AGRICULTURAL AND BIOLOGICAL ENGINEERING

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http://abe.illinois.edu

The Department of Agricultural and Biological Engineering offers a four-year degree program in Agricultural and Biological Engineering through the College of Engineering that is described below.

The Department also offers a five-year dual degree program through both the College of Engineering and the College of ACES. Students who successfully complete this five-year academic program receive the Bachelor of Science in Agricultural and Biological Engineering degree from the College of Engineering as well as the Bachelor of Science in Agriculture degree with a major in Agricultural and Biological Engineering from the College of ACES. Both degree programs are joint between the College of Engineering and the College of ACES with students beginning as new freshmen in the College of ACES.

Curriculum in Agricultural and Biological Engineering
abe.illinois.edu/undergrad_programs (http://www.abe.illinois.edu/undergrad_programs)
Fax: (217) 244-0323
E-mail: abe@illinois.edu

For the Degree of Bachelor of Science in Agricultural and Biological Engineering

Agricultural and biological engineering is the application of mathematics, physical and biological science, and engineering to agriculture, food systems, energy, natural resources, the environment, and related biological systems. This ABET-accredited program has special emphasis on environmental protection and the biological interface of plants, animals, soils, and microorganisms with the design and performance of environments, machines, mechanisms, processes, and structures.

Concentrations

The agricultural and biological engineering program provides two concentrations: Agricultural Engineering and Biological Engineering. Each concentration has specific areas of specialization related to career interest.

Agricultural Engineering Concentration

The B.S. Degree in Agricultural and Biological Engineering provides a concentration in Agricultural Engineering. This concentration includes the integration of physical and biological sciences as a foundation for engineering applications in agriculture, food systems, energy, natural resources, the environment, and related biological systems. Students pursuing this concentration are involved in the design of systems for renewable energy, off-road equipment, water quality, and the utilization and protection of soil and water resources. Important design constraints are economics, conservation of materials and energy, safety, and environmental quality. Within this concentration, students are strongly encouraged to select a set of coherent courses that constitutes a specialization in their area of career interest either from the following list or a customized area chosen in consultation with an advisor:

- Renewable Energy Systems
- Off-Road Equipment Engineering
- Soil and Water Resources Engineering

Biological Engineering Concentration

The B.S. Degree in Agricultural and Biological Engineering also provides a concentration in Biological Engineering. This concentration integrates biology and engineering to provide solutions to problems related to living systems (plants, animals, and microorganisms). Engineered biological systems vary widely in scale. At the molecular level, nanometer-scale devices consist of a few biomolecules inside individual cells. At the other extreme, regionally-scaled complex ecosystems depend upon multiple species of interacting living organisms. Such systems are becoming increasingly important in areas such as bioenergy, bioprocessing, nanotechnology, biosensing, bio-informatics, and bioenvironment. Within this concentration, students are strongly encouraged to select a set of coherent courses that constitutes a specialization in their area of career interest either from the following list or a customized area chosen in consultation with an advisor:

- Bioenvironmental Engineering
- Ecological Engineering
- Food and Bioprocess Engineering
- Nanoscale Biological Engineering

Overview of Curricular Requirements

The curriculum requires 128 hours for graduation. The curriculum is organized as follows.

Orientation and Professional Development

These courses introduce the opportunities and resources that your college, department, and curriculum can offer you as you work to achieve your career goals. They also provide the skills to work effectively and successfully in the engineering profession.

| ABE 100 | Intro Agric & Biological Engrg | 1 |
| ENG 100 | Engineering Orientation | 0 |
| **Total Hours** | | 1 |

1 External transfer students take ENG 300 instead.

Foundational Mathematics and Science

These courses stress the basic mathematical and scientific principles upon which the engineering discipline is based.

| CHEM 102 | General Chemistry I | 3 |
| CHEM 103 | General Chemistry Lab I | 1 |
| CHEM 104 | General Chemistry II | 3 |
| CHEM 105 | General Chemistry Lab II | 1 |
| MATH 221 | Calculus I | 4 |
| MATH 225 | Introductory Matrix Theory | 2 |
| MATH 231 | Calculus II | 3 |
| MATH 241 | Calculus III | 4 |
| MATH 285 | Intro Differential Equations | 3 |
| PHYS 211 | University Physics: Mechanics | 4 |

Information listed in this catalog is current as of 09/2017
PHYS 212  University Physics: Elec & Mag  4  
PHYS 213  Univ Physics: Thermal Physics  2  
Total Hours  34  

1  MATH 220 may be substituted, with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.

Agricultural and Biological Engineering Technical Core
These courses stress fundamental concepts and basic laboratory techniques that comprise the common intellectual understanding of agricultural and biological engineering and the background for the technical courses and electives in each student’s concentration.

For Both Concentrations
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABE 141</td>
<td>ABE Principles: Biological</td>
<td>2</td>
</tr>
<tr>
<td>ABE 223</td>
<td>ABE Principles: Machine Syst</td>
<td>2</td>
</tr>
<tr>
<td>ABE 224</td>
<td>ABE Principles: Soil &amp; Water</td>
<td>2</td>
</tr>
<tr>
<td>ABE 225</td>
<td>ABE Principles: Bioenvironment</td>
<td>2</td>
</tr>
<tr>
<td>ABE 226</td>
<td>ABE Principles: Bioprocessing</td>
<td>2</td>
</tr>
<tr>
<td>ABE 430</td>
<td>Project Management</td>
<td>2</td>
</tr>
<tr>
<td>ABE 469</td>
<td>Industry-Linked Design Project</td>
<td>4</td>
</tr>
<tr>
<td>CS 101</td>
<td>Intro Computing: Engr &amp; Sci</td>
<td>3</td>
</tr>
<tr>
<td>ECE 205</td>
<td>Elec &amp; Electronic Circuits</td>
<td>3</td>
</tr>
<tr>
<td>SE 101</td>
<td>Engineering Graphics &amp; Design</td>
<td>3</td>
</tr>
<tr>
<td>TAM 210</td>
<td>Introduction to Statics</td>
<td>2</td>
</tr>
<tr>
<td>or TAM 211 Statics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAM 212</td>
<td>Introductory Dynamics</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours  30  

Subtotal for both concentrations. See additional technical core requirements below.

1  The extra hour of credit for this course may be used to help meet free elective requirements.

For the Agricultural Engineering Concentration
Select one of the following:
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE 202</td>
<td>Engineering Risk &amp; Uncertainty</td>
<td>3</td>
</tr>
<tr>
<td>IE 300</td>
<td>Analysis of Data</td>
<td>1</td>
</tr>
<tr>
<td>ABE 440</td>
<td>Applied Statistical Methods I</td>
<td>3</td>
</tr>
<tr>
<td>STAT 400</td>
<td>Statistics and Probability I</td>
<td></td>
</tr>
<tr>
<td>ECE 206</td>
<td>Elec &amp; Electronic Circuits</td>
<td>3</td>
</tr>
<tr>
<td>ME 300</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>TAM 251</td>
<td>Introductory Solid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>or TAM 211 Statics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAM 335</td>
<td>Introductory Fluid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>CHBE 421</td>
<td>Momentum and Heat Transfer</td>
<td></td>
</tr>
<tr>
<td>ME 310</td>
<td>Fundamentals of Fluid Dynamics</td>
<td></td>
</tr>
</tbody>
</table>

Total Hours  14  

Total for the Agricultural Engineering Concentration  44  

Total Hours  44  

1  The extra hour of credit for this course may be used to help meet free elective requirements.

For the Biological Engineering Concentration
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABE 341</td>
<td>Transport Processes in ABE</td>
<td>3</td>
</tr>
<tr>
<td>CHBE 321</td>
<td>Thermodynamics</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 232</td>
<td>Elementary Organic Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>MCB 150</td>
<td>Molec &amp; Cellular Basis of Life</td>
<td>4</td>
</tr>
</tbody>
</table>

Subtotal  14  

Total for the Biological Engineering Concentration  44  

1  May be taken for 4 credit hours; the extra hour may be used to help meet free elective requirements.

Technical Electives
This elective course work must be completed to fulfill each Concentration. The subjects build upon the agricultural and biological engineering technical core.

For the Agricultural Engineering Concentration
Biological and natural sciences electives chosen from a departmentally approved list of Biological and Natural Sciences Electives – Group A  6  
Technical electives chosen in consultation with an advisor. At least 8 hours must be Agricultural and Biological Engineering Technical Electives – Group A, and the remainder approved Other Technical Electives – Group A  15  

Total Hours  21  

1  Biological and Natural Sciences Electives - Group A (http://abe.illinois.edu/undergraduate/agricultural)  
2  Agricultural and Biological Engineering Technical Electives - Group A (http://abe.illinois.edu/undergraduate/agricultural)  
3  Other Technical Electives - Group A (http://abe.illinois.edu/undergraduate/agricultural)

For the Biological Engineering Concentration
Biological and natural sciences electives chosen from a departmentally approved list of Biological and Natural Sciences Electives – Group B  6  
Technical electives chosen in consultation with an advisor. At least 8 hours must be Agricultural and Biological Engineering Technical Electives – Group B, and the remainder approved Other Technical Electives – Group B  15  

Total Hours  21  

1  Biological and Natural Science Electives - Group B (http://abe.illinois.edu/undergraduate/biological)  
2  Agricultural and Biological Engineering Technical Electives - Group B (http://abe.illinois.edu/undergraduate/biological)  
3  Other Technical Electives - Group B (http://abe.illinois.edu/undergraduate/biological)

Liberal Education
The liberal education courses (https://wiki.cites.illinois.edu/wiki/display/ugadvise/Liberal+Education+Electives) develop students’ understanding of human culture and society, build skills of inquiry and critical thinking, and lay a foundation for civic engagement and lifelong learning.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON 103</td>
<td>Macroeconomic Principles</td>
<td>3</td>
</tr>
</tbody>
</table>
Electives from the campus General Education Social and Behavioral Sciences list. 3
Electives from the campus General Education Humanities and the Arts list. 6
Electives either from a list approved by the college, or from the campus General Education lists for Social and Behavioral Sciences or Humanities and the Arts. 6
Total Hours 18

1  ECON 102 or ACE 100 may be substituted by petition.

Students must also complete the campus cultural studies requirement by completing (i) one western/comparative culture(s) course and (ii) one non-western/U.S. minority culture(s) course from the General Education cultural studies lists. Most students select liberal education courses that simultaneously satisfy these cultural studies requirements. Courses from the western and non-western lists that fall into free electives or other categories may also be used satisfy the cultural studies requirements.

Composition
These courses teach fundamentals of expository writing.
RHET 105 Writing and Research 4
Advanced Composition (satisfied by completing ABE 469 in the Agricultural and Biological Engineering Technical Core) 4
Total Hours 4

Free Electives
These unrestricted electives, subject to certain exceptions as noted at the College of Engineering Advising Website (https://wiki.cites.illinois.edu/wiki/display/ugadvice/Undergrad+Advising+Home), give the student the opportunity to explore any intellectual area of unique interest. This freedom plays a critical role in helping students to define research specialties or to complete minors.
Free electives. Additional unrestricted course work, subject to certain exceptions as noted at the College of Engineering advising website, so that there are at least 128 credit hours earned toward the degree. 6

1  College of Engineering Advising Website (https://wiki.cites.illinois.edu/wiki/display/ugadvice/Undergrad+Advising+Home)

Suggested Sequence
The schedule that follows for each concentration is illustrative, showing the typical sequence in which courses would be taken by a student with no college course credit already earned and who intends to graduate in four years. Each individual’s case may vary, but the position of required named courses is generally indicative of the order in which they should be taken. Refer to the appropriate sequence below for each concentration.

For the Agricultural Engineering Concentration
First Year
First Semester
ABE 100 Intro Agric Biological Engrg 1
CHEM 102 General Chemistry I 3
CHEM 103 General Chemistry Lab I 1
ENG 100 Engineering Orientation 0

SE 101 Engineering Graphics Design 3
MATH 221 Calculus I 4
Liberal education elective 3,4 3

Semester Hours 15

Second Semester
CHEM 104 General Chemistry II 3
CHEM 105 General Chemistry Lab II 1
MATH 231 Calculus II 3
ABE 141 ABE Principles: Biological 2
PHYS 211 University Physics: Mechanics 4
RHET 105 Writing and Research 3-4
or SE 101 1

Semester Hours 16-17

Second Year
First Semester
ABE 223 ABE Principles: Machine Syst 2
CS 101 Intro Computing: Engrg Sci 3
MATH 241 Calculus III 4
PHYS 212 University Physics: Elec Mag 4
TAM 210 Introduction to Statics or 211 5 2
ABE 224 ABE Principles: Soil Water 2

Semester Hours 17

Second Semester
ABE 225 ABE Principles: Bioenvironment 2
ABE 226 ABE Principles: Bioprocessing 2
MATH 225 Introductory Matrix Theory 2
MATH 285 Intro Differential Equations 3
PHYS 213 Univ Physics: Thermal Physics 2
TAM 212 Introductory Dynamics 3
Biological and natural sciences elective 6a 3

Semester Hours 17

Third Year
First Semester
CEE 202, Engineering Risk Uncertainty 3
IE 300, ABE 440, or STAT 400 5 3
ECE 206 Elec Electronic Circuits Lab 1
TAM 251 Introductory Solid Mechanics 3
Agricultural and biological engineering technical elective 7a 3
Liberal education elective 3,4 3
ECE 205 Elec Electronic Circuits 3

Semester Hours 16

Second Semester
ECON 103 Macroeconomic Principles 3
ME 300 Thermodynamics 3
TAM 335, Introductory Fluid Mechanics 4
CHBE 421, or ME 310 3
Agricultural and biological engineering technical elective 7a 3

Information listed in this catalog is current as of 09/2017
Liberal education elective\(^3,4\)\hspace{1cm}3

\underline{Fourth Year}

\underline{First Semester}

ABE 430  \hspace{0.1cm}Project Management\hspace{0.1cm}2

Agricultural and biological engineering technical elective\(^7_a\)\hspace{0.1cm}3

Other technical elective\(^7_a\)\hspace{0.1cm}3

Liberal education elective\(^3,4\)\hspace{0.1cm}3

Free elective\(^4\)\hspace{0.1cm}3

\underline{Semester Hours} 16

\underline{Second Semester}

ABE 469\(^8\)  Industry-Linked Design Project\hspace{0.1cm}4

Biological and natural sciences elective\(^6_a\)\hspace{0.1cm}3

Other technical elective\(^7_a\)\hspace{0.1cm}3

Liberal education elective\(^3,4\)\hspace{0.1cm}3

Free elective\(^4\)\hspace{0.1cm}3

\underline{Semester Hours} 14

\underline{Total Hours:} 127-128

\textbf{For the Biological Engineering Concentration}

\underline{First Year}

\underline{First Semester}  \hspace{1cm}Hours

ABE 100  \hspace{0.1cm}Intro Agric Biological Engrg\hspace{0.1cm}1

CHEM 102 General Chemistry I\hspace{0.1cm}3

SE 101 Engineering Graphics Design\hspace{0.1cm}3

MATH 221 Calculus I\hspace{0.1cm}4

Liberal education elective\(^3,4\)\hspace{0.1cm}3

CHEM 103 General Chemistry Lab I\hspace{0.1cm}1

ENG 100 Engineering Orientation\hspace{0.1cm}0

\underline{Semester Hours} 15

\underline{Second Semester}

MATH 231 Calculus II\hspace{0.1cm}3

PHYS 211 University Physics: Mechanics\hspace{0.1cm}4

CHEM 104 General Chemistry II\hspace{0.1cm}3

RHET 105 Writing and Research or SE 101^1 \hspace{0.1cm}4-3

CHEM 105 General Chemistry Lab II\hspace{0.1cm}1

ABE 141  \hspace{0.1cm}ABE Principles: Biological\hspace{0.1cm}2

\underline{Semester Hours} 17-16

\underline{Second Year}

\underline{First Semester}

ABE 223  \hspace{0.1cm}ABE Principles: Machine Syst\hspace{0.1cm}2

MATH 241 Calculus III\hspace{0.1cm}4

PHYS 212 University Physics: Elec Mag\hspace{0.1cm}4

TAM 210 Introduction to Statics or 211^5 \hspace{0.1cm}2

ABE 224  \hspace{0.1cm}ABE Principles: Soil Water\hspace{0.1cm}2

CS 101 Intro Computing: Engrg Sci\hspace{0.1cm}3

\underline{Semester Hours} 17

\underline{Second Semester}

ABE 225  \hspace{0.1cm}ABE Principles: Bioenvironment\hspace{0.1cm}2

ABE 226  \hspace{0.1cm}ABE Principles: Bioprocessing\hspace{0.1cm}2

MATH 225 Introductory Matrix Theory\hspace{0.1cm}2

MATH 285 Intro Differential Equations\hspace{0.1cm}3

CHEM 232 Elementary Organic Chemistry I\hspace{0.1cm}4

PHYS 213 Univ Physcs: Thermal Physics\hspace{0.1cm}2

TAM 212 Introductory Dynamics\hspace{0.1cm}3

\underline{Semester Hours} 18

\underline{Second Semester}

CHBE 321 Thermodynamics\hspace{0.1cm}4

ECON 103^5 Macroeconomic Principles\hspace{0.1cm}3

Agricultural and biological engineering technical elective\(^7_b\)\hspace{0.1cm}3

Biological and natural sciences elective\(^6_b\)\hspace{0.1cm}3

Liberal education elective\(^3,4\)\hspace{0.1cm}3

\underline{Semester Hours} 16

\underline{Third Year}

\underline{First Semester}

ABE 341 Transport Processes in ABE\hspace{0.1cm}3

Agricultural and biological engineering technical elective\(^7_b\)\hspace{0.1cm}3

Liberal education elective\(^3,4\)\hspace{0.1cm}3

ECE 205 Elec Electronic Circuits\hspace{0.1cm}3

MCB 150 Molec Cellular Basis of Life\hspace{0.1cm}4

\underline{Semester Hours} 16

\underline{Second Semester}

\underline{Fourth Year}

\underline{First Semester}

ABE 430  \hspace{0.1cm}Project Management\hspace{0.1cm}2

Agricultural and biological engineering technical elective\(^7_b\)\hspace{0.1cm}3

Other technical elective\(^7_b\)\hspace{0.1cm}3

Liberal education elective\(^3,4\)\hspace{0.1cm}3

Free elective\(^4\)\hspace{0.1cm}3

\underline{Semester Hours} 14

\underline{Second Semester}

ABE 469\(^8\)  Industry-Linked Design Project\hspace{0.1cm}4

Biological and natural sciences elective\(^6_b\)\hspace{0.1cm}3

Other technical elective\(^7_b\)\hspace{0.1cm}3

Liberal education elective\(^3,4\)\hspace{0.1cm}3

Free elective\(^4\)\hspace{0.1cm}3

\underline{Semester Hours} 16

\underline{Total Hours:} 129-128

\footnotesize{\textsuperscript{1} RHET 105 may be taken in the first or second semester of the first year as authorized. The alternative is SE 101. Students may take CMN 111 and CMN 112 in place of RHET 105.}

\footnotesize{\textsuperscript{2} MATH 220—Calculus may be substituted with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.}
skills as well as career planning. Emphasis on technical communication and problem-solving for becoming a successful engineer including time management, design of the agricultural and biological engineering discipline. Concepts necessary for an introduction to the engineering profession with career opportunities in the agricultural and biological engineering discipline. Courses

Courses

**ABE 100 Intro Agric & Biological Engrg** credit: 1 Hour.
Introduction to the engineering profession with career opportunities in the agricultural and biological engineering discipline. Concepts necessary for becoming a successful engineer including time management, design concepts, ethics, and teambuilding. Familiarization with laboratories, computer facilities, internships, and other opportunities. Team design experience. Emphasis on technical communication and problem-solving skills as well as career planning.

**ABE 141 ABE Principles: Biological** credit: 2 Hours.
Principles of biology relevant to agriculture, food, energy, and the environment, including microbiology, biochemistry, genetics, plant and animal systems, and ecosystems. Case studies of engineering applications where these biological principles have been taken into account or leveraged for the purpose of design.

**ABE 199 Undergraduate Open Seminar** credit: 1 to 5 Hours.
May be repeated to a maximum of 12 hours.

**ABE 223 ABE Principles: Machine Syst** credit: 2 Hours.
Machinery systems for off-road applications: internal combustion engines; fluid power; tractors, and traction; chemical application; grain harvesting. Prerequisite: One of MATH 220, MATH 221, MATH 234.

**ABE 224 ABE Principles: Soil & Water** credit: 2 Hours.
Engineering principles and methods of design and management of natural resources and environmental systems; watershed and hydrologic cycle; infiltration and surveying; runoff and erosion; water quality; non-point source pollution. Prerequisite: One of MATH 220, MATH 221, MATH 234.

**ABE 225 ABE Principles: Bioenvironment** credit: 2 Hours.
Principles of environmental control for biological structures: psychrometrics; mass and heat transfer through buildings; ventilation requirements. Prerequisite: One of MATH 220, MATH 221, MATH 234.

**ABE 226 ABE Principles: Bioprocessing** credit: 2 Hours.
Principles of bioprocess engineering applied to food and agricultural products: material balances; fluid flow; heat and mass transfers; drying; evaporation; fermentation; distillation; process simulation. Prerequisite: One of MATH 220, MATH 221, MATH 234.

**ABE 341 Transport Processes in ABE** credit: 3 Hours.
Principles of transport processes involving momentum, heat, and mass as applied to biological systems in agriculture, food, energy, and the environment. Credit is not given for both ABE 341 and CHBE 421. Prerequisite: ABE 223, ABE 224, ABE 225, and PHYS 213.

**ABE 361 Off-Road Machine Design** credit: 3 Hours.
Design and development concepts of agricultural and industrial machines; analysis and synthesis of tillage, planting, harvesting, chemical application, material handling mechanisms, and precision farming tools. Prerequisite: ABE 223 and TAM 212.

**ABE 397 Independent Study** credit: 1 to 4 Hours.
Individual research, special problems, thesis, development or design work under the supervision of a member of the faculty. May be repeated to a maximum of 8 hours. Prerequisite: Consent of instructor.

**ABE 398 Special Topics** credit: 1 to 3 Hours.
Subject offerings of new and developing areas of knowledge in agricultural and biological engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate term if topics vary to a maximum of 12 hours.

**ABE 425 Engrg Measurement Systems** credit: 4 Hours.
Principles of instrumentation systems, including sensing, signal conditioning, computerized data acquisition, test design, data analysis and synthesis. Additional fees may apply. See Class Schedule. 4 undergraduate hours. 4 graduate hours. Credit is not given for both ABE 425 and ME 360. Prerequisite: ECE 205.

Information listed in this catalog is current as of 09/2017
ABE 430 Project Management credit: 2 Hours.
Engineering team effectiveness; project definition; assessing related technologies; marketing and business planning related to engineering; budgeting and financial analyses of engineering projects; safety, ethics and environmental considerations; intellectual property; engineering proposal presentation. Same as TSM 430. 2 undergraduate hours. 2 graduate hours.

ABE 436 Renewable Energy Systems credit: 3 or 4 Hours.
Renewable energy sources and applications, including solar, geothermal, wind, and biomass. Renewable energy's role in reducing air pollution and global climate change. Capstone project to design a system for converting renewable energy into thermal or electrical energy. 3 undergraduate hours. 4 graduate hours. Credit is not given for both ABE 436 and TSM 438. Prerequisite: PHYS 211.

ABE 440 Applied Statistical Methods I credit: 4 Hours.
Same as ANSC 440, CPSC 440, FSHN 440, and NRES 440. See CPSC 440.

ABE 445 Statistical Methods credit: 4 Hours.
Same as ANSC 445 and NRES 445. See ANSC 445.

ABE 446 Biological Nanoengineering credit: 3 or 4 Hours.
Nanodevice design through organization of functional biological components; bio-molecular function and bioconjugation techniques in nanotechnology; modulation of biological systems using nanotechnology; issues related to applying biological nanotechnology in food energy, health, and the environment. 3 undergraduate hours. 4 graduate hours. Prerequisite: MCB 150.

ABE 454 Environmental Soil Physics credit: 3 Hours.
Provides the theoretical basis for understanding and quantifying the physical, hydrological, geotechnical, and thermal properties of soil in relation to environmental processes. Topics include general soil properties as a porous media, particle size, soil structure and aggregation, water retention and potential, flow in saturated soil, flow in an unsaturated soil, soil temperature and heat flow, soil mechanics, infiltration, and soil-plant-water relations. 3 undergraduate hours. 3 graduate hours. Prerequisite: TAM 335 or NRES 201 or consent of instructor.

ABE 455 Erosion and Sediment Control credit: 2 Hours.
Processes, estimation, and control of soil erosion by water, wind and resultant sedimentation. Upland, in-channel, urban, agricultural, disturbed (both military training and mining), and forested environments. Capstone experience in site planning and design. 2 undergraduate hours. 2 graduate hours. Prerequisite: CEE 350 or NRES 401; CEE 380 or NRES 201.

ABE 456 Land & Water Resources Engrg credit: 3 or 4 Hours.
Hydrology, hydraulics, design, construction and cost estimating of structures for the conservation and quality control of soil and water resources; relationship of topography, soils, crops, climate, and cultural practices in conservation and quality control of soil and water for agriculture. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: Credit or concurrent registration in TAM 335.

ABE 457 NPS Pollution Processes credit: 2 Hours.
Principles, concepts, and analysis of processes for nonpoint source pollution involving sediment, inorganic and organic chemicals, and microbial pathogens; hydrologic and pollutant interactions, pollutant fate and transport processes from storm water runoff and percolation; impact of pollutant transport on receiving water and ecosystems. 2 undergraduate hours. 2 graduate hours. Prerequisite: ABE 224 or CEE 350.

ABE 458 NPS Pollution Modeling credit: 2 Hours.
Concepts, principles, and application of modeling for assessment and management of agricultural nonpoint source pollution. Modeling of agroecosystems and land use impacts on hydrologic and water quality response of upland catchments. Model selection, calibration, validation, and application for comparative analysis. Case studies in current watershed management issues, with a focus on agricultural waste and nutrient management, using existing field and watershed nonpoint source pollution models. 2 undergraduate hours. 2 graduate hours. Prerequisite: ABE 457.

ABE 459 Drainage and Water Management credit: 3 or 4 Hours.
Design, construction, performance, and maintenance of agricultural drainage systems to meet both production and water quality objectives. Modeling drainage systems. Principles of conservation drainage. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: Credit or concurrent registration in TAM 335.

ABE 463 Electrohydraulic Systems credit: 3 Hours.
Engineering principles of electrohydraulic control systems related to off-road vehicles. Basics of fluid power systems, concepts of electrohydraulic systems and controls, analysis and design of electrohydraulic control systems, and applications of electrohydraulic control. Additional fees may apply. See Class Schedule. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 110 or both ECE 205 and ECE 206; ME 310 or TAM 335.

ABE 466 Engineering Off-Road Vehicles credit: 3 Hours.
Design and application of off-road vehicles for farm and construction use; thermodynamics of engines; measurement of power and efficiencies; power transmission and traction; chassis mechanics; operator environment. 3 undergraduate hours. 3 graduate hours. Credit is not given for both ABE 466 and TSM 464. Prerequisite: ME 300.

ABE 469 Industry-Linked Design Project credit: 4 Hours.
Industry-submitted and sponsored design projects which utilize principles of design, engineering analysis and functional operation of engineering systems. Design teams develop concepts, evaluate alternatives, model and analyze solutions, and build and test a final product. Emphases on communication skills, technical writing, and interaction with industry representatives. 4 undergraduate hours. 4 graduate hours. Prerequisite: One of ABE 361, CHBE 421, TAM 335; or credit or concurrent registration in ME 370. This course satisfies the General Education Criteria for: Advanced Composition

ABE 474 Indoor Environmental Control credit: 3 Hours.
Analysis of indoor environments and relationship with humans, animals and plants. Interactions between facilities operation and both human comfort and animal plant production. Psychrometrics, occupant health and comfort, structural heat transfer, heating and cooling loads, and energy and mass balances as related to indoor environment, air properties, and ventilation. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: TAM 335, and ME 300 or CHBE 321, or consent of instructor.

ABE 476 Indoor Air Quality Engineering credit: 4 Hours.
Principles and applications of indoor air quality. Particle mechanics, gas kinetics, air quality sampling principles and techniques, air cleaning technologies such as filters, cyclones, electrostatic precipitation for indoor environments; ventilation effectiveness for pollutant control. Research or design project. 4 undergraduate hours. 4 graduate hours. Prerequisite: PHYS 213, MATH 285, and TAM 335.

ABE 482 Package Engineering credit: 3 Hours.
Same as FSHN 469. See FSHN 469.
ABE 483  Engrg Properties of Food Matls  credit: 3 Hours.
Physical properties of foods and biological materials; properties relating to equipment design and the sensing and control of food processes; thermal, electromagnetic radiation, rheological, and other mechanical properties. 3 undergraduate hours. 3 graduate hours. Prerequisite: TAM 251; either CHBE 421 or both ME 330 and TAM 335.

ABE 488  Bioprocessing Biomass for Fuel  credit: 3 Hours.
Engineering and scientific principles governing bioprocessing of biomass for production of ethanol and other fermentation products. Process unit operations; conventional and alternative feed stock materials; recovery of value-added coproducts and other variables involved in producing fuel ethanol; process simulation; economic analysis. 3 undergraduate hours. 3 graduate hours. Prerequisite: CHBE 321 and TAM 335.

ABE 497  Independent Study  credit: 1 to 4 Hours.
Individual research, special problems, thesis, development or design work under the supervision of a member of the faculty. 1 to 4 undergraduate hours. No graduate credit. May be repeated to a maximum of 8 hours. Prerequisite: Consent of instructor.

ABE 498  Special Topics  credit: 1 to 4 Hours.
Subject offerings of new and developing areas of knowledge in agricultural and biological engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. 1 to 4 undergraduate hours. 1 to 4 graduate hours. May be repeated in the same or separate terms if topics vary to a maximum of 16 hours.