

# **BE ADVISING MANUAL**

**(Revised: July 2017)**

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## **Biological Engineering Program Goal**

Biological Engineers find the sustainable solutions needed to supply a growing world population with food, fiber, water, and fuel under increasing environmental constraints. The goal of the Biological Engineering program is to prepare graduates for careers in the application of engineering design and analysis to power and machinery systems, structures, production of food and pharmaceuticals, biomass energy systems, and protection of natural resources.

## **Biological Engineering Program Educational Objectives**

Early career Biological Engineering graduates will be expected to:

1. Demonstrate proficiency in basic and engineering sciences related to biological processing, natural resource, and agricultural engineering fields;
2. Effectively identify, analyze and design sustainable solutions to address issues and opportunities throughout the world;
3. Work in teams and effectively communicate within and outside the profession;
4. Demonstrate strong leadership skills, ethical integrity, and professional engagement.

## **Biological Engineering Program Outcomes (Student Outcomes)**

Upon graduation, Biological Engineering students will have:

- a. An ability to apply knowledge of mathematics, science, and engineering;
- b. An ability to design and conduct experiments, as well as to analyze and interpret data;
- c. An ability to design a system, component, or process to meet desired needs;
- d. An ability to function on multi-disciplinary teams;
- e. An ability to identify, formulate, and solve engineering problems;
- f. An understanding of professional and ethical responsibility;
- g. An ability to communicate effectively;
- h. The broad education necessary to understand the impact of engineering solutions in a global and societal context;
- i. A recognition of the need for an ability to engage in life-long learning;
- j. A knowledge of contemporary issues;
- k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

## Introduction

Welcome to Penn State and the Department of Agricultural and Biological Engineering! The faculty and staff are committed to enabling you to have enriching, rewarding, and professional experiences at Penn State.

This manual has been prepared to guide Biological Engineering (BE) majors through their academic programs at Penn State, help students understand the requirements for the Biological Engineering major, and give guidance for selecting various elective courses. The program check sheets should be kept up-to-date and checked periodically against the one in your advisor's file.

Each BE student is assigned an academic advisor when he/she arrives as a freshman (in the College of Agricultural Sciences), declares BE as his/her major in the entrance-to-major process, or transfers to the program from another university. Your advisor will counsel you on the academic requirements of the major and serve as a resource to answer other academic questions. Your advisor will assist in developing your career goals and objectives. It is also hoped that your advisor will become a friend and listener as well as a source of information concerning non-academic matters if the need arises. Normally the same academic advisor is retained until graduation. **Generally, advisors will not search for the students; it is the responsibility of each student to meet with their advisor at least once each semester for counsel, guidance, and career development information.** Any specific interests or concerns you have in Biological Engineering should be discussed with your advisor.

The Agricultural and Biological Engineering Department is committed to providing a stimulating educational environment for all students. Please inform the Department Head immediately of any barriers--real or perceived--that create problems or limitations in the educational opportunities for you or other students in the Department.

For further information about the Biological Engineering major, please contact:

Dr. Megan Marshall  
Senior Instructor & BE Program Coordinator  
814-865-3392  
mnm11@psu.edu

## What is Biological Engineering?

Biological Engineering is the application of engineering principles to biological systems; each of which greatly impact our food and fiber supply. A college education in Biological Engineering prepares students for many exciting career opportunities in the diverse areas of production of food and other biological materials, processing systems, and management of land and water resources. Employment opportunities for Biological Engineers are undoubtedly going to continue to increase as the world's population demands more abundant supplies of nutritious, high quality food at affordable prices.

Courses in the Biological Engineering curriculum provide thorough training in mathematics, physics and the engineering sciences common to all engineering disciplines. In addition, students receive specialized training in biological, environmental, and/or agricultural sciences. Through the selection of an option, electives, and possibly a minor, a Biological Engineering student can specialize. Each student is required to select the **Agricultural Engineering Option**, the **Food and Biological Processing Engineering Option** or the **Natural Resources Engineering Option** at the time that he/she declares the BE major. **However, a student can switch options at any time after declaring the major.** Please see your advisor if you are interested in changing options.

### Agricultural Engineering

- Machinery design and systems management, including off-road equipment for agricultural production, construction, forestry, and food processing
- Structural design and environmental control with a focus on design of wood structures

### Food and Biological Processing Engineering

- Engineering of microbiological systems for pharmaceuticals, renewable energy, and vitamin and food supplements
- Food processing, handling, and storage from the time food is produced until it reaches consumers

### Natural Resources Engineering

- Engineering for the protection of the environment from non-point source pollution, including sediment loss and nutrient/chemical runoff
- Designing solutions for stormwater management and sustainable land development

There are many exciting job opportunities available for Biological Engineering graduates, with specific responsibilities such as engineering design, analysis, field testing, research, development, systems management, sales, consulting and applications engineering. Biological Engineers are uniquely qualified to cope with the various engineering aspects of production and processing of food and other biological materials within the constraints of environmental protection and natural resources conservation.

About 20% of our graduates continue their education by enrolling in the graduate program at Penn State or other leading universities for advanced study in a particular area of Biological Engineering or in a related engineering discipline.

The best way for students to learn more about the Biological Engineering profession is to participate in the Penn State Student Branch of ASABE, the society for engineering in agricultural, food, and biological systems (see page 45), and company visits sponsored by the Department.

## **The student-advisor relationship: roles and expectations**

Biological Engineering students should establish a working relationship with their advisors for a productive and efficient college experience. The following lists provide guidance on the roles and expectations of both the student and the advisor:

### **Responsibilities and Expectations of Students**

- Ensuring that proper courses are selected
- Ensuring that courses are taken in the appropriate sequence, adhering to prerequisites
- Ensuring that graduation requirements are met
- Completing petitions for degree requirement substitutions prior to the graduation semester
- Developing course schedule for each semester

### **Responsibilities and Expectations of Advisor**

- Keeping advisee records up to date each semester
- Providing guidance on selection of courses
- Providing career guidance
- Encouraging students to engage in extra curricular activities
- Promoting summer job, internships and co-op opportunities
- Help inform student of minors and how minors might fit with career plans

**AGRICULTURAL ENGINEERING OPTION –**

**GRADUATION CHECKLIST,**  
**SAMPLE ACADEMIC PLAN,**  
**FLOW CHART,**  
**AND SELECTION LISTS**



**BIOLOGICAL ENGINEERING GRADUATION CHECKLIST  
AGRICULTURAL ENGINEERING OPTION**

Student Name \_\_\_\_\_

Student ID/e-mail \_\_\_\_\_

First Year Seminar (1 cr)  
\_\_\_\_\_ Cr. Completed \_\_\_\_\_ Petition? \_\_\_\_\_

Communications (GWS - 10 cr)  
ENGL 15            3 \_\_\_\_\_  
CAS 100A/B        3 \_\_\_\_\_  
BE 391             2 \_\_\_\_\_  
BE 392             2 \_\_\_\_\_

Quantification (GQ - 14 cr)  
MATH 140          4 \_\_\_\_\_ \*  
MATH 141          4 \_\_\_\_\_ \*  
MATH 231          2 \_\_\_\_\_  
MATH 251          4 \_\_\_\_\_ \*

Natural Science (GN - 12 cr)  
CHEM 110          3 \_\_\_\_\_ \*  
CHEM 111          1 \_\_\_\_\_  
PHYS 211          4 \_\_\_\_\_ \*  
PHYS 212          4 \_\_\_\_\_ \*

Social Science (GS - 6 cr)  
ECON 102, ECON 104,  
or AGBM 101      3 \_\_\_\_\_  
\_\_\_\_\_

Humanities (GH - 6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

Art (GA - 6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

PE & Health (GHA - 3 cr)  
\_\_\_\_\_  
\_\_\_\_\_

US Cultures (US - 3 cr)  
 International Cultures (IL - 3 cr)  
 World Language Admissions

Engineering (21 cr)  
\_\_\_\_\_ Cr. Completed \_\_\_\_\_ Petition? \_\_\_\_\_

EDSGN 100        3 \_\_\_\_\_  
EMCH 211         3 \_\_\_\_\_ \*  
EMCH 212         3 \_\_\_\_\_ \*  
EMCH 213         3 \_\_\_\_\_ \*  
ME 300             3 \_\_\_\_\_ \*  
CE 360 or ME 320 3 \_\_\_\_\_ \*  
IE 424 or STAT 401 3 \_\_\_\_\_

Biological Engineering (32 cr)  
BE 301             3 \_\_\_\_\_ \*  
BE 302             4 \_\_\_\_\_ \*  
BE 304             3 \_\_\_\_\_ \*  
BE 305             3 \_\_\_\_\_ \*  
BE 308             3 \_\_\_\_\_ \*  
BE 460             1 \_\_\_\_\_  
BE 466             3 \_\_\_\_\_

Two BE 30X courses (BE 303/306/307):  
\_\_\_\_\_ 3 \_\_\_\_\_ \*  
\_\_\_\_\_ 3 \_\_\_\_\_ \*

Two BE 4XX courses:  
\_\_\_\_\_ 3 \_\_\_\_\_  
\_\_\_\_\_ 3 \_\_\_\_\_

Math/Basic Science (3 cr)  
\_\_\_\_\_

Biological/Agricultural Science (3 cr)  
\_\_\_\_\_

Engineering Science/Design (6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

Technical Requirement (6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

Total required credits for graduation = 129

\* courses require C or better

**Sample Academic Plan for BE Major -- Agricultural Engineering Option**

Semester 1	Credits	Semester 2	Credits
First Year Seminar	1	CHEM 111 (GN) - Experimental Chemistry I	1
<b><i>CHEM 110 (GN) - Chemical Principles I</i></b>	3	GA/GH/GS	3
ECON 102/ECON 104/AGBM 101 (GS) - Economics	3	<b><i>MATH 141 (GQ) - Calculus with Analytic Geometry II</i></b>	4
EDSGN 100 - Introduction to Engineering Design	3	ENGL 15 (GWS) - Rhetoric and Composition	3
<b><i>MATH 140 (GQ) - Calculus with Analytic Geometry I</i></b>	4	<b><i>PHYS 211 (GN) - General Physics: Mechanics</i></b>	4
GA/GH/GS	3		
Total Credits:	17	Total Credits:	15
Semester 3	Credits	Semester 4	Credits
GA/GH/GS	3	<b>EMCH 212 - Dynamics</b>	3
CAS 100A/B (GWS) - Effective Speech	3	<b>EMCH 213 - Strength of Materials</b>	3
<b>EMCH 211 - Statics</b>	3	<b>ME 300 - Thermodynamics</b>	3
<b><i>MATH 251 - Ordinary and Partial Differential Equations</i></b>	4	MATH 231 - Calculus of Several Variables	2
<b><i>PHYS 212 (GN) - General Physics: Electricity and Magnetism</i></b>	4	Math/Basic Science Selection	3
		GA/GH/GS	3
Total Credits:	17	Total Credits:	17
Semester 5	Credits	Semester 6	Credits
<b>BE 301 - Mathematical Modeling of Biological and Physical Systems</b>	3	BE 391 (GWS) - Contextual Integration of Communication Skills for Technical Workplace	2
<b>BE 304 - Engineering Properties of Food and Biological Materials</b>	3	<b>BE 302 - Heat and Mass Transfer in Biological Systems</b>	4
<b>BE 308 - Engineering Elements of Biochemistry and Microbiology</b>	3	<b>BE 305 - Agricultural Measurements and Control Systems</b>	3
<b>ME 320 or CE 360 - Fluid Mechanics</b>	3	<b>BE 30X - Junior B E Selection</b>	3
GA/GH/GS	3	<b>BE 30X - Junior B E Selection</b>	3
Total Credits:	15	Total Credits:	15
Semester 7	Credits	Semester 8	Credits
BE 392 (GWS) - Contextual Integration of Leadership Skills for the Technical Workplace	2	BE 466 - Biological Engineering Design II	3
BE 460 - Biological Engineering Design I	1	Engineering Science/Design Selection	3
BE 4XX Selection	3	BE 4XX Selection	3
Ag/Bio Science Selection	3	Technical Selection	3
IE 424 - Process Quality Engineering OR STAT 401 - Experimental Methods	3	Technical Selection	3
Engineering Science/Design Selection	3	GHA	1.5
GHA	1.5		
Total Credits:	16.5	Total Credits:	16.5

Total Credits = 129, Italics = ETM requirement, Bold = C or better required

Student Name: \_\_\_\_\_

Student ID: \_\_\_\_\_

**BE Major -- Agricultural Engineering Option**

Semester 1	Credits	Completed	Petition	Semester 2	Credits	Completed	Petition
First Year Seminar	1			CHEM 111 (GN)	1		
*CHEM 110 (GN)	3			GA/GH/GS	3		
ECON 102/ECON 104/AGBM 101 (GS)	3			*MATH 141 (GQ)	4		
EDSGN 100	3			ENGL 15 (GWS)	3		
*MATH 140 (GQ)	4			*PHYS 211 (GN)	4		
GA/GH/GS	3						
Semester 3	Credits			Semester 4	Credits		
GA/GH/GS	3			*EMCH 212	3		
CAS 100A/B (GWS)	3			*EMCH 213	3		
*EMCH 211	3			*ME 300	3		
*MATH 251	4			MATH 231	2		
*PHYS 212 (GN)	4			Math/Basic Sci Selection	3		
				GA/GH/GS	3		
Semester 5	Credits			Semester 6	Credits		
*BE 301	3			BE 391 (GWS)	2		
*BE 304	3			*BE 302	4		
*BE 308	3			*BE 305	3		
*ME 320 or CE 360	3			*BE 30X Selection	3		
GA/GH/GS	3			*BE 30X Selection	3		
Semester 7	Credits			Semester 8	Credits		
BE 392 (GWS)	2			BE 466	3		
BE 460	1			Eng Sci/Dsgn Selection	3		
BE 4XX Selection	3			BE 4XX Selection	3		
Ag/Bio Sci Selection	3			Tech Selection	3		
IE 424 OR STAT 401	3			Tech Selection	3		
Eng Sci/Dsgn Selection	3			GHA	1.5		
GHA	1.5						

Total Credits = 129, \* courses require C or better

World Language Admissions

US Cultures

International Cultures

3		
3		

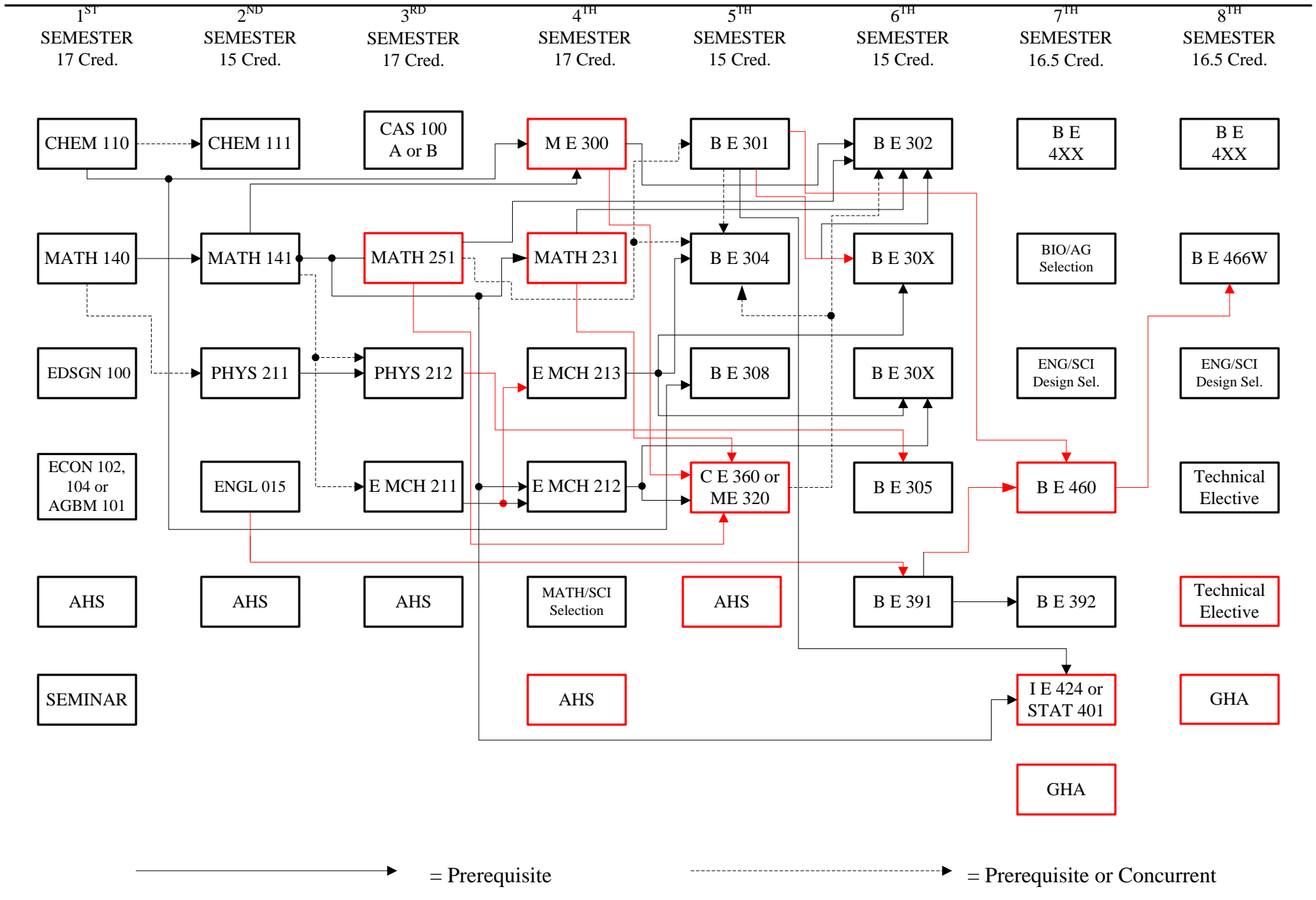
GA 6

GH 6

GS 6


# BIOLOGICAL ENGINEERING

## AGRICULTURAL ENGINEERING OPTION



## AGRICULTURAL ENGINEERING OPTION SELECTION LISTS

### COURSES THAT MEET THE MATH/BASIC SCIENCE REQUIREMENT<sup>+</sup>

AGRO 28	Principles of Crop Management (3) Prerequisite: 6 credits of biological science. Offered: FA
AN SC 201	Animal Science (4) Offered: FA/SP
BIOL 11	Introductory Biology I (3)
BIOL 110	Biology: Basic Concepts and Biodiversity (4) Offered: FA/SP/SU
BIOL 127	Introduction to Plant Biology (3) Offered: FA
BIOL 141	Introductory Physiology (3) Offered: FA/SP/SU
BMB 211	Elementary Biochemistry (3) Prerequisite: CHEM 110; CHEM 202 or CHEM 210. Offered: FA/SP/SU
CHEM 112	Chemical Principles II (3) Prerequisite: CHEM 110 or CHEM 106. Offered: FA/SP/SU
CHEM 202	Fundamentals of Organic Chemistry I (3) Prerequisite: CHEM 101 or CHEM 110 or CHEM 106. Offered: FA/SP/SU
GEO SC 1	Physical Geology (3) Offered: FA/SP
HORT 101	Horticultural Science (3) Offered: FA/SP
MATH 220	Matrices (2-3) Prerequisite: MATH 110 or MATH 140 or MATH 140H. Offered: FA/SP/SU
MICRB 201	Introductory Microbiology (3) Prerequisite: CHEM 110. Offered: FA/SP
PHYS 213	General Physics: Fluids and Thermal Physics (2) Prerequisite: MATH 140, PHYS 211; Concurrent: MATH 141. Offered: FA/SP/SU
PHYS 214	General Physics: Wave Motion and Quantum Physics (2) Prerequisite: MATH 141, PHYS 211 and PHYS 212. Offered: FA/SP/SU
PHYS 237	Introduction to Modern Physics (3) Prerequisite: PHYS 212; Concurrent: PHYS 214. Offered: FA/SP
SOILS 101	Introductory Soil Science (3) Offered: FA/SP

### COURSES THAT MEET THE ENGINEERING SCIENCE/DESIGN REQUIREMENT<sup>+</sup>

AE 308	Introduction to Structural Analysis (4) Prerequisite: EMCH 211, EMCH 213. Offered: FA
AE 310	Fundamentals of Heating, Ventilating, and Air Conditioning (3) Prerequisite: ME 201. Prerequisite or concurrent: AE 202. Offered: SP
AE 402	Design of Concrete Structures for Buildings (3) Prerequisite: AE 221, AE 222, AE 308. Offered: FA
AE 403	Advanced Steel Design for Buildings (3) Prerequisite: AE 401, AE 430. Offered: SP
AE 444	Micro CADD Applications for Buildings (3) Prerequisite: AE 222; CMPSC 201 or CMPSC 202. Offered: FA/SP
AE 470	Residential Building Design and Construction (3) Prerequisite: AE 372 or CE 332. Offered: FA
BE 461	Design of Fluid Power Systems (3) Prerequisite: BE 306 or ME 360; and CE 360 or ME 320. Offered: FA
BE 462	Design of Wood Structures (3) Prerequisite: BE 303, AE 308, or CE 340. Offered: FA
BE 464	Bioenergy Systems Engineering (3) Prerequisite: EME 301, ME 201, ME 300, or CHE 220. Prerequisite or concurrent: BE 308, CHE 340, or CE 479. Offered: FA
BE 465	Food and Biological Process Engineering (3) Prerequisite: BE 302. Offered: FA
BE 467	Design of Stormwater and Erosion Control Facilities (3) Prerequisite: BE 307 or CE 461. Offered: FA
BE 468	Microbiological Engineering (3) Prerequisite: BE 308 or both BMB 211 and MICRB 201. Prerequisite or concurrent: BE 302. Offered: SP
BE 477	Land-Based Waste Disposal (3) Prerequisite: BE 307 or CE 370 or ASM 327. Offered: SP
BE 487	Watershed Modeling for Water Quality Design (3) Prerequisite: BE 307 or CE 461. Offered: SP
CE 310	Surveying (3) Prerequisite: EDSGN 100, MATH 141. Offered: FA/SP/SU
CE 335	Engineering Mechanics of Soils (3) Prerequisite: EMCH 213; AE 221 or GEO SC 1. Offered: FA/SP

CE 340	Structural Analysis (3) Prerequisite: EMCH 213. Prerequisite or concurrent: CMPSC 201 or CMPSC 202. Offered: FA/SP
CE 341	Design of Concrete Structures (3) Prerequisite: CE 340, Prerequisite or concurrent: CE 336. Offered: FA/SP
CE 342	Design of Steel Structures (3) Prerequisite: CE 336, CE 340. Offered: FA/SP
CE 370	Introduction to Environmental Engineering (3) Prerequisite: CHEM 110; MATH 111 or MATH 141. Offered: FA/SP
CE 410	Sustainable Residential Subdivision Design (3) Prerequisite: AE 372 or CE 332. Offered: FA
CE 435	Foundation Engineering (3) Prerequisite: CE 335. Prerequisite or concurrent: CE 341. Offered: FA/SP
CE 461	Water-resource Engineering (3) Prerequisite: CE 360. Offered: FA/SP
CE 462	Open Channel Hydraulics (3) Prerequisite: CE 360. Offered FA/SP
CE 465	Water Resources Capstone Course (3) Prerequisite: CE 461. Prerequisite or concurrent: CE 462. Offered: SP
CE 475	Water Quality Chemistry (4) Prerequisite: C E 370, CHEM 110, CHEM 111. Offered: SP
CE 476	Solid and Hazardous Wastes (3) Prerequisite: CE 370, CE 371. Offered: SP
EDSGN 497	SolidWorks Fundamentals or Current CAD Applications (3). Offered: FA/SP
EDSGN 452	Projects in Humanitarian Engineering (2) Prerequisite: 5 <sup>th</sup> semester standing. Concurrent: EDSGN 453. Offered: SP
EDSGN 453	Design for Developing Communities (1) Prerequisite: 5 <sup>th</sup> semester standing. Offered: SP
EMCH 315	Mechanical Response of Engineering Materials (2) Prerequisite: EMCH 213, EMCH 210H, or EMCH 210. Offered: FA/SP
EMCH 316	Experimental Determination of Mechanical Response of Materials (1) Prerequisite or concurrent: EMCH 315. Offered: FA/SP
IE 312	Product Design and Manufacturing Processes (3) Prerequisite: EMCH 213, EMCH 210H, or EMCH 210; Prerequisite or concurrent: ESC 414M or MATSE 259. Offered: FA/SP/SU
MATSE 259	Properties and Processing of Engineering Materials (3) Prerequisite: EMCH 213 or EMCH 210. Offered: FA/SP/SU
ME 405	Indoor Air Quality Engineering (3) Prerequisite: ME 320 or equivalent. Offered: FA
ME 370	Vibration of Mechanical Systems (3) Prerequisite: EMCH 212, CMPSC 200, MATH 220, MATH 251. Offered: FA/SP
ME 411	Heat-Exchanger Design (3) Prerequisite: ME 410. Offered: SP
ME 410	Heat Transfer (3) Prerequisite: AERSP 308, AERSP 311, CE 360 or ME 320; CMPSC 200 or CMPSC 202; MATH 220 or NUCE 309; MATH 251. Offered: FA/SP/SU
ME 431	Internal Combustion Engines (3) Prerequisite: ME 302. Offered: SP
ME 444	Engineering Optimization (3) Prerequisite: MATH 220; MATH 230 or MATH 231; CMPSC 201 or CMPSC 202 or CMPSC 200. Offered: SP
ME 450	Modeling of Dynamic Systems (3) Prerequisite: ME 370, ME 345. Offered: FA/SP
ME 452	Vehicle Road Dynamics (3) Prerequisite or concurrent: ME 450. Offered: SP
ME 456 (IE 456)	Industrial Robot Applications (3) Prerequisite: MATH 220; MATH 250 or MATH 251; IE 305 or ME 360; CMPSC 200 or CMPSC 201. Offered: FA
ME 462	Lubrication in Machine Design (3) Prerequisite: MATH 251, ME 360. Offered: FA

AG E students with an interest in machinery systems are strongly encouraged to take EDSGN 497, SolidWorks Fundamentals (3), as an Engineering Science/Design or Technical Selection.

#### **COURSES THAT MEET THE BIOLOGICAL/AGRICULTURAL SCIENCE REQUIREMENT<sup>+</sup>**

AGECO 418 (AN SC 418, SOILS 418)	Nutrient Management in Agricultural Systems (3) Offered: FA
AGRO 28	Principles of Crop Management (3) Prerequisite: 6 credits in biological science. Offered: FA
AGRO 423	Forage Crop Management (3) Prerequisite: AGRO 28. Offered: FA
AGRO 425	Field Crop Management (3) Prerequisite: AGRO 28. Offered: SP
ANSC 201	Animal Science (4) Offered: FA/SP

ANSC 309 Beef Cattle Production and Management (4) Prerequisite: ANSC 201. Offered: SP  
 ANSC 310 Dairy Cattle Production and Management (3) Prerequisite: AN SC 201. Offered: SP  
 ANSC 311 Poultry Production and Management (3) Prerequisite: ANSC 201. Offered: FA  
 ASM 309 (ERM 309) Measurement & Monitoring of Hydrologic Systems (3) Prerequisite: PHYS 211 or  
 PHYS 250, CHEM 110. Offered: FA  
 ASM 320 Combustion Engines for Mobile Equipment (3) Prerequisite: BE 306 or ASM 310 or ME  
 360. Offered: SP  
 ASM 420 Principles of Off-Road Machines (3) Prerequisite: BE 306 or ASM 310 or ME 360. Offered:  
 SP  
 ASM 424 Selection and Management of Agricultural Machinery (3) Prerequisite:  
 BE 306 or ASM 310 or ME 360. Offered: FA  
 BIOL 110 Biology: Basic Concepts and Biodiversity (4) Offered: FA/SP/SU  
 BIOL 141 Introductory Physiology (3) Offered: FA/SP/SU  
 BIOL 220W Biology: Populations and Communities (4) Prerequisite: BIOL 110. Offered: SP  
 BIOL 240W Biology: Function and Development of Organisms (4) Prerequisite: BIOL 110, CHEM 110.  
 Offered: SP  
 BRS 411 Biobased Fiber Science (4) Prerequisite: CHEM 110, BRS 300. Offered: SP  
 BRS 417 Wood Products Manufacturing Systems and Processes (4) Prerequisite: WP 200W,  
 WP 203, and sixth-semester standing. Offered: SP  
 BRS 423 Deterioration and Protection of Bioproducts (3) Prerequisite: BRS 300. Concurrent: BRS  
 411. Offered: SP  
 BRS 426 Safety and Health in Agriculture and Biorenewable Industries (3) Prerequisite: BRS 393.  
 Offered: SP  
 ERM 402 Foundations of Sustainable Business (3) Prerequisite: AGBM 101 or ECON 102 or ECON  
 104. Offered: FA  
 ERM 412 Resource Systems Analysis (3) Prerequisite: BIOL 220W, ERM 151, ERM 300 and STAT  
 240; MATH 111 or MATH 141. Offered: FA/SP  
 ERM 430 (PPEM 430) Air Pollution Impacts to Terrestrial Ecosystems (3) Prerequisite: BIOL 220W or  
 FOR 308. Offered: SP  
 ERM 431 (VBSC 431) Environmental Toxicology (3) Prerequisite: BIOL 110, CHEM 110, CHEM 112.  
 Offered: FA  
 ERM 433 Transformation of Pollutants in Soils (3) Prerequisite: CHEM 112, CHEM 111, SOILS 101.  
 Offered: SP  
 ERM 435 (WFS 435) Limnology (3) Prerequisite: BIOL 110, BIOL 220W, CHEM 110. Offered: FA  
 ERM 447 Stream Restoration (3) Prerequisite: ASM 327 or BE 307 or CE 461. Offered: FA  
 ERM 450 (WFS 450) Wetland Conservation (3) Prerequisite: ERM 300 or WFS 209. Offered: FA  
 FOR 455 Remote Sensing and Spatial Data Handling (3) Prerequisite: MATH 110, 3 credits in  
 computer science, 6 credits in ecological and/or geological sciences. Offered: SP  
 FOR 470 Watershed Management (3) Prerequisite: 3 credits in Soils. Offered: SP  
 HORT 101 Horticultural Science (3) Offered: FA/SP  
 HORT 315 Environmental Effects on Horticultural Crops (3) Prerequisite: HORT 101, HORT 202.  
 Offered: SP  
 HORT 402 Plant Nutrition (3) Prerequisite: HORT 315 or BIOL 441, SOILS 101. Offered: SP  
 HORT 412 Post-Harvest Physiology (3) Prerequisite: 6 credits in horticulture or other plant sciences.  
 Offered: SP  
 PLANT 426 Nutrient Management Specialist Preparation (1) Prerequisite: SOILS 101 and SOILS 102.  
 Offered: FA  
 SOILS 101 Introductory Soil Science (3) Offered: FA/SP  
 SOILS 401 Soil Composition and Physical Properties (3) Prerequisite: SOILS 101. Offered: SP  
 SOILS 404 Urban Soils (3) Prerequisite: SOILS 101. Offered: SP  
 SOILS 416 Soil Genesis, Classification, and Mapping (4) Prerequisite: SOILS 101. Offered: FA  
 TURF 235 The Turfgrass (3) Offered: FA

## **COURSES THAT MEET THE TECHNICAL SELECTION REQUIREMENT<sup>†</sup>**

Any course acceptable as a Basic Math/Science, Engineering Science/Design OR Biological/Agricultural Science Requirement may be taken as a Technical Selection, plus CMPSC 121, CMPSC 200, CMPSC 201, CMPSC 202, ENGR 310, ENGR 408, ENGR 451, ENGR 455, ENGR 493, MGMT 215, GEOSC 452.

## **COURSES THAT MEET THE BIOLOGICAL ENGINEERING REQUIREMENT**

BE 461	Design of Fluid Power Systems (3) Prerequisite: BE 306 or ME 360; CE 360 or ME 320. Offered: FA
BE 462	Design of Wood Structures (3) Prerequisite: BE 303, AE 308, or CE 340. Offered: FA
BE 464	Bioenergy Systems Engineering (3) Prerequisite: EME 301, ME 201, ME 300, or CHE 220. Prerequisite or concurrent: BE 308, CHE 340, or CE 479. Offered: FA
BE 465	Food and Biological Process Engineering (3) Prerequisite: BE 302. Offered: FA
BE 467	Design of Stormwater and Erosion Control Facilities (3) Prerequisite: BE 307 or CE 461. Offered: FA
BE 468	Microbiological Engineering (3) Prerequisite: BE 308 or both MICRB 201 and BMB 211. Prerequisite or concurrent: BE 302. Offered: SP
BE 477	Land-Based Waste Disposal (3) Prerequisite: BE 307 or CE 370 or ASM 327. Offered: SP
BE 487	Watershed Modeling for Water Quality Design (3) Prerequisite: BE 307 or CE 461. Offered: SP

<sup>†</sup>Other courses may be taken to meet the engineering science/design, biological/agricultural science, and technical requirements if the student submits a petition approved by the Department of Agricultural and Biological Engineering. All petitions must be submitted and approved prior to the student's graduation semester, however earlier is preferred to ensure adequate progress towards completing degree requirements.



**Recommended electives for students in the Agricultural Engineering option desiring to specialize in  
STRUCTURAL DESIGN**

(See pages 10-13 for complete listing of approved courses)

**BIOLOGICAL ENGINEERING JUNIOR SELECTION (6 credits required)**

- BE 303 Structural Systems in Agriculture (3) Prerequisite: EMCH 210 or EMCH 213. Offered: SP  
BE 307 Soil and Water Engineering (3) Prerequisite or concurrent: CE 360 or ME 320. Offered: SP

**BIOLOGICAL ENGINEERING Requirement (6 credits required)**

- BE 462 Design of Wood Structures (3) Prerequisite: BE 303, AE 308, or CE 340. Offered: FA  
BE 467 Design of Stormwater and Erosion Control Facilities (3) Prerequisite: BE 307 or CE 461.  
Offered: FA

**MATH/BASIC SCIENCE Requirement (3 credits required)**

- ANSC 201 Animal Science (4) Offered: FA/SP  
HORT 101 Horticultural Science (3) Offered: FA/SP

**BIOLOGICAL/AGRICULTURAL SCIENCE Requirement (3 credits required)**

- BRS 417 Wood Products Manufacturing Systems and Processes (4) Prerequisite: WP 200W,  
WP 203, and sixth-semester standing. Offered: SP  
BRS 411 Biobased Fiber Science (4) Prerequisite: CHEM 110, BRS 300. Offered: SP  
BRS 423 Deterioration and Protection of Bioproducts (3) Prerequisite: BRS 300. Concurrent: BRS  
411. Offered: SP

**ENGINEERING SCIENCE/DESIGN Requirement (6 credits required)**

- AE 308 Introduction to Structural Analysis (4) Prerequisite: EMCH 211, EMCH 213. Offered: FA  
AE 470 Residential Building Design and Construction (3) Prerequisite: AE 372 or CE 332. Offered:  
FA  
CE 340 Structural Analysis (3) Prerequisite: EMCH 213. Prerequisite or concurrent: CMPSC 201 or  
CMPSC 202. Offered: FA/SP  
CE 341 Design of Concrete Structures (3) Prerequisite: CE 340, Prerequisite or concurrent:  
CE 336. Offered: FA/SP  
CE 342 Design of Steel Structures (3) Prerequisite: CE 336, CE 340. Offered: FA/SP  
CE 410 Sustainable Residential Subdivision Design (3) Prerequisite: AE 372 or CE 332. Offered:  
FA  
ME 405 Indoor Air Quality Engineering (3) Prerequisite: ME 320 or equivalent. Offered: FA  
ME 410 Heat Transfer (3) Prerequisite: AERSP 308, AERSP 311, CE 360 or ME 320;  
CMPSC 200 or CMPSC 202; MATH 220 or NUCE 309; MATH 251. Offered: FA/SP/SU

**TECHNICAL SELECTION Requirement (6 credits required)**

Any additional 6 credits from the Biological/Agricultural Science or Engineering Science/ Design courses listed above.

**Recommended electives for students in the Agricultural Engineering option desiring to specialize in MACHINERY SYSTEMS**

(See pages 10-13 for complete listing of approved courses)

**BIOLOGICAL ENGINEERING JUNIOR SELECTION (6 credits required)**

BE 306\* Machines for Agricultural and Biological Processing (3) Prerequisite: E MCH 212; E MCH 210 or E MCH 213. Offered: SP

**BIOLOGICAL ENGINEERING Requirement (6 credits required)**

BE 461\* Design of Fluid Power Systems (3) Prerequisite: BE 306 or ME 360; CE 360 or ME 320. Offered: FA

**MATH/BASIC SCIENCE Requirement (3 credits required)**

AGRO 28 Principles of Crop Management (3) Prerequisite: 6 credits in biological science. Offered: FA

**BIOLOGICAL/AGRICULTURAL SCIENCE Requirement (3 credits required)**

AGRO 423 Forage Crop Management (3) Prerequisite: AGRO 28. Offered: FA

AGRO 425\* Field Crop Management (3) Prerequisite: AGRO 28. Offered: SP

ASM 320\* Combustion Engines for Mobile Equipment (3) Prerequisite: BE 306 or ASM 310 or ME 360. Offered: SP

ASM 420\* Principles of Off-Road Machines (3) Prerequisite: BE 306 or ASM 310 or ME 360. Offered: SP

ASM 424\* Selection and Management of Agricultural Machinery (3) Prerequisite: BE 306 or ASM 310 or ME 360. Offered: FA

**ENGINEERING SCIENCE/DESIGN Requirement (6 credits required)**

EDSGN 497 SolidWorks Fundamentals (3). Offered: FA/SP

EMCH 315 Mechanical Response of Engineering Materials (2) Prerequisite: EMCH 213, EMCH 210H, or EMCH 210. Offered: FA/SP

EMCH 316 Experimental Determination of Mechanical Response of Materials (1) Prerequisite or concurrent: EMCH 315. Offered: FA/SP

IE 312 Product Design and Manufacturing Processes (3) Prerequisite: EMCH 213, EMCH 210H, or EMCH 210; Prerequisite or concurrent: ESC 414M or MATSE 259. Offered: FA/SP/SU

MATSE 259 Properties and Processing of Engineering Materials (3) Prerequisite: EMCH 213 or EMCH 210. Offered: FA/SP/SU

ME 431\* Internal Combustion Engines (3) Prerequisite: ME 302. Offered: SP

ME 450 Modeling of Dynamic Systems (3) Prerequisite: ME 370, ME 345. Offered: FA/SP

ME 456 (IE 456) Industrial Robot Applications (3) Prerequisite: MATH 220; MATH 250 or MATH 251; IE 305 or ME 360; CMPSC 200 or CMPSC 201. Offered: FA

ME 462 Lubrication in Machine Design (3) Prerequisite: MATH 251, ME 360. Offered: FA

**TECHNICAL SELECTION Requirement (6 credits required)**

Any additional 6 credits from the Biological/Agricultural Science or Engineering Science/Design courses listed above.

\*Applies toward Off-Road Equipment Minor (<http://abe.psu.edu/majors/minors/off-road-equipment>).

**FOOD AND BIOLOGICAL PROCESSING**  
**ENGINEERING OPTION –**

**GRADUATION CHECKLIST,**  
**SAMPLE ACADEMIC PLAN,**  
**FLOW CHART,**  
**AND SELECTION LISTS**

**BIOLOGICAL ENGINEERING GRADUATION CHECKLIST  
FOOD AND BIOLOGICAL PROCESSING ENGINEERING OPTION**

Student Name \_\_\_\_\_

Student ID/e-mail \_\_\_\_\_

First Year Seminar (1 cr)  
\_\_\_\_\_ 1 \_\_\_\_\_

Communications (GWS - 10 cr)  
ENGL 15           3 \_\_\_\_\_  
CAS 100A/B       3 \_\_\_\_\_  
BE 391             2 \_\_\_\_\_  
BE 392             2 \_\_\_\_\_

Quantification (GQ - 14 cr)  
MATH 140         4 \_\_\_\_\_\*  
MATH 141         4 \_\_\_\_\_\*  
MATH 231         2 \_\_\_\_\_  
MATH 251         4 \_\_\_\_\_\*

Natural Science (GN - 18 cr)  
CHEM 110         3 \_\_\_\_\_\*  
CHEM 111         1 \_\_\_\_\_  
CHEM 202         3 \_\_\_\_\_  
PHYS 211         4 \_\_\_\_\_\*  
PHYS 212         4 \_\_\_\_\_\*  
BMB 211         3 \_\_\_\_\_

Social Science (GS - 6 cr)  
ECON 102, ECON 104,  
or AGBM 101     3 \_\_\_\_\_  
\_\_\_\_\_

Humanities (GH - 6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

Art (GA - 6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

US Cultures (US - 3 cr)  
 International Cultures (IL - 3 cr)  
 World Language Admissions

Engineering (21 cr)

EDSGN 100       3 \_\_\_\_\_  
EMCH 211        3 \_\_\_\_\_\*  
EMCH 212        3 \_\_\_\_\_\*  
EMCH 213        3 \_\_\_\_\_\*  
ME 300           3 \_\_\_\_\_\*  
CE 360 or ME 320   3 \_\_\_\_\_\*  
+ IE 424         3 \_\_\_\_\_

Biological Engineering (26 cr)  
BE 301           3 \_\_\_\_\_\*  
BE 302           4 \_\_\_\_\_\*  
BE 304           3 \_\_\_\_\_\*  
BE 305           3 \_\_\_\_\_\*  
BE 308           3 \_\_\_\_\_\*  
BE 460           1 \_\_\_\_\_  
BE 465           3 \_\_\_\_\_  
BE 466           3 \_\_\_\_\_  
BE 468           3 \_\_\_\_\_

Emphasis Technical Electives (6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

Engineering Science/Design (6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

Technical Requirement (6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

PE & Health (GHA - 3 cr)  
NUTR 100        1.5 \_\_\_\_\_

+ *STAT 401 only acceptable for IE 424 if 3 cr of technical selections are engineering science/design*

Total required credits for graduation = 129

\* courses require C or better

**Sample Academic Plan for BE Major -- Food and Biological Processing Engineering Option**

Semester 1	Credits	Semester 2	Credits
First Year Seminar	1	CHEM 111 (GN) - Experimental Chemistry I	1
<b><i>CHEM 110 (GN) - Chemical Principles I</i></b>	3	GA/GH/GS	3
ECON 102/ECON 104/AGBM 101 (GS) - Economics	3	<b><i>MATH 141 (GQ) - Calculus with Analytic Geometry II</i></b>	4
EDSGN 100 - Introduction to Engineering Design	3	ENGL 15 (GWS) - Rhetoric and Composition	3
<b><i>MATH 140 (GQ) - Calculus with Analytic Geometry I</i></b>	4	<b><i>PHYS 211 (GN) - General Physics: Mechanics</i></b>	4
GA/GH/GS	3		
Total Credits:	17	Total Credits:	15
Semester 3	Credits	Semester 4	Credits
GA/GH/GS	3	<b>EMCH 212 - Dynamics</b>	3
CAS 100A/B (GWS) - Effective Speech	3	<b>EMCH 213 - Strength of Materials</b>	3
<b>EMCH 211 - Statics</b>	3	<b>ME 300 - Thermodynamics</b>	3
<b><i>MATH 251 - Ordinary and Partial Differential Equations</i></b>	4	MATH 231 - Calculus of Several Variables	2
<b><i>PHYS 212 (GN) - General Physics: Electricity and Magnetism</i></b>	4	CHEM 202 - Fundamentals of Organic Chemistry I	3
		GA/GH/GS	3
Total Credits:	17	Total Credits:	17
Semester 5	Credits	Semester 6	Credits
<b>BE 301 - Mathematical Modeling of Biological and Physical Systems</b>	3	BE 391 (GWS) - Contextual Integration of Communication Skills for Technical Workplace	2
<b>BE 304 - Engineering Properties of Food and Biological Materials</b>	3	<b>BE 302 - Heat and Mass Transfer in Biological Systems</b>	4
<b>BE 308 - Engineering Elements of Biochemistry and Microbiology</b>	3	<b>BE 305 - Agricultural Measurements and Control Systems</b>	3
<b>ME 320 or CE 360 - Fluid Mechanics</b>	3	BMB 211 - Elementary Biochemistry	3
GA/GH/GS	3	IE 424 - Process Quality Engineering	3
Total Credits:	15	Total Credits:	15
Semester 7	Credits	Semester 8	Credits
BE 392 (GWS) - Contextual Integration of Leadership Skills for the Technical Workplace	2	BE 466 - Biological Engineering Design II	3
BE 460 - Biological Engineering Design I	1	Engineering Science/Design Selection	3
BE 465 - Food and Biological Process Engineering	3	BE 468 - Microbiological Engineering	3
Emphasis Technical Selection	3	Emphasis Technical Selection	3
Technical Selection	3	Technical Selection	3
Engineering Science/Design Selection	3	GHA	1.5
NUTR 100 (GHA) - Contemporary Nutrition Concerns	1.5		
Total Credits:	16.5	Total Credits:	16.5

Total Credits = 129, Italics = ETM requirement, Bold = C or better required

Student Name: \_\_\_\_\_

Student ID: \_\_\_\_\_

**BE Major -- Natural Resources Engineering Option**

Semester 1	Credits	Completed	Petition	Semester 2	Credits	Completed	Petition
First Year Seminar	1			CHEM 111 (GN)	1		
*CHEM 110 (GN)	3			GA/GH/GS	3		
ECON 102/ECON 104/AGBM 101 (GS)	3			*MATH 141 (GQ)	4		
EDSGN 100	3			ENGL 15 (GWS)	3		
*MATH 140 (GQ)	4			*PHYS 211 (GN)	4		
GA/GH/GS	3						
Semester 3	Credits			Semester 4	Credits		
GA/GH/GS	3			*EMCH 212	3		
CAS 100A/B (GWS)	3			*EMCH 213	3		
*EMCH 211	3			*ME 300	3		
*MATH 251	4			MATH 231	2		
*PHYS 212 (GN)	4			SOILS 101	3		
				GA/GH/GS	3		
Semester 5	Credits			Semester 6	Credits		
*BE 301	3			BE 391 (GWS)	2		
*BE 304	3			*BE 302	4		
*BE 308	3			*BE 305	3		
*CE 360	3			*BE 307	3		
*ASM 309	3			Tech Selection	3		
Semester 7	Credits			Semester 8	Credits		
BE 392 (GWS)	2			BE 466	3		
BE 460	1			BE 477	3		
BE 467	3			BE 487	3		
IE 424 OR STAT 401	3			Eng Sci/Dsgn Selection	3		
Bio/Env Sci Selection	3			GA/GH/GS	3		
Eng Sci/Dsgn Selection	3			GHA	1.5		
GHA	1.5						

Total Credits = 129, \* courses require C or better

World Language Admissions

US Cultures

International Cultures

3		
3		

GA

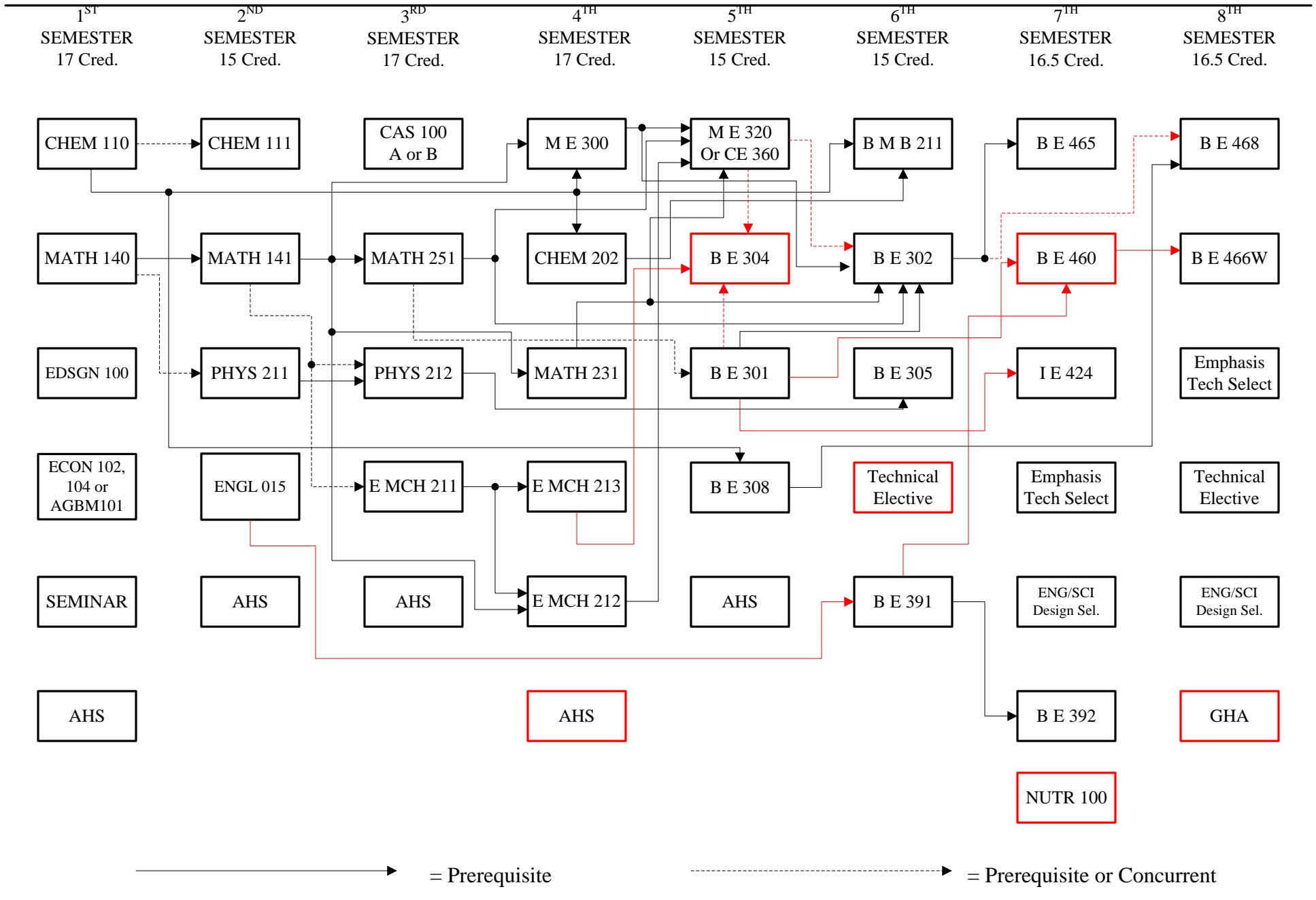
GH

GS

6		
6		
6		

# BIOLOGICAL ENGINEERING

## FOOD AND BIOLOGICAL PROCESS ENGINEERING OPTION



## FOOD AND BIOLOGICAL PROCESS ENGINEERING OPTION SELECTION LISTS

### COURSES THAT MEET THE EMPHASIS TECHNICAL ELECTIVES REQUIREMENT \*

ANSC 300	Integrated Animal Biology (3) Prerequisite: BIOL 11 and BIOL 12, or BIOL 110; at least third-semester standing. Offered: SP
BE 306	Machines for Agricultural and Biological Processing (3) Prerequisite: EMCH 212; EMCH 210 or EMCH 213. Offered: SP
BMB 212	Elementary Biochemistry Laboratory (1) Prerequisite or concurrent: BMB 211. Offered: FA/SP
BMB 251	(MICRB 251) Molecular and Cell Biology I (3) Prerequisite: CHEM 112. Offered: FA/SP
BMB 428	Physical Chemistry with Biological Applications (3) Prerequisite: CHEM 203 or CHEM 212, PHYS 203 or PHYS 251; 3 credits in cell biology. Offered: FA
BMB 442	Laboratory in Proteins, Nucleic Acids, and Molecular Cloning (3) Prerequisite: BMB 251, BIOL 230W, or MICRB 201; CHEM 202 or CHEM 210. Prerequisite or concurrent: BMB 211 or BMB 401. Offered: FA/SP
BMB 460	(MICRB 460) Cell Growth and Differentiation (3) Prerequisite: BMB 252. Offered: SP
BIOL 110	Biology: Basic Concepts and Biodiversity (4) Offered: FA/SP/SU
BIOL 220W	Biology: Populations and Communities (4) Prerequisite: BIOL 110. Offered: SP
BIOL 230W	Biology: Molecules and Cells (4) Prerequisite: BIOL 110, CHEM 110. Offered: FA
BIOL 240W	Biology: Function and Development of Organisms (4) Prerequisite: BIOL 110, CHEM 110. Offered: SP
BIOL 141	Introductory Physiology (3) Offered: FA/SP/SU
BIOL 142	Physiology Laboratory (1) Prerequisite or concurrent: BIOL 141. Offered: FA/SP
BIOTC 416	(MICRB 416) Microbial Biotechnology (2) Prerequisite: MICRB 201, MICRB 202, BMB 442. Offered: FA
BIOTC 459	(HORT 459, BIOL 459) Plant Tissue Culture and Biotechnology (3) Prerequisite: BIOL 230W; or BMB 251, BMB 252. Offered; SP
BIOTC 479	Methods in Biofermentations (3) Prerequisite: MICRB 201, MICRB 202; BMB 251, BMB 252, BMB 442. Offered: FA/SP
BIOTC 489	Animal Cell Culture Methods (3) Prerequisite: MICRB 201, MICRB 202; BIOL 230W or BMB 251. Offered; FA
BME 201	Fundamentals of Cells and Molecules (3) Prerequisite: BIOL 141 or BIOL 240W, CHEM 112, MATH 141. Prerequisite or concurrent: PHYS 212, CMPSC 200. Offered: SP
CHEM 112	Chemical Principles II (3) Prerequisite: CHEM 110 or CHEM 106. Offered: FA/SP/SU
CHEM 113	Experimental Chemistry II (1) Prerequisite: CHEM 111. Prerequisite or concurrent: CHEM 112. Offered: FA/SP
CHEM 203	Fundamentals of Organic Chemistry II (3) Prerequisite: CHEM 202. Offered: FA/SP
FDSC 200	Introductory Food Science (3) Prerequisite: CHEM 110. Offered: SP
FDSC 207	(ANSC 207) Animal Products Technology (2) Offered: FA
FDSC 208	(ANSC 208) Animal Products Technology Laboratory (1) Prerequisite or concurrent: ANSC 207. Offered: FA/SP
FDSC 233	The Science of Winemaking (3) Prerequisite: CHEM 110 or BIOL 110. Offered: SP
FDSC 400	Food Chemistry (4) Prerequisite: CHEM 202. Prerequisite or concurrent: BMB 211, BMB 212, FDSC 200, FDSC 201. Offered: FA
FDSC 404	Sensory Evaluation of Foods (3) Prerequisite: STAT 250, Junior standing. Offered: SP
FDSC 406	Physiology of Nutrition (3) Prerequisite: BMB 211. Prerequisite or concurrent: FDSC 200, FDSC 201. Offered: SP
FDSC 407	Food Toxins (2) Prerequisite: senior standing in food science or related majors. Offered: FA
FDSC 408	Food Microbiology (3) Prerequisite: MICRB 201. Prerequisite or concurrent: FDSC 200, FDSC 201. Offered: FA
FDSC 409	Laboratory in Food Microbiology (2) Prerequisite: MICRB 202, FDSC 200, FDSC 201. Prerequisite or concurrent: FDSC 408. Offered: FA/SP



FDSC 410	Chemical Methods of Food Analysis (3) Prerequisite: BMB 212, FDSC 400. Prerequisite or concurrent: FDSC 200, FDSC 201. Offered: SP
FDSC 411	Managing Food Quality (3) Prerequisite: FDSC 200, FDSC 201, FDSC 408, STAT 250. Offered: FA
FDSC 413	Science and Technology of Plant Foods (3) Prerequisite: FDSC 200, FDSC 201, and at least 2 of the following 400 level courses (FDSC 400, FDSC 405, FDSC 408, FDSC 410). Offered: FA
FDSC 414	Science and Technology of Dairy Foods (3) Prerequisite: FDSC 200, FDSC 201, and at least 2 of the following 400 level courses (FDSC 400, FDSC 405, FDSC 408, FDSC 410). Offered: SP
FDSC 415	Science and Technology of Muscle Foods (3) Prerequisite: FDSC 200, FDSC 201, and at least 2 of the following 400 level courses (FDSC 400, FDSC 405, FDSC 408, FDSC 410). Offered: SP
FDSC 430	Unit Operations in Food Processing (3) Prerequisite: FDSC 400, FDSC 405, FDSC 408
HORT 101	Horticultural Science (3) Offered: FA/SP
HORT 402	Plant Nutrition (3) Prerequisite: HORT 315 or BIOL 441, SOILS 101. Offered: SP
HORT 412	Post-Harvest Physiology (3) Prerequisite: 6 credits in horticulture or other plant sciences. Offered: SP
HORT 420	Plant Growth Regulators (3) Prerequisite: BIOL 110 or HORT 101. Offered: FA

FDSC 405 (Food Engineering Principles) is not accepted as an elective due to overlap in content with engineering fundamentals and B E 465.

#### **COURSES THAT MEET THE ENGINEERING SCIENCE/DESIGN REQUIREMENT<sup>+</sup>**

BE 306	Machines for Agricultural and Biological Processing (3) Prerequisite: EMCH 212; EMCH 210 or EMCH 213. Offered: SP
BE 461	Design of Fluid Power Systems (3) Prerequisite: BE 306 or ME 360; CE 360 or ME 320. Offered: FA
BE 464	Bioenergy Systems Engineering (3) Prerequisite: EME 301, ME 201, ME 300, or CHE 220. Prerequisite or concurrent: BE 308, CHE 340, or CE 479. Offered: FA
BE 477	Land-Based Waste Disposal (3) Prerequisite: BE 307 or CE 370 or ASM 327. Offered: SP
BME 201	Fundamentals of Cells and Molecules (3) Prerequisite: BIOL 141 or BIOL 240W; CHEM 112; MATH 141. Prerequisite or concurrent: PHYS 212; CMPSC 200. Offered: SP
BME 301	Analysis of Physiological Systems (4) Prerequisite: BIOL 141 or BIOL 240W; PHYS 212; MATH 250 or MATH 251; CMPSC 200. Offered: FA
BME 303	Bio-Continuum Mechanics (3) Prerequisite: BIOL 141 or BIOL 240W; EMCH 210 or EMCH 211 and EMCH 213; MATH 230 or MATH 231 and MATH 232; MATH 251. Offered: FA
BME 406	Medical Imaging (3) Prerequisite: PHYS 212; CMPSC 200 or CMPSC 201. Offered: FA
BME 410	Biomedical Applications of Microfluidics (3) Prerequisite: CHEM 112; PHYS 211. Prerequisite or concurrent: BME 303, ME 320, CHE 330, AERSP 308, or PHYS 213. Offered: FA
BME 413	Mass Transport in Biological Systems (3) Prerequisite: BME 313 or ME 300 or ME 302 or CHE 220 or PHYS 213 and MATH 250 or MATH 251 and BIOL 141 or BIOL 240W. Offered: SP
BME 419	Artificial Organs and Prosthetic Devices (3) Prerequisite: BIOL 141 or BIOL 240W or BIOL 472 and CMPSC 200 or CMPSC 201 or CMPSC 121. Offered: SP
BME 423	Reaction Kinetics of Biological Systems (3) Prerequisite: BIOL 141 or BIOL 240W, CHEM 112, MATH 250 or MATH 251, BME 313 or CHE 210 or ME 300. Concurrent or prerequisite: BME 413 or CHE 410 or BE 302. Offered: SP
BME 433	Drug Delivery (3) Prerequisite: CHEM 112; BME 201 or BIOL 230W or BMB 251; BME 413 or BE 302 or CHE 410. Offered: FA

BME 443	(MATSE 403) Biomedical Materials (3) Prerequisite: MATSE 201 or CHEM 112; MATH 230 or MATH 231. Offered: FA
BME 444	(IL) (MATSE 404) Surfaces and the Biological Response to Materials (3) Prerequisite: CHEM 112 or MATSE 112. Offered: SP
BME 445	Tissue Engineering: Concepts, Calculations and Applications (3) Prerequisite: CHEM 112; BME 201, BIOL 230W, or BMB 251; PHYS 211. Offered: FA
BME 446	Polymers in Biomedical Engineering (3) Prerequisite: CHEM 112, CHEM 113, CHEM 202 or CHEM 210, EMCH 210 or EMCH 211 and EMCH 213. Offered: FA
CHE 340	Introduction to Biomolecular Engineering (3) Prerequisite: CHE 210 with "C" or better, BMB 251, CHEM 212. Offered: FA/SP
CHE 449	Bioseparations (3) Prerequisite: CHE 410. Offered: SP
CE 370	Introduction to Environmental Engineering (3) Prerequisite: CHEM 110; MATH 111 or MATH 141. Offered: FA/SP/SU
CE 371	Water and Wastewater Treatment (3) Prerequisite: CE 360, CE 370. Offered: FA/SP/SU
EDSGN 452	Projects in Humanitarian Engineering (2) Prerequisite: 5 <sup>th</sup> semester standing. Concurrent: EDSGN 453. Offered: SP
EDSGN 453	Design for Developing Communities (1) Prerequisite: 5 <sup>th</sup> semester standing. Offered: SP
EDSGN 497	Solidworks Fundamentals or Current CAD Applications (3) Offered: FA/SP
ENVSE 400	Safety Engineering (3) Prerequisite: CHEM 110, PHYS 211, MATH 141. Offered: FA
IE 312	Product Design and Manufacturing Processes (3) Prerequisite: EMCH 213, EMCH 210H, or EMCH 210; Prerequisite or concurrent: ESC 414M or MATSE 259. Offered: FA/SP/SU
IE 327	Introduction to Work Design (3) Prerequisite: MATH 141; Prerequisite or concurrent: EMCH 211 or E MCH 210. Offered: FA/SP/SU
IE 405	Deterministic Models in Operations Research (3) Prerequisite: MATH 220. Offered: FA/SP/SU
IE 425	Stochastic Models in Operations Research (3) Prerequisite: MATH 220 and IE 322. Concurrent: IE 405. Offered: FA/SP/SU
IE 467	Facility Layout and Location (3) Prerequisite: IE 322, IE 405. Offered: SP
ME 410	Heat Transfer (3) Prerequisite: AERSP 308, AERSP 311, CE 360 or ME 320, CMPSC 200 or CMPSC 202, MATH 220 or NUCE 309, MATH 251. Offered: FA/SP/SU
ME 411	Heat-Exchanger Design (3) Prerequisite: ME 410. Offered: SP
ME 420	Compressible Flow I (3) Prerequisite: ME 320. Offered: SP

### **COURSES THAT MEET THE TECHNICAL SELECTION REQUIREMENT\***

Any course acceptable as Engineering/Science Design or Emphasis Technical Elective may be taken as a Technical Selection, plus CMPSC 121, CMPSC 200, CMPSC 201, CMPSC 202, ENGR 310, ENGR 408, ENGR 451, ENGR 455, ENGR 493, ERM 402, MATH 220 and MGMT 215.

\*Other courses may be taken to meet the engineering science/design, biological/agricultural science, and technical requirements if the student submits a petition approved by the Department of Agricultural and Biological Engineering. All petitions must be submitted and approved prior to the student's graduation semester, however earlier is preferred to ensure adequate progress towards completing degree requirements.

**Recommended electives for students in the Food and Biological Process Engineering option desiring to specialize in BIOLOGICAL PROCESS ENGINEERING**

(See pages 21-23 for complete listing of approved courses)

**EMPHASIS TECHNICAL ELECTIVE Requirement (6 credits required)**

BIOL 141	Introductory Physiology (3) Offered: FA/SP/SU
BMB 251*	(MICRB 251) Molecular and Cell Biology I (3) Prerequisite: CHEM 112. Offered: FA/SP
BMB 442	Laboratory in Proteins, Nucleic Acids, and Molecular Cloning (3) Prerequisite: BMB 251, BIOL 230W, or MICRB 201; CHEM 202 or CHEM 210. Prerequisite or concurrent: BMB 211 or BMB 401. Offered: FA/SP
BIOL 110	Biology: Basic Concepts and Biodiversity (4) Offered: FA/SP/SU
BIOL 230W	Biology: Molecules and Cells (4) Prerequisite: BIOL 110, CHEM 110. Offered: FA
BIOTC 416	(MICRB 416) Microbial Biotechnology (2) Prerequisite: MICRB 201, MICRB 202, BMB 442. Offered: FA
BIOTC 459	(HORT 459, BIOL 459) Plant Tissue Culture and Biotechnology (3) Prerequisite: BIOL 230W; or BMB 251, BMB 252. Offered; SP
BIOTC 479	Methods in Biofermentations (3) Prerequisite: MICRB 201, MICRB 202; BMB 251, BMB 252, BMB 442. Offered: FA/SP
BIOTC 489	Animal Cell Culture Methods (3) Prerequisite: MICRB 201, MICRB 202; BIOL 230W or BMB 251. Offered; FA
BME 201	Fundamentals of Cells and Molecules (3) Prerequisite: BIOL 141 or BIOL 240W; CHEM 112; MATH 141. Prerequisite or concurrent: PHYS 212; CMPSC 200. Offered: SP
CHEM 112	Chemical Principles II (3) Prerequisite: CHEM 110 or CHEM 106. Offered: FA/SP/SU

**ENGINEERING SCIENCE/DESIGN Requirement (6 credits required)**

BE 464	Bioenergy Systems Engineering (3) Prerequisite: EME 301, ME 201, ME 300, or CHE 220. Prerequisite or concurrent: BE 308, CHE 340, or CE 479. Offered: FA
BME 413	Mass Transport in Biological Systems (3) Prerequisite: BME 313 or ME 300 or ME 302 or CHE 220 or PHYS 213 and MATH 250 or MATH 251 and BIOL 141 or BIOL 240W. Offered: SP
BME 423	Reaction Kinetics of Biological Systems (3) Prerequisite: BIOL 141 or BIOL 240W, CHEM 112, MATH 250 or MATH 251, BME 313 or CHE 210 or ME 300. Concurrent or prerequisite: BME 413 or CHE 410 or BE 302. Offered: SP
BME 433	Drug Delivery (3) Prerequisite: CHEM 112; BME 201 or BIOL 230W or BMB 251; BME 413 or BE 302 or CHE 410. Offered: FA
CHE 340	Introduction to Biomolecular Engineering (3) Prerequisite: CHE 210 with "C" or better, BMB 251, CHEM 212. Offered: FA/SP
CHE 449	Bioseparations (3) Prerequisite: CHE 410. Offered: SP

**TECHNICAL SELECTION Requirement (6 credits required)**

Any additional 6 credits from the Emphasis Technical Elective or Engineering Science/Design courses listed above.

\*BMB 251 can be petitioned as substitute for BMB 211

**Recommended electives for students in the Food and Biological Process Engineering option desiring to specialize in FOOD PROCESS ENGINEERING**

(See pages 21-23 for complete listing of approved courses)

**EMPHASIS TECHNICAL ELECTIVE Requirement (6 credits required)**

BE 306	Machines for Agricultural and Biological Processing (3) Prerequisite: EMCH 212; EMCH 210 or EMCH 213. Offered: SP
FDSC 400	Food Chemistry (4) Prerequisite: CHEM 202. Prerequisite or concurrent: BMB 211, BMB 212, FDSC 200, FDSC 201. Offered: FA
FDSC 408	Food Microbiology (3) Prerequisite: MICRB 201. Prerequisite or concurrent: FDSC 200, FDSC 201. Offered: FA
FDSC 409	Laboratory in Food Microbiology (2) Prerequisite: MICRB 202, FDSC 200, FDSC 201. Prerequisite or concurrent: FDSC 408. Offered: FA/SP
FDSC 411	Managing Food Quality (3) Prerequisite: FDSC 200, FDSC 201, FDSC 408, STAT 250. Offered: FA
FDSC 430	Unit Operations in Food Processing (3) Prerequisite: FDSC 400, FDSC 405, FDSC 408
HORT 101	Horticultural Science (3) Offered: FA/SP
HORT 412	Post-Harvest Physiology (3) Prerequisite: 6 credits in horticulture or other plant sciences. Offered: SP

**ENGINEERING SCIENCE/DESIGN Requirement (6 credits required)**

BE 306	Machines for Agricultural and Biological Processing (3) Prerequisite: EMCH 212; EMCH 210 or EMCH 213. Offered: SP
BE 461	Design of Fluid Power Systems (3) Prerequisite: BE 306 or ME 360; CE 360 or ME 320. Offered: FA
BE 464	Bioenergy Systems Engineering (3) Prerequisite: EME 301, ME 201, ME 300, or CHE 220. Prerequisite or concurrent: BE 308, CHE 340, or CE 479. Offered: FA13
CHE 449	Bioseparations (3) Prerequisite: CHE 410. Offered: SP
ENVSE 400	Safety Engineering (3) Prerequisite: CHEM 110, PHYS 211, MATH 141. Offered: FA
IE 405	Deterministic Models in Operations Research (3) Prerequisite: MATH 220. Offered: FA/SP/SU
IE 425	Stochastic Models in Operations Research (3) Prerequisite: MATH 220 and IE 322. Concurrent: IE 405. Offered: FA/SP/SU
ME 410	Heat Transfer (3) Prerequisite: AERSP 308, AERSP 311, CE 360 or ME 320, CMPSC 200 or CMPSC 202, MATH 220 or NUCE 309, MATH 251. Offered: FA/SP/SU
ME 411	Heat-Exchanger Design (3) Prerequisite: ME 410. Offered: SP

**TECHNICAL SELECTION Requirement (6 credits required)**

Any additional 6 credits from the Emphasis Technical Elective or Engineering Science/Design courses listed above.

**NATURAL RESOURCES ENGINEERING OPTION –**

**GRADUATION CHECKLIST,**  
**SAMPLE ACADEMIC PLAN,**  
**FLOW CHART,**  
**AND SELECTION LISTS**

**BIOLOGICAL ENGINEERING GRADUATION CHECKLIST  
NATURAL RESOURCES ENGINEERING OPTION**

Student Name \_\_\_\_\_

Student ID/e-mail \_\_\_\_\_

First Year Seminar (1 cr)  
\_\_\_\_\_ Cr. Completed \_\_\_\_\_ Petition? \_\_\_\_\_

Communications (GWS - 10 cr)  
ENGL 15            3    \_\_\_\_\_  
CAS 100A/B        3    \_\_\_\_\_  
BE 391             2    \_\_\_\_\_  
BE 392             2    \_\_\_\_\_

Quantification (GQ - 14 cr)  
MATH 140          4    \_\_\_\_\_\*  
MATH 141          4    \_\_\_\_\_\*  
MATH 231          2    \_\_\_\_\_  
MATH 251          4    \_\_\_\_\_\*

Natural Science (GN - 15 cr)  
CHEM 110          3    \_\_\_\_\_\*  
CHEM 111          1    \_\_\_\_\_  
PHYS 211          4    \_\_\_\_\_\*  
PHYS 212          4    \_\_\_\_\_\*  
SOILS 101         3    \_\_\_\_\_

Social Science (GS - 6 cr)  
ECON 102, ECON 104,  
or AGBM 101      3    \_\_\_\_\_  
\_\_\_\_\_

Humanities (GH - 6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

Art (GA - 6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

US Cultures (US - 3 cr)  
 International Cultures (IL - 3 cr)  
 World Language Admissions

Engineering (21 cr)  
\_\_\_\_\_ Cr. Completed \_\_\_\_\_ Petition? \_\_\_\_\_

EDSGN 100        3    \_\_\_\_\_  
EMCH 211         3    \_\_\_\_\_\*  
EMCH 212         3    \_\_\_\_\_\*  
EMCH 213         3    \_\_\_\_\_\*  
ME 300             3    \_\_\_\_\_\*  
CE 360             3    \_\_\_\_\_\*  
IE 424 or STAT 401   3    \_\_\_\_\_

Biological Engineering (35 cr)  
ASM 309          3    \_\_\_\_\_\*  
BE 301             3    \_\_\_\_\_\*  
BE 302             4    \_\_\_\_\_\*  
BE 304             3    \_\_\_\_\_\*  
BE 305             3    \_\_\_\_\_\*  
BE 307             3    \_\_\_\_\_\*  
BE 308             3    \_\_\_\_\_\*  
BE 460             1    \_\_\_\_\_  
BE 466             3    \_\_\_\_\_  
BE 467             3    \_\_\_\_\_  
BE 477             3    \_\_\_\_\_  
BE 487             3    \_\_\_\_\_

Biological/Environmental Science (3 cr)  
\_\_\_\_\_

Engineering Science/Design (6 cr)  
\_\_\_\_\_  
\_\_\_\_\_

Technical Requirement (3 cr)  
\_\_\_\_\_

PE & Health (GHA - 3 cr)  
\_\_\_\_\_  
\_\_\_\_\_

Total required credits for graduation = 129

\* courses require C or better

**Sample Academic Plan for BE Major -- Natural Resources Engineering Option**

Semester 1	Credits	Semester 2	Credits
First Year Seminar	1	CHEM 111 (GN) - Experimental Chemistry I	1
<b><i>CHEM 110 (GN) - Chemical Principles I</i></b>	3	GA/GH/GS	3
ECON 102/ECON 104/AGBM 101 (GS) - Economics	3	<b><i>MATH 141 (GQ) - Calculus with Analytic Geometry II</i></b>	4
EDSGN 100 - Introduction to Engineering Design	3	ENGL 15 (GWS) - Rhetoric and Composition	3
<b><i>MATH 140 (GQ) - Calculus with Analytic Geometry I</i></b>	4	<b><i>PHYS 211 (GN) - General Physics: Mechanics</i></b>	4
GA/GH/GS	3		
Total Credits:	17	Total Credits:	15
Semester 3	Credits	Semester 4	Credits
GA/GH/GS	3	<b>EMCH 212 - Dynamics</b>	3
CAS 100A/B (GWS) - Effective Speech	3	<b>EMCH 213 - Strength of Materials</b>	3
<b>EMCH 211 - Statics</b>	3	<b>ME 300 - Thermodynamics</b>	3
<b><i>MATH 251 - Ordinary and Partial Differential Equations</i></b>	4	MATH 231 - Calculus of Several Variables	2
<b><i>PHYS 212 (GN) - General Physics: Electricity and Magnetism</i></b>	4	SOILS 101 - Introductory Soil Science	3
		GA/GH/GS	3
Total Credits:	17	Total Credits:	17
Semester 5	Credits	Semester 6	Credits
<b>BE 301 - Mathematical Modeling of Biological and Physical Systems</b>	3	BE 391 (GWS) - Contextual Integration of Communication Skills for Technical Workplace	2
<b>BE 304 - Engineering Properties of Food and Biological Materials</b>	3	<b>BE 302 - Heat and Mass Transfer in Biological Systems</b>	4
<b>BE 308 - Engineering Elements of Biochemistry and Microbiology</b>	3	<b>BE 305 - Agricultural Measurements and Control Systems</b>	3
<b>ASM 309 - Measurement and Monitoring of Hydrologic Systems</b>	3	<b>BE 307 - Principles of Soil and Water Engineering</b>	3
<b>CE 360 - Fluid Mechanics</b>	3	Technical Selection	3
Total Credits:	15	Total Credits:	15
Semester 7	Credits	Semester 8	Credits
BE 392 (GWS) - Contextual Integration of Leadership Skills for the Technical Workplace	2	BE 466 - Biological Engineering Design II	3
BE 460 - Biological Engineering Design I	1	BE 477 - Land-Based Waste Disposal	3
BE 467 - Design of Stormwater and Erosion Control Facilities	3	BE 487 - Watershed Modeling for Water Quality Design	3
Engineering Science/Design Selection	3	Engineering Science/Design Selection	3
IE 424 - Process Quality Engineering OR STAT 401 - Experimental Methods	3	GA/GH/GS	3
Bio/Env Science Selection	3	GHA	1.5
GHA	1.5		
Total Credits:	16.5	Total Credits:	16.5

Total Credits = 129, Italics = ETM requirement, Bold = C or better required

Student Name: \_\_\_\_\_

Student ID: \_\_\_\_\_

**B E Major -- Natural Resources Engineering Option**

<b>Semester 1</b>	<b>Credits</b>	<b>Completed</b>	<b>Petition</b>	<b>Semester 2</b>	<b>Credits</b>	<b>Completed</b>	<b>Petition</b>
First Year Seminar	1			CHEM 111 (GN)	1		
*CHEM 110 (GN)	3			GA/GH/GS	3		
ECON 102/ECON 104/AG BM 101 (GS)	3			*MATH 141 (GQ)	4		
EDSGN 100	3			ENGL 015 (GWS)	3		
*MATH 140 (GQ)	4			*PHYS 211 (GN)	4		
GA/GH/GS	3						
<b>Semester 3</b>	<b>Credits</b>			<b>Semester 4</b>	<b>Credits</b>		
GA/GH/GS	3			*E MCH 212	3		
CAS 100A/B (GWS)	3			*E MCH 213	3		
*E MCH 211	3			*M E 300	3		
*MATH 251	4			MATH 231	2		
*PHYS 212 (GN)	4			SOILS 101	3		
				GA/GH/GS	3		
<b>Semester 5</b>	<b>Credits</b>			<b>Semester 6</b>	<b>Credits</b>		
*B E 301	3			B E 391 (GWS)	2		
*B E 304	3			*B E 302	4		
*B E 308	3			*B E 305	3		
*C E 360	3			*B E 307	3		
*A S M 309	3			Tech Selection	3		
<b>Semester 7</b>	<b>Credits</b>			<b>Semester 8</b>	<b>Credits</b>		
B E 392 (GWS)	2			B E 466W	3		
B E 460	1			B E 477	3		
B E 467	3			B E 487	3		
I E 424 OR STAT 401	3			Eng Sci/Dsgn Selection	3		
Bio/Env Sci Selection	3			GA/GH/GS	3		
Eng Sci/Dsgn Selection	3			GHA	1.5		
GHA	1.5						

Total Credits = 129, \* courses require C or better

World Language Admissions

US Cultures

International Cultures

3  
3


GA 6

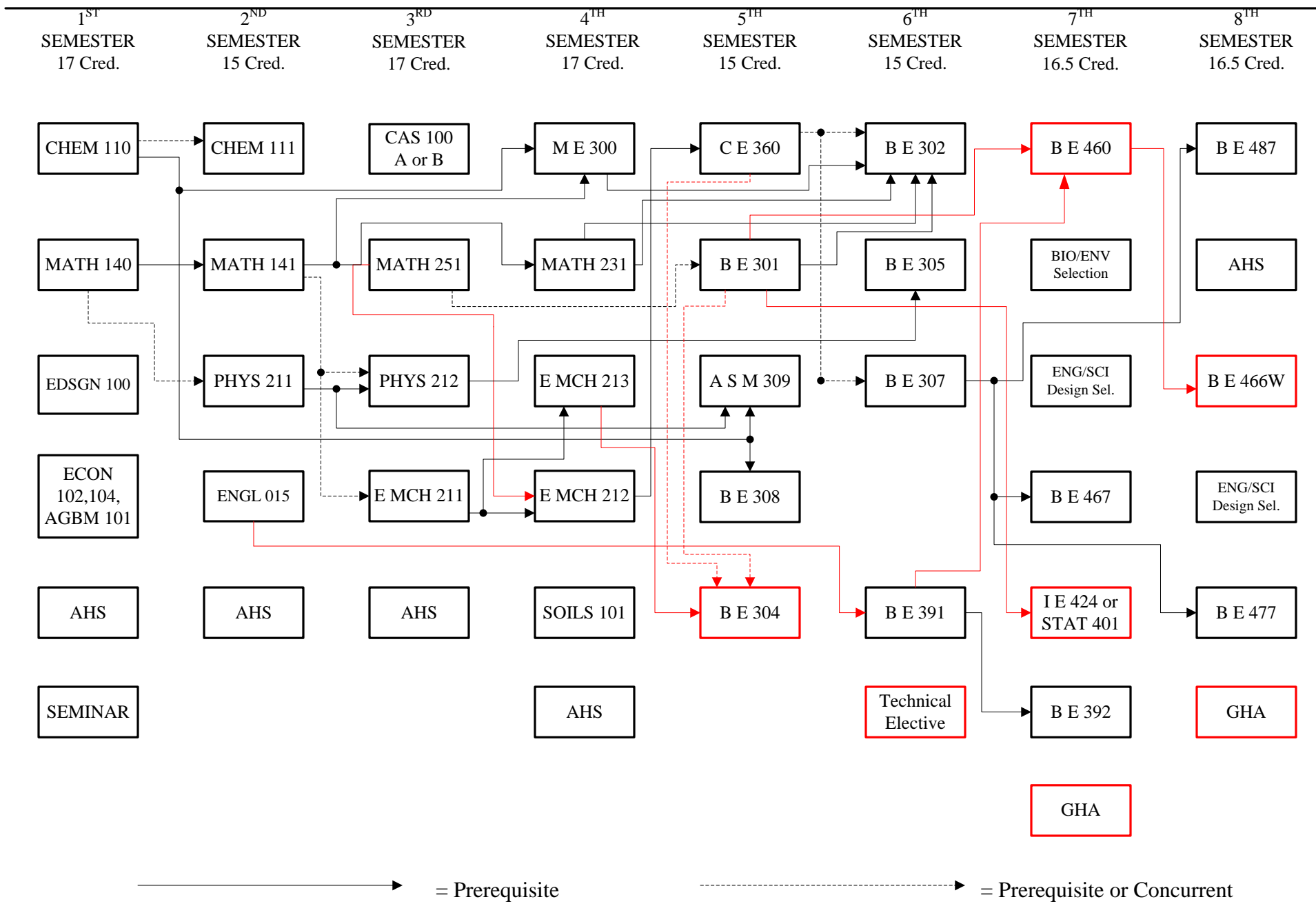
GH 6

GS 6




# BIOLOGICAL ENGINEERING

## NATURAL RESOURCE ENGINEERING OPTION



## NATURAL RESOURCES ENGINEERING OPTION SELECTION LISTS

### COURSES THAT MEET THE BIOLOGICAL/ENVIRONMENTAL SCIENCE REQUIREMENT <sup>+</sup>

AGRO 28	Principles of Crop Management (3) Prerequisite: 6 credits in biological science. Offered: FA
AGECO 418	(AN SC 418, SOILS 418) Nutrient Management in Agricultural Systems (3) Offered: FA
BIOL 110	Biology: Basic Concepts and Biodiversity (4) Offered: FA/SP/SU
BIOL 220W	Biology: Populations and Communities (4) Prerequisite: BIOL 110. Offered: SP
BIOL 240W	Biology: Function and Development of Organisms (4) Prerequisite: BIOL 110, CHEM 110. Offered: SP
CE 370	Introduction to Environmental Engineering (3) Prerequisite: CHEM 110; MATH 111 or MATH 141. Offered: FA/SP/SU
ENT 425	Freshwater Entomology (3) Offered: FA
ERM 402	Foundations of Sustainable Business (3) Prerequisite: AGBM 101 or ECON 102 or ECON 104. Offered: FA
ERM 433	Transformation of Pollutants in Soils (3) Prerequisite: CHEM 112, CHEM 111, SOILS 101. Offered: SP
ERM 435	(WFS 435) Limnology (3) Prerequisite: BIOL 110, BIOL 220W, CHEM 110. Offered: FA
ERM 447	Stream Restoration (3) Prerequisite: ASM 327 or BE 307 or CE 461. Offered: FA
ERM 450	(WFS 450) Wetland Conservation (3) Prerequisite: ERM 300 or WFS 209. Offered: FA
FOR 203	Field Dendrology (3) Concurrent: FOR 200W or WP 200W and WP 203. Offered: FA
FOR 455	Remote Sensing and Spatial Data Handling (3) Prerequisite: MATH 110, 3 credits in computer science, 6 credits in ecological and/or geological sciences. Offered: SP
GEOSC 1	Physical Geology (3) Offered: FA/SP
GEOSC 452	Hydrogeology (3) Prerequisite: CHEM 112; GEOSC 1, GEOSC 20 or GEOSC 71; MATH 140 or MATH 110. Offered: FA/SP
HORT 101	Horticultural Science (3) Offered: FA/SP
HORT 131	Herbaceous Perennial and Annual Identification (3) Prerequisite: BIOL 127, BIOL 110 or HORT 101. Offered: FA
PLANT 426	Nutrient Management Specialist Preparation (1) Prerequisite: SOILS 101 and SOILS 102. Offered: FA
SOILS 102	Introductory Soil Science Laboratory (1) Prerequisite or concurrent: SOILS 101. Offered: FA/SP
SOILS 401	Soil Composition and Physical Properties (3) Prerequisite: SOILS 101. Offered: SP
SOILS 404	Urban Soils (3) Prerequisite: SOILS 101. Offered: SP
SOILS 416	Soil Genesis, Classification, and Mapping (4) Prerequisite: SOILS 101. Offered: FA
SOILS 450	Environmental Geographic Information Systems (3) Prerequisite: SOILS 101. Offered: FA

### COURSES THAT MEET THE ENGINEERING SCIENCE/DESIGN REQUIREMENT <sup>+</sup>

AE 444	Micro CADD Applications for Buildings (3) Prerequisite: AE 222; CMPSC 201 or CMPSC 202. Offered: FA/SP
BE 303	Structural Systems in Agriculture (3) Prerequisite: BE 301, EMCH 213. Offered: SP
BE 462	Design of Wood Structures (3) Prerequisite: BE 303, AE 308, or CE 340. Offered: FA
BE 464	Bioenergy Systems Engineering (3) Prerequisite: EME 301, ME 201, ME 300, or CHE 220. Prerequisite or concurrent: BE 308, CHE 340, or CE 479. Offered: FA
BE 468	Microbiological Engineering (3) Prerequisite: BE 308 or both MICRB 201 and BMB 211 Prerequisite or concurrent: BE 302. Offered: SP
CE 310	Surveying (3) Prerequisite: EDSGN 100, MATH 141. Offered: FA/SP/SU
CE 335	Engineering Mechanics of Soils (3) Prerequisite: EMCH 213; AE 221 or GEOSC 1. Offered: FA/SP
CE 340	Structural Analysis (3) Prerequisite: EMCH 213. Prerequisite or concurrent: CMPSC 201 or CMPSC 202. Offered: FA/SP

CE 370	Introduction to Environmental Engineering (3) Prerequisite: CHEM 110; MATH 111 or MATH 141. Offered: FA/SP/SU
CE 371	Water and Wastewater Treatment (3) Prerequisite: CE 360, CE 370. Offered: FA/SP/SU
CE 410	Sustainable Residential Subdivision Design (3) Prerequisite: AE 372 or CE 332. Offered: FA
CE 461	Water-resource Engineering (3) Prerequisite: CE 360. Offered: FA/SP
CE 462	Open Channel Hydraulics (3) Prerequisite: E 360. Offered: FA/SP
CE 465	Water Resources Capstone Course (3) Prerequisite: CE 461. Prerequisite or concurrent: CE 462. Offered: SP
CE 475	Water Quality Chemistry (4) Prerequisite: CE 370, CHEM 110, CHEM 111. Offered: SP
CE 476	Solid and Hazardous Wastes (3) Prerequisite: CE 370, CE 371. Offered: SP
EDSGN 452	Projects in Humanitarian Engineering (2) Prerequisite: 5 <sup>th</sup> semester standing. Concurrent: EDSGN 453. Offered: SP
EDSGN 453	Design for Developing Communities (1) Prerequisite: 5 <sup>th</sup> semester standing. Offered: SP
EDSGN 497	Current CAD Applications (3) Offered: FA/SP

*NRE students are strongly encouraged to take EDSGN 497, Current CAD Applications (3), as an Engineering Science/Design or Technical Selection. Students interested in learning AutoCAD Civil 3D should also consider taking CE 410 as an Engineering Science/Design or Technical Selection.*

#### **COURSES THAT MEET THE TECHNICAL SELECTION REQUIREMENT <sup>+</sup>**

Any course acceptable as Engineering/Science Design or Biological/Environmental Science may be taken as a Technical Selection, plus CHEM 112, CHEM 202, CMPSC 121, CMPSC 200, CMPSC 201, CMPSC 202, ENGR 310, ENGR 408, ENGR 451, ENGR 455, ENGR 493, MATH 220, and MGMT 215

<sup>+</sup>Other courses may be taken to meet the engineering science/design, biological/agricultural science, and technical requirements if the student submits a petition approved by the Department of Agricultural and Biological Engineering. All petitions must be submitted and approved prior to the student's graduation semester, however earlier is preferred to ensure adequate progress towards completing degree requirements.

## General Education

In Biological Engineering, the General Education requirements are met as follows:

- A. First-year seminar (1 credit required)
- B. Learning skills (15 credits required)
  - 1. Writing/Speaking (9 credits required plus a writing across the curriculum course)  
English 15 or 30 GWS  
BE 391 GWS and BE 392 GWS  
CAS 100A or 100B GWS  
B E 466
  - 2. Quantification (6 credits required)  
MATH 140 GQ and MATH 141 GQ
- C. Health and Physical Activity (3 credits required)
  - 1. Health Science and/or Phys. Ed.  
Courses in FDSC, NUTR, KINES, and BBH and designated with the suffix GHA satisfy this component. In the Food and Biological Processing Engineering Option, NUTR 100 is required as one of the courses.
- D. Distribution Component (27 credits required)
  - 1. Natural Sciences (9 credits required)  
  
CHEM 110 GN, CHEM 111 GN, PHYS 211 GN, PHYS 212 GN
  - 2. Arts (6 credits required)
  - 3. Humanities (6 credits required)
  - 4. Social and Behavioral Sciences (6 credits required)
  - 5. IL and US credits required  
United States (US) Culture (3 credits)  
International (IL) Culture (3 credits)

### **Arts, Humanities, and Social and Behavioral Science**

Each student in Biological Engineering must complete 18 credits in the Arts, Humanities, and Social and Behavioral Sciences. Each student must complete either ECON 102, or ECON 104, or AGBM 101 to satisfy 3 credits in the Social and Behavioral Sciences area. In addition, each student must complete at least 3 credits of Social and Behavioral Sciences (GS), 6 credits in Arts (GA) and 6 credits in Humanities (GH) chosen from the University list.

An acceptable alternative to the requirement described above is for a student to complete 9 credits in either the Arts, Humanities, or Social and Behavioral Sciences by substituting 3 credits from one of the other two areas. When a student chooses to complete 9-credits in one area, he/she will be required to complete 6 credits in one of the remaining areas and 3 credits in the third area. ECON 102 or ECON 104 or AGBM 101 is still required as all or part of the Social and Behavioral Science (GS) requirement.

A language course at the 12<sup>th</sup> credit level or higher can be substituted for 3 credits of GA, GH, or GS. At Penn State, language courses are 4 credits each, so 12<sup>th</sup> credit level would be level III, such as SPAN 003 or FR 003. If a student plans to use the 9-6-3 alternative described above and the language substitution, the language can not be substituted in the 3 credit category.

### **IL and US**

Each student must take three credits of International Culture (IL) courses and three credits of US Culture (US) courses. Students are **HIGHLY** encouraged to select IL and US courses that also meet the general education requirement in Arts, Humanities, or Social and Behavioral Sciences. The College of Engineering has a limited list of GA, GH, and GS courses that also satisfy the IL requirement and are recommended for Engineering students (<http://www.engr.psu.edu/global/students/illimited.htm>).

### **Reserve Officers' Training Corps (ROTC) Credits**

Students who complete the courses required to remain in the ROTC program can use six ROTC credits toward degree requirements. At the completion of the ROTC program, students can substitute 3 ROTC credits for the GHA requirement and 3 ROTC credits for a technical selection.

### **Registering for Courses Under Departmental Control**

If you wish to register for a course and can not because the course is under Departmental Control, please consider the following procedures. These procedures should be supervised by your academic advisor, who may assist your efforts. Presently, most of these courses are in the CE, BME, CHE, IE, and ME Departments, but others may also apply. These are generally over-enrolled majors where classes are large and often over subscribed.

1. If the course is a required course (not an elective or selection), you should contact the scheduling officer in the department offering the controlled course. The department scheduling office will generally honor the request; assuming there is actually room left in the section. The Registrar maintains a list of department contacts for scheduling (<http://www.registrar.psu.edu/departments/index.cfm#universitypark>).
2. If this does not work, or the course is an elective, continue trying to register for the course until the first day of classes. BME typically maintains a wait list for full or controlled classes and you can contact the scheduling officer to be added to the list. CE follows a similar procedure for classes like CE 370. Other departments (such as CE, ME, and IE) will often add you to a controlled class, if there is space and you have the listed or equivalent prerequisites, after their students have completed registration.
3. If by the first day of classes you have not been able to register for the restricted course, go to and sit through the first class of the course. At the end of this first class period, politely ask the instructor if there is room and may you please be added to the course. [In almost every case, this has resulted in the student being added to the class, if there was room in the section.]
4. Only after each of the above actions have failed, should the academic advisor get personally involved in calling a department and requesting that their advisee be admitted to a class.

## Course Descriptions in Biological Engineering

BE 301 MATHEMATICAL MODELING OF BIOLOGICAL AND PHYSICAL SYSTEMS (3) Modeling tools, quantification of processes, linear and non-linear systems of equations, numerical methods, matrix operations, applied to bio-physical systems. Prerequisite or concurrent: MATH 251. Offered each **Fall** Semester.

BE 302 HEAT AND MASS TRANSFER IN BIOLOGICAL SYSTEMS (4) Engineering applications of the fundamentals of heat and mass transfer to natural and engineered biological systems. Prerequisite: MATH 231, MATH 251, BE 301, ME 300. Prerequisite or concurrent: CE 360 or ME 320. Offered each **Spring** Semester.

BE 303 STRUCTURAL SYSTEMS IN AGRICULTURE (3) Engineering analysis and design of structural systems in agriculture. Topics: reliability, loads, components and system design. Prerequisite: E MCH 210 or E MCH 213. Offered each **Spring** Semester.

BE 304 ENGINEERING PROPERTIES OF FOOD AND BIOLOGICAL MATERIALS (3) Composition, structure, and properties relationships. Measurement of mechanical, thermal, chemical, and biological properties, their variability, and use in engineering calculations. Prerequisite or concurrent: MATH 251, CE 360 or ME 320, BE 301. Prerequisite: E MCH 210 or E MCH 213. Offered each **Fall** Semester.

BE 305 AGRICULTURAL MEASUREMENTS AND CONTROL SYSTEMS (3) Principles of measurements, instruments, controls, and data acquisition systems, with emphasis on agricultural applications. Prerequisite: PHYS 212. Offered each **Spring** Semester.

BE 306 MACHINES FOR AGRICULTURAL AND BIOLOGICAL PROCESSING (3) Application of engines, motors, and power transmission systems to agricultural production and processing machinery. Functional design and analysis of equipment. Prerequisite: EMCH 212; EMCH 210 or EMCH 213. Offered each **Spring** Semester.

BE 307 PRINCIPLES OF SOIL AND WATER ENGINEERING (3) Utilization and engineering of soil-water resources; including rainfall-runoff, soil-water movement, erosion/sediment transport and flow processes. Prerequisite or concurrent: CE 360 or ME 320. Offered each **Spring** Semester.

BE 308 ENGINEERING ELEMENTS BIOCHEMISTRY AND MICROBIOLOGY (3) Introduction of basic biochemistry and microbiology as well as industrial and environmental applications. Prerequisite: CHEM 110. Offered each **Fall** Semester.

BE 391 CONTEXTUAL INTEGRATION OF COMMUNICATION SKILLS FOR THE TECHNICAL WORKPLACE (2) To develop corporate communication skills in technically focused students in a contextual manner. Prerequisite: Junior level standing in BE or BRS. Offered each **Spring** Semester.

BE 392 CONTEXTUAL INTEGRATION OF LEADERSHIP SKILLS FOR THE TECHNICAL WORKPLACE (2) To develop corporate leadership skills in technically focused students in a contextual manner. Prerequisite: BE 391, Junior level standing in BE or BRS. Offered each **Fall** Semester.

BE 460 BIOLOGICAL ENGINEERING DESIGN I (1) Part one of a two course sequence; culminating design experience with projects in agricultural, food and biological processing, and natural resource engineering. Prerequisite: BE 301, BE 391, 7<sup>th</sup> semester standing. Offered each **Fall** Semester.

BE 461 DESIGN OF FLUID POWER SYSTEMS (3) Hydraulic power systems, hydrostatic transmission, and electro-hydraulic control systems with applications in agricultural production and processing systems; integrated design projects. Prerequisite: BE 306 or ME 360; CE 360 or ME 320. Offered each **Fall** Semester.

BE 462 DESIGN OF WOOD STRUCTURES (3) Structural properties of wood; design of wood structural elements; design of wood systems; design of post-frame buildings. Prerequisite: AE 308; or BE 303; or CE 340. Offered each **Fall** Semester.

BE 464 BIOENERGY SYSTEMS ENGINEERING (3) Fundamental theories and applied technologies for production and conversion of biomass into energy and co-products. Prerequisite: EME 301 or ME 201 or ME 300 or CHE 220. Prerequisite or concurrent: BE 308 or CHE 340 or CE 479. Offered each **Fall** Semester.

BE 465 FOOD AND BIOLOGICAL PROCESS ENGINEERING (3) Reactor design, kinetics, fluid flow, thermal processes, and other topics applied to the design of systems for the food and biological process industry. Prerequisite: BE 302. Offered each **Fall** Semester.

BE 466 BIOLOGICAL ENGINEERING DESIGN II (3) Part two of a two course sequence; culminating design experience with projects in agricultural, food and biological processing, and natural resource engineering. Satisfies writing across the curriculum requirement. Prerequisite: B E 460. Offered each **Spring** Semester.

BE 467 DESIGN OF STORMWATER AND EROSION CONTROL FACILITIES (3) Design of best management practices for stormwater management, erosion and sediment control as applied to the agriculture-urban interface. Prerequisite: BE 307 or CE 461. Offered each **Fall** Semester.

BE 468 MICROBIOLOGICAL ENGINEERING (3) Application of basic engineering principles and designs in biochemical and biological processes. Prerequisite: BE 308 or both MICRB 201 and BMB 211. Prerequisite or concurrent: BE 302. Offered each **Spring** Semester.

BE 477 LAND-BASED WASTE DISPOSAL (3) Analysis, design, and management of land-based systems for recycling and disposal of municipal, industrial, and agricultural wastes. Prerequisite: BE 307 or CE 370 or ASM 327. Offered each **Spring** Semester.

BE 487 WATERSHED MODELING FOR WATER QUALITY DESIGN (3) Application of common watershed models used to investigate design alternatives for flow and quality effects. Prerequisite: BE 307 or CE 461. Offered each **Spring** Semester.

BE 495 BIOLOGICAL ENGINEERING INTERNSHIP (1-6) Independent study and supervised cooperative education experience related to the student's career objective.

BE 496 INDEPENDENT STUDIES (1-18)

Any senior with a 3.50 grade-point average or a Schreyer's Honor Scholar may be admitted to 500-level courses with the consent of the instructor and Graduate Enrollment Services; other seniors with a B average or better may be admitted to graduate courses with the consent of the instructor, the student's academic advisor, and Graduate Enrollment Services. The form for this request is available here: <http://www.gradsch.psu.edu/forms-and-documents/ges-owned-forms-and-documents/500level2pdf/>

## Minors and Certificates

### **ENVIRONMENTAL ENGINEERING MINOR**

The Environmental Engineering Minor is designed to provide students in engineering, science and other majors with a comprehensive study of environmental issues and the skills to solve problems associated with environmental pollution. For entrance into this minor, students must have completed CHEM 110, MATH 141, and PHYS 211 with a C or higher in each course and have a minimum GPA of 2.0.

Requirements for the Minor: The minor consists of 18 credits, at least 6 of which must be at the 400 level. A grade of C or better is required in all courses in the minor.

Introduction to Environmental Engineering (3 credits) CE 370(3)

Chemistry & Biological Sciences (Select 3 credits)

**BE 308 (3)**, CE 479(3), CHEM 202(3), CHEM 210(3)

Process Engineering (Select 0-3 credits)

**BE 302 (4)**, CHE 210(3), EGEE 302(3), MNPR 301(3), NUCE 430(3)

Applied Fluid Mechanics (Select 3 credits)

AERSP 308(3), **BE 467(3)**, CE 371(3), CE 462(3), CHE 330(3), EME 303(3), ME 320(3), METEO 454(3), NUCE 431(4)

Environmental Sciences & Design (Select 6-9 credits)

**BE 468(3)**, **BE 477(3)**, CE 472(3), CE 475(3), CE 476(3), CHEM 402(3), ERM 411(3), ERM 412(3), ERM 413(3), ERM 447(3), ERM 450(3), EGEE/ME 430(3), EGEE 470(3), ENVSE 408(3), FSC 431(3), GEOSC 452(3), ME 405(3), ME 433(3), NUCE 405(3), NUCE 420(3), NUCE 428(3), SOILS 420(3)

For more information: <http://www.cee.psu.edu/academics/undergraduate/majors-minors-and-certificates.aspx#EnviroMinor>

*Notes for BE students:* In addition to the selection lists above, BE students have used **BE 467(3)** and **BE 487(3)** in the Environmental Sciences & Design category with the approval of the minor coordinator. However, as stated in policy 59-10, “**at least six credits of the minor must be unique from the Prescribed Courses required by the student’s major program(s).**”

### **WATERSHEDS & WATER RESOURCES MINOR**

Watersheds are important landscape features that control the biogeochemistry of natural waters. This interdisciplinary minor enables students to learn the fundamental processes governing the transport and chemical evolution of surface and subsurface waters. It provides a complement to elective and required coursework in earth sciences, resource management, wastewater treatment, and/or environmental planning. Students in this program will learn to apply fundamental concepts of chemistry, biology, geoscience, and landscape evolution to processes operating at the watershed scale. Learning objectives for the minor include excellence in written and oral expression, the ability to collect and interpret data from dynamic natural systems, and rigor in scientific thought.

A grade of C or better is required for all courses in the minor.

Requirements for the Minor: Select 18 credits from the WWR committee's approved list of courses, which includes but is not limited to courses listed below (at least 6 credits must be taken at the 400 level):

**BE 307(3)**, **BE 467(3)**, ASM 217(3), ASM 327(3), CE 370(3), CE 371(3), CE 461(3), CE 473(3), CE 475(4), CHEM 202(3), CHEM 402(3), ERM 411(3), ERM 435(3), ERM 450(3), ENVE 411(3), ENVE



415(3), ENVSE 408(3), FOR 470(3), FOR 471(1), GEOG 431(3), GEOSC 201(4), GEOSC 340(3), GEOSC 412(3), GEOSC 413W(3), GEOSC 419(3), GEOSC 445(4), GEOSC 452(3), METEO 417(3), METEO 448(3), SOILS 405(3), SOILS 418(3), WFS 410(3), WFS 422(3)

For more information: <http://www.geog.psu.edu/wwrminor>

*Notes for B E students:* In addition to the courses listed above, the minor coordinator has indicated that **ASM 309 (3)**, **BE 487 (3)**, and ERM 447 (3) would be approved as selections.

### **BIOMEDICAL ENGINEERING MINOR**

This interdisciplinary minor is designed for students interested in the application of engineering principles to medical and biological problems. The minor is particularly suitable for students pursuing an undergraduate degree in a different engineering major, physics, or other applied science who are seeking careers in health-related professions. PHYS 211 GN(4), PHYS 212 GN(4), and calculus through differential equations (MATH 250 or 251) are required for entrance to minor. Additional prerequisites for prescribed and supporting courses may be required and should be researched prior to applying for the minor (e.g. CHEM 112 GN(3) and CMPSC 200 GQ(3)).

Requirements for the Minor: The minor consists of 18-20 credits. A grade of C or better is required for all courses in the minor.

Physiology (Select 3-4 credits)

BIOL 141(3), BIOL 240W(4), BIOL 472(3)

Molecular/Cell Biology (Select 3-4 credits)

BMB 251(3), BME 201(3), BIOL 230W(4)

Biomedical Engineering (Select 9-12 credits)

BME courses at the 400 or 500 level (BME 406(3), BME 410(3), BME 413(3), BME 419(3), BME 423(3), BME 433(3), BME 443(3), BME 444(3), BME 445(3), and BME 446(3) are good options for BE students. You might have suitable equivalent prerequisites, including ME 300, ME 320, BE 302, BE 304, and BE 305.)

Biomedical Engineering-related courses (Select 0-3 credits)

MATSE 403(3)/BME 443(3), MATSE 404(3)/BME 444(3), IE 327(3), **BE 308(3)**, **BE 468(3)**, CHE 340(3), CHE 438(3), NUCE 420(3), EE 455(3)/CMPEN 455(3), EE 458(3)

For more information: <http://www.bme.psu.edu/students/undergraduate/undergraduate-majors-and-minors.aspx>

*Notes for BE students:* BE students in the Food and Biological Processing Option may choose to substitute BMB 251(3) (selection for the BME minor) for BMB 211(3), which is required for the Food and Biological Processing Option.

### **OFF-ROAD EQUIPMENT MINOR**

From apple harvesters to zambonis, all off-road equipment have some things in common: engines, drive trains, safety needs, electronics, operator interfaces, power transmission, hydraulics. The Off-Road Equipment minor focuses on these topics. This technical minor is a great complement to majors such as Mechanical Engineering, Mining Engineering, Plant Sciences, Turfgrass Science, BE, and BioRenewable Systems.

Requirements for the Minor: The minor consists of 18 credits. A grade of C or better is required for all courses in the minor.

Prescribed Courses (3 credits): ASM 420(3)

Select 3 credits: ASM 320(3), ME 431(3)

Select 3 credits: **BE 306(3)**, ASM 310(3), ME 360(3)

Select 3 credits: **BE 305(3)**, BRS 428(3), ME 345(4)

Select 3 credits: ASM 424(3), AGRO 423(3), AGRO 425(3), HORT 408(4), TURF 425(3)

Select 3 credits: **BE 461(3)**, BRS 426(3)

For more information: <http://abe.psu.edu/majors/minors/off-road-equipment>

### **ENTREPRENEURSHIP & INNOVATION MINOR (ENTI)**

The ENTI minor uses problem-based learning pedagogy to prepare students to create value and be agents of positive change in their discipline and their careers. There are different clusters to meet the students' broad range of entrepreneurship and innovation interests. The following clusters are especially of interest to BE students: Food and Bio-innovation, Social Entrepreneurship, and Technology Based Entrepreneurship.

Requirements for the Minor: The minor consists of 18-19 credits. A grade of C or better is required in all classes in the minor.

Prescribed Courses (9 credits): MGMT 215 (3), ENGR 310(3), ENGR 425(3)

Additional Courses (9 credits): Select 9 or more credits from one of the following clusters.

#### **Food and Bio-innovation Cluster**

Select up to 6 credits of the following 200-300 courses in the College of Agricultural Sciences: **ASM 391(2), ASM 392(2)**, AEE 201(3), AGBM 200(3), AGBM 220(3), AGBM 302(3), AGBM 308W(3), AGBM 338(3), ANSC 207(2), ANSC 306(3), ANSC 308(4), ANSC 309(4), ANSC 310(3), ANSC 311(3), ANSC 324(3), ANSC 327(3), ANSC 350(2), CED 375(3), ERM 300(3), FDSC 200(3), FDSC 206(3), FOR 201(3), HORT 250(3)

Select at least 3 credits of the following 400 level courses in the College of Agricultural Sciences: AGBM 407(3), AGBM 408(3), AGBM 440(3), AGBM 460(3), ANSC 410(4), ANSC 429(3), ANSC 450(3), CED 417(3), ERM 411(3), ERM 412(3), ERM 413(3), FDSC 411(2), FDSC 417(2), FDSC 430(3), FOR 440(3), HORT 410(3), HORT 450(3), HORT 453(3), HORT 455(3), RSOC 452(3), TURF 436(3), WP 416(3) (Sem:1-8)

#### **Social Entrepreneurship Cluster**

Required courses to be taken in the following order: ENGR 451(3), EDSGN 452(2) and EDSGN 453(1) concurrent, EDSGN 454(0.5), and ENGR 455(3)

#### **Technology Based Entrepreneurship Cluster**

Required courses: ENGR 411(3), ENGR 407(3) in sequence or concurrent, and ENGR 415(3)

For more information: <http://www.enti.psu.edu>

### **ENGINEERING LEADERSHIP DEVELOPMENT MINOR**

The Engineering Leadership Development Minor is an interdisciplinary minor designed to enable engineering undergraduate students to develop the practical leadership skills that they will need throughout their careers.

Requirements for the Minor: The minor consists of 18 credits. A grade of C or better is required in all classes in the minor. For admission to the minor, students must have completed ENGR 408(2) and ENGR 493(1) with a B or better.

Prescribed Courses (12 credits): ENGR 408(3), ENGR 407(3), ENGR 409(3)\*, Capstone Course(3)

Supporting Courses (6 credits): Select from approved list

\*A student can substitute this course with international alternatives, including ENGR 422 (International Leadership of Engineering and Development) and an international experience during maymester.

**BE 391** and **392** can be used toward 6-credit supporting course requirement, by petition. For BE students pursuing this minor, prescribed courses can be petitioned for technical selections in BE degree requirements. Please consult with your BE advisor.

For more information: <http://sedtapp.psu.edu/eld/minor.aspx>

### **SUSTAINABILITY LEADERSHIP MINOR**

The Intercollege Minor in Sustainability Leadership has been designed for students who wish to promote environmental, social, and economic sustainability in their personal and professional lives. Through a combination of coursework and immersive experiences in sustainability, students develop the knowledge, skills, and attitudes required to become sustainability leaders in their respective fields.

Requirements for the Minor: The minor consists of 18 credits. Students may apply toward the minor no more than six credits from their major requirements and no more than six credits from their other minor requirements. The Sustainability Leadership Capstone credits may not be used simultaneously to fulfill capstone or thesis requirements for any other degree program. All minor programs must include at least six credits at the 400 level. A grade of C or better is required in all classes in the minor.

Prescribed Courses (3 credits): SUST 200 GS(3)

Additional Courses (6 credits):

Take the following 6 credits, or approved substitutions, in consultation with the minor advisor:

SUST 295 or 495, or approved substitution that provides an immersive sustainability experience (3)

SUST 496 or approved substitution that offers a capstone project in sustainability leadership (3)

Supporting and Related Course Area (9 credits):

Allowable courses in this area vary by Sustainability Leadership Thematic Track (**Design for Sustainable Communities**, Educating for Sustainability, **Humanistic Understanding of Sustainability**, and **Sustainability and Food Systems**). See more details at the website below.

For more information: <http://sustainability.psu.edu/learn/students/minor-sustainability-leadership>

### **INTERNATIONAL AGRICULTURE MINOR**

This minor is an interdisciplinary program of study designed to enable students to (1) gain an awareness and appreciation for the interrelationship and interdependency of the nations of the world for their food and fiber; (2) gain an awareness of problems in international agriculture and sustainability of alternative

solutions; (3) understand global impacts of technology; and (4) understand systems of learning across cultures.

Requirements for the Minor: 18 credits. A grade of C or better is required for all courses in the minor. Students must have six credits of 400 level course work for the minor.

Prescribed Courses (6 credits)

INTAG 100 GS;IL(3), INTAG 490(3)

Additional Courses\* (12 credits. Select courses from three of the first four categories (9 credits) and one internationally-oriented experience from Category 5(3 credits)):

Category 1: Socioeconomic and Communication Systems

AEE 400(3), AEE 440(3), AGBM 102(3), AGBM 338 IL(3), AYFCE 438 US(1-3), CED 230(3), CED 410(3), CED 417(3), CED 425(3), GEOG 20 GS;US;IL(3), GEOG 40 GS;IL(3), GEOG 123 GS;IL(3), GEOG 126 GS;US;IL(3), GEOG 428 US(3), RSOC/WMNST/CED 420 US;IL(3), any university language skill development course

Category 2: Food, Health, and Nutrition

BBH 305 IL(3), BBH 402 IL(3), BBH 407 IL(3), FDSC 105(3), FDSC 200(3), NUTR 421 US;IL(3), NUTR 430 IL(3)

Category 3: Plant and Animal Sciences

AGECO 134(3), AGECO/ENT 457(3), AGRO 28(3), ANSC 201(4), INTAG 300 IL(3), SOILS 71 IL(3), SOILS 10(3)

Category 4: Natural Resources and Environment

ASM 327(3), BIOL 436(3), CED 427(3), CED 450 IL(3), ERM 210(3), EARTH 2(3), FOR 418 US;IL(3), FOR 488Y(3), GEOG 30 GS;IL(3), GEOG 110(3), GEOG 310(3), GEOG 430(3), GEOG 444(3)

Category 5: Internationally-oriented Experience

INTAG 296(3), INTAG 297(3), INTAG 298(3), INTAG 397(3), INTAG 398(3), INTAG 399(3), INTAG 495(3), INTAG 496(3), INTAG 497(3), INTAG 498(3), INTAG 499 IL(3), or other international embedded course with agricultural content with approval of INTAG minor coordinator, including but not limited to: AGECO 499(3), CED 499(3), ERM 499(3), EDSGN 452(2) and EDSGN 453(1)

\*Students have the option of participating in a semester study abroad program that would be discussed and approved by the INTAG coordinator and the student's academic advisor. Twelve credits maximum can count toward the minor and the study abroad program needs to focus on courses within the food, agriculture, or natural resource areas.

For more information: <http://agsci.psu.edu/international/intag>

### **INTERNATIONAL ENGINEERING CERTIFICATE PROGRAM**

The International Engineering Certificate is intended to recognize the completion of course work, language study, and international experiences that will contribute toward the attainment of a global perspective of engineering. Requirements to be eligible for the certificate are:

- Three (3) credits of study in a second language at the 003 level (third-semester or 12th credit) or higher as a Penn State student.
- Six (6) credits (typically two courses) of study in courses approved to meet the International Cultures requirement (IL) of General Education.

- One to three (1-3) credits of approved study or work abroad, of at least six weeks duration.
- Completion of all degree requirements for a College of Engineering baccalaureate program.

For more information: <http://www.engr.psu.edu/global//Students/IntlEngrCertificate.htm>

### **HOUSING CERTIFICATE**

This program is designed to provide undergraduate students with a means of developing some basic knowledge of housing and preparing for a career in the housing industry. The certificate requires 12 credits. Students must earn a B grade or better in each required course. A minimum GPA of 2.5 is required for certification.

Residential Building Design and Construction (3 credits): AE 470

Selection List (choose 9 credits):

AE 432(3), **BE 462(3)**, CE 410(3), CE/AE 542(3), RM 303(3), RM 450(3)

For more information: <http://www.cee.psu.edu/academics/undergraduate/majors-minors-and-certificates.aspx#HousingCert>

## Opportunities for International Experiences

One of the characteristics of a world-class engineer is knowledge and appreciation for the international challenges and opportunities now and anticipated in future years. Probably the best way to gain global experiences is through participation in an international activity while you are still a student. Fortunately there are numerous opportunities for gaining international experiences and perspectives through activities such as study abroad programs (for a semester or academic year), international co-ops and internships, alternative Spring Break tours, technical study tours, PSU course/international tour combinations, and May study tours.

### Financial support for international activities

There are scholarships available through the College of Ag Sciences and College of Engineering specifically for students who are gaining international experiences. Undergraduate students in BE have obtained significant amount of financial support from both Colleges to participate in international programs of various formats. BE students planning to study abroad should set up a meeting with the Department Head to discuss possible department contribution toward program costs.

The deadline dates to apply for awards from College of Ag Sciences for programs are typically:

- Fall Semester programs: March 15
- Spring Semester programs: September 30 of previous year
- Summer programs (not associated with a spring semester class): March 15
- Short Term programs embedded in a fall class and traveling during fall break or the break between semesters: September 30
- Short Term programs embedded in a spring class and traveling during spring break or directly after the end of the semester: January 31

Students who apply after the above deadline dates might be considered for awards, depending on whether all the funds have been awarded or not. For additional information, please contact Ms. Ketja Lingenfelter at [ketja@psu.edu](mailto:ketja@psu.edu) or 863-4164 and refer to the following website: <http://agsci.psu.edu/international/study-abroad/funding/funding-application>

The Penn State Office of Global Programs offers Whole-World scholarships. Whole-World scholarships provide recognition and financial incentives to undergraduate students from PSU who are enrolled or planning to enroll in select Education Abroad study abroad programs in non-traditional locations. Scholarships are given in amounts of \$2,000 for full-year, \$1,000 for one semester and \$500 for summer programs in such areas as Eastern Europe, Latin America, Africa, Asia, and the Middle East. Refer to <http://global.psu.edu/info/education-abroad-whole-world-scholarship> for more information.

### Penn State tuition when participating in an international program

If the program is during the summer, you may be required to register for summer session. For instance, if you participate in a PSU/international tour combination, you may register for a 2.5-credit course on campus during the Spring Semester and then a 0.5-credit course during the international travel during May. The College of Agricultural Sciences offers several courses with embedded travel experience, as shown on this website: <http://agsci.psu.edu/international/study-abroad/study-abroad/current/short-term-agsci-ieee>

Semester programs through the Office of Global Programs assess Penn State tuition. Each program on the Global Programs website has a budget sheet, which clearly shows tuition costs as well as additional program fees and expected expenses.

## **International opportunities in a particular country of interest**

The College of Engineering has created a web site about International Programs. The site contains a searchable database of study abroad programs for engineering majors, checklists for how to prepare for international experiences, information about program deadlines and application procedures, and useful resources for going abroad. A good place to start on the College of Engineering website is the program matrix: <http://www.engr.psu.edu/Global/Students/programmatrix.aspx>. While this matrix is a useful tool, it does not contain every possible study abroad program for students in Biological Engineering. Another resource is the program search on the Office of Global Programs website: <http://gpglobalea.gp.psu.edu/index.cfm?FuseAction=Programs.SimpleSearch>. You can easily search by country, semester, and other requirements (such as semester standing and GPA). Programs that offer science and engineering coursework may be suitable for BE students.

Engineers without Borders, Engineers for a Sustainable World, Engineering Ministries International, and Global Brigades are organizations that foster engineering projects in developing countries.

There are many NGOs (non-governmental organizations) such as churches, civic and fraternal groups, and humanitarian organizations that sponsor various types of short-term trips to a wide variety of countries, where they seek to build buildings (schools, clinics, orphanages, etc), develop clean water supplies, build effective waste facilities, provide basic health education, introduce basic agricultural production practices, and more.

Be sure to read the weekly newsletters from College of Ag Sciences and College of Engineering. These electronic newsletters frequently identify numerous opportunities for various international activities.

## **Answers to other questions related to gaining international experiences**

- University Office of Global Programs, 410 Boucke Bldg., 814-865-6348, [global.psu.edu](http://global.psu.edu)
- Office of International Programs, College of Ag. Sciences, 106 Ag. Admin. Bldg., 814-863-0249, <http://agsci.psu.edu/international/undergraduates>
- Global Engineering Education, [www.engr.psu.edu/Global](http://www.engr.psu.edu/Global)

## **Co-ops/Internships**

The BE major does not have a formal Internship program. Students are encouraged to participate in the Engineering Co-op program or to seek summer employment to develop career related experiences. Students completing three co-op rotations can use three co-op credits (ENGR 295, 395, and 495) towards degree requirements as a technical selection. This substitution will only be applied by petition after three rotations are completed. Typically, when the work experience is during the summer, students say that the value is in the experience not in obtaining credit. However, if the work experience is in the fall or spring semester, there are benefits to being registered for a co-op or internship (ENGR 195) course. These benefits include maintaining your student status (not necessary to take leave of absence), not being asked to begin student loan payments, maintaining access to Penn State Library resources, etc. For more details: <http://www.engr.psu.edu/career/Students/coopintern/creditoptions/courses.aspx>

If a student wishes to have BE 495, Internship, entered on his/her transcript, please contact Dr. Megan Marshall (mnm11@psu.edu, 814-865-3392) for the Internship packet. Please note that students are required to pay for these Internship credits, make all the necessary arrangements with the employer, submit an end-of-summer report to their advisor, and make sure the employer submits the evaluation form to your advisor. Internship grades are given by the student's academic advisor based on the written report and the employer's evaluation. BE 495 credits can not be used towards degree requirements.

Please see your advisor or Dr. Marshall if you have questions.



## Student Organizations

The Penn State Student Branch of ASABE is a professional organization that all BE students should join (<http://abe.psu.edu/students/clubs-and-organizations>). The meetings are generally held every other week. Organization activities included guest speakers, field trips, fund raising events, and social activities. Through active participation in this organization, students have an excellent opportunity to learn more about the Agricultural and Biological Engineering profession, to develop leadership and organizational skills, and to establish important leads on potential career opportunities.

## Scholarships

Biological Engineering students are eligible for scholarships awarded through both the College of Agricultural Sciences and College of Engineering. To apply for scholarships, a student needs to complete an online form through the College of Agricultural Sciences Scholarship Application site, usually by April 30. To be eligible for scholarships that require financial need, you must complete the online FAFSA application. Only when a student completes the College of Agricultural Sciences form will he/she be considered for scholarships from the College of Agricultural Sciences. More than \$80,000 in Departmental scholarships were awarded to BE and BRS students for the 2017-18 academic year. For a complete list of Departmental scholarships, please see <http://agsci.psu.edu/students/scholarships>

## Admission to Graduate School

Undergraduate students looking forward to graduation frequently consider graduate work after graduation.

The basic requirements for admission to graduate study in the Agricultural and Biological Engineering (ABENG) program are:

1. Graduation with a baccalaureate degree in engineering from Penn State.
2. Competitive applicants generally have a junior-senior grade point average of at least 3.00.

Most students enrolled in graduate study in the ABENG program receive graduate research assistantships. The current stipends for M.S. and Ph.D. assistantships are approximately \$22,500 per year plus full waiver of tuition and fees. Specific inquiries concerning the opportunities for graduate study in Agricultural and Biological Engineering should be addressed to Dr. Virendra Puri ([vmpuri@psu.edu](mailto:vmpuri@psu.edu)).

## Searching for Employment

### **"Self-directed" Job Searches**

- Use targeted contacts rather than a mass mailing.
- Target a company and conduct research on the company before sending cover letter and resume.
- Sell yourself in the cover letter.
- Gain experiences via co-op and other employment programs.
- Focus upon what you want to do in your professional career.
- Send resume and other materials to Chief Engineer, not Human Resources Division. Find the name of the Chief Engineer.
- Assemble a portfolio of accomplishments related to career goals.
- Network. Become actively involved with trade groups, professional societies, civic organizations, the Student Branch, etc.
- Be willing to start as a volunteer if necessary.
- Persist with follow-up.
- Explore non-standard job opportunities.



- Be assertive, but not to the extent of becoming obnoxious.

### **How Do Employers Evaluate Job Applicants?**

- Neatness of cover letter and resume. Two or three misspelled words are a "knock out."
- Resume that is easy to read, neat, and in logical order.
- Well-written cover letter and resume that are targeted to the interests and needs of the employer.
- Specifics in letters from professional references. Avoid use of personal references (friends, neighbors, relatives, etc.).
- Junior and senior academic performance.
- Performance in certain courses specific to the company's interests.
- Experiences from summer jobs, co-ops, internships.
- Percentage of school expenses earned by working.
- Participation in campus activities and/or work activities.
- Geographic mobility. For some companies, this is absolutely essential.
- Competence with a foreign language.
- Follow-up by the applicant.
- Interest shown in the company or organization.

### **Online Resources**

There are many resources at Penn State to help you with your job search:

	<b>Job Search Tips</b>	<b>Job Postings</b>
Penn State	Bank of America Career Services Center <a href="http://studentaffairs.psu.edu/career/students/job_search.shtml">http://studentaffairs.psu.edu/career/students/job_search.shtml</a>	Nittany Lion Career Network <a href="http://studentaffairs.psu.edu/career/students/NLCN.shtml">http://studentaffairs.psu.edu/career/students/NLCN.shtml</a>
College of Ag Sciences	Center for Experiential Learning and Career Services, 110 Ag Admin <a href="http://agsci.psu.edu/students/opportunities">http://agsci.psu.edu/students/opportunities</a>	Ag Sci Career Network <a href="http://agsci.psu.edu/students/careers/agsci-career-network">http://agsci.psu.edu/students/careers/agsci-career-network</a>
College of Engineering	Engineering Career Resources, 205 Hammond Bldg <a href="http://www.engr.psu.edu/career/Students/Default.aspx">http://www.engr.psu.edu/career/Students/Default.aspx</a>	eCareer <a href="http://www.engr.psu.edu/career/students/search.aspx">http://www.engr.psu.edu/career/students/search.aspx</a>
ABE Department		<a href="http://www.abe.psu.edu/students/job-postings">http://www.abe.psu.edu/students/job-postings</a>

There are also many general job resources online:

<b>General Sites with Job Postings</b>	<a href="http://www.indeed.com/">http://www.indeed.com/</a> <a href="http://college.monster.com/">http://college.monster.com/</a> <a href="http://www.careerbuilder.com/">http://www.careerbuilder.com/</a>
<b>Company Information</b>	<a href="http://www.hoovers.com">http://www.hoovers.com</a> <a href="http://www.thomasregister.com">http://www.thomasregister.com</a>
<b>State and Local Information</b>	<a href="https://www.cwds.state.pa.us/cwdsonline/">https://www.cwds.state.pa.us/cwdsonline/</a>
<b>Salary Information</b>	<a href="https://www.jobsearchintelligence.com/salary-calculator-intro-etc">https://www.jobsearchintelligence.com/salary-calculator-intro-etc</a> <a href="http://www.engr.psu.edu/career/Students/averagesalaries.aspx">http://www.engr.psu.edu/career/Students/averagesalaries.aspx</a>

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## Important Phone Numbers

Emergency (Police--Fire--Ambulance)	911
Police Services (Non-Emergency)	3-1111
Department of Environmental Health and Safety (General Safety Information)	5-6491
Physical Plant Service Desk (Structural, Plumbing, Electrical Problems)	5-4731
PSU Escort Service	5-WALK

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