DEPARTMENT OF
BIOLOGICAL AND ENVIRONMENTAL ENGINEERING

Mission Statement

- Educate the next generation of professionals and discover new knowledge in biological engineering;

- Disseminate cutting edge research-based engineering information through scientific media and outreach programs;

- Conduct all programs in the context of a world-class university and deliver the highest value knowledge to our students, citizens, and global society.

Our Commitment

The educational objectives of the Biological Engineering program are consistent with those of the College of Engineering and Cornell University. We are committed to providing an excellent undergraduate engineering program in a nurturing environment where our graduates acquire knowledge and develop skills for professional success. Graduates of our program include a diverse group of leaders and problem solvers who contribute technically, professionally and personally to our society.

The Educational Objectives of the Biological Engineering Program are to

1. Advance in careers and opportunities related to Biological Engineering and other related fields and professions based on a solid educational background in appropriate mathematics, physical and life sciences, liberal studies (including communication and ethics) and engineering.

2. Pursued advanced degrees in engineering and related professional fields.

Undergraduate Program
Department of Biological and Environmental Engineering
2014-2015

Cornell University is an equal opportunity, affirmative action educator.

Handbook cover designed by Deborah Higgins.
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INTRODUCTION

The Department of Biological and Environmental Engineering offers engineering degree programs in Biological Engineering and Environmental Engineering. A separate program guide for the Environmental Engineering degree is available on-line at www.bee.cornell.edu or from BEE Student Services, 207 Riley-Robb Hall.

We welcome your interest in our programs, whether that interest is as a prospective or continuing student, an alumnus, or as a prospective employer of our students.

For more information, visit our web site at: www.bee.cornell.edu

If you have questions about our undergraduate programs, please contact:

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BIOLOGICAL ENGINEERING

"We Bring Engineering to Life and Life to Engineering"

Administrative Structure

Biological Engineering is an engineering program accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET). There are two administrative pathways Cornell students may use to complete the Biological Engineering program. Students may matriculate in the College of Engineering and affiliate with the Biological Engineering major, or they may matriculate in the College of Agriculture and Life Sciences with a major in Biological Engineering. The curriculum and degree requirements are the same for all students in the Biological Engineering program regardless of the administrative pathway they use to complete it. Faculty advisors are assigned to each undergraduate at the time they formally enter the Biological Engineering major.

Affiliation (College of Engineering Enrolled Students)

Students who matriculate in the College of Engineering (CoE) may affiliate with the Biological Engineering program in their second year of study. (Transfer students entering the CoE affiliate with their major program at the time of transfer.) Affiliated students pay endowed tuition and complete all Biological Engineering requirements while enrolled in the engineering college.

Joint Program (College of Agriculture and Life Sciences Enrolled Students)

Students who enroll in the College of Agriculture and Life Sciences (CALS) as freshmen majoring in Biological Engineering complete a joint degree program with the College of Engineering. In the joint degree program, students register in CALS for their freshmen and sophomore years and then are registered jointly with CALS and CoE for their junior and senior years (the registration process in years 3 and 4 is facilitated by the BEE department administration). The primary college in the junior year is CALS and in the senior year, the students' primary college is the College of Engineering. Students in the joint degree program pay state contract college tuition all four years of their program.

Program Focus

The Biological and Environmental Engineering (BEE) department focuses on three great challenges facing humanity today: protecting the world's natural resources, including water, soil, air, biodiversity, and energy; developing engineering systems that monitor, replace, or intervene in the mechanisms of living organisms; and ensuring an adequate and safe food supply in an era of expanding world population. The Undergraduate Engineering program in Biological Engineering has a unique focus on biological systems, including the environment that is realized through a combination of fundamental engineering sciences, biology, applications courses, and liberal studies.

Biological engineers work on problems related to nonpoint-source pollution, such as chemical movement through watersheds, the soil, and aquifers. They develop processes to create novel value-added products from biologically derived feedstocks. They develop innovative technology for expanding the use of food and biological products in an ethical and sustainable way. They are involved in the development and application of biotechnology in ways that help people and protect our environment. Finally, they apply their knowledge of biology and engineering principles to solve biomedical problems.

Because biological engineers work at the interface between biology and engineering, they must be knowledgeable in both disciplines. They are rigorously prepared for this breadth by taking core courses in

mathematics, physics, and the engineering sciences as well as biology and chemistry. They select additional foundation and advanced courses in subjects like molecular biology, biochemistry, microbiology, animal and plant physiology, and emerging engineering subjects like biocomputing. This integration of engineering and biology is the distinguishing feature that makes Biological Engineering unique among the engineering disciplines and an excellent preparation for advanced study. Many graduates from the Biological Engineering Program continue their education at the finest graduate schools in the world. They pursue Master of Engineering (M. Eng.), Master of Science (M.S.), or Doctoral (Ph.D.) programs in various related engineering disciplines, or they sometimes complement their engineering degrees with a Master of Business Administration (MBA), a Doctor of Medicine (MD), or Doctor of Law (LLD) degree.

Students in the Biological Engineering Program may pursue minor programs. Minors in biomedical engineering, engineering management, mechanical engineering, and operations research and management science tend to fit well with Biological Engineering students' interests and academic programs. Minors in other areas, for example music, German Studies, or food science, are also available to our students.

Careers

Career opportunities for Biological Engineering graduates cover the spectrum of private industry, public agencies, educational institutions, and graduate and professional programs in engineering, science, medicine, and law. In recent years graduates have pursued careers in consulting, biotechnology, and pharmaceutical industries, biomedical engineering, management and business, and international development.

The curriculum proves an excellent preparation for biomedical engineering and public health, medical or veterinary studies or for a career in research or manufacturing in bioprocess-based industries, health and medical technology industries, and biotechnology firms. For example, biological engineers may develop sensors and devices to monitor physiological systems, or design and improve processes and product recovery systems for bio-based industries. Biological engineers are also well equipped to solve environmental problems by developing models to better understand the interface between humans and their surroundings, by designing bioremediation systems for pollution abatement, and advising state and local municipalities in developing guidelines and laws for sustainable land use.

After graduation, biological engineers may pursue advanced degrees or work in research and industry, usually as a member of a team of scientists and engineers, and often as a team leader. They work with consulting firms, manufacturers, and government agencies. Products of their efforts help ensure a safe and adequate supply of food and water, create new medicines, diagnose and cure diseases in people and animals, and enable people to utilize plant, animal and microbial systems in more efficient and sustainable ways.

The living world is all around us and within us. The biological revolution races forward, continually creating opportunities for multidisciplinary problem solvers, engineers fluent in both the physical and life sciences, who can communicate effectively, who are sensitive to the needs of people and the environment, and who are interested in the solving the challenges facing society. The Department of Biological and Environmental Engineering is committed to educating Biological Engineers to meet these challenges.

BIOLOGICAL ENGINEERING CURRICULUM

Biological engineering is engineering applied to living systems on a range of scales from molecules to whole organisms. Our discipline has progressed from the interface of biological and engineering systems to the development of biological components with specific functions and the design of systems incorporating these biological components. Cells and enzymes are used as sensors. Nucleic acid is engineered to make molecular structures for drug delivery and nano-bar codes to identify specific biological and chemical elements. Phytochelatins synthesized by plants, yeast and algae are employed to detoxify metals in the environment. Engineered microbial films are used to biodegrade man-made and toxic organics. Metabolic pathways in target organisms can be engineered to enable novel biological function. Complex enzymatic systems are modified with "designer" enzymes to convert plant material to biobased products, including liquid fuels. Animals and plants serve as pharmaceutical "factories". Tissue engineering is used to develop compatible biological components on a large scale. Novel medical devices and drug delivery systems are developed by altering biological systems on a small scale. Engineering analysis and computational modeling are used to develop predictive tools for design of biological, environmental and food products providing improved efficiency, quality and safety.

Conceptually, biological engineering involves: 1) characterizing, measuring and modeling of systemic processes within biological systems; 2) understanding the relationships between biological systems and their environment; and 3) designing components, processes and systems that protect, influence, control, and employ biological materials, components and organisms. Biological engineering integrates engineering topics, such as mechanics, fluid flow, chemical kinetics, electronics, and computer applications with basic biology.

YOUR ADVENTURE IN BIOLOGICAL ENGINEERING

The foundation of our undergraduate program in biological engineering is built upon fundamental physical and life sciences, mathematics, core biological engineering sciences, biological engineering concentrations and liberal studies. Our fundamental courses provide a depth of knowledge in both the biological sciences and the physical sciences. Courses within our core engineering sciences are uniquely designed for our curriculum and integrate biological principles with the engineering sciences. The department and college have invested significant resources in laboratory facilities and new faculty whose interests support our concentrations of Biomedical Engineering, Bioprocess Engineering and Bioenvironmental Engineering. These people and facilities provide our undergraduates with excellent educational and research opportunities in our overall program and concentrations.

The biological engineering curriculum stresses a basic knowledge of the biological sciences, chemistry, physics, mathematics and engineering sciences. This knowledge is used to develop new biological components, to employ biological components as engineering tools and to solve engineering problems involving biological systems.

Biological science requirements include: a year of introductory biology, biochemistry and an advanced biology elective course. A strong background in chemistry is required to most effectively understand the underlying functions found in biological systems. Therefore, we require general chemistry, organic chemistry and biochemistry.

All engineering disciplines build upon a set of fundamentals in mathematics, physics and engineering sciences. Our mathematics and physics requirements are the same as other engineering disciplines: four semesters of math and two semesters of physics. Each engineering discipline has a set of the engineering distribution courses that the student needs as background for upper level courses. Like all engineering fields, we require two distribution courses: 1) mass and energy balances (ENGRD/BEE 2600 or ENGRD/BEE 2510); and 2) mechanics of solids. Many students elect to take additional distribution courses in order to fulfill minor requirements and general interest.

The ***core biological engineering courses*** of our program include an introduction to biological engineering, molecular and cellular bioengineering, biological transport processes, bio-fluid mechanics and bioengineering thermodynamics. All of these courses provide strong biological content and reinforce engineering problem solving. The biological engineering major is further defined by your choice of a concentration in Biomedical Engineering, Bioprocess Engineering or Bioenvironmental Engineering. Within the concentrations, students can take courses that provide laboratory and design experiences as well as other "hands-on" experiences with biological applications.

Communication, both written and oral, is important for all professionals. Technical communication is emphasized throughout our curriculum. We also recommend courses in the history of technology and in medical or environmental ethics to reinforce the relevant social and ethical responsibilities shared by all engineers who apply new technologies to living organisms.

BIOLOGICAL ENGINEERING
Sample 8-Semester Plan

Freshman Year

Fall Semester		Spring Semester	
MATH 1910, Calculus I	4	MATH 1920, Calculus II	4
BEE 1510, Intro Computer Prog	4	PHYS 1112, Mechanics	4
Intro Biology[a]	3	Intro Biology[a]	3
BIOG 1500, Bio Lab[a]	2	BEE 1200[b], The BEE Experience	1
First Year Writing Seminar	3	First Year Writing Seminar	3
	16		15

Sophomore Year

MATH 2930, Differential Equations	4	MATH 2940, Linear Algebra	4
PHYS 2213, Electromagnetism	4	CHEM 1570, Organic Chemistry	3
CHEM 2070 or 2090, Gen Chem	4	BEE 2220, Biokinetics and Thermo	3
BEE 2510 or BEE 2600, MEB[c]	3	Liberal Studies Elective	3
		ENGRD 2020, Mech of Solids	4
	15		17

Junior Year

BEE 3500, Bio & Env Trans Proc	3	Bio. Sci. Elective, upper level	3
BEE 3310, Bio-Fluid Mechanics	4	Biological Engineering Elective	3
BIOMG 3300, Biochemistry	4	Biological Engineering Elective	3
CEE 3040, Uncertainty Analysis	4	Concentration Elective	3/4
Liberal Studies Elective	3	Liberal Studies Elective	3
	18		15/16

Senior Year

Concentration Elective	3/4	Concentration Elective	3/4
Biological Engineering Elective	3	Biological Engineering Elective	3
Biological Engineering Elective	3	Biological Engineering Elective	3
Approved Elective	3	Approved Elective	3
Liberal Studies Elective	3	Liberal Studies Elective	3
Liberal Studies Elective	3		
	18/19		15/16

[a]Students choose two of the following four courses: BIOMG 1350, BIOG 1440, BIOG 1445 or BIOEE 1610 plus BIOG 1500. BIOG 1500 may be taken in the spring term.
[b]BEE 1200 is not required of students who have taken an ENGRI 1XXX course.
[c]Mass and Energy Balances with a biological (BEE 2600) or environmental (BEE 2510) focus.

Minimum degree credits = 126

DEGREE REQUIREMENTS
Biological Engineering Program

A student earning a Bachelor of Science degree in the Biological Engineering Program must complete the following academic requirements. Degree requirements apply to students matriculating in the fall semester of 2014 or later. A minimum of 126 credit hours of courses is required.

Group Subject Matter **Credit Hours**

1. Mathematics 16
(1910, 1920, 2930, 2940)
All math courses in this sequence must be completed with a grade of C- or better.

2. Physics 8
Calculus-based Physics (1112, 2213)

3. Chemistry 7
General Chemistry (2070 or 2090)
Organic Chemistry (1570, 3530 or 3570)

4. Biological Sciences 15
Introductory Biology (8 credits)[a]
Biochemistry or Microbiology (BIOMG 3300 or 3330 or BIOMG 3350 or BIOMG 3310+3320 or BIOMI 2900 recommended) (3 or 4 credits)
Advanced Biological Science (3 or 4 credits)[b]

5. Written Expression 6
First Year Writing Seminars
Technical Writing – one course required. Technical writing courses are listed in the *Courses of Study*, College of Engineering section. BEE 4530, BEE 4590, BEE 4730 and BEE 4890 are approved courses.

6. Liberal Studies (6 courses) 18
Liberal Studies courses are listed in the *Courses of Study*, College of Engineering section.
Minimum of 6 courses in at least 3 of the 7 groups, at least 2 of 6 courses at or above 2000 level.
1. Cultural Analysis (CA)
2. Historical Analysis (HA)
3. Literature and the Arts (LA)
4. Knowledge, Cognition, and Moral Reasoning (KCM)
5. Social and Behavioral Analysis (SBA)
6. Communications in Engineering (CE)
7. Foreign Language (FL, not literature)

7. Computer Programming 4
Intro to Computer Programming - BEE 1510 (or CS 1112)

8. Engineering Distribution and Field Courses (all must be taken for letter grade, except BEE/BME 5010) ... 46

(a) Required Courses
Mechanics of Solids - ENGRD 2020[c] (4 credits)
Engineering Statistics and Probability - ENGRD 2700 or CEE 3040 (recommended) (3 or 4 credits)

(b) Biological Engineering Core Courses
The BEE Experience - BEE 1200 (1 credit) [Not required of students who have completed an ENGRI course]
Engineering Distribution[c] - BEE/ENGRD 2600 (recommended) or BEE/ENGRD 2510 (3 credits)
Biological and Environmental Transport Processes - BEE 3500 (3 credits)
Fluid Mechanics - BEE 3310 or CEE 3310 (4 credits) [Students may petition CHEME 3230 (3 credits).]
Thermodynamics - BEE 2220 or ENGRD 2210 (3 credits). [Students may petition to substitute CHEME 3130 (4 credits); MSE 3030 (4 credits); or AEP 4230 (4 credits).]

(c) Biological Engineering Concentration – three courses from one concentration (minimum of 9 credits), see pages 12-15.

DEGREE REQUIREMENTS (CONT'D)
Biological Engineering Program

Group Subject Matter **Credit Hours**

(d) Major-approved engineering electives to complete 46 engineering credits

BEE and other Engineering courses at 2000 level or above from BEE or the College of Engineering. A maximum of 4 credits of engineering research, project team, teaching or independent study may be used in this category. BEE/BME 5010 may be taken twice. Engineering Laboratory (select one course) - BEE 3650, BEE 4270, BEE 4500, BEE 4550, or CEE 4530. Capstone Design (select one course) – BEE 4350, BEE 4500, BEE 4530, BEE 4590, BEE 4600, BEE 4730, BEE 4740, BEE 4810/4960, or BEE 4870. One course in this category must satisfy the College of Engineering Technical Writing requirement (the Technical Writing requirement may also be satisfied by specific liberal studies courses applied towards the liberal studies requirement).

9......**Approved Electives**.....6

These courses are selected by the student with approval of the student's Faculty Advisor.

TOTAL MINIMUM 126

[a]Students choose two of the following four courses: BIOMG 1350, BIOG 1440, BIOG 1445 or BIOEE 1610, plus BIOG 1500. Students must complete at least 15 credits in the Biological Sciences category. All bio courses must be taken for letter grade.
[b]Upper-level Biology: any biology course at the 2000-level or above which has a biology prerequisite and is taken for a letter grade. This requirement may also be satisfied by an upper-level course in a science department (excluding engineering, fine arts, liberal studies and mathematics) which has a biology (not social science) content of 95% or greater and a biology prerequisite. Students must receive approval for these alternative courses by consulting their BE faculty advisor or the main BE Advising Office, 207 Riley-Robb Hall. One credit seminars may not be used to meet this requirement. Up to 4 credits of BIOG 4980 or 4990, but not BIOG 2990, may be used in this category if taken for letter grade.
[c]Engineering distribution requirement is satisfied by ENGRD 2020 and ENGRD/BEE 2600 or ENGRD/BEE 2510

Concentrations

All students are required to complete a concentration. Concentrations represent areas in biological engineering that relate to individual interests or preparation for careers or graduate study. The concentrations are intended to help in choosing electives while planning an individual curriculum. The three concentrations are *Biomedical Engineering, Bioprocess Engineering and Bioenvironmental Engineering.*

Special Courses

Courses numbered 10XX, such as PHYS 1012, do not count toward graduation requirements. Academic Excellence Workshops (ENGRG 1091, 1092, 2093 and 2094) may not be used as Biological Engineering Electives.

Transfer Credit

All transfer credit for the engineering major must be approved before it will be posted on the Cornell transcript. Courses completed prior to matriculation will be evaluated when the student matriculates at Cornell. Courses taken outside of Cornell after matriculation must be approved before the student enrolls in them to ensure credit will count toward the engineering degree. If a transfer course meets the subject matter content, but lacks full credit content, the student must fulfill the credit requirement by petitioning the College of Engineering to substitute engineering credits.

Physical Education

Two semesters of physical education are required. All students must pass a swim test prior to graduation. Transfer students are exempted from one semester of PE for each full-time semester they transfer into Cornell.

Letter and S/U Grading

All courses must be taken for letter grade except for Liberal Studies and Approved Electives.

Additional program information is provided at the Courses of Study website in the College of Engineering section and in the College of Engineering Undergraduate Handbook.

BIOLOGICAL ENGINEERING PROGRAM PROGRESS FORM

Applies to students matriculating in the Fall Semester of 2014 or later.

Name: _____ Empl ID: _____
E-mail: _____ Advisor: _____
Minor: _____ Anticipated Graduation Date: _____
Concentration: _____ Double Major: _____

	Course Title and Required Credits	Course (Credits)	Semester	Credits	Grade
1.	**Mathematics:** 16 credits				
	Calculus for Engineers I*	MATH 1910 (4)	_____	_____	_____
	Calculus for Engineers II*	MATH 1920 (4)	_____	_____	_____
	Engineering Math* (Differential Equations)	MATH 2930 (4)	_____	_____	_____
	Engineering Math* (Linear Algebra)	MATH 2940 (4)	_____	_____	_____
	*Must earn at least a C- or repeat course				
2.	**Physics:** 8 credits				
	Mechanics	PHYS 1112 (4)	_____	_____	_____
	Electromagnetism	PHYS 2213 (4)	_____	_____	_____
		.			
3.	**Chemistry:** 7 credits				
	General Chemistry	CHEM 2070 or 2090 (4)	_____	_____	_____
	Organic Chemistry	CHEM 1570, 3530 or 3570 (3)	_____	_____	_____
4.	**Biological Sciences:** 15 credits				
	Introductory Biological Science	_____	_____	_____	_____
	Introductory Biological Science	_____	_____	_____	_____
	Introductory Bio Lab	_____	_____	_____	_____
	Biochemistry or	_____	_____	_____	_____
	BIOMG 3300 (4) or 3330 (4) or 3310+3320 (5) 3350 (4)				
	Microbiology	_____	_____	_____	_____
	BIOMI 2900 (3) or CEE 4510 (3)				
	Students following the Bioenvironmental Engineering Concentration are encouraged to include Microbiology				
	Advanced Bio Sci Elective (to complete 15 credits)	_____	_____	_____	_____
5.	**Written Expression** (First Year Writing Seminars): 6 credits				
	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____

6. **Liberal Studies:** 18 credits (Minimum of six courses in at least three of the seven groups; at least two of six courses at or above 2000 level.)

Cultural Analysis (CA)	Knowledge, Cognition, and Moral Reasoning (KCM)
Historical Analysis (HA)	Social Behavior and Analysis (SBA)
Literature and the Arts (LA)	Foreign Language (FL, not literature)
Communications in Engineering (CE)	

_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Course Title and Required Credits	Course (Credits)	Semester	Credits	Grade
7. **Computer Programming:** 4 credits				
Intro to Computer Programming	BEE 1510 or CS 1112 (4)	_____	_____	_____
8. **Engineering Distribution and Field Courses:** 46 credits				
(a) Required Courses				
Mechanics of Solids	ENGRD 2020[a] (4)	_____	_____	_____
Engineering Statistics and Probability	ENGRD 2700 (3) or CEE 3040 (4)	_____	_____	_____
(b) Biological Engineering Core Courses				
The BEE Experience or ENGRI	BEE 1200 (1)[b] or ENGRI (3)[c]	_____	_____	_____
Engineering Distribution**	BEE 2600 or BEE 2510 (3)	_____	_____	_____
Students following the Bioenvironmental Engineering concentration should include BEE 2510 and CEE 3510				
Biological and Bioenv. Transport Processes	BEE 3500 (3)	_____	_____	_____
Bio-Fluid Mechanics/Fluid Mechanics	BEE 3310 or CEE 3310 (4)	_____	_____	_____
Thermodynamics	BEE 2220 or ENGRD 2210 (3)	_____	_____	_____
(c) Biological Engineering Concentration				
Three courses from one concentration (minimum of 9 credits)				
Concentration Elective I	_____	_____	_____	_____
Concentration Elective II	_____	_____	_____	_____
Concentration Elective III	_____	_____	_____	_____
(d) Major-approved electives to complete 46 engineering credits				
BEE and other Engineering courses at 2000 level or above (unless cross listed with a liberal studies course)				
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
9. **Approved Electives:** 6 credits				
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

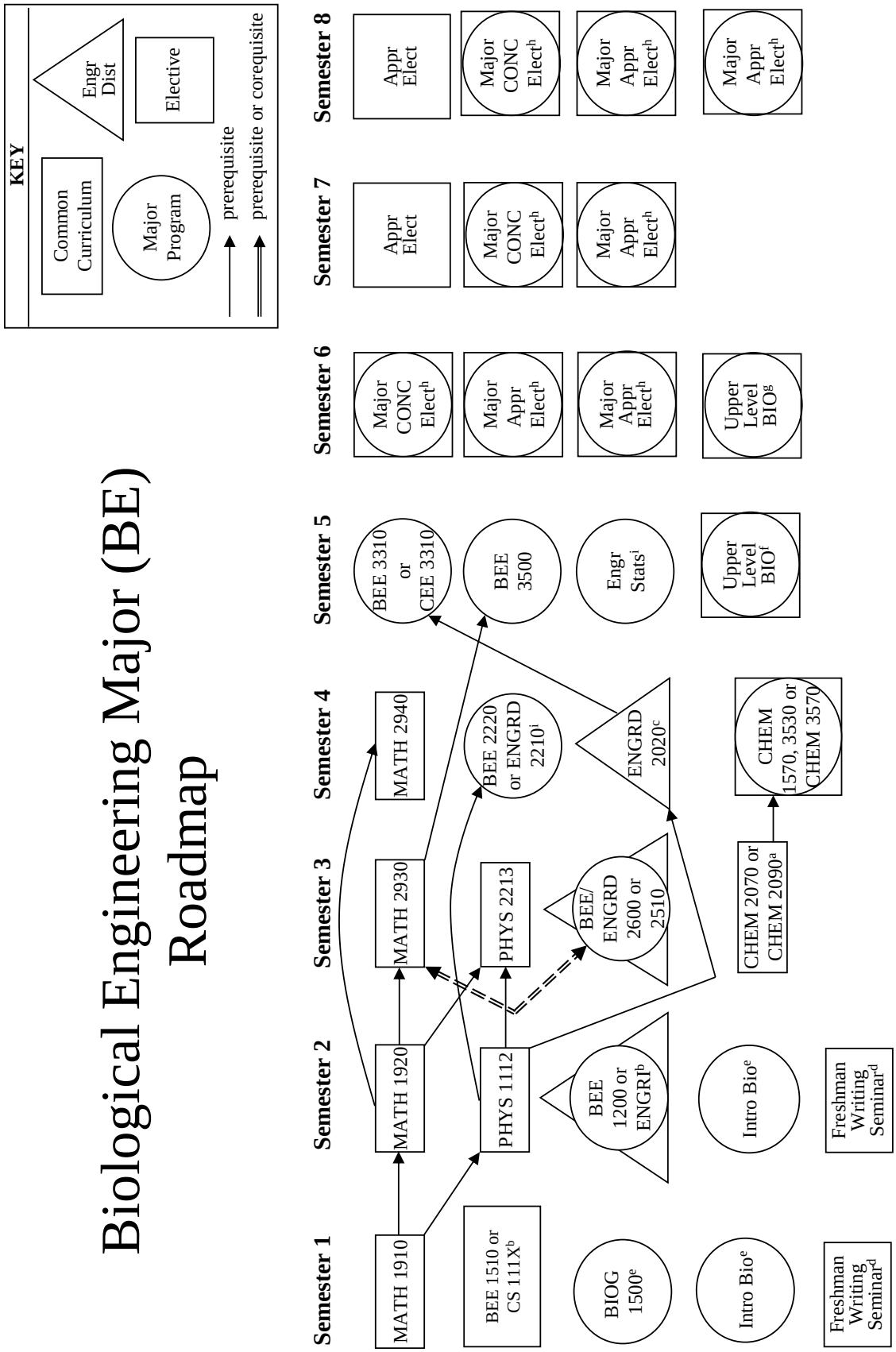
Minimum Credits Required: 126

_____Technical Writing Course _____
_____Capstone Design Course _____
_____Laboratory Course _____

_____PE
_____PE

[a]Engineering distribution requirement is satisfied by ENGRD 2020 and ENGRD/BEE 2510 or ENGRD/BEE 2600
[b]Students matriculating in CALS
[c]Students matriculating in the College of Engineering

Biological Engineering Major (BE) Roadmap



[a]CALS matriculants must enroll in CHEM 2070 (fall); CoE matriculates must enroll in CHEM 2090 (fall, spring). Students in either college may also substitute CHEM 2150 for either CHEM 2070 or 2090.

[b]BEE 1510 and BEE 1200 required of CALS matriculates. CS 111X and ENGRI required of CoE matriculates.

[c]The major program includes nine (9) credits of courses outside the major. These are satisfied by ENGRD 2020, CEE 3040 or ENGRD 2700, and a non-BEE major approved elective.

[d]In addition to the Freshman Writing seminars, a technical writing course must be taken as an engineering distribution, liberal studies, approved elective or major course.

[e]Choose two of the following four courses: BIOMG 1350, BIOG 1440 or BIOG 1445 or BIOEE 1610; plus BIOG 1500. All BIO courses must be taken for letter grade. If you received a 4 on AP BIO, you will receive 4 credits of intro bio. You will still need to take one of the four courses above plus the lab (BIOG 1500). If you received a 5 on AP BIO, you will receive 8 credits of intro bio and that will satisfy the intro bio requirement.

[f]Either biochemistry or microbiology is required: BIOMG 3300 or BIOMG 3330 or BIOMG 3350 or BIOMG 3310 +3320, or BIOMI 2900, or CEE 4510.

[g]Upper-level Biology: any biology course at the 2000-level or above which has a biology prerequisite and is taken for a letter grade. This requirement may also be satisfied by an upper-level course in a science department (excluding engineering, fine arts, liberal studies and mathematics) which has a biology (not social science) content of 95% or greater and a biology prerequisite. Students must receive approval for these alternative courses by consulting their BE faculty advisor or the main BE Advising Office, 207 Riley-Robb Hall. (One credit seminars may not be used to meet this requirement.).

[h]Engineering electives must include a BE capstone design course and a BE lab experience course. See department web page for a current list of approved courses.

[i]BEE 2220 or ENGRD 2210 and Engineering Statistics preferably before Semester 6.

CONCENTRATIONS WITHIN THE BIOLOGICAL ENGINEERING PROGRAM

A concentration is a graduation requirement. Students are required to complete one of the three Biological Engineering Concentrations: ***Biomedical Engineering, Bioprocess Engineering, Bioenvironmental Engineering***. Concentrations are intended to be used as an introduction to areas in biological engineering that relate to individual interests and preparation for careers or graduate study. They are also intended to help students select electives while planning an individual curriculum. You are encouraged to work closely with your faculty advisor to select concentration electives that meet your academic objectives.

BIOMEDICAL ENGINEERING CONCENTRATION

Although biological engineering is broader than any one application area such as biomedical engineering, human system applications obviously form a critical part of the biological engineering program. Many of the biological engineering courses, especially at the junior and senior level, have been designed with human systems as the major emphasis. Thus, the *core biological engineering courses* in molecular and cellular biological engineering, bio-thermodynamics, bio-fluid mechanics and bio-transport all include biomedical applications.

The objective of the concentration in biomedical engineering is to relate the broader biological engineering program to the individual's interest in preparing for an industrial career or graduate study in areas related to human medicine, veterinary medicine and dentistry. The concentration should guide the individual in choosing elective subjects that they will use in their life after graduation.

The table below is a list of elective courses in biomedical engineering (beyond the *core* discussed earlier) grouped into topical areas of upper level subject matter and applications.

To further enhance the concentration and the curriculum in general, undergraduate research or independent study is encouraged. Such work could be with faculty members within Cornell (Engineering departments, Veterinary Medicine, Weill Medical College in New York City) or outside of Cornell, in academia or industry.

Select three courses from the list below (9 credits minimum required)

F	AEP 4700	Biophysical Methods (BIONB/VETMM 4700; BME 5700)[c]
S	BEE 3600	Molecular and Cellular Bioengineering (BME 3600)[a, e]
S	BEE 3650	Properties of Biological Materials [c]
S	BEE 4500	Bioinstrumentation[b]
S	BEE 4530	CAE: Applications to Biomedical Processes (MAE 4530)[e]
F	BEE 4550	Biologically Inspired Microsystems Engineering[b, e] (3 cr only)
F	BEE 4590	Biosensors and Bioanalytical Techniques[b]
F	BEE 4600	Deterministic and Stochastic Modeling in Biological Engineering [a, e]
F	BEE 4940	Design and Analysis of Biomaterials[c]
F	BME 3300	Introduction to Computational Neuroscience (BIONB/PSYCH/COGST 3300) [b, e]
F	BME 4010	Biomedical Engineering Analysis (MAE 4660) [a, e]
S	BME 4020	Electrical and Chemical Physiology[a]
F	BME 4110	Science and Technology Approaches to Problems in Human Health[a]
S	BME 4910	Principles of Neurophysiology (BIONB/ECE 4910) [a]
S	BME 5390	Biomedical Materials and Devices for Human Body Repair (FSAD 4390) [c] (3 cr only)
S	BME 5600	Biotransport and Drug Delivery[a]
F	BME 5850	Current Practice in Tissue Engineering [c]
F	BME 6670	Nanobiotechnology (AEP 6630/MSE 5630) [e]
S	CHEME 4810	Biomedical Engineering (BME 4810) [a]
S	ECE 3530	Introduction to Systems and Synthetic Biology (BME 4980) [e]
S	ECE 5780	Computer Analysis of Biomedical Images (BME 5780) [e]
S	MAE 4640	Orthopaedic Tissue Mechanics (BME 4640)[d]
F	MAE 5680	Soft Tissue Biomechanics (BME 5810) [d]
S	MAE 5690	Clinical Biomechanics of Musculoskeletal Tissue (BME 5690) [d]
S	MSE 4610	Biomedical Materials and their Applications [c]

Some of these courses have pre-requisites not included in the Biological Engineering curriculum.

Topic Areas
[a]Quantitative Physiology
[b]Instrumentation
[c]Materials
[d]Mechanics
[e]Analysis/Modeling of Biomedical Systems

F = Fall; S = Spring

BIOPROCESS ENGINEERING CONCENTRATION

Increasingly, manufacturers are finding that the fastest, most environmentally sound, and most economical route to a product is through a biological system. From pharmaceuticals to foods to industrial enzymes, biological systems are being harnessed to increase product yield, purity, and efficacy. Bioprocess engineering is the use of cell cultures, bacteria, enzymes, plants and even farm animals (in short, any biological system) for the synthesis of industrially-relevant product, such as drugs, foods, and detergent additives. There are typically many steps to a bioprocess and, hence, many opportunities for biological engineers to get involved. The three main areas of interest are process development, product recovery, and process validation and modeling. Courses that have a particular focus in these areas are noted below. Much like chemical engineers, bioprocess engineers need a strong background in kinetics, thermodynamics, statistics, and chemistry (especially biochemistry). In addition, courses in food science, microbiology, cell biology, and physiology can be essential depending on where the student wants to work.

The educational objective for the concentration in bioprocess engineering is to relate the broader biological engineering program to the individual's interest in preparing for an industrial career or graduate study in areas related to bioprocess development, product recovery, or process validation and modeling. The concentration should guide the individual in choosing elective subjects that they will use in their life after graduation.

To further enhance the concentration and the curriculum in general, undergraduate research and independent study are encouraged. Such work could be with faculty members within Cornell (Engineering departments, Microbiology, Food Science) or outside of Cornell University, in academia or industry.

Select three courses from the list below (9 credits minimum required)

S	BEE 3600	Molecular and Cellular Bioengineering (BME 3600)[a, c]
S	BEE 4500	Bioinstrumentation[a]
S	BEE 4530	Computer aided Engineering[c] (MAE 4530)
F	BEE 4550	Biologically Inspired Microsystems Engineering[a,c] (3 cr only)
F	BEE 4590	Biosensors and Bioanalytical Techniques[a, b, c]
F	BEE 4600	Deterministic and Stochastic Modeling in Biological Engineering
F	BEE 4640	Bioseparation Processes[b]
F	BEE 4870	Sustainable Bioenergy Systems[a]
S	CHEME 3320	Analysis of Separation Processes[b]
S	CHEME 3720	Introduction to Process Dynamics and Control[a]
S	CHEME 4700	Process Control Strategies[a]
F	CHEME 5430	Biomolecular Engineering of Bioprocesses[a]
F	ORIE 5100	Design of Manufacturing Systems[a]
S	ORIE 4710	Applied Linear Statistical Models[c]

Some of these courses have pre-requisites not included in the Biological Engineering curriculum.

Topic Areas
[a]Research and Bioprocess Development
[b]Product Recovery
[c]Validation/Modeling

F = Fall
S = Spring

BIOENVIRONMENTAL ENGINEERING CONCENTRATION

The bioenvironmental engineering concentration is for students who want to apply their interest in biological systems to the environment. The natural environment is influenced to a great extent by the consortium of organisms that inhabit it. In order to understand the natural environment or to mitigate the negative impact of human activities we must understand not only fundamental biological processes (material covered in the core program), but we must also understand how the natural environment works (for example how water cycles in the environment—hydrology) and how organisms interact with their environment. Courses suggested for this concentration include those that focus on the natural environment as well as courses on engineered systems which rely on biology to remediate contamination.

The educational objective of the concentration in bioenvironmental engineering is to relate the broader biological engineering program to the individual's interest in preparing for an industrial career or graduate study in areas related to environmental engineering, environmental sustainability, or environmental management. To further enhance the concentration and the curriculum in general, undergraduate research or project team participation is encouraged.

Select three courses from the list below (9 credits minimum required)

S	BEE 3710	Physical Hydrology for Ecosystems
S	BEE 4010	Renewable Energy Systems
S	BEE 4550	Biologically Inspired Microsystems Engineering (3 cr only)
S	BEE 4710	Introduction to Groundwater (EAS 4710)
F	BEE 4730	Watershed Engineering
S	BEE 4740	Water and Landscape Engineering Applications
F	BEE 4750	Environmental Systems Analysis
S	BEE 4760	Solid Waste Engineering
S	BEE 4800	Our Changing Atmosphere: Global Change and Atmospheric Chemistry (EAS 4800)
S	BEE 4860	Industrial Ecology of Agriculturally Based Bioindustries
F	BEE 4870	Sustainable Bioenergy Systems
S	BEE 4880	Applied Modeling and Simulation for Renewable Energy Systems
S	CEE 3510	Environmental Quality Engineering
S	CEE 4320	Hydrology
S	CEE 4360	Case Studies in Environmental Fluid Mechanics
F	CEE 4510	Microbiology for Environmental Engineering
F	CEE 4540	Sustainable Municipal Drinking Water Treatment
S	CEE 4650	Transportation, Energy, and Environmental Systems for Sustainable Development
S	CEE 5970	Risk Analysis and Management (TOX 5970)
F	CEE 6530	Water Chemistry for Environmental Engineering
F	CEE 6550	Transport, Mixing, and Transformation in the Environment
F	EAS 4570	Atmospheric Air Pollution
F	MAE 5010	Future Energy Systems

Some of these courses have pre-requisites not included in the Biological Engineering curriculum.

F = Fall
S = Spring

HONORS PROGRAM

"With Honors" Designation

The Bachelor of Science degree with honors will be granted to engineering students who, in addition to having completed the requirements for a bachelor's degree, have satisfactorily completed the honors program in the Department of Biological & Environmental Engineering and have been recommended for the degree by the honors committee of the department. To be eligible for field honors, a student must enter the program with and maintain a cumulative GPA ≥ 3.50 (no rounding).

A BE honors program shall consist of at least nine credits beyond the 126 minimum required for graduation in BEE plus a presentation in a public scholarly research forum. These credits shall be drawn from one or more of the following categories (A, B, or C) with at least six credit hours in category A:

A. A significant research experience or honors project under the direct supervision of a BEE faculty member using BEE 4990 (Undergrad Research) and BEE 4993 (Honors Thesis). A written senior honors thesis must be submitted as part of the 2nd component. A minimum grade of A- in both courses is required for successful completion of the honors requirement. It is expected that the two research courses will be taken in consecutive semesters.
B. A significant teaching experience under the direct supervision of a BEE faculty member or as part of a regularly recognized course in the department under BEE 4980 - Undergraduate Teaching.
C. Advanced or graduate courses. These additional courses must be technical in nature and related to the student's research area (i.e., engineering, mathematics, biology, chemistry and physics at the 4000 and graduate level).
D. Research Forum. The student must present a poster or oral presentation in a public research forum, such as a national or regional professional society meeting, Cornell Bio Expo, or another university or regional event by the end of the last semester of the project.

A written proposal for the honors project must be accepted by the student's research advisor. Advisor-approved proposals must be submitted to your honors research advisor, faculty advisor and Brenda Marchewka **by the end of the 7th week of classes in the term in which BEE 4990 is taken,** for review by the BEE Committee on Academic Programs.

A preliminary draft of your honors thesis is due to your honors research advisor, faculty advisor and Brenda Marchewka **by the end of the 9th week of classes in the term in which BEE 4993 is taken**.

A final spiral bound copy of the honors thesis is due to your research advisor, faculty advisor and Brenda Marchewka **by the Wednesday after the last day of classes in the semester in which BEE 4993 is taken**.

Timing: All eligible students desiring to enter the honors program must complete a written application no later than the end of the third week of the first semester of the senior year, but are encouraged to make arrangements with a faculty member during the second semester of their junior year. A student must be in the program for two consecutive semesters during their senior year. Students planning to graduate early should consult with Brenda Marchewka about completing the honors program in the spring and fall before their December graduation.

Procedures: Each applicant to the BE honors program must have a BEE faculty advisor to supervise the honors program. Written approval is required from the faculty member who will direct the research.

Latin Honors Designation

Cum laude is awarded to all engineering students with an overall GPA >3.50. Cum laude is also awarded to all engineering students who received a semester GPA >3.50 in each of the last four semesters of attendance at Cornell; in each of these semesters, at least 12 letter-grade credits must be taken with no failing, unsatisfactory, missing, or incomplete grades. If the student is an Engineering Co-op student, then the Engineering Co-op summer term will count as one of the last four. Students who were approved for prorated tuition in their final semester will be awarded cum laude if they received a semester GPA >3.50 in their last semester and meet the conditions above in the prior four semesters. Magna cum laude is awarded to all engineering students with a GPA >3.75 (based on all credits taken at Cornell). Summa cum laude is awarded to all engineering students with a GPA >4.0 (based on all credits taken at Cornell). All GPA calculations are minimums and are not rounded.

Deans' List designation

Dean's List citations are presented each semester to students with exemplary academic records by the college in which the student is enrolled. Currently the requirements are a semester GPA of 3.50 or higher (without rounding); no failing, unsatisfactory, missing, or incomplete grades (including physical education); no grade below a C- (CALS only) and completion of at least 12 letter-grade credits.

MINORS AND PRE-MED STUDY

Biological Engineering majors may choose to complete one or more of the minors offered in any college. There are over 70 to choose from. Most students can complete a minor within their Biological Engineering program in 8 semesters provided they work closely with their faculty advisor to carefully plan and schedule their courses. Completion of a minor is noted on the final Cornell transcript as official recognition of academic achievement above and beyond the Bachelor of Science degree requirements. Students may participate in either the Biological Engineering minor or the Biomedical Engineering minor, but not both. Note that the Minor in Biological Engineering offered by BEE is NOT available to Biological Engineering majors.

Minors are listed on this web site: http://www.cornell.edu/academics/minors.cfm

An example program shown on the next page meets the requirements of the Biological Engineering major and Biomedical Engineering minor.

Pre-Medical Study

Biological engineers in the pre-med program often complete the Biomedical Engineering minor. A sample curriculum plan which identifies the minor and pre-med courses is shown on the following page. Students contemplating a medical career are strongly advised to consult the Health Careers Advising office, 103 Barnes Hall for detailed information on Pre-Medical study. The Health Careers website is: http://www.career.cornell.edu/HealthCareers/

BIOLOGICAL ENGINEERING

Sample Program for Biological Engineering which meets requirements for the **Biomedical Engineering Minor** and **pre-medical study**

	Course Title and Required Credits	Course Number	Credit Hours	Total Credits
1.	**Mathematics:** 16 credits			
	Calculus for Engineers I	MATH 1910[a]	4	
	Calculus for Engineers II	MATH 1920[a]	4	
	Engineering Math (Differential Equations)	MATH 2930	4	
	Engineering Math (Linear Algebra)	MATH 2940	4	16
2.	**Physics:** 8 credits			
	Mechanics	PHYS 1112	4	
	Electromagnetism	PHYS 2213	4	8
	Pre-medical students may petition the College of Engineering to substitute PHYS 2208.			
3.	**Chemistry:** 7 credits			
	General Chemistry I (Chem II counted in Area 9)	CHEM 2070 or 2090[a]	4	
	Organic Chemistry I (O-Chem II counted in Area 9)	CHEM 3570[a]	3	7
4.	**Biological Sciences:** 15 credits			
	Introduction to Biological Science I	BIOG 1XXX[a,b,d]	3-4	
	Introduction to Biological Science II	BIOG 1XXX[a,b,d]	3-4	
	Introductory Bio Lab	BIOG 1500	2	
	Biological Science: 2000 level or above, 3 credits (Select 1-2 courses)			
	Biochemistry (BIOBM 3300 recommended)	BIOMG 3300 or 3330 or BIOMG 3310+3320	4/5	
	Microbiology/Micro Lab (Both recommended)	BIOMI 2900/2910[a,b]	5	
	Behavior/Neurobiology	BIONB 2210[a]/2220[a,b]		
	Physiology/Histology	BIOAP 3110[a,b]/4130[a]		17-20
5.	**Written Expression** (First Year Writing Seminars): 6 credits			
	_____	_____	3	
	_____	_____	3	6
6.	**Liberal Studies:** 18 credits (minimum of 6 courses)			
	Minimum of six courses in at least three of the seven groups; at least two of six courses at or above 2000 level.			
	Cultural Analysis (CA)	Knowledge, Cognition, and Moral Reasoning (KCM)		
	Historical Analysis (HA)	Social Behavior and Analysis (SBA)		
	Literature and the Arts (LA)	Foreign Language (FL, not literature)		
	Communications in Engineering (CE)			
	_____	_____	3	
	_____	_____	3	
	_____	_____	3	
	_____	_____	3	
	_____	_____	3	
	_____	_____	3	18

	Course Title and Required Credits	Course Number	Credit Hours	Total Credits
7.	**Computer Programming:** 4 credits			
	Intro to Computer Programming	BEE 1510 or CS 1112	4	
				4
8.	**Engineering Distribution and Field Courses:** 46 credits			
	(a) Required Courses			
	Mechanics of Solids	ENGRD 2020[c]	4	
	Engineering Probability and Statistics	ENGRD 2700 or CEE 3040	3/4	
	(b) Biological Engineering Core Courses			
	The BEE Experience	BEE 1200 or ENGRI	1/3	
	Engineering Distribution	BEE/ENGRD 2600	3	
	Biological & Bioenvironmental Transport	BEE 3500	3	
	Bio-Fluid Mechanics	BEE 3310	4	
	Thermodynamics & Biokinetics	BEE 2220	3	
	(c) Biological Engineering Concentration			
	Three courses in biomedical concentration for this example (minimum of 9 credits)			
	Com-Aided Engineering	BEE 4530[b]	3	
	Deterministic and Stochastic Modeling in BE	BEE 4600[b]	3	
	Biosensors and Bioanalytical Techniques	BEE 4590[b]	3	
	(d) Major-approved electives to complete 46 engineering credits			
	BEE and other Engineering courses at 2000 level or above			
	Properties of Biological Materials	BEE 3650[b]	3	
	Bioinstrumentation	BEE 4500[b]	4	
	Molecular Principles of Biomedical Engineering	BME 3010[b]	3	
	Bioengineering Seminar	BME 5010[b]	1	
	Biomedical Engineering	BME 4810[b]	3	
	Biomed Eng Analysis of Metabolic & Structural	BME 4010 [b]	3	46-48
9.	**Approved Electives:** 6 credits			
	General Chemistry II	CHEM 2080[a]	4	
	Organic Chemistry II, O Chem Lab	CHEM 3580[a]/2510[a]	5	9

TOTAL: 132-137
(Minimum required: 126)

[a]Courses satisfying pre-medical requirements.
[b]Courses may be used in Biomedical Engineering Minor (See Engineering Handbook).
[c]Engineering distribution requirement is satisfied by ENGRD 2020 and ENGRD/BEE 2510 or ENGRD/BEE 2600.
[d]Choose BIOG 1440, BIOMG 1350, BIOG 1500.

COURSE OFFERINGS

1200 The BEE Experience
Spring 1 credit
J.B. Hunter
Letter grade only. Requirement for CALS BEE freshman. Not required for students who have completed an ENGRI course. Prerequisite: BEE majors or permission of instructor. Lec T 3:35-4:25.

Forum covering the career opportunities for engineering students and the activities and curricula that lead to these opportunities. A series of seminars are given by practicing engineers, Cornell faculty members, alumni, staff from the Cornell Career Services offices, and students. Students develop their undergraduate course plans; complete a web search assignment to locate jobs and internships, and select future courses to meet their academic objectives and career goals.

1510 Introduction to Computer Programming
Fall 4 credits
C. L. Anderson
Letter grade only. Limited to 18 students per lab and rec. No previous programming experience is assumed. Pre-or co-requisite: MATH 1910 or equivalent. Lec M W 10:10-11:25; Lab W R 12:20-2:15, 2:30-4:25.

Introduction to computer programming and concepts of problem analysis, algorithm development and data structure in an engineering context. The structured programming language MATLAB is used, implemented on interactive personal computers, and applied to problems of interest in biological and environmental engineering.

2220 Bioengineering Thermodynamics and Kinetics
Spring 3 credits
J. B. Hunter
Letter grade only. Prerequisites: MATH 1920, PHYS 2213 and chemistry course completed or concurrent. Lec M W F 11:15-12:05.

Living systems rely on chemical and phase equilibria, precise coordination of biochemical pathways, and the release of chemical energy as heat, all of which are governed by the laws of thermodynamics and the rates of chemical reactions. The course covers concepts and laws of thermodynamics as applied to phase transformations, work, heat, and chemical reactions; and reaction kinetics applied to industrial processes and living systems, all with a focus on biological examples.

2510 Engineering for a Sustainable Society (ENGRD 2510)
Fall 3 credits
L. Aristilde
Letter grade only. Pre-requisite: CHEM 2070, 2090 or AP CHEM. Pre- or co-requisite: MATH 2930. Lec T R 10:10-11:25.

This course introduces students to the chemistry, ecology, biology, geology, ethics and environmental legislation relevant to addressing environmental problems as an engineer. Students learn to apply basic biological and chemical sciences along with math, physics and engineering sciences to solve energy and mass balances. Emphasis is on solving case studies of contemporary environmental issues including contamination in natural systems, air quality assessment, hazardous waste management, and sustainable engineering solutions in developing countries. BE and EnvE students must complete either BEE 2510 or BEE 2600 according to their academic plan. Students who complete both BEE 2510 and BEE 2600 will receive engineering credit toward their degree for only one of these courses.

2600 Principles of Biological Engineering (ENGRD 2600)
Fall 3 credits
M. Wu
Letter grade only. Pre-or co-requisite: MATH 2930, 2 semesters of core biology major classes and the investigative lab or BIOG 1445. Lec T R 10:10-11:25.

Focuses on the integration of biological principles with engineering, math and physical principles. Students learn how to formulate equations for biological systems in class and practice in homework sets. Topics range from molecular principles of reaction kinetics and molecular binding events to macroscopic applications such as energy and mass balances of bioprocessing and engineering design of implantable sensors. Students will also experience scientific literature searches as related to the biological engineering topics, and critical analysis and evaluation of relevant information sources. BEE students must complete either BEE 2510 or BEE 2600 according to their academic plan. BEE students who complete both BEE 2510 and BEE 2600 receive engineering credit for only one of these courses.

3299 Sustainable Development
Spring, Summer 3 credits
M. F. Walter
S/U or Letter grade. Prerequisite: at least sophomore standing. Course is web based.

Sustainable development is the dominant economic, environmental and social issue of the 21st century. This course develops the concepts of sustainable development as an evolutionary process, demanding the integration of the physical sciences and engineering with the biological and social sciences for design of systems. Topics include the nature of ecosystems, global processes, sustainable communities, and industrial ecology, renewable energy and life cycle analysis.

3310 Bio-Fluid Mechanics
Fall, Summer 4 credits
K. G. Gebremedhin
Letter grade only. Prerequisites: ENGRD 2020 and Engineering math sequence. Lec M W F 10:10-11:00, Disc R 2:55-3:45; two evening prelims and a final exam.

Properties of Newtonian and non-Newtonian fluids; hydrostatic and dynamic forces; principles of continuity, conservations of mass, energy and momentum and their applications; laminar and turbulent flows and boundary layer, introduction to Navier Stokes; dimensional analysis and similarity; blood flow in the cardiovascular system; gas exchange in the pulmonary system; blood flow and sodium transport in the kidney. The major concepts are covered by case studies.

3500 Biological and Bioenvironmental Transport Processes
Fall, Summer 3 credits
A. K. Datta
Letter grade only. Pre- or co-requisites: MATH 2930 and fluid mechanics course. Lec M W F 11:15-12:05; Disc W 1:25-2:15, two evening prelims.

Focuses on understanding the principles of heat and mass transfer in the context of biological (biomedical/bioprocessing/bioenvironmental) systems. Emphasizes physical understanding of transport processes and simple reaction rates with application examples from plant, animal and human biology, in the bioenvironment (soil/water/air), and industrial processing of food and biomaterials.

3600 Molecular and Cellular Bioengineering (BME 3600)
Spring 3 credits
J. C. March
Letter grade only. Prerequisites: BEE 2600, biochemistry, linear algebra, ordinary differential equations, or permission of instructor. Lec T R 2:55-4:10

Biotechnology viewed at the cellular and molecular level. Advances in biotechnology will be broken down to their functional parts using the tools of biological engineering (thermodynamics, transport, kinetics, etc.) to understand how and why they work with an emphasis on design. Particular attention paid to gene therapy, synthetic biology, protein engineering and nucleic acid engineering. Case studies in biomedical, bioprocess, and bioenvironmental engineering.

3650 Properties of Biological Materials
Spring 3 credits
J. A. Bartsch
Letter grade only. Satisfies the BE laboratory experience requirement. Pre- or co-requisite: ENGRD 2020. Lec T R 12:20-1:10; Lab W 2:30-4:25 or 7:30-9:25 PM.

Mechanics and structural properties of biological materials; mechanical testing of animal, plant, and food products. Laboratory exercises involve quasistatic and dynamic testing of materials and interpretation of test results. Uses experimental techniques to determine engineering properties of these materials.

3710 Physical Hydrology for Ecosystems (Offered alternate years)
Spring 3 credits
M. T. Walter
Letter grade only. Prerequisite: MATH 1920 or permission of instructor. Lec T R 9:05-9:55; Lab R 2:30-4:25.

This is an introduction to physical hydrology with an emphasis on roles and interactions between hydrological processes and ,ecological, biogeochemical, and human systems. http://www.hydrology.bee.cornell.edu/BEE371Index.htm

4010 Renewable Energy Systems
Spring 3 credits
M. B. Timmons
Letter grade only. Prerequisite: BEE 2220 or ENGRD 2210, or BEE 3310 or CEE 3310. Lec T R 10:10-11:25.

Introduces energy systems with emphasis on quantifying costs and designing/optimizing renewable energy systems to convert environmental inputs into useful forms of energy. Covers solar energy, small scale hydropower, wind, house energy balances, and psychrometric principles as applied to biomass drying. Focuses on the technologies and small-scale system design, not policy issues. Use of spreadsheets is extensive. Personal laptop computers are required for each class. Class time is often focused on solving weekly homework problems. Required term project that student selects a client and develops a project proposal on a self-selected renewable energy project.

4270 Water Measurement and Analysis Methods
Fall 3 credits
L. D. Geohring, T. S. Steenhuis
Letter grade only. Satisfies BE and EnvE laboratory experience requirement. Prerequisites: CEE 3310 or hydrology course. Lec T 9:05-9:55; Lab T 1:25-4:25.

Get wet and muddy learning how to monitor and characterize water and soil management problems in the natural environment. This is a field based lab course that integrates science and engineering technologies, using various measurement equipment and analytical techniques to quantify water flow and quality parameters in surface and subsurface environments. Measurement accuracy, water sampling quality assurance protocols, and interpretation of watershed contaminants are addressed.

4350 Principles of Aquaculture
Spring 3 credits
M. B. Timmons
Letter grade only. Prerequisite: at least junior standing and one semester of physics and chemistry. No-one is allowed to add the course after the 2nd lecture. Two required field trips require class to return to campus at approximately 7 p.m. Lectures are web based with required reading from course text, “Recirculating Aquaculture”, Timmons and Ebeling (3rd Ed., 2013, Ithaca Publishing Company, LLC. Ithaca, NY). Course is intended for those considering a career in aquaculture or closely related field. Lec W 2:55-4:10

An in-depth treatment of the principles of aquacultural engineering: mass balances, waste treatment design, gas conditioning, production economics, & system design. Some coverage of fish processing, nutrition and fish health in context of global and local demand is presented, all in the context of engineering analysis and design. Course intended to build upon previous coursework. Course includes "hands on" fish cutting lab and weekly audio-tutorial lectures.

4500 Bioinstrumentation
Spring 3-4 credits
D. J. Aneshansley
Letter grade only. Satisfies both BE laboratory experience and BE capstone design requirement, if taken for 4 credits. Prerequisites: MATH 2940, introductory computing, two semesters of physics, statistics, or permission of instructor. Lec T R 8:40-9:55; Lab: M W F 2:30-4:25.

Bioinstrumentation applications are emphasized in this laboratory-based course. Electronic instruments from sensor to computer are considered. Static and dynamic characteristics of components and systems are examined theoretically and empirically. General analog and digital signal condition circuits are designed, constructed, and tested. A variety of biological applications of instrumentation are discussed. Without capstone design 3 credits, with capstone design 4 credits. Priority given to students taking capstone design.

4530 Computer-Aided Engineering: Applications to Biomedical Processes (MAE 4530)
Spring 3 credits
A. K. Datta
Letter grade only. Satisfies BE capstone design requirement. Satisfies College of Engineering technical writing requirement. Prerequisite: heat and mass transfer (BEE 3500 or equivalent). Lec M W F 10:10-11:00.

Introduction to simulation-based design as an alternative to prototype-based design; analysis and optimization of complex real-life processes for design and research, using industry-standard physics-based computational software. Emphasis is on problem formulation, starting from a real process and developing its computer model. Covers biomedical processes in thermal therapy and drug delivery that involve heat transfer, mass transfer and fluid flow. Computational topics introduce the finite-element method, pre-and post-processing, and pitfalls of using computational software. Students choose their own semester-long biomedical project, which is the major part of the course (no final exam).

4550 Biologically Inspired Microsystems Engineering
Fall 2-3 credits
M. Wu
Letter grade only. Satisfies BE laboratory experience requirement when taken for 3 credits. Prerequisites: one year of biology, BEE 2220 or an equivalent thermodynamics course, or co-registration in BEE 3500 or permission of instructor. Lec W F 8:40-9:55. Lab M 1:25-4:25.

Covers fundamental mechanisms that nature uses to build and control living systems at micro- and nano-meter length scales; engineering principles for fabricating micro/nano-meter scale devices; examples of solving contemporary problems in health sector and environment. The lab sessions will provide students with hands on experiences in cell culture, microfluidic device and live cell imaging techniques. Meets concurrently with BEE 6550.

4590 Biosensors and Bioanalytical Techniques
Fall 3 credits
K. A. Edwards
Letter grade only. Satisfies BE capstone design requirement. Satisfies College of Engineering technical writing requirement. Prerequisites: biochemistry course and permission of instructor. Lec T R 1:25-2:40.

Provides students with an understanding of the scientific and engineering principles of biosensors and bioanalytical techniques. Addresses selected topics from simple home-pregnancy-style tests to nanofabricated lab-on-a-chip devices. Biosensor and lab-on-a-chip device applications in environmental analysis, food safety, and medical diagnostic are explored. The class is designed to be highly interactive, seeks student participation via frequent discussion sessions. Students also give oral presentations, practice in-depth literature source evaluations analyze biosensors published in literature and theoretically design a biosensor based on criteria discussed in class. Students work together in teams of two to three.

4600 Deterministic and Stochastic Modeling in Biological Engineering
Fall 3 credits
J. C. March
S/U or Letter grade. Satisfies BE capstone design requirement. Prerequisites: MATLAB, MATH 2930, MATH 2940, BEE 3500 or equivalent, Mass and Energy Balances, or permission of instructor. Lec T R 10:10-11:25.

This course covers modeling biological systems from an engineering standpoint. Starting with deterministic approaches, the class will functionally decompose and mathematically model systems important to biological engineers (including bioprocessing, biomedicine, and microbial ecology). Mechanistic aspects of biology will be handled using stochastic (probabilistic) approaches in the second half of the semester.

4640 Bioseparation Processes (Offered alternate years)
Fall 3 credits
J. B. Hunter
S/U or Letter grade. Prerequisites: introductory biochemistry, physics, calculus, BEE 2600 or equivalent, or permission of instructor. Lec M W F 12:20-1:10.

Separation methods used in the biotechnology industry, governing principles and applications, and scale-up. Key topics (centrifugation, filtration, extraction, membrane methods, chromatography) supplemented with student presentations.

4710 Introduction to Groundwater (EAS 4710) (Offered alternate years)
Spring 3 credits
T. S. Steenhuis, L.M. Cathles, M. T. Walter,
S/U or Letter grade. Prerequisites: fluid mechanics or hydrology course. Lec F 1:25-4:25, Field Trip.

Fresh water is a limited resource that is under pressure worldwide because of increasing populations and a changing climate. Water in general and groundwater in specific is an important source of drinking water that we need to conserve for future generations. In this course, you will learn how to apply theory of groundwater flow and contaminant transport to real world groundwater pollution problems, simplifying the problem in such a way that it is easily solvable. The focus of many hydrology courses is theory, and deriving analytical equations. This is not the case in Introduction to groundwater. Although the theory is important, a good engineer knows the answer to a problem beforehand and then finds ways to calculate the solution. We will practice this by putting conceptual, analytical and simulation models in the broader context of past, current, and potential future groundwater quantity and quality issues triggered by natural, human, or combined actions. This elective course is intended for seniors and graduate students interested in environmental processes, and essential for those wanting to learn how to use their knowledge to solve real world problems.

4730 Watershed Engineering
Fall 4 credits
M. T. Walter
Letter grade only. Satisfies BE and EnvE capstone design requirement. Satisfies College of Engineering technical writing requirement. Prerequisite: CEE 3310 or hydrology course. Lec T R 10:10-11:00; Disc R 1:25-4:25.

This course teaches basic design and analysis as practiced for water control and nonpoint source pollution prevention. We will discuss the origins of design approaches including their theoretical bases but this is not a theory course. Most of the course is dedicated to practicing applied design. Assignments are generally representative of real-life engineering problems and will involve as much hands-on experience as possible. Some example topics include risk analysis, water conveyance, nonpoint source pollution control, stream restoration, stormwater management, and erosion control.

4740 Water and Landscape Engineering Applications
Spring 3 credits
L. D. Geohring, T. S. Steenhuis
Letter grade only. Satisfies BE and EnvE capstone design requirement. Prerequisites: CEE 3310 or hydrology course or permission of instructor. Lec M W F 12:20-1:10.

This course will focus on how water moves in soil and the implications for design of drainage and irrigation systems in the landscape. The course addresses aspects of soil physics, flow in porous media, water quality and water supply or disposal in regard to drainage and irrigation applications. Emphasis is on problem solving of actual situations, and a major site-design project is required.

4750 Environmental Systems Analysis
Fall 3 credits
D. A. Haith
Letter grade only. Prerequisites: BEE 2510 or BEE 2600 or permission of instructor. Lec T R 11:40-12:55.

Applications of mathematical modeling, simulation, and optimization to environmental-quality management. Fate and transport models for contaminants in air, water, and soil. Optimization methods (search techniques, linear programming) to evaluate alternatives for solid-waste management and water and air pollution control. Introduction to hydrologic simulation (runoff and streamflow). Software packages for watershed analyses of point and nonpoint source water pollution.

4760 Solid Waste Engineering
Spring 3 credits
D. A. Haith
Letter grade only. Prerequisites: BEE 3500 or CEE 3510 or permission of instructor. Lec T R 11:40-12:55.

Planning and design of processes and facilities for management of municipal solid wastes. Source characterization and reduction; collection and transport systems; waste-to-energy combustion; sanitary landfills; composting; recycling and materials recovery facilities; and hazardous waste management. Emphasizes quantitative analyses.

4800 Our Changing Atmosphere: Global Change and Atmospheric Chemistry (EAS 4800)
Fall 3 credits
P. G. Hess
S/U or letter grade. Prerequisites: CHEM 2070 or 2090, MATH 1920, PHYS 1112 or equivalent, or permission of instructor. Lec T R 1:25-2:40.

This course investigates the science behind changes in our atmospheres composition and its relation to global change. We will examine the chemistry and physics that determines atmospheric composition on global scales, including the effects of biogeochemistry and atmospheric photochemistry.

4810 LRFD-Based Engineering of Wood Structures (CEE 4810)
Spring 3 credits
K. G. Gebremedhin
Letter grade only. Satisfies BE capstone design requirement when co-registered in BEE 4960. Prerequisite: ENGRD 2020. Lec M W F 12:20-1:10 (Hollister Hall), two evening prelims and a final exam.

Computer-aided and manual computation procedures of Load and Resistance Factor Design (LRFD)-based engineering of wood structures. National design codes and standards; estimation of factored design loads and load combinations; mechanical properties of wood and wood products; designs of beams, columns, trusses, frames, arches, bridges, diaphragms, connections, and wood structural systems. Also discussion engineering design as an integral component of the quantitative design procedure.

4860 Industrial Ecology of Agriculturally Based Bioindustries
Spring 3 credits
L. P. Walker
Letter grade only. Prerequisites: one year of calculus, some knowledge of MATLAB. Lec T R 1:25-2:40.

Agricultural-based biofuels and bioproducts systems are very complex and highly integrated. Each of these subsystems are composed of a number of biological, chemical, and physical processes that can be interconnected to a multitude of ways to generate the essential material and energy flows for the production of biofuels and bioproducts. For this course an input/output modeling methodology is employed to develop and manipulate the structure of complex agriculturally-based bio-industries and to generate the material, energy and monetary flows. Students will use linear algebra and state space tools in the MATLAB toolbox to simulate static and dynamic behavior of these complex webs of connected processes and to conduct lifecycle analysis of these complex webs.

[4870 Sustainable Bioenergy Systems
Fall 3 credits
L. Angenent
Letter grade only. Satisfies BE and EnvE capstone design requirement. Intended for upper-level undergraduates and graduate students. Prerequisites: BEE 2220 or an equivalent thermodynamics course. Lec T R 9:05-9:55; Lab W 1:25-4:25. Next offered 2015/2016.

Offers a systems approach to understanding renewable bioenergy systems (biomass) and their conversion processes, from various aspects of biology, engineering, environmental impacts, economics, and sustainable development. A large part of the course will deepen your understanding of bioprocessing with undefined mixed cultures of microbes.]

[4880 Applied Modeling and Simulation for Renewable Energy Systems
Spring 3 credits
C. L. Anderson
Letter grade only. Prerequisite: senior in engineering, graduate standing or permission of instructor. Lec M W 10:10–11:25. Next offered 2015/2016.

This course will provide an applied introduction to modeling, simulation and optimization techniques for various renewable energy systems. The course will be modular in nature. Each module will focus on a particular renewable energy application and relevant modeling/simulation tools. Some modules are independent and some will build on previous modules. The instructional format of the course will include lectures, scientific paper reviews, and some MATLAB™ programming. Students will have an opportunity to apply new techniques to a relevant modeling project. The course will culminate with a modeling project relevant to renewable energy. Undergraduates will work in teams of 2-3 students to complete the team project. Meets concurrently with BEE 6880.]

4890 Entrepreneurial Management for Engineers
Fall 4 credits
M. B. Timmons
Letter grade only. Satisfies College of Engineering technical writing requirement. Prerequisite: junior standing or higher. No one is allowed to add the course after 2nd week. Lecture M W 2:30-3:20 and 3:35-4:25.

The course focuses on how to start a new company centered on engineering or biological technologies. Course objectives include coverage of: entrepreneurship principles, fund raising, negotiation, financial calculations (internal rate of return, time value of money, proforma statements); legal structures of businesses; project management; and technical writing and communication. Majority of work done in teams including a complete business plan that is presented to angel investors. Business plans should represent an opportunity one member of the group is willing to pursue upon leaving Cornell. Intention is to make the team project as real-world as possible, meaning that the Phase I start up funds are < $100,000. The Wednesday lab time is devoted to working on business plan components. The engineering economics coverage is in the context of entrepreneurship but covers all topics that are included in the Fundamentals of Engineering Exam (FE), which is the first step towards professional licensing. The overall goal of the course is to move the student towards being prepared to function in a professional work world.

4940 Special Topics in Biological and Environmental Engineering
Fall, Spring 4 credits maximum
Staff
S/U or Letter grade.

The department teaches “trial” courses under this number. Offerings vary by semester and will be advertised by the department. Courses offered under this number will be approved by the department curriculum committee and the same course will not be offered twice under this number. Each 4940 has a unique course ID for enrollment.

[4940 Terrestrial Hydrology in a Changing Climate (offered alternate years)
Spring 3 credits
P. G. Hess, M. T. Walter
S-U or Letter grade. Prerequisite: one hydrology course (e.g., BEE 3710) or climate course (e.g., EAS 3050) at the 2000 level or higher. Lec T R 11:40-12:55. Next offered 2016-2017.

Explore the impact of climate change on hydrology and the resulting impacts and uncertainty in future water management practices. Course activities will include lectures, seminars, readings, and student lead presentations, discussions and project related to climate change and hydrology.]

[4940 Cross Scales Biogeochemical Modeling (EAS 4940)
Spring 3 credits
P. G. Hess, N. Mahowald, L. Derry
S-U or Letter grade. Prerequisite: graduate student standing; undergraduate junior or senior with math 2930 and physics 1112; or permission of instructor. Lec T R, 10:10-11:25. Next offered 2015-2016.

The course will teach the basic principles of biogeochemical modeling from the process level to the global earth system and will include hands-on computer programming.]

4940 Design and Analysis of Biomaterials
Fall 3 credits
M. Ma
Letter grade only. Prerequisite: thermodynamics. Pre or co-req: mass transport. Lec T R 8:40-9:55

Covers the analysis of different types of biomaterials, synthetic or bio-derived, their synthesis, characterization and applications. The fundamental understanding of biomaterials chemistry and physics at the molecular level is emphasized. Mathematical analysis towards rational design of biomaterials is used throughout the course. In addition, examples from forefront biomaterials research will be used for case studies.

4940 Surface Chemistry of Particles in Natural and Engineered Processes
Spring 3-4 credits
L. Aristilde
Letter grade only. Prerequisite: CSS 3650 or EAS 3030 (for undergrads only). Lec: M W 1:25-2:40, discussion on Tuesday. 3 credits for undergrads and 4 credits for grad students. Graduate students will attend a weekly discussion section on Tuesdays (to be scheduled).

Natural particles such as clay minerals, mineral oxides, and organo-mineral composites facilitate the cycling of elements in the environment, transport and degradation of contaminants, and physico-chemical processes in environmental and chemical engineering. This course will cover the surface chemistry of these particles relevant to their role in these natural and engineered processes. The applications of chemical kinetics, chemical equilibrium, and molecular spectroscopy in particle characterization will be discussed.

4960 Capstone Design in Biological and Environmental Engineering
Spring 1 credit
K. G. Gebremedhin
Letter grade only. Co-requisite: Students must co-register in BEE 4810.

Involves capstone design experience, including a team project incorporating analysis, design, evaluation, synthesis, and a written and oral report of the end-product.

4970 Individual Study in Biological and Environmental Engineering
Fall, Spring 1-4 Credits
Staff
Letter grade only. Prerequisites: written permission of instructor and adequate ability and training for work proposed; normally reserved for seniors in upper two-fifths of their class. Students from all colleges must register with an Independent Study Form (available on line at: https://dust.cals.cornell.edu/IndStudyPolicy.aspx).

Special work in any area of biological and environmental engineering on problems under investigation by the department or of special interest to the student, provided, in the latter case, that adequate facilities can be obtained.

4971 Engineers Without Borders Independent Study
Fall, Spring 1-4 credits
M. F. Walter
S/U or letter grade. Prerequisite: students need to be members of Engineers Without Borders. Students from all colleges must register with an Independent Study Form (available on line at: https://dust.cals.cornell.edu/IndStudyPolicy.aspx).

The course content must relate directly to goals of Engineers Without Borders (EWB) and can be taken for 1

to 4 credits under supervision of a College of Engineering faculty member with approval of the EWB faculty advisor (Currently M.F. Walter). Internships can consist of on- or off-campus research or work experiences. The independent study should be purposeful, provide opportunities for reflection, present a continual challenge to the student, and incorporate active learning. The student is expected to be an active participant in all stages of the experience from planning to evaluation. Students taking this course must be members of Cornell EWB.

4980 Undergraduate Teaching
Fall, Spring 1-4 credits
Staff
Letter grade only. Prerequisite: written permission of instructor. Students from all colleges must register with an Independent Study Form (available on line at: https://dust.cals.cornell.edu/IndStudyPolicy.aspx).

The student assists in teaching a biological and environmental engineering course appropriate to his/her previous training. The student meets with a discussion or laboratory section, prepares course materials, grades assignments, and regularly discusses objectives and techniques with the faculty member in charge of the course.

4990 Undergraduate Research
Fall, Spring 1-4 credits
Staff
Letter grade only. Prerequisites: normally reserved for seniors in upper two-fifths of their class; adequate training for work proposed; written permission of instructor. Students from all colleges must register with an Independent Study Form (available on line at: https://dust.cals.cornell.edu/IndStudyPolicy.aspx).

Research in any area of biological and environmental engineering on problems under investigation by the department or of special interest to the student, provided that adequate facilities can be obtained. The student must review pertinent literature, prepare a project outline, carry out an approved plan, and submit a formal final report.

4993 Honors Thesis
Fall, Spring 3 credits
Staff
Letter grade only. Students must be enrolled in BEE 4990 in the previous term and are expected to complete this course during their final term before graduation. Intended for, and open to, BEE students already accepted into the BEE honors program. Students from all colleges must register with an Independent Study Form (available on line at: https://dust.cals.cornell.edu/IndStudyPolicy.aspx).

Intended for students pursuing the research honors program in BEE. This course is the culmination of the program's honors project requirement. Students enrolled in the BEE Honors program will prepare an honors thesis based on the subject matter of a BEE 4990 project from the previous semester, under the supervision of their BEE 4990 research mentor. A preliminary draft and the final copy will be submitted according to the deadline and formatting requirements of the Honors program.

5010 Bioengineering Seminar (BME 5010)
Fall, Spring 1 credit
D. Lipson, J. Black
S/U grades only. Prerequisite: junior, senior, or graduate standing.

Students must attend and report on 10 self-selected seminars to fulfill the requirements of the course. Self-selected seminars may include topics related to bioengineering, engineering and biology or life science. Seminars offered at other universities or at national scientific meetings may be used as long as the topic is relevant.

All students must be enrolled in Blackboard. Official course registration through Cornell's system now automatically enrolls you in Blackboard. All communications about the course and its requirements will be sent through Blackboard. Also, the final report must be downloaded and re-uploaded via Blackboard in order to receive a grade. The 10 seminars that you attend must be summarized in the final report found under "Assignments" in Blackboard. Download a copy of the form and rename the file with your name and netID. Give a 2 sentence summary of each seminar along with the date, name and affiliation of the speaker and seminar title and location. We will check for reporting on cancelled seminars. Once completed, your report should be uploaded to Blackboard under the same location in "Assignments" by the first Monday after the last day of classes. Click on the title in bold next to the book icon to find the report submission page.

REMINDER: Cornell's Code of Academic Integrity requires that you not misrepresent your attendance at these seminars (http://www.theuniversityfaculty.cornell.edu/AcadInteg/code.html).

5330 Engineering Professionalism
Spring 1 credit
M. B. Timmons, J. R. Stedinger, other Engineering Faculty
S/U or Letter grade. Prerequisite: graduate student with an accredited engineering degree or senior who will graduate with an accredited engineering degree. Four required lectures (weeks 1, 2, 3 and 11). The other weeks are Wednesday evening working sessions where a professor is present along with two TA's who work primarily one-on-one with students on the weekly homework assignments. Group interaction and teaching is encouraged. Lec W 7:30-8:45.

Course prepares the student for the general national FE Examination. FE review homework addresses FE exam preparation, and students complete a formal comprehensive review of engineering subjects associated with the Fundamentals of Engineering Exam. The NY FE exam is valid in any state and does not expire.

Students *should* sign up to take the NY Fundamental of Engineering (FE) exam held throughout the year in consecutive months starting each January & February with one month between the next pair of active months, i.e., no exams given in March, but April & May, not June, etc. Students sign up directly with the NCEES site (see www.ncees.org). Each state has Pearson testing centers (similar to GRE exam or SAT's); in NY, the closest are: 421-423 E. Main Street, Endicott, NY, and 6700 Kirkville Rd, E. Syracuse, NY. There are fees paid to NCEES and NY State associated with the registration (~$200).Once the nationally conducted FE exam is passed, it is valid forever and is valid in any state for Professional Engineering registration (requires an additional 4 years of experience under another registered engineer).

5400 Engineering Ethics and Professional Practice
Fall 3 credits
M. B Timmons, R. A. Evans
S/U or Letter grade. Prerequisite: graduate level or senior standing.

A web-based course that is an in-depth treatment of the ethical issues facing an engineer practicing in today's business and cultural environment. Course will present the engineering code of ethics and an engineer's responsibility to guard the public's health, welfare, and safety. In that context, competing ideologies will be identified that creates conflicts in choice. Several case histories will be explored to identify conflicting ideologies. Each student will be required to investigate a current case where engineer ethics are critical to the outcome of the issue/case. Students are asked to develop their own personal statement of ethics and to construct personal professional goals.

Students participate via Blackboard in weekly forums with required submissions on a bi- weekly topic including supporting arguments with references on Blackboard Class. After postings, there is a required forum discussion that includes posting of comments and arguments. There are two required 2-hour live-time chat sessions one that involves leaders in the local community and the other is a discussion of personal goals and professional development. The time slot for the live chat are to be arranged, weekly office hours and on demand.

5901-5902 M.P.S Project
Fall, Spring 1-6 credits
BEE Graduate Faculty
Letter grade only. Prerequisite: requirement of each M.P.S. candidate in the field.

Comprehensive project emphasizing the application of agricultural technology to the solution of a real problem.

5951-5952 Master of Engineering Design Project
Fall, Spring 3-6 credits
BEE Graduate Faculty
Letter grade only. Prerequisite: admission to the M.Eng. degree program.

Comprehensive engineering design projects relating to the candidate's area of specialization. Projects are supervised by BEE faculty members on an individual basis. A formal project report and oral presentation of the design project are required for completion of the course(s). A minimum of 3 to a maximum of 9 credits of 5951-5952 is required for the M.Eng. degree.

6430 Veterinary Perspectives on Pathogen Control in Animal Manure (VTMED/BIOMI 6430)
Spring 2 credits
D. D. Bowman
Letter grade only. Prerequisite: third and fourth year veterinary students. Lec M T W R 3:00-4:00, March 24-May 16.

In-depth look at the management of pathogens in animal manures. Reviews the pathogens involved, the role of governing agencies, the survival of pathogens in the field, and methods of pathogen destruction. Discusses commercial methods of manure processing for the control of these pathogens for the protection of other animals and the human population. Concludes with class discussions

with major stakeholders representing the dairy, beef, pork, and poultry industries and their understanding of the problem as it relates to veterinary students.

6550 Biologically Inspired Microsystems Engineering
Fall 2-3 credits
M. Wu
Letter grade only. Prerequisites: thermodynamics course, and permission of instructor. Lec W F 8:40-9:55. Lab M 1:25-4:25.

Covers fundamental mechanisms that nature uses to build and control living systems at micro- and nano-meter length scales; engineering principles for fabricating micro/nano-meter scale devices; examples of solving contemporary problems in health sector and environment. The lab sessions will provide students with hands on experiences in cell culture, microfluidic device and live cell imaging techniques. Graduate students will take a leadership role in the team projects (which consists of the mid-term presentation, final presentation, as well as lab). Meets concurrently with BEE 4550.

[6570 Mixed-Culture Engineered Systems: Bioenergy and Microbial Ecology (Offered alternate years)
Spring 3 credits
L. Angenent
Letter grade only. Prerequisite: graduate standing only. Lec T R 10:10-11:25. Next offered 2015/2016.

We will perform an in-depth analysis of the latest publications that describe undefined mixed cultures of microbes in engineered systems for bioenergy production. We will especially discuss different organic waste treatment options, such as anaerobic digestion, aerobic digestion, composting, bioelectrochemical systems (such as microbial fuel cells), and carboxylic-acid fermentation systems. The latest and most powerful molecular biology techniques (e.g., 16S rRNA gene surveys, metagenomics, proteomics, metatranscriptomics) will be discussed in the context of undefined mixed culture engineered systems. Some bioinformatic and microbial ecology tools will also be used in a hands-on project module. After completing this course, you should be able to critically read and evaluate scientific papers that show results obtained with molecular techniques from engineered systems. More specifically, you should be able to know the limitations of the utilized techniques and be able to give other techniques that may complement or improve the knowledge gained from the study.]

[6580 Biofuels Topics (Offered alternate years)
Spring 3 credits
L. Angenent
S/U or letter grade. Prerequisites: graduate standing. Lec T R 10:10-11:25. Next offered 2016-2017.

The specific topic changes each year, and will be chosen with the input from graduate students at the beginning of the course, but will be within the area of biofuels or bioenergy generation. This class is highly participation-oriented and each student is expected to actively participate. During each lecture we will review a single paper selected by a student and go in depth. Within the biofuels topic, we will not only discuss the research and science, but also the application and evaluation. For example, we will examine the economic analysis and the life cycle assessment. The student choosing the paper will be expected to lead the discussion after a small lecture. The others will provide a summary of each paper possibly with additional sources.]

[6740 Ecohydrology (Offered alternate years)
Spring 3 credits
M. T. Walter
Letter grade only. Prerequisite: ecology or hydrology course. Lec T R 9:05-9:55; Sec R 2:30-4:25. Next offered 2015/2016.

The objective of this course is to investigate novel topics that involve the interactions between physical hydrological processes and ecosystem processes, including the impacts of human activities on the ecohydrological system. The course is designed to encourage teams of students from historically disparate disciplines to collaboratively combine their unique skills and insights to answer multidisciplinary ecohydrological questions. This course will consider a broad range scales from a stomate and a soil pore to a forest, watershed, and region, with emphasis placed on those scales and systems most appropriate to student interests. Through course work we will clarify the current understanding of various topics, identify knowledge gaps, develop hypotheses, and test them quantitatively by creating models and analyzing available data. The goal of this course is to identify the basic principles of ecohydrology and become familiar and comfortable with a range of quantitative tools and approaches for answering ecohydrological questions.]

[6880 Applied Modeling and Simulation for Renewable Energy Systems
Spring 3 credits
C. L. Anderson
Letter grade only. Prerequisite: senior in engineering, graduate standing or permission of instructor. Lec M W 10:10-11:25. Next offered 2015/2016.

This course will provide an applied introduction to modeling, simulation and optimization techniques for various renewable energy systems. The course will be modular in nature. Each module will focus on a particular renewable energy application and relevant modeling/simulation tools. Some modules are independent and some will build on previous modules. The instructional format of the course will include lectures, scientific paper reviews, and some MATLAB™ programming. Students will have an opportunity to apply new techniques to a relevant modeling project. The course will culminate with a modeling project relevant to renewable energy. Graduate students will be required to complete the term project on an individual basis. . Meets concurrently with BEE 4880.]

6940 Graduate Special Topics in Biological and Environmental Engineering
Fall, Spring 4 credits maximum
BEE Graduate Faculty
S/U or Letter grade.

The department teaches "trial" courses under this number. Offerings vary by semester and are advertised by the department. Courses offered under this number will be approved by the department curriculum committee and the same course will not be offered twice under this number. Each 6940 has a unique course ID for enrollment.

BEE 6940 Untapped Potential: Sustainable Bioenergy Production on Marginal Lands of New York and the Northeast (new number in process for Spring 2015)
Spring 1-2 credits
B. Richards
S/U or letter grade. Open to upper-level undergraduate and graduate students. W 2:30-4:25

Marginal agricultural lands are an oft-cited but largely untapped regional resource base for bioenergy crop production. They constitute the primary available land base for production of "second generation" bioenergy crops such as perennial grasses and short-rotation woody crops in New York and the Northeast. In this broadly multidisciplinary seminar series we will explore the challenges of and opportunities for using marginal lands from multiple viewpoints: researchers, agency personnel, and bioenergy advocates.

6940 Linear Programming Applications in Energy and the Environment
Spring 2 credits
C.L. Anderson, M.G. Martinez
Letter grade only. Graduate standing or permission of instructor. No previous programming experience is assumed Lec T R 10:10-11:25.

This is an introductory course on linear programming with emphasis on modeling and analysis of linear optimization problems. This course includes an introduction to linear programming modeling, duality and post-optimization analysis including sensitivity analysis, worst-case and Monte Carlo approaches. Students will learn how to formulate and solve linear optimization problems using YALMIP toolbox for MATLAB™. Linear programming can be applied to various fields of study, in this course we will cover several examples of applications of linear programming in engineering.

After completion of this course students should be able to set up linear optimization models, implement and solve linear optimization problems using YALMIP, and analyze the optimal solution.

6970 Graduate Individual Study in Biological and Environmental Engineering
Fall, Spring 1-6 credits
BEE Graduate Faculty
S/U or Letter grade. Prerequisite: permission of instructor.

Topics are arranged by faculty at the beginning of the semester.

7000 Orientation to Graduate Study
Fall 1 credit
J. C. March
S/U grade only. Prerequisite: new graduate students in BEE. Lec first 7 weeks, M 10:10-11:00.

Introduction to BEE research policy, programs, methodology, resources, and degree candidates' responsibilities.

7540 Water Management in an Era of Growing Water Scarcity (IARD 7540)
Spring 2-3 credits
T. S. Steenhuis, G. Holst-Warhaft, et al.
S/U or Letter grade. Prerequisite: graduate standing or permission of instructors. Lec R 2:40-4:25.

Scarcity of water might be well overtake climate change as the main issue limiting future development. In fact in many water-short areas in the world, such as the Mediterranean, much of Sub-Saharan Africa, and India, it is already a main cause of the prevailing poverty. Management of water in water scarce regions demands tradeoffs between a wide range of goals: preservation or enhancement of the environment, enhancement of social equity, preservation of cultural identity, and economically efficient utilization of water. Water management also requires consideration of a wide range of factors, some physical other socio/cultural, economic, legal, and political. The end result is seldom perfect since the goals are often are in conflict with one another.

A principal goal of this course is to identify the specific factors that should be considered in the management of water in different situations and to explore the areas where trade-offs in achieving these goals must be made. The context of this course will be the issues facing the following water-scarce regions: the Mediterranean, the Nile basin and India, and the South-West of the United States with an emphasis on the largest water user - irrigation for food production. This will include discussion of related issues such a land acquisition for food production and virtual water use throughout the world. Students that take this course for 3 credits will be required to submit an extra paper/project.

7600 Nucleic Acid Engineering (BME 7600)
Spring 3 credits
D. Luo
S/U or Letter grade. Prerequisite: graduate standing, seniors by permission of instructor. Lec T R 2:55-4:10.

Nucleic acid engineering focuses on manipulating nucleic acid molecules in a true engineering sense as well as in the "genetic engineering" sense by treating nucleic acids (including DNA and RNA,) as both genetic and generic materials. Both biomedical and non-biomedical applications of nucleic acid engineering, including tool kits for nucleic acid engineering and current examples of DNA-based engineering, DNA nanotechnolgy, and DNA-based medicine are introduced. Efficient and effective literature reading and evaluation are emphasized. Student presentations are required and frequent. The class also has a project design.

7710 Soil & Water Engineering Seminar
Fall, Spring 1 credit
T. S. Steenhuis, M. F. Walter, M. T. Walter.
S/U or letter grade. Prerequisite: graduate standing or permission of instructor. Lec M 3:30-4:25.

Study and discussion of research or design procedures related to selected topics in watershed management, erosion control, hydrology, colloid transport, and water quality.

8900 Master's-Level Thesis Research
Fall, Spring 1-15 credits
BEE Graduate Faculty
S/U grade only. Prerequisite: permission of advisor. Variable credit for M.S. research.

9900 Doctoral-Level Thesis Research
Fall, Spring 1-15 credits
BEE Graduate Faculty
S/U grade only. Prerequisite: permission of advisor. Variable credit for Ph.D. research.

BEE FACULTY AND INSTRUCTORS

BETH A. AHNER, 104 Riley-Robb Hall, 607.255.2270, baa7@cornell.edu

In general, my research in environmental biotechnology explores how organisms adapt to environmental stress and how organisms can be harnessed to produce raw materials in a sustainable manner. I am particularly interested in trace metal stress in the environment– for example how plants solubilize, take up, detoxify and sequester toxic or nutrient metals. My laboratory group focuses on research questions involving intracellular detoxification mechanisms and how biological processes affect the biogeochemical cycling of metals in the natural environment and in engineered systems. One application of this research is to phytoremediation, the use of plants to remove metals from contaminated soils. I am also working in the area of biofuels both through biomolecular farming or the production of specialty enzymes and proteins in transgenic plants and algae and through projects that specifically focus on algae biomass as a biofuel source.

LOUIS D. ALBRIGHT, 425 Riley-Robb Hall, 607.255.2483, lda1@cornell.edu

My interests concern environmental control and energy management in agricultural buildings, particularly commercial greenhouses. Recent emphasis has been on energy conservation, microclimate, and computer control of Controlled Environment Agriculture (CEA) facilities for vegetable production in cold and cloudy climates. Development of fault-detection methods, and a systems approach to greenhouse production, are related concerns also part of the research effort. Mathematical modeling of the thermal environment of greenhouses and animal housing continues to be of interest as is the use of energy-efficient microclimate control to enhance the production of pharmaceuticals and other high-value chemicals from plants, both natural and genetically modified.

C. LINDSAY ANDERSON, 316 Riley-Robb Hall, 607.255.4533, cla28@cornell.edu

My research interests are in the area of systems analysis, particularly the modeling, simulation and optimization of energy systems. Much of my research deals with the interactions between market forces and environmental issues in deregulated electricity markets. Currently I am examining ways to moderate the uncertainty associated with wind energy, so that wind farms can participate more fully in the US energy markets. I am also interested in the development of a framework for the design of effective biofuels industry in North America.

Teaching

BEE 1510	Introduction to Computer Programming
BEE 4880/6880	Applied Modeling and Simulation for Renewable Energy Systems
BEE 6940	Linear Programming Applications in Energy and the Environment

DANIEL J. ANESHANSLEY, 318 Riley-Robb Hall, 607.255.3069, dja4@cornell.edu

I have always been an experimenter and have spent most of my teaching and research career experimenting with biological and electrical systems. My courses are laboratory based in which I try to share the variety of tools I have accumulated as an engineer and through associations with biologists, animal scientists, veterinarians and physicians. I have studied biological systems to see how they solve engineering problems, designed engineering interfaces to biological systems, designed and constructed nondestructive testing or inspection systems for food products and modeled biological and agricultural systems. Most of this activity is related to bioinstrumentation, but has connections to bioinspection (apples, beef, swine), biomimetics (insect defense and communication system), cellular transport (mosquito kidneys), electrophysiology (affects of electricity on dairy cows) and aspects of energy (biomass and reduced usage).

Teaching

BEE 4500	Bioinstrumentation

LARGUS ANGENENT, 226 Riley-Robb Hall, 607.255.2480, la249@cornell.edu

I am interested in converting organic materials into useful products, and have worked mainly in the area of energy generation. The members in my lab (The Angenent Lab) optimize biological anaerobic fermentation processes to foster undefined mixed cultures or pure cultures to generate the energy carriers - methane, electrical current, hydrogen, and alcohols. In this area, my lab focuses on improving the performance and stability of anaerobic digesters, on novel microbial fuel cell configurations, and on the optimization of anaerobic fermentation. When necessary, molecular biology techniques are used in conjunction with long-term bioreactor studies. We use PCR assays, hybridization assays, functional genomic approaches, and highly parallel sequencing technologies, to ascertain the biological mechanisms of substrate conversion. We are, thus, working on the interface between biology and engineering to produce bioenergy from lignocellulosic materials or industrial, agricultural, and municipal waste (water).

Teaching

BEE 4870	Sustainable Bioenergy Systems
BEE 6570	Mixed-Culture Engineered Systems: Bioenergy and Microbial Ecology
BEE 6580	Biofuels Topics

LUDMILLA ARISTILDE, 214 Riley-Robb Hall, 607.255.6845, la31@cornell.edu

The research efforts in my group are aimed towards understanding of the "why" and "how" of the environmental behavior of biologically-active organic molecules and contaminants with implications for ecosystem health. We are particularly interested in the fate and effects of emerging contaminants including pharmaceuticals, antibiotics, hormones, and natural toxins in soils and surface waters and in the reactivity and fate of important macromolecules including proteins, enzymes, and genetic fragments in soils. Our approach is to employ a combination of experimental and computational techniques to elucidate the mechanisms of the chemical and biochemical interactions relevant to the environmental chemistry and toxicology of these molecules. The long-term goal of our research is to contribute to the evaluation of the potential risk or implications of these bioactive molecules for environmental fate and exposure, ecosystem health, and environmental toxicology.

Teaching

BEE 2510	Engineering for a Sustainable Society
BEE 4940	Surface Chemistry of Particles in Natural and Engineered Processes

ANTJE J. BAEUMNER, ajb23@cornell.edu

My research focuses on the development of biosensors and bioanalytical microsystems (micro-TAS) for the detection of viable pathogenic organisms in food, the environment and in clinical diagnostic. Pathogens of interest range from *Cryptosporidium parvum* to Dengue virus to *B. anthracis*. Molecular biological recognition of the pathogenic organisms is integrated with micro- and nanofabricated devices in order to develop portable analytical systems for field use. A group of postdocs, graduate students and several undergraduate students is working on projects investigating highly specific mRNA sequences of pathogens and how to amplify their presence using molecular biological techniques, modeling and designing micromixers, developing micropotentiostats, developing novel cell lysis systems based on lasers, and combining all of this for the development of a micro-TAS. Testing the biosensors in a variety of matrices such as apple cider, environmental water samples, blood etc. is in progress for a couple of pathogen analytes. Most recently, sensor systems for the use in the Third World have become a design focus in part of the research group. Challenges such as stability of the biological systems under high temperature tolerance and simplicity of use are being addressed. Examples of analytes here include CD4+ T-lymphocytes for AIDS/HIV related diagnostics.

JAMES A. BARTSCH, 216 Riley-Robb Hall, 607.255.2800, jab35@cornell.edu

My primary interest is working with students in a teaching and advising capacity. The BEE undergraduate program and all of the people associated with it is the single most enjoyable part of my job at Cornell.

I teach a course (BEE 3650) on the engineering properties of food products and biological materials, along with two freshmen introductory courses.

My research includes work in Material Properties and Postharvest Systems Engineering for Horticultural Crops. Part of my time is devoted to outreach in the postharvest systems area and in International development and appropriate technology.

Teaching

BEE 3650	Properties of Biological Materials

ASHIM K. DATTA, 208 Riley-Robb Hall, 607.255.2482, akd1@cornell.edu

My research and teaching programs are built around the application of transport phenomena (e.g., energy and water transport, fluid flow) in biological processes in an effort to better understand their complexities. We have been active in two broad application areas industrial food processing and medicine. From a fundamental engineering standpoint, these two areas have a lot in common that become particularly evident as we approach from a transport phenomena viewpoint. In food process engineering, we develop quantitative models for complex processes such as frying and meat cooking under various heating modes (such as microwave and infrared) and their combinations, with a goal to improve their safety and quality in industrial processing. From time to time we have ongoing biomedical projects, jointly with College of Veterinary Medicine at Cornell or with Albert Einstein College of Medicine, in the areas of modeling physiological flows or drug delivery, respectively. My teaching program provides the knowledge base in transport processes-- the first course deals with the basics of energy and mass transport and the second one builds on the first one through class projects involving real-life biomedical processes.

Teaching

BEE 3500	Biological and Bioenvironmental Transport Processes
BEE 4530	Computer-aided Engineering: Applications to Biomedical Processes

KATIE A. EDWARDS, 145 Riley-Robb Hall, 607.254.6435, kae24@cornell.edu

My research is centered on the development and characterization of biosensors and bioanalytical methodologies. Techniques employed for characterization include fluorescence spectrosopy, isothermal titration calorimetry, resonant waveguide grating biosensors, and high performance liquid chromatography. These techniques are used to understand and improve the specificity and sensitivity of portable assays similar to home pregnancy tests and high-throughput assays commonly found in laboratory environments for analytes of environmental, national security, and clinical interest.

Teaching

BEE 4590	Biosensors and Bioanalytical Techniques

KIFLE G. GEBREMEDHIN, 304 Riley-Robb Hall, 607.255.2499, kgg1@cornell.edu

My current research focus areas involve: (1) thermal stress physiology of livestock; characterization of stress factors; modeling animal bioenergetics (heat and mass transfer) to determine their energy budget; engineering thermal environments for biological systems; and (2) post-frame design and construction, diaphragm action in post-frame buildings, sustainable use of wood and wood products in structural applications through testing, modeling, and development of analysis techniques to design efficient and safe structures.

Teaching

BEE 3310	Bio-Fluid Mechanics
BEE 4810	Load Resistance Factored Design (LRFD) Based Engineering of Wood Structures
BEE 4960	Capstone Design in Biological and Environmental Engineering (with BEE 4810)

LARRY D. GEOHRING, 212 Riley-Robb Hall, 607.255.2481, ldg5@cornell.edu

I joined Cornell in 1977 to coordinate an interdisciplinary project dealing with water management on agricultural and rural lands in New York State. Having a farm background and prior drainage and irrigation experience working in the Colorado River Basin, my interests in applied research and technology transfer in hydrology and soil and water management complement those of other faculty in the Department of Biological and Environmental Engineering. My engineering and construction skills have also facilitated several drainage and irrigation infrastructure improvements on various Cornell University research farms, providing experiential learning opportunities for students in engineering design classes and benefiting researchers in other Departments. Research interests include managing water quantity and quality for the benefit of agricultural production, society, and the environment; and encompass aspects of soil-water-plant relationships and the fate and transport processes of nutrients and other potential pollutants. My interests in technology transfer and teaching is in identifying, developing, applying, and facilitating natural or engineered solutions to address various soil and water resource management concerns and environmental policy issues, and in encouraging students to broaden their education and horizons to do the same.

Teaching

BEE 4270	Water Measurement and Analysis Methods
BEE 4740	Water and Landscape Engineering Applications

DOUGLAS A. HAITH, 308 Riley-Robb Hall, 607.255.2802, dah13@cornell.edu

My work is in environmental systems analysis, or the application of mathematical modeling and optimization to environmental problems. Much of my research deals with nonpoint source pollution, risk assessment, and toxicology. Current research includes watershed modeling, environmental and human health impacts of pesticides applied to turf, and climate change implications of solid waste management.

Teaching

BEE 4750	Environmental Systems Analysis
BEE 4760	Solid Waste Engineering

PETER G. HESS, 228 Riley-Robb Hall, 607.255.2495, pgh25@cornell.edu

My research is geared towards understanding how anthropogenic and natural processes affect the chemical composition of the atmosphere. The composition of the atmosphere affects air quality and the response of the climate system to global change. I am particularly interested in the coupling between atmospheric chemistry and climate and in predicting future changes. My research primarily makes use of large three dimension computer simulations of the atmosphere and its chemistry.

Teaching

BEE 4800	Our Changing Atmosphere: Global Change and Atmospheric Chemistry
BEE 4940	Cross Scales Biogeochemical Modeling
BEE 4940	Terrestrial Hydrology in a Changing Climate

JEAN B. HUNTER, 207 Riley-Robb Hall, 607.255.2297, jbh5@cornell.edu

Currently my main research interest is in the engineering design and optimization of space life support technology, particularly the food and water subsystems. Recent projects have dealt with water recovery from challenging waste streams such as ISRU condensates and water reprocessing brines, drying and stabilization of astronaut cabin waste (space trash), design and cost analysis of food systems based on bulk packaged ingredients and crops grown on planetary surfaces. I also retain an interest in the use of fermentation, enzyme technology, and bioseparation processes for manufacturing value-added products from agricultural and food processing residues.

Teaching

BEE 1200	The BEE Experience
BEE 2220	Bioengineering Thermodynamics and Kinetics
BEE 4640	Bioseparation Processes

LYNNE H. IRWIN, 422 Riley-Robb Hall, 607.255.2805, lhi1@cornell.edu

My general area of research and extension interest is low-volume, farm-to-market roads. My research focuses on the structural evaluation of roads using the falling weight deflectometer (FWD). We have developed computer programs for determining the properties of pavement layers from FWD data, along with instrumentation and software for calibrating FWDs.

In the past we have investigated ways to understand how soil stabilization improves highway materials through a study of the basic strength properties of stabilized soils. Several recent graduate student theses describe our progress in this area.

A related research interest is in the investigation of seasonal variations of pavement strength. This project is directed at understanding the impact of freeze-thaw and other environmental parameters on the weight of vehicles that can safely use farm-to-market roads. The FWD is used in our field research program.

In the highway drainage area I am interested in developing improved methods for runoff estimation and drainage design. I am also interested in erosion control, particularly by comparing some of the newer synthetic products with the traditional methods for erosion control.

My extension activities are directed primarily at the city and village public works officials and the town and county highway superintendents in New York State. Each year we conduct two statewide conferences on road and bridge issues, we teach 50 to 60 one-day workshops around the state, and periodically I speak at meetings of local associations of highway officials.

DAN LUO, 211 Riley-Robb Hall, 607.255.8193, dl79@cornell.edu

My general research and teaching interests focus on bioengineering at the molecular and cellular level. In particular, my group has been engaged in engineering nucleic acids including DNA and RNA. In addition to the critical role nucleic acids play in living organisms as the carriers of genetic information, nucleic acid can also be employed as a generic material. My group has been employing DNA/RNA as true polymers for novel, generic materials, from which we are exploring real-world applications in diagnostics, pharmaceutics, protein production, drug delivery, cell culture and optoelectronics.

Teaching

BEE 7600 Nucleic Acid Engineering

MINGLIN MA, 322 Riley-Robb Hall, 607.255.3570, mm826@cornell.edu

We are interested in using the concept of cell packaging to solve some of the toughest problems in the biomedical world. We develop novel biomaterials and engineering approaches to pack live things ranging from single cancer stem cells to multi-cellular organisms for both diagnostic and therapeutic applications. Examples of current projects in my lab are:

- development of compartmentalized microtissues for drug screening applications and drug resistance studies;
- development of immuno-invisible surfaces to improve the safety and performance of biomedical implants;
- development of cell-based therapies for incurable diseases such as type 1 diabetes and Alzheimer's disease.

I enjoying teaching and interacting with students. One class I will be teaching is Biomaterials. This course covers the analysis and design of different types of biomaterials, synthetic or bio-derived, their synthesis, characterization and applications. The fundamental understanding of biomaterials chemistry and physics at the molecular level is emphasized. Mathematical analysis towards rational design of biomaterials is used throughout the course. In addition, examples from forefront biomaterials research will be used for case studies.

Topics include:

- Molecular design fundamentals of synthetic biomaterials and their synthesis
- Characterization and analysis of both synthetic and bio-derived biomaterials
- Interactions of biomaterials with cells and living bodies
- Rational design of biomaterials for drug delivery, tissue engineering and regenerative medicine.

Teaching

BEE 4940 Design and Analysis of Biomaterials

JOHN C. MARCH, 202 Riley-Robb Hall, 607.254.5471, jcm224@cornell.edu

Work in my laboratory is focused on reconfiguring biological systems for improved performance in the areas of biomedicine and sustainability. We attempt to change bacterial or eukaryotic signal transduction to make cells that are more responsive to their environment and more efficient as technological tools. By rewiring cellular signaling circuitry, we tailor highly specific responses to a wide array of process inputs. Most of the work in our laboratory is centered in three major areas: 1) signal transduction, 2) metabolism and 3) eukaryotic-prokaryotic interactions. Into each of these disciplines we take the tools of biological engineering. While we are primarily concerned with events occurring at a subcellular level, sometimes the best solution can be found by focusing on the environment immediately around a cellular population. To that end we are working with collaborators to develop platforms that can house cells in a way that facilitates high throughput screening of various environments. Currently there are three specific areas that are of interest:

- Engineering eukaryotic cells for recombinant cell culture,
- Ingestible Microorganisms for Adjustive Gene Expression, and
- Microfluidic platforms for exploring waste product conversion.

Teaching

BEE 3600	Molecular and Cellular BioEngineering
BEE 4600	Deterministic and Stochastic Modeling in Biological Engineering
BEE 7000	Orientation to Graduate Study

GERALD E. REHKUGLER, 324 Riley-Robb Hall, 607.255.0150, ger1@cornell.edu

I am an Emeritus Professor volunteering for advising undergraduate students and enjoy providing assistance to aspiring biological and environmental engineers. I continue to be interested in design of machinery in the context of biological systems. Energy demand of the food system as a function of dietary needs also intrigues me. I also follow the impact of sustainability upon the energy supply and use. My most recent completed project was to rehab the machinery model artifacts of the Agricultural Museum of Cornell established in 1877. A History and Directory of the Cornell Agricultural Museum is currently published on line with eCornell. Currently we are planning for a historical display in Riley-Robb Hall along with illustrations of the current and future prospects for Biological and Environmental Engineering.

BRIAN K. RICHARDS, 121 Riley-Robb Hall, 607.255.2463, bkr2@cornell.edu

My primary research directions include 1) the impacts of agricultural perennial bioenergy cropping systems on soils and the environment, particularly in the context of marginal soils that are the primary land base available for expanded bioenergy production in the Northeast US, and 2) assessments of pesticide/herbicide occurrence in New York groundwater.

Teaching

BEE 6940	Untapped Potential: Sustainable Bioenergy Production on Marginal Lands of New York and the Northeast

NORMAN R. SCOTT, 324 Riley-Robb Hall, 607.255.0150, nrs5@cornell.edu

I have been involved in bioengineering research and teaching throughout my academic career. Research has focused on thermoregulation in poultry, biomechanics of machine milking of dairy cows and electronic applications in agriculture, with particular attention to automatic identification and estrus detection of livestock. A principal theme of this research is biothermal engineering for plants, animals and humans.

I have now redirected my research and teaching interests to sustainable development. I believe “sustainable development” is the dominant economic, environmental and social issue for the 21st century. To meet this challenge requires an entrepreneurship, which combines energy, environmental, industrial, and agricultural knowledge and innovation. The objective is to combine science, engineering, technology, economics, and social principles to “engineer” new ecologically sustainable communities. The concept represents the epitome of systems analysis— a challenge combining the insight from the physical sciences with those of the biological and social sciences. Characteristics of a sustainable community will be based in biologically-derived fuels, renewable energy, recycling, energy conservation, reduced transportation, managed ecosystems, advanced housing systems and sustainable agriculture.

TAMMO S. STEENHUIS, 206 Riley-Robb Hall, 607.255.2489, tss1@cornell.edu

Recently, my interest is how the hydrology, population increases (and resulting climate change) and landscape interact and how this affects the water availability and quality thought out the world. In addition, I am fascinated by the movement of nano and micron sized particles in porous media. I co-teach various courses on these two topics. I divide my time between Bahir Dar University where I am adjunct professor in Ethiopia and the Ithaca Cornell campus.

Teaching

BEE 4270	Water Measurement and Analysis Methods
BEE 4710	Introduction to Groundwater
BEE 4740	Water and Landscape Engineering Applications
BEE 7540	Water Management in an Era of Growing Water Scarcity
BEE 7710	Soil and Water Engineering Seminar

MICHAEL B. TIMMONS, 302 Riley-Robb Hall, 607.255.1630, mbt3@cornell.edu

Optimization of animal environments to maximize economic return is a primary focus of my research programs. Aquacultural engineering activities are currently being addressed with emphasis on water quality and management systems. My research focuses on the broad area of aquaculture with particular emphasis on water recycle systems. Recent research has addressed biological filtration, gas transfer processes, bi-valves used for filtration, and use of growth hormone. Species of interests include various salmonids, tilapia, oysters and clams and salt-water shrimp. An Extension program related to the above topics is also being conducted.

Emphasis on computer modeling in developing user software is being emphasized to answer a producer's questions of, "what if ...", i.e., the economic ramifications of a change in management.

Named by President and Board of Trustees in 2000 as a J. Thomas Clark Professor of Entrepreneurship & Personal Enterprise Program (Multi-university Program).

Teaching

BEE 4010	Renewable Energy Systems
BEE 4350	Principles of Aquaculture
BEE 4890	Entrepreneurial Management for Engineers
BEE 5330	Engineering Professionalism
BEE 5400	Engineering Ethics and Professional Practice

LARRY P. WALKER, 232 Riley-Robb Hall, 607.255.2478, lpw1@cornell.edu

The use of enzymes, microorganisms and plants as active components of industrial processes is a rapidly expanding and challenging area of study. What makes this area so fascinating is the numerous opportunities for integrating biological and engineering concepts to develop new products and processes. Many of the new developments in modern agriculture are products of this synthesis. My research activities are focused on developing processes and methods for the industrial utilization of enzymes, microorganisms, and plants. Currently, my research activities are focused in two areas: enzymatic hydrolysis of polysaccharides, and high-solids aerobic decomposition. My enzymatic research has focused on understanding the molecular mechanisms of synergism between cellulases -- the cooperative interactions of cellulases on insoluble cellulose; and how cellulose morphological features, such as pore size distribution and crystalline structure, influence the binding and catalytic activity of native enzymes and their respective catalytic (CDs) and binding domains (CBDs). My aerobic decomposition research has focused on understanding and manipulating coupled mass and energy transport mechanisms and microbial kinetics in solid-state microbial processes. In addition, I am also interested in studying changes in the microbial ecology due to changes in environmental conditions and to changes in the type and distribution of carbon sources. A relatively new area of research is the use of plants for bioremediation of sites contaminated with toxic metals. Once again, the focus is on identifying and modeling the mechanisms responsible for ion uptake and active transport in plants, and coupling this knowledge with the science of mass transport to design and manipulate plant based bioremediation systems.

Teaching

BEE 4860	Industrial Ecology of Agriculturally Based Bioindustries

MICHAEL F. WALTER, 218 Riley-Robb Hall, 607.255.3161, mfw2@cornell.edu

My program is focused primarily on international and sustainable development. I am particularly interested in working on interdisciplinary programs with my expertise in irrigation, soil and water conservation, and rural development. The nexus of water and energy is a particular interest.

Teaching

BEE 3299	Sustainable Development
BEE 4971	Engineers Without Borders Independent Study
BEE 7710	Soil and Water Engineering Seminar

M. TODD WALTER, 222 Riley-Robb Hall, 607.255.2488, mtw5@cornell.edu

My primary interests are in the linkages between hydrology and ecosystems and as such my research is generally interdisciplinary, collaborative, and broad in scope. Much of my research is focused on the transport and fate of nutrients, organisms, sediments, and other substances in the environment. My work is typically mechanistic, or physically based, and considers a wide span of spatial scales from bacteria and raindrops to watershed-wide ecohydrological processes. Two of my current focus areas are: (1) linking hydrology with biogeochemical hotspots and (2) developing nanobiotechnology to study landscape scale processes. Other interests include water quality protection, environmental fluid mechanics, cold-regions hydrology, watershed and hydro-meteorological modeling, environmental biophysics, and climate change impacts on water resources.

Teaching

BEE 3710	Physical Hydrology for Ecosystems
BEE 4710	Introduction to Groundwater
BEE 4730	Watershed Engineering
BEE 4940	Terrestrial Hydrology in a Changing Climate
BEE 6740	Ecohydrology
BEE 7710	Soil and Water Engineering Seminar

MINGMING WU, 306 Riley-Robb Hall, 607.255.9410, mw272@cornell.edu

My research and teaching interests are in the field of cellular bioengineering - an emerging field that aims at a quantitative understanding of cell functions using engineering principles and applies this understanding to develop cell-based biotechnologies. More specifically, my lab is working on a range of problems that elucidate how prokaryotic and eukaryotic cells proliferate, adhere and move in respond to physical (*e.g.* fluid flow or mechanical stress) and chemical (chemokine/growth factor gradient) cues within their microenvironment, using an integrated method of Microsystems engineering, cellular engineering, advanced imaging methods and theoretical modelling. Currently, one research project is to develop high throughput microfluidic devices to model 3D cancer cell microenvironment, to learn how physical and chemical microenvironment of cancer cells play a role in cancer cells' ability to metastasize. Cancer metastasis is a leading cause of all cancer death. This work can potentially improve current diagnostic tools for cancer patients. A second research project is to develop novel micro-scale 4D imaging techniques to track cellular dynamics, as well as to map mechanical stresses around the cells in space and time. We are using this tool to learn how mechanical environment of cancer cells influences cancer progression. A third project investigates the fluid mechanics of a living fluid – bacterial suspension. We are particularly interested in how cell-cell, cell-fluid interactions as well as chemotactic cell migration mediate the transport of cells within this new fluid. Undergraduate research has always been an integrate part my research program, as they often bring in new ideas and expand the ranges of things we do in the lab. Many of the undergraduate students in my lab have published in peer reviewed journals as a result of their work in the lab.

Teaching

BEE 2600	Principles of Biological Engineering
BEE 4550/6550	Biologically Inspired Microsystems Engineering

YOUR FACULTY ADVISOR

Each Biological Engineering student is assigned a faculty advisor. The primary role of the advisor is to guide you through your academic program and to assist with questions or problems you may have along the way. You will pre-register for each semester's classes in the middle of the previous semester using CoursEnroll. You should plan on meeting with your faculty advisor early in the pre-enrollment process to discuss your progress and course selections. Advisors do not select your courses for you and you are ultimately responsible for meeting all graduation requirements. However, we do track your progress and alert you of your progress toward graduation in each semester of the junior and senior year.

We also enjoy getting to know you and we appreciate hearing about your successes in academics and in life. We will talk with you about career plans, provide letters of recommendation and assist you with applying to graduate or professional schools if this is what you want to do next. Faculty advisors help students applying for study abroad and internships, and they provide advice as you look for summer jobs and undergraduate research. Therefore, you are encouraged to make opportunities to visit with us at times other than during the scramble of pre-enrollment.

Everyone (especially students) at Cornell is busy and juggling a number of responsibilities and activities. The following suggestions will allow you to maximize the help your advisor can offer with regard to your academics. If you follow them, you will get the most out of your relationship with your advisor.

- **Plan ahead**! Schedule routine appointments ahead of time.
- When you need to see your **Biological Engineering advisor**, use E-mail to **schedule an appointment in advance** and indicate why you wish to meet. If your advisor is unavailable or **if you are experiencing an emergency**, contact Brenda Marchewka (607.255.2173; bls19@cornell.edu) or Professor Jean Hunter (607.255.2297; jbh5@cornell.edu). They will work with you and bring your advisor into the loop as quickly as possible.
- **Be prepared to think about the big picture.** One place you will do this is in BEE 1200 in your second semester of study, where you will prepare a draft four-year course plan. Your future direction may change, but it helps both you and your advisor to see in the beginning where you think you are headed.
- **Always have a copy of your schedule** or a list of courses with you when you meet with your advisor to pre-enroll. A copy of your unofficial transcript is also helpful.
- Make a **list** of **questions and concerns** that you want to raise with your advisor before you meet so you don't forget anything important.
- **Share good news and personal accomplishments** with your advisor. This helps us get to know you and gives you another good reason to dialog with us.

If you have questions about your academic focus, if your interests shift, or if you decide to make some changes in the direction of your education, you may change faculty advisors (or even your major). To change advisors in Biological Engineering, contact Professor Jean Hunter to discuss your situation. Contact the Counseling and Advising Office in Roberts Hall at 607.255.2257 if you are seeking a new major in CALS. Contact the College of Engineering Advising Office in Olin Hall at 607.255.7414 if you are seeking to transfer to a different Engineering major. Biological Engineering Advisors are knowledgeable about other majors in both colleges, and will talk with you even if you feel you might want to change majors. Our interest is in your education and what is best for you!

ACADEMIC SUPPORT SERVICES

Having problems managing your workload or your time? Have you been sleeping more but still feel tired all the time? Having problems getting out of bed and getting motivated? Each year, many students in the College and the University find that they are having problems academically, socially, and/or personally. Deciding how you respond to these obstacles can profoundly affect your level of success at Cornell.

Cornell offers several resources to help students with their academic work. The best time to visit is as soon as you identify a problem – don't wait until it's overwhelming.

Biology Advising Center
8am-4:30pm Monday-Thursday and 8am-4pm on Friday; 216 Stimson Hall
Tel: 607.255.5233; Fax: 607.255.0470; Email: bioadvising@cornell.edu
http://biology.cornell.edu/index.php/oub-advising-services

Engineering Advising Office
8am-4:30pm Monday-Friday; 167 Olin Hall
Tel: 607.255.7414; Fax: 607.255.9297; Email: adv_engineering@cornell.edu
http://www.engineering.cornell.edu/resources/advising/index.cfm

Learning Strategies Center
8:30am-4:30pm Monday-Thursday, 8:30am-4pm Friday; 420 Computing and Communications Center (CCC)
Tel: 607.255.6310; Email: jcb13@cornell.edu
http://lsc.sas.cornell.edu/

Math Support Center
Open during Academic Year – see web site for specific hours; 256 Malott Hall
Tel: 607.255.4658; Email: mst1@cornell.edu (that fourth character is a one, not an "eye")
http://www.math.cornell.edu/Courses/FSM/
http://www.math.cornell.edu/twiki/bin/view/MSC/

Writing Workshop
8:30am-5pm Monday-Friday –see web site to schedule an appointment; 174 Rockefeller Hall
Tel: 607.255.6349; Fax: 607.255.4010; Email: thc33@cornell.edu
http://www.arts.cornell.edu/knight_institute/walkin/walkin.htm

Minority & Women's Programs in Engineering
8am-4:30pm; 146 Olin Hall
Tel: 607.255.6403; Fax: 607.255.2834; Email: dpeng@cornell.edu
http://www.engineering.cornell.edu/diversity/

Tau Beta Pi (http://www.rso.cornell.edu/tbp/tutoring.html) **and Ho-Nun-De-Kah** (http://www.rso.cornell.edu/hndk/request.html)
Both offer a match-up service for free tutoring.

Student Disability Services
(sds.cornell.edu/index.html) Tel: 607.254-4545; Email: sds_cu@cornell.edu

MENTAL WELLNESS SUPPORT

Sometimes obstacles aren't rooted in study habits but in medical or psychological problems. These range from low iron or blood sugar to depression or anxiety. For many students this is the first time they are living away from home and are responsible for their own well-being. Although many people see you each day and may genuinely care about you, no one is making sure that you are eating well, getting regular exercise, and are healthy. Indeed, it is less likely that people will recognize if you're facing some minor or major emotional problem, especially if you are living off-campus. It is important that you care for yourself, and ask for help and direction from your Resident Advisor, faculty advisor, or other campus or community office/agency.

Cornell offers mental wellness support to students through the following services, among others:

CAPS (Counseling and Psychological Services) at Gannett: Cornell University Health Services; Tel: 607.255.5155; Email: gannett@cornell.edu
http://www.gannett.cornell.edu/services/counseling/caps/index.cfm

CAPS has noted a trend that engineering students tend to wait a long time before they seek assistance. This behavior results from the belief – usually mistaken! - that the problem solving skills of engineers extend to emotional and psychological issues. Failure to seek help usually ends up putting the student in more academic and personal risk. If you are really stressed, tired all the time, having trouble getting yourself to class, not able to complete assignments on time, confused about life in general, sad, anxious, or just want someone to talk to so you can decompress, contact CAPS. Or if these issues are burdening a friend, encourage your friend to contact CAPS. Oftentimes just talking with a trained professional can help you feel better. Note: each student is limited to 12 individual counseling sessions per year, this is not long-term counseling. Informal, confidential walk-in consultations are available at sites around campus through the "Let's Talk" program:
http://www.gannett.cornell.edu/cms/services/counseling/caps/talk/index.cfm

EARS (Empathy, Assistance, and Referral Service); Tel: 607.255.3277
http://ears.dos.cornell.edu/
Free and confidential consultations with calm, understanding peer counselors who help callers and drop-in visitors explore their issues, options, and possible solutions without judging or giving advice. A great place to start if you're worried about yourself or a friend

General Medical Problems
Gannett Health Center; Tel: 607.255.5155; Email: gannett@cornell.edu
http://www.gannett.cornell.edu
If you've had a lingering health concern, please have it checked out. Even minor illnesses can detract from your overall enjoyment of 'the college experience'.

PROFESSIONAL REGISTRATION

Engineers must have a professional engineering license (obtained after passing two examinations and also having 4 years of suitable experience) to practice engineering in each state of the U.S. While not required for all Environmental Engineering jobs, licensure is important for environmental engineers because they are responsible for public safety in much of their work. Most states and communities require that a registered engineer give final approval to all plans and specifications for engineering projects. Students can take the first step towards obtaining their Professional Engineering (PE) license while still a senior at Cornell. Students are eligible during their last term to take Part A of the nationwide examination, the "Fundamentals of Engineering (FE) Examination." Successful completion earns the title "Intern Engineer" (often also called "Engineer-in-Training"). Because Part A emphasizes fundamental knowledge gained in engineering distribution courses and core courses, there is a comparative advantage in taking this exam during your last term, while this material is still relatively "fresh" in your memory. **Please be sure to have BEE notified of your exam results so we receive the feedback we need to document the success of our graduates.** Success or failure in this examination has no bearing on your academic standing at Cornell.

Students can sign up to take the Fundamental of Engineering (FE) exam held throughout the year in consecutive months starting each January & February with one month between the next pair of active months, i.e., no exams given in March, but April & May, not June, etc. Students sign up directly with the NCEES site (see www.ncees.org). Each state has Pearson testing centers (similar to GRE exam or SAT's); in NY, the closest exam sites are: 421-423 E. Main Street, Endicott, NY, and 6700 Kirkville Rd, E. Syracuse, NY. There are fees paid to both NCEES and NY State associated with the registration (total ~$200). Once the nationally conducted FE exam is passed, it is valid forever and is valid in any state for Professional Engineering registration (requires an additional 4 years of experience under another registered engineer). More details on New York licensure can be found at http://www.op.nysed.gov/prof/pels/.

Part B of the examination may be taken after four years for engineering students who have suitable engineering experience after passing Part A. Successful completion of Part B will give you the title "Professional Engineer" in the state where you took the Part B exam. With some exceptions registration in other states may usually be obtained by reciprocity rather than taking another exam.

BEE 5330, Engineering Professionalism, prepares the student for the general national FE Examination. FE review homework addresses FE exam preparation, and students complete the formal comprehensive review of engineering subjects associated with the Fundamentals of Engineering Exam.

GRADUATE EDUCATION

It's not too early to consider additional study beyond your bachelor's degree. B.S. degree holders in engineering from Cornell who have a grade point average of 2.7 are generally eligible for admission to either option of the Master of Engineering program outlined below. However, each application is evaluated individually, and BEE and CEE reserve the right to make all admission decisions. To apply visit: http://www.gradschool.cornell.edu./

MASTER OF ENGINEERING (BIOLOGICAL AND ENVIRONMENTAL ENGINEERING) PROGRAM

The Master of Engineering (MEng) degree builds on the foundation of the engineering BS degree to prepare candidates for a professional career. The program integrates technical engineering with the biological and life sciences, enabling graduates to solve technical problems on a scale ranging from molecular to whole organism to eco system depending on their interests. Graduates assume positions in production companies, consulting firms, government and agencies, and in the public service sector. The degree may also be used as a pathway to advanced study in science and engineering or professional study in business, law and medicine.

Curriculum Requirements

A total of 30 credits* is required for the master of engineering degree, and the program is usually completed in two semesters. Cornell Engineering undergraduates may apply early and be accepted into the program in their last undergraduate semester if they have 8 or fewer credits remaining in their bachelor's program. All MEng students must complete the following:

- BEE 5951-5952, Master of Engineering Design Project, 3 to 9 credits
- Biological and Environmental Engineering focus courses, 9 credits minimum
- A total of 30 credits* approved by their MEng Faculty Advisor

Students work with their graduate faculty advisor to develop their design project and complete appropriate courses in one of the following major concentrations:

- Bioenergy and Integrated Energy Systems
- Bioenvironmental Engineering
- Biological Engineering
- Bioprocess Engineering
- Ecohydrology
- Environmental Engineering
- Environmental Management (M.P.S. (A.L.S.) only)
- Food Engineering
- Industrial Biotechnology
- Nanobiotechnology
- Sustainable Systems
- Synthetic Biology

*Detailed requirements are shown on the department web site.

Applicants to the program need to apply directly to the Cornell Grad School at www.gradschool.cornell.edu/

MASTER OF SCIENCE AND PH.D. PROGRAMS

Some students pursue a research-oriented Master of Science (M.S.) program either here or elsewhere, and an increasing percentage of students continue on to the Ph.D. for careers in research, teaching, or consulting. Some students prefer to take a job immediately after receiving the B.S. and then return for graduate study a few years later. Ask your advisor, professors, or the BEE Director of Graduate Studies (Professor John March) for information about graduate study.

ACADEMIC INTEGRITY AND PLAGIARISM

Absolute integrity is expected of every Cornell student in all academic undertakings. Integrity entails a firm adherence to values most essential to an academic community, including honesty with respect to the intellectual efforts of oneself and others. Both students and faculty at Cornell assume the responsibility of maintaining and furthering these values. A Cornell student's submission of work for academic credit implies that the work is the student's own. Outside assistance should be acknowledged, and the student's academic position truthfully reported. In addition, Cornell students have the right to expect academic integrity from each of their peers. It is plagiarism for anyone to represent another person's work as his or her own. As stated in the University Code of Academic Integrity, "The maintenance of an atmosphere of academic honor . . . is the responsibility of the student and faculty. . ." To become better acquainted with academic integrity responsibilities, each student should read the Code of Academic Integrity. A copy may be obtained from the Engineering Advising Office, 167 Olin Hall, or from the Dean of the Faculty, 315 Day Hall. It is also available on the web at: http://cuinfo.cornell.edu/Academic/AIC.html with an explanation at http://www.theuniversityfaculty.cornell.edu/AcadInteg/

Gray areas sometimes exist when students study and work together. It is important that faculty state clearly what is expected, and that students understand what authorship citations an instructor expects. If you are uncertain whether a particular type of collaboration is permitted, such as lab partners using the same graph in individually prepared lab reports, it is your responsibility to clarify the matter with your instructor. Note too that the principle of academic integrity also applies to requests for homework extensions and for academic leniency in the case of missed lab sessions, classes or examinations.

FREEDOM FROM SEXUAL HARASSMENT

The well-being of the University community requires that every individual be treated with respect. Sexual harassment and sexist comments are incompatible with this goal. Unwelcome sexual advances, requests for sexual favors, or other verbal or physical contact or written communication of a sexual nature constitute sexual harassment when any of the following occurs:

1. Submission to such conduct is made either explicitly or implicitly a term or condition of employment or academic standing; or

2. Submission to or rejection of such conduct is used as the basis for employment or academic decisions affecting the individual; or

3. Such conduct has the purpose or effect of unreasonably interfering with an individual's work, academic performance, or participation in extracurricular activities; or creating an intimidating, hostile, or offensive working or learning environment.

Any student, staff employee, or faculty member who believes she/he has been victimized by sexual harassment is encouraged to promptly contact a title IX coordinator via the Office of Workforce Policy and Labor Relations at 607.254.7232 or equalopportunity@cornell.edu. Individuals may also contact the University Ombudsman at 607.255.4321 in 118 Stimson Hall, 8:30am-4:30pm Monday-Friday or other times by appointment.

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