DEPARTMENT OF BIOLOGICAL AND ENVIRONMENTAL ENGINEERING

MISSION

The mission of our undergraduate program is to educate students as engineers who use biology to solve problems and apply engineering principles to biological systems. We prepare students to drive innovation in diverse fields, including biotechnology, environment, public health, energy, food and agriculture. Upon graduation, students pursue private and public sector careers, advanced studies and professional degrees.

PROGRAM EDUCATIONAL OBJECTIVES

The Program Educational Objectives (PEOs) of the biological engineering major are to prepare graduates who, within 3-5 years of graduation:

1. Communicate effectively in a range of situations, both inside and outside of the biological engineering field.
2. Engage in lifelong learning through both the pursuit of advanced degrees in engineering and related professional fields and opportunities for professional development outside of the classroom.
3. Develop and exhibit leadership qualities in their professional engineering work.
4. Contribute to the improvement of their communities, their profession, and the world by embracing a sense of civic responsibility.
5. Demonstrate strong commitment to professional and ethical norms in all endeavors that prioritizes public health and safety and environmental protection.
6. Apply fundamental engineering skills such as experimentation, computational modeling and design to solve complex problems across diverse settings.

STUDENT OUTCOMES

Attainment of the following Student Outcomes prepares BE graduates to enter the professional practice of engineering:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
8. an ability to apply engineering skills to biological systems.

Undergraduate Program
Department of Biological and Environmental Engineering
2023-2024

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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 https://cals.cornell.edu/environmental-engineering

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: https://cals.cornell.edu/biological-environmental-engineering

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

Professor John March
Director of Undergraduate Studies
Biological & Environmental Engineering
207 Riley-Robb Hall
Cornell University
Ithaca, NY 14853-5701
Phone: 607.254-5471
E-Mail: bee-ugrad@cornell.edu

Brenda Marchewka
Student Services Coordinator
Biological & Environmental Engineering
207 Riley-Robb Hall
Cornell University
Ithaca, NY 14853-5701
Phone: 607.255.2173
E-Mail: bee-ugrad@cornell.edu

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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) http://www.abet.org. 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. Students in the joint degree program will pay state contract college tuition all four years of their program.

Program Focus

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 insure 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 a more efficient and sustainable way.

The living world is all around us and within us. The biological revolution continues and it has created a demand 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 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 and environmental engineering (BEE) programs address three great challenges facing humanity today: ensuring an adequate and safe food supply in an era of expanding world population; protecting and remediating the world's natural resources, including water, soil, air, biodiversity, and energy; and developing engineering systems that monitor, replace, or intervene in or add value to the mechanisms of living organisms. The biological engineering (BE) major has a unique focus on biological systems, including the environment, which is realized through a combination of fundamental engineering sciences, biology, engineering applications and design courses, and liberal studies.

Students interested in the BE major should have a strong aptitude for the sciences and math and an interest in the complex social issues that surround technology.

YOUR ADVENTURE IN BIOLOGICAL ENGINEERING

Students take courses in math, engineering, statistics, computing, physics, chemistry, basic and advanced biology, fundamental engineering sciences (mechanics, thermodynamics, fluid mechanics, and transport processes), plus biomaterials, bioinstrumentation, systems biology, and engineering design. Students select upper-level engineering courses in subjects that include bioprocessing, biotechnology applications, renewable energy, engineering aspects of animal and cellular physiology, soil and water management, environmental systems analysis, sustainable energy, and waste management and disposal plus technical electives from other engineering majors. Students may further strengthen their programs by completing a minor or a second engineering major. Students planning for health careers also take additional lab-based courses in chemistry and biology. Throughout the curriculum, emphasis is placed on communications and teamwork skills, and all students complete a capstone design project.

Career opportunities cover the spectrum of self-employment, private industry, public agencies, educational institutions, and graduate and professional programs in engineering and science, as well as professional fields like medicine, business, and law. In recent years, graduates have pursued careers in consulting, biotechnology, the pharmaceutical industry, biomedical engineering, management, and international development.

The living world is all around us and within us. The ongoing biological revolution has given rise to a growing demand for technical problem solvers who have studied biology, who have strong math and science skills, who can communicate effectively, and who are sensitive to the needs of people and the environment, and interested in the challenges facing society. The Biological Engineering major is designed to educate the next generation of engineers to meet these challenges.

BIOLOGICAL ENGINEERING
Sample 8-Semester Plan

Fall Semester | **Spring Semester**

Freshman Year

Fall Semester		Spring Semester	
MATH 1910, Calculus I	4	MATH 1920, Calculus II	4
CS 1112 or 1110, Intro Comp Prog	4	PHYS 1112, Mechanics	3
BIOG 1500, Bio Lab[a]	2	PHYS 1110	1
CHEM 2070 or 2090, Gen Chem	4	Intro Biology[a]	3
First Year Writing Seminar	3	ENGRI 1xxx	3
ENGRG 1050, Engineering Seminar	1	First Year Writing Seminar	3
	18		17

Sophomore Year

Fall Semester		Spring Semester	
MATH 2930, Differential Equations	4	MATH 2940, Linear Algebra	4
PHYS 2213, Electromagnetism	4	CHEM 1570, Organic Chemistry	3
Intro Bio	3	BEE 2220, Biokinetics and Thermo	3
BEE 2510 or BEE 2600, MEB[c]	3	Liberal Studies Elective	3
Liberal Studies	3	ENGRD 2020, Mech of Solids	4
	17		17

Junior Year

Fall Semester		Spring Semester	
BEE 3500, Bio & Env Trans Proc	4	Bio. Sci. Elective, upper level	3
BEE 3310, Bio-Fluid Mechanics	4	BEE 3600, Molec & Cellular Bioeng	3
BIOMG 3300, Biochemistry	4	BEE 3400, Des. & Anal. Of Biomaterials	3
CEE 3040, Uncertainty Analysis	4	BEE 4500, Bioinstrumentation	3/4
Liberal Studies Elective	3	Liberal Studies Elective	3
	19		15/16

Senior Year

Fall Semester		Spring Semester	
Biol Eng. Capstone Design	4	Biol. Eng. Focus Area Elective	3/4
Biol. Eng. Focus Area Elective	3/4	Biol. Eng. Focus Area Elective	3/4
Biol. Eng. Focus Area Elective	3/4	Advisor Approved Elective	3
Advisor Approved Elective	3	Liberal Studies Elective	3
Liberal Studies Elective	3		
	16/18		12/14

[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.

[c]Mass and Energy Balances with a biological (BEE 2600) or environmental (BEE 2510) focus.

Minimum degree credits = 128

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 2023 or later. A minimum of 128 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. 1110, 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 (BIOMG 3300 or BIOMG 3350 or BIOMG 3310+3320 (4 or 5 credits)
Advanced Biological Science (3 or 4 credits)[b]

5. **First Year Writing Seminars** 6
First Year Writing Seminars – 2 required
Engineering Technical Communications – one course required. Engineering technical communication courses are listed in the *Courses of Study*, College of Engineering section. BEE 4530, BEE 4590 (with ENGRC 4590), and BEE 4730 are approved courses.

6. **Liberal Studies** (6 courses) 18
Liberal Studies courses are listed in the *Courses of Study*, College of Engineering section.
At least six courses chosen from the 6 Groups listed below totaling minimum 18 credits; courses must come from at least three of the six groups; no more than two courses may be chosen from Group 6 (CE); at least two courses at the 2000 level or higher.
Group 1. Cultural Analysis (CA); Literature and the Arts/Literature, the Arts and Design (LA/LAD) Arts, Literature, and Culture (ALC), Social Difference (SCD)
Group 2. Historical Analysis (HA), Historical Analysis (HST)
Group 3. Knowledge, Cognition, and Moral Reasoning (KCM), Ethics and the Mind (ETM)
Group 4. Social and Behavioral Analysis (SBA), Social Sciences (SSC), Global Citizenship (GLC)
Group 5. Foreign Language (not literature courses) (FL)
Group 6. Communications in Engineering (CE)

7. **Computer Programming** 4
Intro to Computing: An Engineering and Science Perspective - (CS 1112, recommended) or A Design and Development Perspective (CS 1110)

8. **Engineering Distribution and Field Courses** (all must be taken for letter grade) 48

(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
Engineering Seminar - ENGRG 1050 (1 credit)
Engineering Distribution[c] - BEE/ENGRD 2600 (recommended) or BEE/ENGRD 2510 (3 credits)
Biological and Environmental Transport Processes - BEE 3500 (4 credits)
Fluid Mechanics - BEE 3310 (4 credits)
Thermodynamics - BEE 2220 or ENGRD 2210 or CHEME 3130 or MSE 3030 (3 or 4 credits).
Design and Analysis of Biomaterials – BEE 3400 (3 credits)
Molecular and Cellular Bio Engineering – BEE 3600 (3 credits)
Bioinstrumentation – BEE 4500 (3 or 4 credits)

DEGREE REQUIREMENTS (CONT'D)
Biological Engineering Program

Group Subject Matter **Credit Hours**

(c) Biological Engineering Focus Area Electives *15 or more credits of courses from 1 or more of the 7 focus areas (typically 5 courses)*, see pages 10-13. One of the focus area courses must include a required capstone course (BEE 4530 or BEE 4590).

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

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

TOTAL MINIMUM 128

[a]Students choose two of the following four courses: BIOMG 1350, BIOG 1440, BIOG 1445 or BIOEE 1610, plus BIOG 1500. Will need to 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, bee-ugrad@cornell.edu. One credit seminars may not be used to meet this requirement.
[c]Engineering distribution requirement is satisfied by ENGRD 2020 and ENGRD/BEE 2600 or ENGRD/BEE 2510

Focus Area Courses

To complete the curriculum, electives are chosen depending on individual interests. Electives can be chosen from any of the BE Focus Areas. Fifteen or more credits are picked from 1 or more of 7 Focus Areas. A list of Focus Area courses is continuously updated on the BE Advised website.

- Students may use a maximum of 4 credits of research, project team, teaching or independent study taken in an engineering department towards the 46 engineering credits in category 8. You must have an engineering role and be conducting engineering research; CEE 2550 does not count.
- ***One course in this category must satisfy the capstone design requirement (BEE 4530 or BEE 4590)***. Students may take both Capstone courses if desired as one focuses on physical design, the other on computational design.

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 2023 or later.

Name: ______________________________ Empl ID: ______________________
Net ID: _____________________________ Advisor: _______________________
Minor: ______________________________ Anticipated Graduation Date: ______
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 (3)	______	_____	_____
	Intro to Experimental Physics	PHYS 1110 (1)	______	_____	_____
	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	__________________________	______	_____	_____
	BIOMG 3300 (4) or 3310+3320 (5) or 3350 (4)				
	Advanced Bio Sci Elective (to complete 15 credits)	__________________________	______	_____	_____
5.	**First Year Writing Seminars:** 6 credits				
	______________________________	______________________	______	_____	_____
	______________________________	______________________	______	_____	_____

6. **Liberal Studies:** 18 credits (Minimum of six courses in at least three of the six groups; no more than two courses may be choses from the CE group; at least two of six courses at or above 2000 level.)

Cultural Analysis (CA, LA/LAD, ALC, SCD)
Historical Analysis (HA, HST)
Communications in Engineering (CE)
Knowledge, Cognition, and Moral Reasoning (KCM, ETM))
Social Behavior and Analysis (SBA, SSC, GLC)
Foreign Language (FL, not literature)

______________________________	______________________	______	_____	_____
______________________________	______________________	______	_____	_____
______________________________	______________________	______	_____	_____
______________________________	______________________	______	_____	_____
______________________________	______________________	______	_____	_____
______________________________	______________________	______	_____	_____

	Course Title and Required Credits	Course (Credits)	Semester	Credits	Grade
7.	**Computer Programming:** 4 credits				
	Intro to Computing: An Eng and Science Perspective or A Design and Development Perspective	CS 1112 or CS 1110 (4)	______	_____	_____
8.	**Engineering Distribution and Field Courses:** 48credits				
	(a) Required Courses				
	Mechanics of Solids	ENGRD 2020[a] (4)	______	_____	_____
	Engineering Statistics and Probability	ENGRD 2700 (3) or CEE 3040 (4)	______	_____	_____
	(b) Required Biological Engineering Core Courses				
	Intro to Engineering	ENGRI 1xxx (3)	______	_____	_____
	Thermodynamics	BEE 2220, ENGRD 2210, CHEME 3130 or MSE 3030 (3)	______	_____	_____
	Engineering Distribution**	BEE 2600 or BEE 2510 (3)	______	_____	_____
	Bio-Fluid Mechanics	BEE 3310 (4)	______	_____	_____
	Design and Analysis of Biomaterials	BEE 3400 (3)	______	_____	_____
	Heat and Mass Transfer in BioEng	BEE 3500 (4)	______	_____	_____
	Molecular and Cellular BioEng	BEE 3600 (3)	______	_____	_____
	Bioinstrumentation	BEE 4500 (3/4)	______	_____	_____
	(c) Biological Engineering Focus Area Electives				
	15 or more credits of courses from 1 or more of the 7 focus areas (typically 5 courses)				
	Focus Area Elective (capstone)	BEE 4530 or BEE 4590 (3/4) (one required)	______	_____	_____
	Focus Area Elective	______________________	______	_____	_____
	Focus Area Elective	______________________	______	_____	_____
	Focus Area Elective	______________________	______	_____	_____
	Focus Area Elective	______________________	______	_____	_____
9.	**Approved Electives:** 6 credits				
	______________________________	______________________	______	_____	_____
	______________________________	______________________	______	_____	_____

Minimum Credits Required: 128

_____Engineering Technical Communication Course ______________________

_____Capstone Design Course ______________________

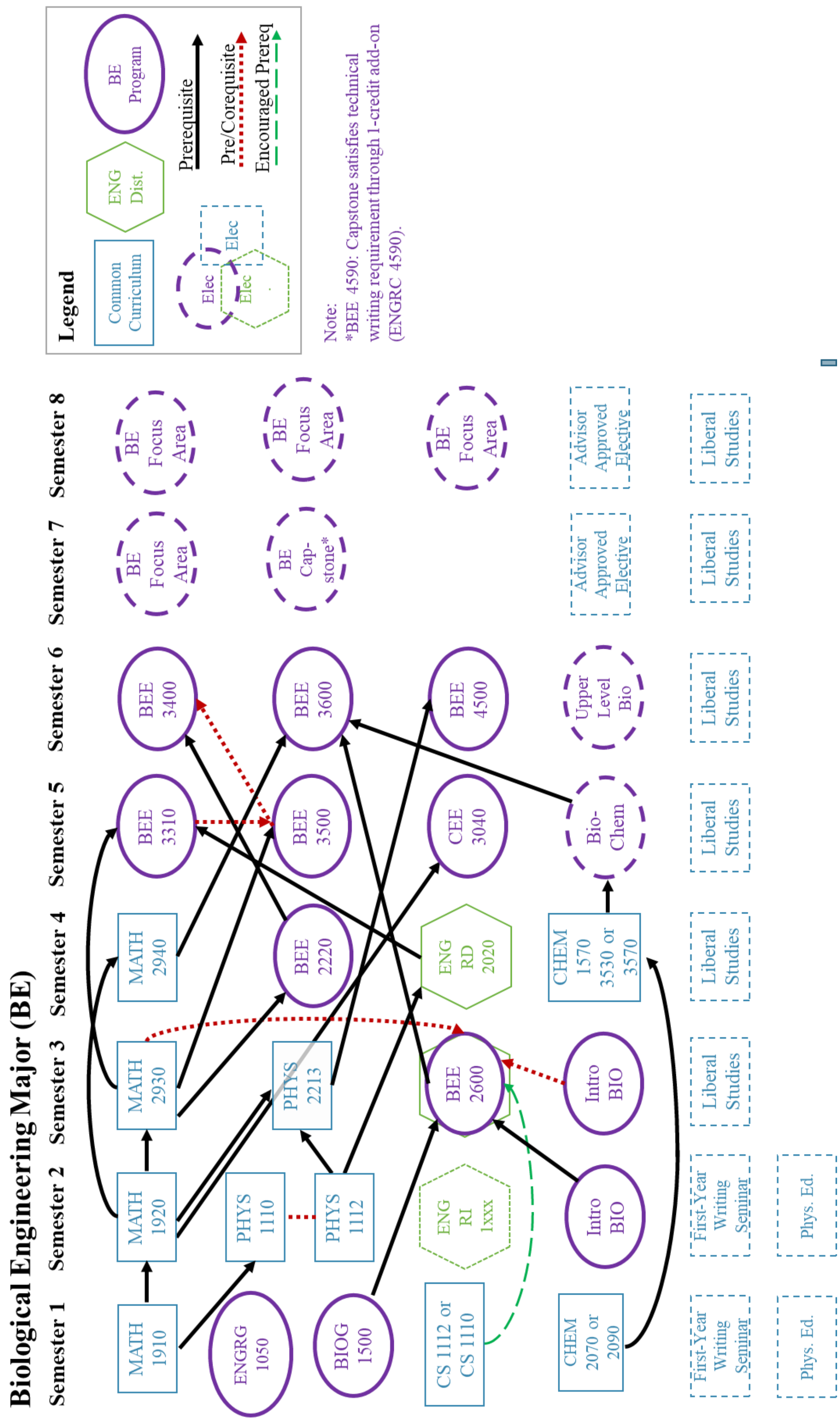
_____ENGRG 1050

_____EHS Online Lab Safety Training (#2555)

_____PE

_____PE

[a]Engineering distribution requirement is satisfied by ENGRD 2020 and ENGRD/BEE 2510 or ENGRD/BEE 2600
Only 1 D allowed in major (categories 2-4, 7 and 8).
If you receive more than 1 D, you will have to take one of the courses over.


Biological Engineering Major (BE)
Semester 1
Semester 2
Semester 3
Semester 4
Semester 5
Semester 6
Semester 7
Semester 8
MATH 1910
ENGRG 1050
BIOG 1500
CS 1112 or CS 1110
CHEM 2070 or 2090
First-Year Writing Seminar
Phys. Ed.
MATH 1920
PHYS 1110
PHYS 1112
ENG RI 1xxx
Intro BIO
First-Year Writing Seminar
Phys. Ed.
MATH 2930
PHYS 2213
BEE 2600
Intro BIO
Liberal Studies
MATH 2940
BEE 2220
ENG RD 2020
CHEM 1570 3530 or 3570
Liberal Studies
BEE 3310
BEE 3500
CEE 3040
Bio-Chem
Liberal Studies
BEE 3400
BEE 3600
BEE 4500
Upper Level Bio
Liberal Studies
BE Focus Area
BE Cap-stone*
Advisor Approved Elective
Liberal Studies
BE Focus Area
BE Focus Area
BE Focus Area
Advisor Approved Elective
Liberal Studies
Legend
Common Curriculum
ENG Dist.
BE Program
Elec
Elec
Elec
Prerequisite
Pre/Corequisite
Encouraged Prereq
Note:
*BEE 4590: Capstone satisfies technical writing requirement through 1-credit add-on (ENGRC 4590).

FOCUS AREAS WITHING THE BIOLOGICAL ENGINEERING PROGRAM

Focus Area 1: Molecular and Cellular Systems
Focus Area 2: Ecological and Microbial Systems
Focus Area 3: Nanobiotechnology
Focus Area 4: Computational Biological Engineering
Focus Area 5: Synthetic Biology
Focus Area 6: Biomaterials
Focus Area 7: Sustainability

Courses in Focus Area 1: Molecular and Cellular Systems

- BEE 4550/6550 – Biologically Inspired Microsystems Engineering
- BEE 4590/5590 – Physical Design in Biological Engineering
- BEE/ENGRC 5330 – Engineering Professionalism
- BME 3010 – Cellular Principles of Biomedical Engineering
- BME 3020 – Molecular Principles of Biomedical Engineering
- BME 4010 – Biomedical Engineering Analysis of Metabolic and Structural Systems
- BME 4910 – Principles of Neurophysiology
- BME 5110/6110 – Stem Cell Bioengineering
- BME 5700 – Biophysical Methods
- BME 6120 – Precision and Genomic Medicine
- BME 6180 – Principles of Magnetic Resonance Imaging
- BME 6320 – Modern Biomedical Microscopy
- CHEME 5430 – Bioprocess Engineering

Courses in Focus Area 2: Ecological and Microbial Systems

- BEE 4590/5590 – Physical Design in Biological Engineering
- BEE/ENGRC 5330 – Engineering Professionalism
- BEE 6740 – Ecohydrology
- BME 6320 – Modern Biomedical Microscopy
- CEE 6570 – Biological Processes
- CHEME 5430 – Bioprocess Engineering

Courses in Focus Area 3: Nanobiotechnology

- BEE 4550/6550 – Biologically Inspired Microsystems Engineering
- BEE 4590/5590 – Physical Design in Biological Engineering
- BEE/ENGRC 5330 – Engineering Professionalism
- BME 6260 – Optical Microscopy and Fluorescence Methods for Research
- BME 6320 – Modern Biomedical Microscopy
- CHEME 4840 – Microchemical and Microfludic Systems
- ECE 4320 – Integrated Micro Sensors and Actuators (MAE 4320)

- ECE 4360 – Nanofabrication and Characterization of Electronics (MSE 5410)
- ORIE 4100 – Manufacturing Systems Design: A Consulting Boot Camp

Courses in Focus Area 4: **Computational Biological Engineering**

- BEE 3900/5900 – Bio-Robotics
- BEE 3910/5910 – Advanced Biorobotics
- BEE 4530/5530 – Computer-Aided Engineering: Applications to Biomedical Processes (MAE 4530)
- BEE 4590/5590 – Physical Design in Biological Engineering
- BEE 4630/6630 – Digital Food Physics and Engineering
- BEE 4560/6560 – Ecological Mechanics
- BEE/ENGRC 5330 – Engineering Professionalism
- BME 3310 – Medical and Preclinical Imaging
- BME 3410 – Systems Mechanobiology
- BME 4390 – Circuits, Signals and Sensors: Instrumentation Laboratory
- BME 5310 – Machine Learning with Biomedical Data (ECE 5970)
- BME 6320 – Modern Biomedical Microscopy
- BME 6350 – Introduction to Neurotechnology
- CHEME 6800 – Computational Optimization (SYSEN 6800)
- CS 4220 – Numerical Analysis: Linear and Nonlinear Problems
- CS 5306 – Crowdsourcing and Human Computation
- CS 4700 – Foundations of Artificial Intelligence
- CS 4701 – Practicum in Artificial Intelligence
- CS 4775 – Computational Genetics and Genomics (BTRY 4840/6840)
- CS 4780 – Machine Learning for Intelligent Systems
- CS 4820 – Introduction to Analysis of Algorithms
- CS 4850 – Mathematical Foundations for the Information Age
- ECE 3250 – Mathematics of Signal and System Analysis
- ECE 4271 – Evolutionary Processes, Evolutionary Algorithms and Game Theory
- MAE 4700 – Finite Element Analysis for Mechanical and Aerospace Design
- ORIE 3300 – Optimization I
- ORIE 4350 – Introduction to Game Theory
- ORIE 4580 – Simulation Modeling and Analysis
- ORIE 4740 – Statistical Data Mining I
- ORIE 4741 – Learning with Big Messy Data
- ORIE 4820 – Spreadsheet-Based Modeling and Data Analysis
- SYSEN 5100 – Model Based Systems Engineering
- SYSEN 5220 – System Dynamics
- SYSEN 5740 – Design Thinking for Complex Systems

Courses in Focus Area 5: Synthetic Biology

- BEE 4550/6550 – Biologically Inspired Microsystems Engineering
- BEE 4590/5590 – Physical Design in Biological Engineering
- BEE/ENGRC 5330 – Engineering Professionalism
- BME 3110 – Cellular Systems Biology

- BME 6130 – Engineering the Microbiome
- BME 6320 – Modern Biomedical Microscopy
- CHEME 5440 – Advanced Biomolecular Engineering
- ORIE 4100 – Manufacturing Systems Design: A Consulting Boot Camp

Courses in Focus Area 6: Biomaterials

- BEE 4590/5590 – Physical Design in Biological Engineering
- BEE/ENGRC 5330 – Engineering Professionalism
- BEE 6400 – Advanced Topics in Biomaterials
- BME 5390* – Biomedical Materials and Devices for Human Body Repair
- BME 5810 – Soft Tissue Biomechanics
- BME 5830 – Cell Biomaterial Interactions
- BME 5850 – Current Practices in Tissue Engineering
- BME 6210 – Engineering Principles for Drug Delivery (CHEME 6310)
- BME 6320 – Modern Biomedical Microscopy
- CHEME 6400 – Polymeric Materials
- MSE 4610 – Biomedical Materials and Their Applications
- MSE 5210 – Properties of Solid Polymers
- MSE 5230 – Physics of Soft Materials
- MSE 5620 – Biomineralization: The Formation and Properties of Inorganic Biomaterials (BME 5620)
- ORIE 4100 – Manufacturing Systems Design: A Consulting Boot Camp

*NOTE: FSAD 4390 does not count unless taken Fall 2019 and prior, this is no longer cross-listed with BME 5390)

Courses in Focus Area 7: Sustainability

- BEE 3280/6280 – Systems and Synthetic Biology for Sustainable Energy (formerly BEE 6940)
- BEE 3299/5299 – Sustainable Development
- BEE 3710/5710 – Physical Hydrology for Ecosystems
- BEE 4270/5270 – Water Measurement and Analysis Methods
- BEE 4110/6110 – Hydrologic Engineering in a Changing Climate
- BEE 4310/6310 – Multivariate Statistics for Environmental Applications
- BEE 4590/5590 – Physical Design in Biological Engineering
- BEE 4710/6710 – Introduction to Groundwater
- BEE 4730/5730 – Watershed Engineering
- BEE 4750/5750 – Environmental Systems Analysis
- BEE/EAS 4800/6800 – Atmospheric Chemistry
- BEE/CEE 4880/6880 – Applied Modeling and Simulation for Renewable Energy Systems
- BEE/ENGRC 5330 – Engineering Professionalism
- BEE/MAE 5459 – Energy Seminar 1
- BEE/MAE 5469 – Energy Seminar II
- CEE 4210 – Renewable Energy Systems (previously BEE 4010)
- CHEME 4880 – Global Food, Energy and Water Nexus – Engage the US, China and India for Sustainability

- CHEME 6660 – Analysis of Sustainable Energy Systems
- CHEME 66XX – Modules for CHEME 6660
- MAE 5010 – Future Energy Systems
- ORIE 4100 – Manufacturing Systems Design: A Consulting Boot Camp

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 128 minimum required for graduation in BEE plus a presentation in a public scholarly research forum. These nine 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)-4. 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 or your project.

A written proposal of 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** 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.

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

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.

MINORS AND PRE-MED STUDY

Biological Engineering majors may choose to complete one or more of the minors offered in any college. There are 122 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. Students contemplating a medical career are strongly advised to consult the Health Careers Advising office, (140 Roberts Hall CALS students; 180 Rhodes Hall for ENG students) for detailed information on Pre-Medical study. The Health Careers website is: http://www.career.cornell.edu/HealthCareers/

Course Offerings

ENGRG 1050 Engineering Seminar
Fall 1 credit
J March
S/U grade only. Enrollment limited to: BEE majors or permission of instructor. Requirement for CALS BE and EnvE freshmen.

First-year engineering students meet in groups weekly with the BEE Director of Undergraduate Studies. Discussions may include the engineering curriculum and student programs, what engineers do, the character of engineering careers, active research areas in the college and in engineering in general, and study and examination skills useful for engineering students. Groups may visit campus academic, engineering, and research facilities.

ENGRI 1337 Introduction to Biological Engineering
Fall 3 credits
J. March
Letter grade only.

This course introduces first-year students to the field of Biological Engineering (BE). Students will gain an appreciation for basic theory and practice in BE, including material balances, organizing along several length scales, simple experimental design, engineering design methodology, and professional development. Organized as three modules, the course will cover BE at the meso-scale, microscale, and in abiotic (non-living) systems. Field trips to outside engineering firms will be organized to expose students to professional practice in the field.

2000 Perspectives on the Climate Change Challenge
Spring 1 credit
P. Hess
Letter grade only.
Forbidden Overlap: due to an overlap in content, students will not receive credit for both BEE 2000 and BEE 2010.

This university-wide seminar series provides critically important perspectives on the grand challenge of climate change. Speakers from Cornell University and other institutions will cover a range of topics including the science of climate change, implications for ecosystems, oceans, forests, agriculture and communities, the important ethical, philosophical and legal insights on the issue, and provide thoughts on societal responses through international mechanisms, economic drivers and communication tools. This seminar series counts towards the requirements of the climate change minor and the ESS minor and major.

2010 Perspectives on the Climate Change Challenge Discussion
Spring 3 credits
P. Hess
Forbidden Overlap: due to an overlap in content, students will not receive credit for both BEE 2000 and BEE 2010.

This course serves as a rigorous extension of the weekly seminar course, BEE 2000. BEE 2010 adds additional learning activities in and outside of an additional 75-minute class period to explore in greater depth the subject matter covered in the seminars. No specific background is assumed for students, as long as they are willing to learn across disciplines.

2220 Sustainable Engineering Thermodynamics
Spring 3 credits
J. Goldfarb
Letter grade only. Prerequisites: MATH 2930, CHEM 2070, 2090, 2150; BEE 2510 or BEE 2600.

The laws of thermodynamics are elegant statements about the conservation, nature, and behavior of energy in the universe. They are also the roadmap to designing and evaluating sustainable solutions to the world's most pressing challenges, from climate change to food insecurity to the energy crisis. After all, the problem of climate change is essentially an energy imbalance between the heat flow into and out of Earth. The goal of this course is to explore fundamental thermodynamic and kinetics concepts as they relate to key sustainability challenges. We will examine how the first and second laws of thermodynamics underpin life cycle analyses. We will use the concept of exergy to benchmark forms of energy and their potential to do work, enabling us to evaluate policies that promote sustainable solutions such as transportation fleet electrification and landfill diversion strategies. Together, we'll break down complex concepts such as Gibbs Free Energy and Chemical Potential to understand why pollutants move as mixtures in the environment and how the sea level is rising because of human activities.

2510 **Engineering Processes for Environmental Sustainability (ENGRD 2510)**
Fall 3 credits
N. Cápiro
Letter grade only. Pre-requisite: CHEM 2070, 2090 or AP CHEM. Pre- or co-requisite: MATH 2930.

Students will quantitatively understand and analyze environmental issues such as: the impact of industrial contaminants and excess nutrients on water quality; the global carbon cycle; improving global access to clean water. This course integrates principles from chemistry, biology, math and engineering to understand and solve real-world problems that impact three major environmental compartments: air, water, and soil. Students will solve mass and energy balances beginning with simple, closed systems, then progress through reactive, open systems to describe environmental fate and transport of pollutants, natural environmental cycles and remediation scenarios. Students will be exposed to technical and lay material from interdisciplinary sources to understand the environmental externalities – social, political, economic and cultural – that must be considered when proposing solutions to today's most pressing environmental issues. 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 receive engineering credit toward their degree for only one of these courses.

2600 **Principles of Biological Engineering (ENGRD 2600)**
Fall 3 credits
J. March
Letter grade only. Pre-or co-requisite: MATH 2930, 2 semesters of core biology major classes and the investigative lab or BIOG 1445.

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.

3280 **Systems and Synthetic Biology for Sustainable Energy**
Fall 3 credits
B. Barstow
S/U or Letter grade. Prerequisite: Intro bio (such as BIOG 1440), Biochem (such as BIOMG 3300), MATH 2930, and MATH 2940. Recommended prerequisites: BEE 2600 and BEE 3600 or permission of instructor. Co-meets with BEE 5280.

The world today is in a state of enormous transition. In the coming few decades, billions of people will leave poverty and enter the developed world. This unprecedented development will be one of the greatest opportunities ever presented to improve global public health and quality of life, but it will only be realized if it's done right. The challenge of sustainable energy is not just to provide energy without polluting the atmosphere with fossil carbon, but to do so at a global scale at a cost that everyone can afford. Thanks to capabilities ranging from room temperature and pressure catalysis to self-assembly, biology offers first draft solutions to problems in sustainable energy from the safe use of nuclear energy, the capture and storage of solar power, mining and purifying elements critical for sustainable energy technologies like rare earths and even in the construction of advanced materials. In each class we will discuss a set of scientific journal articles and use these discuss the advantages, disadvantages and potential of biology in applications in sustainable energy. In each of the past two years we have used these discussions to write a scientific article with students as co-authors.

3299 **Sustainable Development**
Spring 3 credits
B. Richards
S/U or Letter grade. Prerequisite: at least sophomore standing. Co-meets with BEE 5299.

Sustainable development is a predominant environmental, economic, and social concern of the 21st century. This course seeks to introduce students from across Cornell's colleges to key concepts of sustainable development and how they are integrated into life cycle analysis (LCA) assessments of sustainability. Students seeking to expand their knowledge of sustainable development through readings, videos, written assignments, and interactions with their peers are welcome to take the course. Students learn to evaluate sustainability by carrying out LCA assessments from environmental, economic, and social perspectives throughout the semester for a system/product of their choice, Over the course of the semester, work is posted on an e-portfolio to enable peer sharing and commenting. Course is solely asynchronous and web-based. Additional course information can be found at our Sustainable Development page.

3310 Bio-Fluid Mechanics
Fall 4 credits
C. Roh
Letter grade only. Prerequisites: MATH 1910, MATH 1920, MATH 2930, ENGRD 2020 and basic knowledge in complex numbers. Co-meets with BEE 5310.

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, introduction to Navier Stokes; dimensional analysis and similarity; internal and external bio-fluid examples will be covered e.g. blood circulatory systems and animal locomotion.

3400 Design and Analysis of Biomaterials
Spring 3 credits
M. Ma
Letter grade only. Prerequisite: BEE 2220. Pre or co-requisite: BEE 3500.

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.

3500 Biological and Bioenvironmental Transport Processes
Fall 4 credits
A. K. Datta
Letter grade only. Pre- or co-requisites: MATH 2930 and fluid mechanics course. Co-meets with BEE 5500.

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 with application examples from plant, animal and human biology, the bioenvironment (soil/water/air), and industrial processing of food and biomaterials..

3600 Molecular and Cellular Bioengineering
Spring 3 credits
B. Barstow
Letter grade only. Prerequisites: BEE 2600, biochemistry, linear algebra, ordinary differential equations, or permission of instructor. Knowledge of Matlab or Python really helps but is not essential. Co-meets with BEE 5600.

In this class you'll learn about mathematical models of biology that you can use to build engineered organisms. We will cover how to make back of the envelope calculations about biological systems, study the mathematics of metabolic networks for producing commodity chemicals and pharmaceuticals, learn how to approach building a new mathematical model of a biological system, and study mathematical models of gene regulation.

3710 Physical Hydrology for Ecosystems
Spring 3 credits
M. T. Walter
Letter grade only. Prerequisite: MATH 1920 or permission of instructor. Co-meets with BEE 5710.

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

3900 Bio-Robotics
Fall 3 credits
S. Jung
Letter grade only. Prerequisite: differential equations (MATH 2930). Highly recommended prerequisite: BEE 2600 or permission of instructor. Co-meets with BEE 5900.

Introduction to bio-inspired and bio-enabled robotics across scales by an interdisciplinary approach, by gradually integrating knowledge in mechanical engineering and bioengineering. The concept and basic principles of biorobotics are discussed through macroscale robots in various fields including agriculture such as fruit picking robots. Homework includes programming, literature searches, and design studies of their own biorobots.

3910 Advanced Bio-Robotics
Spring 3 credits
S. Jung
Letter or S/U. Prerequisite: BEE 3900/5900.

Follow-on course to BEE 3900/5900. Students translate materials in BEE 3900/5900 to explore bio-robotics for biological engineering applications such as fruit harvesting. Embedding robotics into biological systems (i.e. plants or animals) will be tested with soft bio-robotics. Students will translate the concept and basic principles of biorobotics into a practical robot in this course. Their designed robot will meet ASABE national robotic competition standards. Homework includes programming, literature searches, and design studies of their own biorobots. Required hands-on laboratory component.

4110 **Hydraulic Engineering in a Changing Climate (offered odd numbers years starting Fall 2025)**
Fall 3 credits
S. Steinschneider
Letter grade only. Prerequisite: CEE 3040 or ENGRD 2700, one hydrology course (BEE 3710) at the 2xxx level or higher or permission of instructor. Co-meets with BEE 6110.

This course introduces methods in hydrologic engineering to assess and cope with climate variability and change. The course will cover both statistical and physical approaches to analyzing and modeling hydrologic systems. Students will learn the core concepts of traditional statistical analysis in hydrology, and will also learn the limitations of these approaches in a changing climate. Students will become familiar with physical modeling approaches to understand hydrologic response under future climate projections and their limitations. Students will recognize the rapidly changing nature of the field of hydrologic engineering as it tries to adapt to the impacts of climate change. Topics include extreme event frequency analysis, trend detection, water balance modeling, and hydrologic simulations under projected climate change. Applications to stormwater and flood risk analyses are discussed and used as examples throughout the course.

4270 **Water Measurement and Analysis Methods**
Fall 3 credits
B. Richards, T. S. Steenhuis
Letter grade only. Satisfies EnvE laboratory experience requirement. Prerequisites: hydrology, soil or fluid mechanics course. Co meets with BEE 5270.

Managing soil and water resources requires monitoring. In this field-based lab course, you learn techniques to quantify water flow in surface and subsurface environments and monitor water quality in lakes, rivers and groundwater. Soil health considerations, measurement accuracy, and water sampling quality assurance are discussed. The final project involves designing a water quality monitoring plan for a research or industrial site.

4310 **Multivariate Statistics for Environmental Applications (offered even numbered years starting Fall 2024)**
Fall 3 credits
S. Steinschneider
Letter grade only. Prerequisite: CEE 3040 or ENGRD 2700, MATH 1920, MATH 2940, or permission of instructor. Co-meets with BEE 6310.

This class provides an introduction to relatively simple but powerful multivariate statistical techniques needed to analyze and model complex datasets frequently encountered in the environmental sciences. Emphasis is given to developing the mathematical foundation of these methods to foster a deeper understanding of their benefits and limitations. The goal is to provide students in the environmental sciences and engineering with a toolbox of methods not taught in more introductory statistical courses, but also to ensure that students can use these methods in their own work without viewing them as a "black box". The course only assumes a limited knowledge of calculus, linear algebra, and statistics, and will provide a review of the mathematical concepts needed to understand the statistical techniques presented. Applications will be presented primarily from the geophysical and ecological sciences, but the theory will be applicable to other environmental fields. Upon completion of the course, students will be able to use the multivariate techniques presented in the course to understand and evaluate environmental problems of interest in their respective domains.

4500 **Bioinstrumentation**
Spring 3-4 credits
M. Wu
Letter grade only. Prerequisite: MATH 2940, introductory computing, two semesters of physics including electromagnetism, statistics, or permission of instructor.

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. Lecture and lab only for 3 credits; lecture, lab and a design project for 4 credits.

4510 Sustainable Water Resources System Design
Spring 3 credits
S. Steinschneider
Letter grad only. Prerequisite: CEE 3040 or ENGRD 2700; or permission of instructor. Co-requisite: CEE 3230.

This course provides a capstone experience in the design of multi-objective water resources systems. The course is designed to teach the fundamentals of planning and management as practiced in water resources engineering, and to simulate interdisciplinary project teams common in industry and government. The course takes a "systems" focus, including the identification and quantification of objectives that reflect the interests of multiple stakeholder groups; the development of alternative designs for water system management; and the utilization of a computational modeling framework to evaluate how those alternative designs define tradeoffs between objectives. We adopt a focus on sustainable water systems, taking into account both ecological impacts of water management and the potential threats of climate change on system performance. Students will explore these aspects of system design in the context of Lake Ontario, one of the largest regulated lakes in the world that is currently undergoing a major revision to the design of its management plan.

4530 Computer-Aided Engineering: Applications to Biomedical Processes (MAE 4530)
Spring 3 credits
A. K. Datta
Letter grade only. Satisfies BE (computational) capstone design requirement. Satisfies College of Engineering technical communications requirement. Prerequisite: BEE 3500, MAE 3240, CHEME 3240 or equivalent. Co-meets with BEE/MAE 5530.

Introduction to simulation-based design as an alternative to prototype-based design; modeling 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. Modeling application (project) can be biomedical (thermal therapy and drug delivery) or broader biological and bioenvironmental applications that involve heat transfer, mass transfer, and fluid flow. Computational topics introduce the finite-element method, model validation, pre- and post-processing, and pitfalls of using computational software. Students choose their own semester-long project, which is a major part of the course (no final exam).

4550 Biologically Inspired Microsystems Engineering
Spring 2-3 credits
M. Wu
Letter grade only. Prerequisite: one year of biology, BEE 2220 or an equivalent thermodynamics course, or co-registration in BEE 3500, or permission of instructor. Co-meets with BEE 6550.

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 the health sector and environment. The lab sessions will provide students with hands on experiences in cell culture, microfluidic device and live cell imaging techniques. Lecture only for 2 credits; lecture and lab for 3 credits.

4560 Ecological Mechanics
Fall 3 credits
C. Roh
S/U or Letter grade. Prerequisite: ENGRD 2020 (or equivalent statics and mechanics of solid), BEE 3310 (or equivalent fluid mechanics), BEE 3500 (or equivalent heat and mass transport), and BEE 3400 (or equivalent solid mechanics). Co-meets with BEE 6560.

Ecological mechanics explores ecological relations from a mechanics perspective, including fluid, solid, structural mechanics, and heat and mass transport. While other ecological studies incorporate transport of mass, energy, and information, consideration of momentum transport and its consequence in biotic and abiotic relations in organisms is unique to this discipline. We begin the course by introducing the fundamental and advanced concepts in mechanics. Then we will learn how to incorporate these concepts by considering response function (the functional relationship between condition imposed on the system and its response) to understand and predict ecological phenomena such as predator-prey relation and pattern formation.

4590 Physical Design in Biological Engineering
Fall 3 credits
S. Jung
Letter grade only. Prerequisite: general physics or permission of instructor is required. Corequisite: students must enroll in ENGRC 4590 (College of Engineering technical communications requirement). Satisfies BE (physical) capstone design requirement. Satisfies College of

Engineering technical communications requirement. Co-meets with BEE 5590.

Students will choose a project depending on their interests, and complete the project goal by integrating the knowledge of biology, physics, and engineering. Students will present their proposal and final results, and write a report at the end of the semester.

4630 **Digital Food Physics and Engineering**
Spring 3 credits
A. Datta
Letter grade only. Prerequisite: Fluid mechanics, heat transfer, and mass transfer, or permission of instructor. The graduate version of the course (BEE 6630) will require prior coursework in at least fluid mechanics and heat transfer. Co-meets with BEE 6630.

Mechanistic, model-based understanding and digital tools critically innovate in the design cycle for products and processes, food manufacturing is no exception. The course will introduce tools such as computational modeling, digital twins, and predictive knowledge bases, exploring deeper into the underlying universal physics-based frameworks describing transformations in food during processing. Grading is based on in-class and online quizzes, homework and project (no exams). BEE 6630: The graduate version of the course will require the project to be substantially more challenging computationally or in physical detail. In addition, in several places throughout the syllabus, graduate version of the course will have more advanced content (there will be separate web modules for undergraduates and graduates).

4670 **Applied Water Research in NYS**
Spring 1 credit
B. Rahm
S/U grade. Co-meets with BEE 6670.

Every year, the New York State Water Resources Institute (NYSWRI) at Cornell supports applied research that addresses critical water resource problems in the New York State and the nation. This seminar series brings together researchers who work with NYSWRI and state agency partners to support and improve water management in the state. Speakers will present on a broad range of water related topics including water engineering and infrastructure, climate and flood resilience, water quality monitoring and assessment and aquatic ecosystems. The seminar will focus on ways in which robust science can support and influence on-ground management and policy outcomes, and center collaborative and interdisciplinary work between academics, water resource scientists, educators, managers, and policymakers in New York State. Students are expected to attend each seminar, submit periodic reflections, and submit a 4-page essay at the end of the semester reflecting on the speakers' presentations and analyzing connections between topics. Find more information about the themes that will be covered here.

4710 **Introduction to Groundwater (EAS 4710)**
Spring 3 credits
T. S. Steenhuis, P. Fulton
S/U or Letter grade. Prerequisites: hydrology, geology or fluid mechanics course. Co-meets with BEE 6710.

Fresh water has become a limited resource in many parts of the world. In arid and semi-arid regions, groundwater levels are declining at unstainable levels. In several industrial areas, groundwater is contaminated and unsuitable as potable water. Sustainability and pollution of groundwater will be addressed in this course by first understanding the theory of saturated and unsaturated flow and contaminant transport under ideal conditions. Subsequently, we learn to simplify groundwater systems in complex subsurface environments to obtain practical solutions. At the end of the course, the learned material will be put in a broader context as they are affected by natural or human actions. Throughout the course, guest speakers will discuss topics of current interest related to water. This elective course is intended for seniors interested in subsurface water and solute transport applications to sustainable groundwater use and prevention of pollution. Well-prepared juniors are welcome too.

4730 **Watershed Engineering**
Fall 4 credits
M. T. Walter
Letter grade only. Satisfies EnvE capstone design requirement. Satisfies College of Engineering technical communications requirement. Prerequisite: CEE 3310 or hydrology course. Co-meets with BEE 5730.

Teaches basic engineering design and analysis as practiced for water control and nonpoint source pollution prevention. Discusses the origins of design approaches, including their theoretical bases and recent or emerging methods and concepts. Most of the course is dedicated to practicing applied design. Assignments are generally representative of real-life engineering problems and involve as much hands-on experience as possible. Some example topics include risk analysis, water conveyance, stormwater management, including green infrastructure and low-impact development.

4750 **Environmental Systems Analysis**
Fall 3 credits
V. Srikrishnan
Letter grade only. Prerequisites: BEE 2510 or BEE 2600 or permission of instructor. Co-meets with BEE 5750.

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, integer programming) to evaluate alternatives for waste management and water and air pollution control. Introduction to the impact of uncertainty on solutions and risk assessment through simulation.

4800 **Atmospheric Chemistry: From Air Pollution to Global Change (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. Co-meets with BEE 6800.

This course investigates the science behind changes in our atmosphere's composition and its relation to global change. Students examine the chemistry and physics that determines atmospheric composition on global scales including the effects of biogeochemistry and atmospheric photochemistry.

BEE 4850 **Environmental Data Analysis and Simulation**
Spring 3 credits
V. Srikrishnan
Letter grades only. Prerequisites: One introductory course in probability and statistics (CEE 3040, ENGRD 2700, or equivalent), one course in programming (CS 1110/CS 1112, ENGRD 2700, CEE 3040, or equivalent), one course in systems analysis (BEE 4750/BEE 5750 or equivalent), or permission of instructor. Co-meets with BEE 5850.

Understanding data is an increasingly integral part of working with environmental systems. Data analysis is an integral part of developing statistical and numerical models to understand system dynamics and project future conditions and outcomes. Simulation from models can represent alternative datasets consistent with a set of assumptions about the underlying data-generating process, facilitating model assessment and hypothesis testing. This course will provide an overview of a generative approach to environmental data analysis, which uses simulation and assessments of predictive performance to provide insight into the structure of data and its data-generating process. The goal is to provide students with a framework and an initial toolkit of methods that they can use to formulate and update hypotheses about data and models. Students will actively analyze and use real data from a variety of environmental systems, potentially including the climate system, sea levels, air pollution, and the electric power system.

4880 **Applied Modeling and Simulation for Renewable Energy Systems (CEE 4880)**
Spring 3 credits
J. Mays
Letter grade only. Prerequisite: senior in engineering, or permission of instructor. Co-meets with BEE 6880.

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 Julia 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 term project.

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.

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.

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.

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.

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.

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
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.

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.

5270 Water Measurement and Analysis Methods
Fall 3 credits
B. Richards, T. S. Steenhuis
Letter grade only. Prerequisites: hydrology, soil or fluid mechanics course. Co-meets with BEE 4270.

Managing soil and water resources requires monitoring. In this field-based lab course, you learn techniques to quantify water flow in surface and subsurface environments and monitor water quality in lakes, rivers and groundwater. Soil health considerations, measurement accuracy, and water sampling quality assurance are discussed. The final project involves designing a water quality monitoring plan for a research or industrial site. Graduate students review the literature on the accuracy of the lab methods and present the results in class.

5280 Systems and Synthetic Biology for Sustainable Energy
Fall. 3 credits
B. Barstow
S/U or Letter grade. Prerequisite: Intro bio (such as BIOG 1440), Biochem (such as BIOMG 3300), MATH 2930, and MATH 2940. Recommended prerequisites: BEE 2600 and BEE 3600 or permission of instructor. Co-meets with BEE 3280.

The world today is in a state of enormous transition. In the coming few decades, billions of people will leave poverty and enter the developed world. This unprecedented development will be one of the greatest opportunities ever presented to improve global public health and quality of life, but it will only be realized if it's done right. The challenge of sustainable energy is not just to provide energy without polluting the atmosphere with fossil carbon, but to do so at a global scale at a cost that everyone can afford. Thanks to capabilities ranging from room temperature and pressure catalysis to self-assembly, biology offers first draft solutions to problems in sustainable energy from the safe use of nuclear energy, the capture and storage of solar power, mining and purifying elements critical for sustainable energy technologies like rare earths and even in the construction of advanced materials. In each class we will discuss a set of scientific journal articles and use these discuss the advantages, disadvantages and potential of biology in applications in sustainable energy. In each of the past two years we have used these discussions to write a scientific article with students as co-authors.

5299 Sustainable Development
Spring 3 credits
B. Richards
S/U or Letter grade. Enrollment limited to graduate/profession and (with instructor permission) advanced undergraduate studnets. Co-meets with BEE 3299.

Sustainable development is a predominant environmental, economic, and social concern of the 21st century. This course introduces the key concepts of sustainable development and how they are integrated into life cycle analysis (LCA) assessments of sustainability. Students seeking to expand their knowledge of sustainable development through readings, videos, written assignments, and interaction with their peers are welcome to take the course. Students learn to evaluate sustainability by carrying out LCA assessments from environmental, economic, and social perspectives throughout the semester for a system/product of their choice relevant to their majors. Over the course of the semester, work is posted on an e-portfolio to enable peer sharing and commenting. Course is solely asynchronous and web-based. This course follows the same trajectory as BEE 3299 but with greater required depth of research and extent of peer interaction. Additional course information can be found at our Sustainable Development page.

5310 Bio-Fluid Mechanics
Fall 4 credits
C. Roh
Letter grade only. Prerequisites: MATH 1910, MATH 1920, MATH 2930, ENGRD 2020 and basic knowledge in complex numbers. Co-meets with BEE 3310.

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, introduction to Navier Stokes; dimensional analysis and similarity; internal and external bio-fluid examples will be covered e.g. blood circulatory systems and animal locomotion.

5330 Engineering Professionalism (ENGRG 5330)
Spring 1 credit
D. Orr
S/U or Letter grade. Prerequisite: seniors who will graduate with an accredited engineering degree and graduate students with accredited engineering degree. Course includes evening lectures, short asynchronous videos, and weekly help sessions. Group interaction is encouraged.

The primary focus is to prepare students for the Fundamentals of Engineering (FE) exam, which is the first step in obtaining a Professional Engineering license. Students complete a formal comprehensive review of engineering subjects associated with the FE exam. Engineering professionalism topics will be covered in some of the lectures or asynchronous videos.

Students are advised to sign up to take the Fundamental of Engineering (FE) exam during the semester. Students sign up directly with the NCEES site. Once the nationally conducted FE exam is passed, it is valid forever in any state as part of Professional Engineering registration.

Course grading is based upon weekly quizzes, assignments within the asynchronous videos, and a comprehensive online final that is like the FE exam. Alternatively, the quizzes and final can be covered by passing of the FE Exam during the semester.

5459 Energy Seminar I (ECE 5870, CHEME 5870, MAE 5459)
Fall 1 credit
C.L. Anderson, D. Hammer, K. Zhang
Student option grading.

Energy Seminars will explore energy-related topics of emerging, contemporary and historical interest. An abbreviated list of subjects explored in the seminars includes: global energy resources, energy generation technologies (present and future), energy storage options, environmental impacts and climate change mitigation, energy policy, and energy delivery economics and systems. Seminar speakers will be distinguished practicing engineers and executives from industry and government as well as faculty members from several departments at Cornell, and other academic institutions. Students from any department in Engineering or the Physical Sciences should find these talks informative.

5469 Energy Seminar II (ECE 5880, CHEME 5880, MAE 5469)
Fall 1 credit
C.L. Anderson, D. Hammer, K. Zhang
Student option grading. Different speakers and/or topics are discussed in ECE 5880.

Energy Seminars will continue to explore energy-related topics of emerging, contemporary and historical interest. An abbreviated list of subjects explored in the seminars includes: global energy resources, energy generation technologies (present and future), energy storage options, environmental impacts and climate change mitigation, energy policy, and energy delivery economics and systems. Seminar speakers will be distinguished practicing engineers and executives from industry and government as well as faculty members from several departments at Cornell, and other academic institutions. Students from any department in Engineering or the Physical Sciences should find these talks informative. *Seminar I topics are not repeated in Energy Seminar II, so students are encouraged to attend both semesters.*

5500 Biological and Bioenvironmental Transport Processes
Fall 4 credits
A. K. Datta
Letter grade only. Pre- or co-requisites: MATH 2930 and fluid mechanics course. Co-meets with BEE 3500.

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 with application examples from plant, animal and human biology, the bioenvironment (soil/water/air), and industrial processing of food and biomaterials. Students in BEE 5500 will develop a more complex computational model (for which analytical solution is difficult) using the software used in one of the homework. The goal of this activity will not be computation itself but using numerical computation to probe deeper into one or more aspects of conduction/diffusion, flow, generation/depletion, or geometry effect in a transport process.

5530 Computer-Aided Engineering: Applications to Biomedical Processes (MAE 5530)
Spring 3 credits
A. K. Datta
Letter grade only. Prerequisite: BEE 3500, MAE 3240, CHEME 3240 or equivalent. Co-meets with BEE/MAE 4530

Introduction to simulation-based design as an alternative to prototype-based design; modeling 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. Modeling application (project) can be biomedical (thermal therapy and drug delivery) or broader biological and bioenvironmental applications that involve heat transfer, mass transfer, and fluid flow. Computational topics introduce the finite-element method, model validation, pre- and post-processing, and pitfalls of using computational software. Students choose their own semester-long project, which is a major part of the course (no final exam). Students in BEE 5530 will expand the developed model as an individual effort separate from the group effort and include this as an individual report that is an extension of the group report. Such an extension of the mathematical model can include additional and substantial computational work approved by the instructor in any (but not all) of the areas—physics, geometry, properties, and validation.

5590 Physical Design in Biological Engineering
Fall 3 credits
S. Jung
Letter grade only. Prerequisite: general physics or permission of instructor is required. Co-meets with BEE 4590.

Students will choose a project depending on their interests, and complete the project goal by integrating the knowledge of biology, physics, and engineering. Students will present their proposal and final results, and write a report at the end of the semester.

5600 Molecular and Cellular Bioengineering
Spring 3 credits
B. Barstow
Letter grade only. Prerequisites: BEE 2600, biochemistry, linear algebra, ordinary differential equations, or permission of instructor. Knowledge of Matlab or Python really helps but is not essential. Co-meets with BEE 3600.

In this class you'll learn about mathematical models of biology that you can use to build engineered organisms. We will cover how to make back of the envelope calculations about biological systems, study the mathematics of metabolic networks for producing commodity chemicals and pharmaceuticals, learn how to approach building a new mathematical model of a biological system, and study mathematical models of gene regulation.

5710 Physical Hydrology for Ecosystems
Spring 3 credits
M. T. Walter
Letter grade only. Prerequisite: MATH 1920 or permission of instructor. Co-meets with BEE 3710.

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

5730 Watershed Engineering
Fall 4 credits
M. T. Walter
Letter grade only. Prerequisite: CEE 3310 or hydrology course. Co-meets with BEE 4730.

Teaches basic engineering design and analysis as practiced for water control and nonpoint source pollution prevention. Discusses the origins of design approaches, including their theoretical bases and recent or emerging methods and concepts. Most of the course is dedicated to practicing applied design. Assignments are generally representative of real-life engineering problems and involve as much hands-on experience as possible. Some example topics include risk analysis, water conveyance, stormwater management, including green infrastructure and low-impact development.

5750 Environmental Systems Analysis
Fall 3 credits
V. Srikrishnan
Letter grade only. Prerequisites: BEE 2510 or BEE 2600 or permission of instructor. Co-meets with BEE 4750.

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, integer programming) to evaluate alternatives for waste management and water and air pollution control. Introduction to the impact of uncertainty on solutions and risk assessment through simulation.

5850 Environmental Data Analysis and Simulation
Spring 3 credits
V. Srikrishnan
Letter grades only. Prerequisites: One introductory course in probability and statistics (CEE 3040, ENGRD 2700, or equivalent), one course in programming (CS 1110/CS 1112, ENGRD 2700, CEE 3040, or equivalent), one course in systems analysis (BEE 4750/BEE 5750 or equivalent), or permission of instructor. Co-meets with BEE 4850.

Understanding data is an increasingly integral part of working with environmental systems. Data analysis is an integral part of developing statistical and numerical models to understand system dynamics and project future conditions and outcomes. Simulation from models can represent alternative datasets consistent with a set of assumptions about the underlying data-generating process, facilitating model assessment and hypothesis testing. This course will provide an overview of a generative approach to environmental data analysis, which uses simulation and assessments of predictive performance to provide insight into the structure of data and its data-generating process. The goal is to provide students with a framework and an initial toolkit of methods that they can use to formulate and update hypotheses about data and models. Students will actively analyze and use real data from a variety of environmental systems, potentially including the climate system, sea levels, air pollution, and the electric power system.

5900 Bio-Robotics
Fall 3 credits
S. Jung
Letter grade only. Prerequisite: differential equations (MATH 2930). Highly recommended prerequisite: BEE 2600 or permission of instructor. Co-meets with BEE 3900.

Introduction to bio-inspired and bio-enabled robotics across scales by an interdisciplinary approach, by gradually integrating knowledge in mechanical engineering and bioengineering. The concept and basic principles of biorobotics are discussed through macroscale robots in various fields including agriculture such as fruit picking robots. Homework includes programming, literature searches, and design studies of their own biorobots.

5910 Advanced Bio-Robotics
Spring 3 credits
S. Jung
S/U or Letter grades. Prerequisite: BEE 3900/5900 or equivalent. Co-meets with BEE 3910.

Students translate materials learned in BEE 3900/5900 to explore bio-robotics for biological engineering applications such as fruit harvesting. Embedding robotics into biological systems (i.e. plants or animals) will be tested with soft bio-robotics. Students will translate the concept and basic principles of biorobotics into a practical robot in this course. Their designed robot will meet ASABE national robotic competition standards.

5951-5952 Master of Engineering Design Project
Fall, Spring 1-6 credits, variable: R grade only in BEE 5951 (in progress).
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.

6110 **Hydraulic Engineering in a Changing Climate (offered odd numbers years starting Fall 2025)**
Fall 3 credits
S. Steinschneider
Letter grade only. Prerequisite: CEE 3040 or ENGRD 2700, one hydrology course (BEE 3710) at the 2xxx level or higher or permission of instructor. Co-meets with BEE 4110.

This course introduces methods in hydrologic engineering to assess and cope with climate variability and change. The course will cover both statistical and physical approaches to analyzing and modeling hydrologic systems. Students will learn the core concepts of traditional statistical analysis in hydrology, and will also learn the limitations of these approaches in a changing climate. Students will become familiar with physical modeling approaches to understand hydrologic response under future climate projections and their limitations. Students will recognize the rapidly changing nature of the field of hydrologic engineering as it tries to adapt to the impacts of climate change. Topics include extreme event frequency analysis, trend detection, water balance modeling, and hydrologic simulations under projected climate change. Applications to stormwater and flood risk analyses are discussed and used as examples throughout the course.

6310 **Multivariate Statistics for Environmental Applications (offered even numbered years starting Fall 2024)**
Fall 3 credits
S. Steinschneider
Letter grade only. Prerequisite: CEE 3040 or ENGRD 2700, MATH 1920, MATH 2940, or permission of instructor. Co-meets with BEE 4310.

This class provides an introduction to relatively simple but powerful multivariate statistical techniques needed to analyze and model complex datasets frequently encountered in the environmental sciences. Emphasis is given to developing the mathematical foundation of these methods to foster a deeper understanding of their benefits and limitations. The goal is to provide students in the environmental sciences and engineering with a toolbox of methods not taught in more introductory statistical courses, but also to ensure that students can use these methods in their own work without viewing them as a "black box". The course only assumes a limited knowledge of calculus, linear algebra, and statistics, and will provide a review of the mathematical concepts needed to understand the statistical techniques presented. Applications will be presented primarily from the geophysical and ecological sciences, but the theory will be applicable to other environmental fields. Upon completion of the course, students will be able to use the multivariate techniques presented in the course to understand and evaluate environmental problems of interest in their respective domains.

6400 **Advanced Topics in Biomaterials**
Fall 2 credits
M. Ma
Letter or S/U grading. Prerequisites: BEE 3400 or permission of instructor. Enrollment limited to: graduate level or senior standing.

In this class, we will discuss some classical as well as cutting-edge research papers from the biomaterials field on topics including: (1) Polymer Biomaterials; (2) Hydrogel Biomaterials; (3) Inorganic and Composite Biomaterials; and (4) Applications of Biomaterials in Agriculture and Life Sciences. For each topic, the professor will first give introductory lectures, and the students will then give presentations and lead discussions on chosen papers.

6550 **Biologically Inspired Microsystems Engineering**
Spring 2-3 credits
M. Wu
Letter grade only. Prerequisites: thermodynamics course, and permission of instructor. Co-meets with BEE 4550.

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 the 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). Lecture only for 2 credits, lecture and lab for 3 credits.

6560 **Ecological Mechanics**
Fall 3 credits
C. Roh
S/U or Letter grade. Prerequisite: ENGRD 2020 (or equivalent statics and mechanics of solid), BEE 3310 (or equivalent fluid mechanics), BEE 3500 (or equivalent heat and mass transport), and BEE 3400 (or equivalent solid mechanics). Co-meets with BEE 4560.

Ecological mechanics explores ecological relations from a mechanics perspective, including fluid, solid, structural mechanics, and heat and mass transport. While other ecological studies incorporate transport of mass, energy, and information, consideration of momentum transport and its consequence in biotic and abiotic relations in organisms is unique to this discipline. We begin the course by introducing the fundamental and advanced concepts in mechanics. Then we will learn how to incorporate these concepts by considering response function (the functional relationship between condition imposed on the system and its response) to understand and predict ecological phenomena such as predator-prey relation and pattern formation.

6630 Digital Food Physics and Engineering
Spring 3 credits
A. Datta
Letter grade only. Prerequisite: fluid mechanics, heat transfer, and mass transfer, or permission of instructor. This course will require the project to be substantially more challenging computationally or in physical detail. In addition, in several places throughout the syllabus, graduate version of the course will have more advanced content (there will be separate web modules for undergraduates and graduates).Co-meets with BEE 4630.

Mechanistic, model-based understanding and digital tools critically innovate in the design cycle for products and processes, food manufacturing is no exception. The course will introduce tools such as computational modeling, digital twins, and predictive knowledge bases, exploring deeper into the underlying universal physics-based frameworks describing transformations in food during processing.

6640 Sustainable Bioenergy Production on Marginal Lands of New York and the Northeast (offered on demand)
Fall 1 credit
S/U or Letter grade.
B. Richards

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. Our goal is to expose participants to issues involved in the development of low-cost sustainable perennial bioenergy feedstock production based on marginal lands of New York and the Northeast. Having heard and interacted with speakers representing a spectrum of disciplines and perspectives, participants will be better able to understand, evaluate, and/or contribute to the development of bioenergy resources in the region. Participants will develop an appreciation for challenges of bioenergy development and the cross-disciplinary efforts required to address them.

6670 Applied Water Research in NYS
Spring 1 credit
B. Rahm
S/U grade. Co-meets with BEE 4670.

Every year, the New York State Water Resources Institute (NYSWRI) at Cornell supports applied research that addresses critical water resource problems in the New York State and the nation. This seminar series brings together researchers who work with NYSWRI and state agency partners to support and improve water management in the state. Speakers will present on a broad range of water related topics including water engineering and infrastructure, climate and flood resilience, water quality monitoring and assessment and aquatic ecosystems. The seminar will focus on ways in which robust science can support and influence on-ground management and policy outcomes, and center collaborative and interdisciplinary work between academics, water resource scientists, educators, managers, and policymakers in New York State. Students are expected to attend each seminar, submit periodic reflections, and submit a 4-page essay at the end of the semester reflecting on the speakers' presentations and analyzing connections between topics. Find more information about the themes that will be covered here.

6710 Introduction to Groundwater (EAS 6710)
Spring 3 credits
T. S. Steenhuis, P. Fulton
S/U or Letter grade. Prerequisites: hydrology, geology or fluid mechanics course. Co-meets with BEE 4710.

Fresh water has become a limited resource in many parts of the world. In arid and semi-arid regions, groundwater levels are declining at unstainable levels. In several industrial areas, groundwater is contaminated and unsuitable as potable water. Sustainability and pollution of groundwater will be addressed in this course by first understanding the theory of saturated and unsaturated flow and contaminant transport under ideal conditions. Subsequently, we learn to simplify groundwater systems in complex subsurface environments to obtain practical solutions. At the end of the course, the learned material will be put in a broader context as they are affected by natural or human actions. Throughout the course, guest speakers will discuss topics of current interest related to water. This elective course is intended for graduate students interested in subsurface water and solute transport applications to sustainable groundwater use and prevention of pollution.

6740 **Ecohydrology (On demand)**
Spring 3 credits
T. Walter
Letter grade only. Prerequisite: ecology or hydrology course.

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.

6800 **Atmospheric Chemistry: From Air Pollution to Global Change (EAS 6800)**
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. Co-meets with BEE 4800.

This course investigates the science behind changes in our atmosphere's composition and its relation to global change. Students examine the chemistry and physics that determines atmospheric composition on global scales including the effects of biogeochemistry and atmospheric photochemistry.

6880 **Applied Modeling and Simulation for Renewable Energy Systems (CEE 6880)**
Spring 3 credits
J. Mays
Letter grade only. Prerequisite: graduate students, or permission of instructor. Co-meets with BEE 4880.

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. .

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.

6940 **Climate Uncertainties: Engineering the Architecture of Future Climates**
Fall 2 credits
F. Lofti-Jam, V. Srikrishnan
S/U or Letter grades.

"Climate Uncertainties" is an interdisciplinary course jointly offered by the College of Architecture, Art, and Planning and the College of Agriculture and Life Sciences under the 2030 Project. The course examines climate and hydrological engineering challenges, exploring a decarbonized and decolonized future from spatial, cultural, and political perspectives. Our journey will take us through a spectrum of climate-related themes, from scrutinizing historical hazard events in modern socio-economic contexts, to critically examining climate modeling and its unequal impacts. In parallel, we will also navigate the politics of modeling, simulating, and visualizing climate realities, exploring how these tools can be deployed to not just predict, but challenge and disrupt the status quo. The course leverages state-of-the-art tools, such as uncertainty, hydrodynamic and agent-based modeling, digital twins, and generative AI programming, offering students a multifaceted approach to confronting real-world climate challenges. Beyond the classroom, the course is enriched by a dedicated speaker series and site visits, facilitated through generous funding. As part of the larger The 2030 Project initiative, students will also have the opportunity to showcase their work to a broader audience through publications, exhibitions, and events.

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
S. Jung
S/U grade only. Prerequisite: new graduate students in BEE.

This course is intended to introduce students to graduate school in Biological and Environmental Engineering. It is intended for first year graduate students although others may find it helpful. It consists of a seminar series and series of classes introducing students to such topics as: how to write a research proposal, how to give a scientific talk, how to get the most out of Cornell resources and time management.

7600 Nucleic Acid Engineering
Spring 3 credits
D. Luo
S/U or Letter grade. Enrollment limited to: graduate standing, seniors by permission of instructor.

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, RNA, PNA, and TNA) as both genetic and generic materials. Both biomedical and nonbiomedical applications of nucleic acid engineering, including tool kits for nucleic acid engineering and current examples of DNA-based engineering, DNA nanotechnology, 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. T. Walter.
S/U or letter grade. Prerequisite: graduate standing or permission of instructor.

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

BEE Faculty and Instructors

BETH AHNER, 220 Riley-Robb Hall, 607.255.4677, baa7@cornell.edu

Beth Ahner is a Professor in the Department of Biological and Environmental Engineering. Her professional objectives have been to explore basic science in pursuit of better engineering solutions. In particular, she seeks to understand how organisms adapt to trace metal stress in the environment and in turn, how they influence the form of metals in the environment. Discoveries in this area lead to better strategies to remediate metal contamination in the environment and to a better understanding of natural ecosystems.

LINDSAY ANDERSON, 104 Riley-Robb Hall, 607.255.4533, cla28@cornell.edu

Lindsay Anderson is a Professor in Biological and Environmental Engineering and is currently the chair of the department. She is also the Norman R. Scott Sesquicentennial Faculty Fellow, as well as the Kathy Dwyer Marble and Curt Marble Faculty Director for Energy with the Atkinson Center for a Sustainable Future. Professor Anderson's overarching goal is to accelerate the transition to a low carbon energy future. She is particularly interested in the effective integration of wind and solar resources, through the leveraging of distributed and demand side resources. Anderson' s approach to this problem is through improvement of operational strategies to include supply and demand side resources in frameworks for optimization under uncertainty.

BUZ BARSTOW, 228 Riley-Robb Hall, bmb35@cornell.edu

Buz Barstow is an Assistant Professor in Biological and Environmental Engineering. He is a physicist using synthetic biology to build sustainable energy technologies.

NATALIE CÁPIRO, 214 Riley-Robb Hall, 607.254.2303, nlc6@cornell.edu

Natalie Cápiro is an Assistant Professor in the Department of Biological and Environmental Engineering. Here interests are applied environmental microbiology, bioremediation, fate and transport of legacy and emerging contaminants in natural systems, development of groundwater remediation strategies, nanoparticle-microbial interactions in the environment.

MICHAEL CHARLES, 322 Riley-Robb Hall, 607.254.3232, mtc58@cornell.edu

Michael Charles is an Assistant Professor in the Department of Biological and Environmental Engineering. His interests are sustainability analysis and engineering, process systems engineering, computational simulation and design, applications of academia and Indigenous knowledge, community-based systems dynamics, environmental and tribal policy.

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

Ashim Datta is a Professor in the Department of Biological and Environmental Engineering. He is interested in the physics of food processes; in particular, how increased efficiency and competitiveness in food production, processing, and equipment design can be obtained from physics-based models of food quality and safety.

PETER HESS, 202 Riley-Robb Hall, 607.255.2495, pgh25@cornell.edu

Peter Hess is a Professor in the Department of Biological and Environmental Engineering. His research interests focus on understanding atmospheric chemistry within the context of the earth's climate system. His work will advance understanding of how the chemistry and composition of the atmosphere may change over the 21st Century and help to prepare adaptive responses or mitigation strategies. These changes in atmospheric chemistry not only drive climate change but also directly threaten human health, agricultural productivity, and natural ecosystems.

JEAN HUNTER, 332 Riley-Robb Hall, 607.255.2297, jbh5@cornell.edu

Jean Hunter is an Emeritus Associate Professor in the Department of Biological and Environmental Engineering. Her research interests include bioprocess and food engineering, with applications including space life support.

SUNNY JUNG, 302 Riley-Robb Hall, 607.255.5798, sj737@cornell.edu

Dr. Sunghwan (Sunny) Jung is a Professor in the Department of Biological and Environmental Engineering at Cornell University and Director of Graduate Studies. He received his Ph.D. in physics at the University of Texas at Austin, and then became a postdoctoral researcher at the Courant Institute at NYU & a math instructor at MIT.

Dr. Jung's research interest is to investigate various physics and biology problems emerging from the interaction of biological systems with surrounding environments. His group has integrated mathematical modeling, fluid dynamics, and physical & biological experiments to understand animal behaviors and plant physiology for better functions and performance. Some examples include how animals drink, how birds dive into water, how animals jump out of water, how plant spores are dispersed, how raindrops impact biological surfaces, and more.

Dr. Jung has trained students with diverse backgrounds to acquire knowledge and skills integrate and perform multidisciplinary research rather than learning skills in narrow fields of interest.

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

Dan Luo is a Professor in the Department of Biological and Environmental Engineering. He works with DNA and RNA as both generic and genetic materials.

MINGLIN MA, 304 Riley-Robb Hall, 607.255.3570, mm826@cornell.edu

Minglin Ma is a Professor in the Biological and Environmental Engineering Department. He received his BS degree from Tsinghua University and PhD from MIT, both in Chemical Engineering. Prior to joining Cornell in 2013, he worked as a Lead Scientist at General Electric Global Research Center and as a postdoctoral fellow in Dr. Robert Langer's laboratories at MIT Koch Institute. His group are interested in developing advanced biomaterials for agricultural and biomedical applications with a particular focus on cell replacement therapies for type 1 diabetes.

JOHN MARCH, 207 Riley-Robb Hall, 607.254.5471, jcm224@cornell.edu

John March is a Professor in the Department of Biological and Environmental Engineering and Director of Undergraduate Studies. His work in cell signaling is focused on reconfiguring biological systems for improved performance in the areas of biomedicine and sustainability. His work attempts to change bacterial or eukaryotic signal transduction to make cells that are more responsive to their environment and more efficient as technological tools.

DAVID ORR, 416 Riley-Robb Hall, 607.255.8033, david.orr@cornell.edu

David Orr, PE, PhD. is Director / Senior Engineer for the Cornell University Local Roads Program, the New York State LTAP Center. With over 30 years in the local highway community, David has experiences covering the gamut from the field to the office and from storms to sunny days. He has a broad range of expertise and experience in highway engineering and construction, including design, inspection, project management, purchasing, budgeting and supervision.

He was the 2018-2019 President of NLTAPA, the association of 52 LTAP & TTAP Centers located across the county. Before joining the Program, he worked for eight years at the Yates County Highway Department. He is a licensed professional engineer in New York State and has Ph.D. on local roads from Cornell University.

BRIAN RICHARDS, B66A Riley-Robb Hall, 607.255.2463, bkr2@cornell.edu

Brian Richards is a Senior Research Associate in the BEE Soil and Water Lab. His research focuses on the interaction of soil, water and a wide range of substances – including trace elements, nutrients, pesticides, colloids – which in the wrong place and/or at deleterious concentrations are regarded as contaminants. Recent major research directions include the impacts of agricultural and perennial bioenergy cropping systems on soils and soil emissions.

CHRIS ROH, 212 Riley-Robb Hall, cr296@cornell.edu

Chris Roh is an Assistant Professor in Biological and Environmental Engineering. Insect's well-adapted interactions with abiotic and biotic surroundings offer inspiration for innovative engineering designs and concepts. One of the primary abiotic components in nature is fluids. In air, water, or in between, insect's small sizes contend with multiple fluid forces. Through morphological and behavioral adaptations, insects have found numerous ways of foraging, evading, communicating, and feeding in dynamic fluid environments. My main research interest is to study these adaptations and apply the findings to different engineering disciplines, such as agricultural, biomedical, and aeronautical engineering.

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

Scott was involved in bioengineering research and teaching for over 20 years prior to spending 14 years as a Cornell administrator (Director of Cornell University Agricultural Experiment Station & Vice President of Research and Advanced Studies). His early research was 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, as well as the effects of transient current on dairy cows. Since returning to the faculty in 1998, he has focused on research in sustainable development. This research is directed to development of sustainable communities with emphasis on biologically derived fuels, renewable energy, recycling, managed ecosystems and industrial ecology. Grant support has been obtained from New York State Energy Research & Development Authority and USDA.

VIVEK SRIKRISHNAN, 318 Riley-Robb Hall, viveks@cornell.edu

Vivek Srikrishnan is an Assistant Professor in the Department of Biological & Environmental Engineering at Cornell University. He works on quantifying impacts from climate change and identifying and evaluating strategies for climate risk management. His research employs methods and insights from systems engineering, data science, decision science, and economics.

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

Prof. Tammo Steenhuis received a Ph.D. from the University of Wisconsin, Madison, in 1978’ He is a Professor in Biological and Environmental Engineering at Cornell University. He serves as an Adjunct Professor at the University of Bahir Dar in Ethiopia, working with Ph.D. graduate students. He is also a fellow of the American Geophysical Union. In the past, together with graduate students, his research ranged from soil colloid movement to basin-wide movement of water and constituents. Recently, Prof Steenhuis has been primarily interested in landscape processes in the northeastern US, Ethiopia and China. He cooperates on research in sustainable agricultural practices, self-organization distributed hydrological processes, pesticide movement and gully formation and prevention.

SCOTT STEINSCHNEIDER, 320 Riley-Robb Hall, 607.255.2155, ss3378@cornell.edu

Dr. Scott Steinschneider is an Associate Professor in the Department of Biological and Environmental Engineering at Cornell University. His primary expertise is in statistical hydroclimatology, with two principal focus areas: (1) the characterization of hydroclimatic variability across space-time scales, and (2) the analysis of hydroclimate impacts in the water sector. His work has focused on water systems across the United States and globally and has been sponsored by the U.S. Army Corps of Engineers, National Atmospheric and Oceanic Administration, New York Sea Grant, National Science Foundation, and US Department of Agriculture. He earned his BA in Mathematics from Tufts University and his M.S. and Ph.D. in Civil and Environmental Engineering from the University of Massachusetts, Amherst. Prior to arriving at Cornell, he was a postdoctoral research fellow at Columbia University.

TODD WALTER, 232 Riley-Robb Hall, 607.255.2488, mtw5@cornell.edu

Professor Todd Walter is a Professor in the Department of Biological and Environmental Engineering. His research emphasis is on the interactions between hydrology, ecology, and biogeochemistry. He applies physical hydrology and water resources engineering to a broad range of multidisciplinary research interests and pursues questions that cross the traditional academic boundaries of hydrology and terrestrial ecology.

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

Mingming Wu is a Professor in the Department of Biological and Environmental Engineering. She was drawn to the field of biological engineering by her admiration of the exquisite micro- and nano-scale machinery found in the natural world. She is leading a lab that develops micro- and nano-scale technologies for solving contemporary biological, medical, and environmental problems. Her lab gains inspiration by exploring how tiny cells (often 1/10th of the width of a hair) move within a given microenvironment. Her lab motto is to see the unseeable and to measure the unmeasurable, all though the development of new technologies.

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 (bee-ugrad@cornell.edu) or Professor John March (bee-ugrad@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 1050 in your first 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 John March to discuss your situation. Contact the Office of Student Services in Roberts Hall at 607.255.2257 if you are seeking a new major in CALS. Contact the College of Engineering Advising Office in Rhodes 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
Tel: 607.255.5233; Email: bioadvising@cornell.edu
http://biology.cornell.edu/index.php/oub-advising-services

Engineering Advising Office
8am-4:30pm Monday-Friday; 180 Rhodes Hall
Tel: 607.255.7414; Email: adv_engineering@cornell.edu
http://www.engineering.cornell.edu/resources/advising/index.cfm

Learning Strategies Center
9:00am-5:00pm Monday-Thursday, 9:00am-4pm Friday; 420 Computing and Communications Center (CCC)
Tel: 607.255.6310; Email: learningstrategiescenter@cornell.edu
https://lsc.cornell.edu/

Math Support Center
Open during Academic Year – see web site for specific hours; 256 Malott Hall
Tel: 607.255.4658; http://www.math.cornell.edu/Courses/FSM/
https://math.cornell.edu/math-support-center-msc

Writing Workshop
See web site to schedule an appointment; 174 Rockefeller Hall
Tel: 607.255.2280; Email: knight_institute@cornell.edu
https://knight.as.cornell.edu/

Minority & Women's Programs in Engineering
146 Olin Hall
Tel: 607.255.6403; Email: dpeng@cornell.edu
http://www.engineering.cornell.edu/diversity/

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 Cornell Health: Cornell University Health Services; Tel: 607.255.5155; Email: cornellhealth@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 – usually mistaken – belief 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. 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. Let's Talk:
https://health.cornell.edu/services/mental-health-care/lets-talk

EARS (Empathy, Assistance, and Referral Service); Tel: 607.255.3277
http://ears.dos.cornell.edu/
Free and confidential.

General Medical Problems
Cornell Health Center; Tel: 607.255.5155; Email: cornellhealth@cornell.edu
https://health.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 are licensed (after examination and if they also have suitable experience) to practice engineering in each state of the U.S. While not required for all Environmental Engineering jobs, registration 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 toward getting a 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"). Students are advised to sign up to take the Fundamental of Engineering (FE) exam during the semester. Students sign up directly with the NCEES site. Once the nationally conducted FE exam is passed, it is valid forever in any state as part of Professional Engineering registration. 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. Success or failure in this examination has no bearing on your academic standing at Cornell.

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/ENGRG 5330, Engineering Professionalism, prepares students for the Fundamentals of Engineering (FE) exam, which is the first step in obtaining a Professional Engineering license. Students complete a formal comprehensive review of engineering subjects associated with the FE exam. Engineering professionalism topics will be covered in some of the lectures or asynchronous videos.

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
- All 30 credits need to be at the 5xxx level or above

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, 180 Rhodes Hall, or from the Dean of the Faculty, 315 Day Hall. It is also available on the web at: https://theuniversityfaculty.cornell.edu/dean/academic-integrity/

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.

NOTES