequisites: Bio I (0401.100) and Bio II (0401.101)

Environmental Toxicology (0420.425)
Prerequisites: 0401.100, 0410.101, 1906.100, 1906.101, 1907.200, 0420.310, Junior or Senior class standing; or permission from the instructor

Microbiology (0411.330)
Pre-requisites: Bio I & II

Cell Biology (0401.430)
Pre-requisites: BioI and BioII

Developmental Biology- it will be offered beginning Fall 2006
Pre-requisites: Biology 1 (0401.100), Biology II (0401.101), and any one of the following Genetics (0422.335), Introduction to Biochemistry (0414.348), Introduction to Biochemistry-Lecture only (0414.440), Embryology of Animals (0427.401), Cell Biology (0401.430) or permission of instructor

Concepts in Human Genetics: (undergraduate-0422.410 and graduate-0422.598)
Prerequisites: Genetics (0422.335) is required or permission from the instructor.

Human Anatomy and Physiology I (0410.210)
Pre-requisites: Bio I and Bio II

Human Anatomy and Physiology II (0410.212)
Pre-requisites: Bio I and Bio II

Chemistry

Biochemistry (1907.348) 4 s.h.
Prerequisite: Organic Chemistry II – 1907.201.

Advanced Biochemistry (1907.408) 4 s.h.
Prerequisite: Biochemistry.

Biophysical Chemistry (1908.305) 4 s.h.
Prerequisites: Organic Chemistry II – 1907.201; Calculus II – 1701.131; Physics II (for scientists and engineers) – 1902.201; Quantitative Analysis – 1909.250; and Biology II – 0401.101.

Medicinal Chemistry (1907.410) 3 s.h.
Prerequisite: 1907.201