BIOLOGICAL SYSTEMS ENGINEERING

Description
Website: http://bsen.unl.edu/

Biological systems engineering (BSEN) is one of two engineering degree programs offered in the Department of Biological Systems Engineering. BSEN students emphasize engineering course work in one of three areas: biomedical engineering, bioenergy and food engineering, or environmental and water resources engineering. A biological systems engineer could work on systems to micropropagate tissue culture, develop biomaterials and biofibers, design equipment and processes for producing foods and biofuels, or design devices for performing minimally invasive surgery. Still another could be responsible for developing biological sensors and imaging devices for detecting diseases in humans, for measuring plant and animal stress, or for controlling the environment of greenhouses and animal facilities. Biological systems engineers could also be involved in resolving environmental issues associated with waste management, water quality and sustainable energy production. Job opportunities for graduates are available in industry, public agencies, consulting, and private practice. A significant number of graduates pursue graduate school or studies in medical or law school.

By two to six years after graduation, BSEN alumni will share the attribute of improving the organization for which they work, and the community and country in which they live. They will do this whether they are involved in biomedical engineering, environmental or water resources engineering, bioenergy and food engineering, or other professional endeavors such as business, law or medicine. In doing so, they will:

- provide innovative and effective solutions to problems in a variety of work environments through the use of their unique background in biological systems engineering and the biological sciences;
- look beyond components in isolation thereby providing holistic solutions to complex issues involving (for example) interactions at the ecosystem, organism, organ, cellular or subcellular level;
- think logically using appropriate elements of mathematics, science, and engineering to develop, manage, and interpret data, to correctly interpret new research findings, and to design new systems for the benefit of society;
- successfully integrate technical knowledge with organizational, listening, communication, and interpersonal skills to lead and work effectively in teams, and to respectfully articulate the role of engineering decisions in the workplace, community, and world;
- responsibly address issues such as health and safety, personal and professional ethics, cultural diversity, as well as the social, environmental, and global impacts of their work; and
- continue their personal growth, professional development, and professional and community service through various opportunities provided by institutions, professional organizations and other venues.

The Department of Biological Systems Engineering is located in Chase Hall on East Campus. BSEN students participate in classes and laboratories on both the East and City Campuses. BSEN courses are offered on the East Campus. Basic courses in math, chemistry, physics, engineering sciences, computers, and electives in mechanical, civil, electrical, and chemical engineering are taken on the City Campus. Convenient bus transportation is available between campuses.

Students benefit from small classes and personal acquaintances with faculty. In consultation with their advisor, students select electives that permit specialization in an emphasis area applicable to their career aspirations. Many students work part-time on departmental research projects, gaining valuable experience for employment in industry and for graduate or professional studies. Students also benefit from summer jobs, internships and co-op programs. These opportunities give students practical experience to learn about careers in engineering. Students also gain valuable experience through participation in professional organizations such as the American Society of Agricultural and Biological Engineers, the Water and Environmental Federation, the Soil and Water Resources Club, the Biomedical Engineering Society, the Nebraska Society of Professional Engineers and the Society for Women Engineers.

Major Department Admission

Pre-professionally admitted College of Engineering (COE) students majoring in biological systems engineering (BSEN) have their records examined for advancement to professionally admitted status during the fall, spring, and summer immediately following the term in which 43 or more credits applicable to the BSEN degree have been completed. **Students must be professionally admitted in order to enroll in AGEN 470/BSEN 470 Design I in Agricultural and Biological Systems Engineering.**

To be professionally admitted to BSEN, the student must first meet the general Professional Admission criteria of the College of Engineering (i.e., completion of at least one semester in the College, a cumulative GPA of 2.5 or greater, and not having been already declined admission by two other engineering majors). BSEN Professional Admission criteria require consistent grades of C or better in calculus, calculus-based physics, chemistry, communications, and engineering science courses. Specifically, the student must have completed MECH 223 Engineering Statics and AGEN 225/BSEN 225 Engineering Properties of Biological Materials or BSEN 244 Thermodynamics of Living Systems with grades of a C or better to gain Professional Admission to BSEN.

Students who meet the above criteria with a cumulative GPA of 3.0 or greater with all grades above a C in University of Nebraska—Lincoln mathematics, science, engineering, and communications courses, may be professionally admitted without further review by Department faculty. Students not meeting the 3.0 GPA standard, or having grades below a C in the listed areas, will have their record reviewed by Department faculty for evidence of ability to succeed in BSEN. Under special circumstances, the Department may elect to defer Professional Admission for an additional term.

The Department faculty may recommend provisional admission and specify deficiencies and performance criteria to transition out of provisional status. If a student has not met the admission criteria and has not, in the opinion of the Department faculty demonstrated a minimum standard of good professional judgment in the pursuit of their academic program as expected of degree engineers, they may be denied Professional Admission to the degree program. The student may appeal this decision to the BSE department head and then, if necessary, to the College of Engineering Curriculum and Academic Standards Committee.
College Requirements

College Admission

College Entrance Requirements

Students must have high school credit for (one unit is equal to one high school year):

1. 4 units of mathematics: 2 of algebra, 1 of geometry, 1 of precalculus and trigonometry.
2. 4 units of English.
3. 3 units of natural science that must include 1 unit of physics and 1 unit of chemistry (chemistry requirement waived for students in construction management).
4. 2 units of a single foreign language.
5. 3 units of social studies.
6. Students having a composite ACT score of 28 or greater (or equivalent SAT score) will be admitted to the College of Engineering even if they lack any one of the following: trigonometry, chemistry, or physics.
7. Students having an ACT score of 19 or less in English (or equivalent SAT score) must take ENGL 150 Writing and Inquiry or ENGL 151 Writing and Argument.

A total of 16 units is required for admission.

Students must have an ACT (enhanced) score of 24 or greater (or equivalent SAT). Students who lack entrance requirements may be admitted based on ACT scores, high school rank and credits, or may be admitted to pre-engineering status in the Exploratory and Pre-Professional Advising Center. Pre-engineering students are advised within the College of Engineering.

Students for whom English is not their language of nurture must meet the minimum English proficiency requirements of the University.

Students who lack entrance units may complete precollege training by Independent Study through the University of Nebraska–Lincoln Office of On-line and Distance Education, in summer courses, or as a part of their first or second semester course loads while in the Exploratory and Pre-Professional Advising Center or other Colleges at Nebraska.

Students should consult their advisor, their department chair, or Engineering Student Services if they have questions on current policies.

Other Admission Requirements

Students who transfer to the University of Nebraska–Lincoln from other accredited colleges or universities and wish to be admitted to the College of Engineering (COE) must meet COE freshman entrance requirements and have a minimum cumulative GPA of 2.5, and be calculus-ready. Students not meeting either of these requirements must enroll in the Explore Center or another University college until they meet COE admission requirements.

The COE accepts courses for transfer for which a C or better grade was received. Although the University of Nebraska–Lincoln accepts D grades from the University of Nebraska at Kearney and at Omaha, not all majors in the COE accept such low grades. Students must conform to the requirements of their intended major and, in any case, are strongly encouraged to repeat courses with a grade of C- or less.

All transfer students must adopt the curricular requirements of the undergraduate catalog current at the time of transfer to the COE—not that in use when they entered the University of Nebraska–Lincoln. Upon admission to Nebraska, students wishing to pursue degree programs in the COE will be classified and subject to the policies defined in the subsequent section.

Students who were previously admitted to COE and are returning to the College of Engineering must demonstrate a cumulative GPA of 2.5 in order to be readmitted to COE.

College Degree Requirements

Grade Rules

Grade Appeals

In the event of a dispute involving any college policies or grades, the student should appeal to his/her instructor, and appropriate department chair or school director (in that order). If a satisfactory solution is not achieved, the student may appeal his/her case through the College Academic Appeals Committee on his/her campus.

Catalog Rule

Students must fulfill the requirements stated in the catalog for the academic year in which they are first admitted at the University of Nebraska–Lincoln. In consultation with advisors, a student may choose to follow a subsequent catalog for any academic year in which they are admitted to and enrolled as a degree-seeking student at Nebraska in the College of Engineering. Students must complete all degree requirements from a single catalog year. The catalog which a student follows for degree requirements may not be more than 10 years old at the time of graduation.

Learning Outcomes

Majors in biological systems engineering will develop:

1. An ability to apply knowledge of mathematics, science, and engineering. (a)
2. An ability to design and conduct experiments, as well as to analyze and interpret data. (b)
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. (c)
4. An ability to function on multidisciplinary teams. (d)
5. An ability to identify, formulate, and solve engineering problems. (e)
6. An understanding of professional and ethical responsibility. (f)
7. An ability to communicate effectively. (g)
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. (h)
9. A recognition of the need for, and an ability to engage in life-long learning. (i)
10. A knowledge of contemporary issues. (j)
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. (k)

NOTE: Letters are references to ABET Engineering Accreditation Commission outcomes (a through k).
# Major Requirements

## Specific Major Requirements

### First Semester
- **BSEN 100 / AGEN 100**
  - Introduction to Biological Engineering and Agricultural Engineering
- **CHEM 113**
  - Fundamental Chemistry I 1
- **ENGR 10**
  - Freshman Engineering Seminar
- **MATH 106**
  - Calculus I
- **CSCE 155N**
  - Computer Science I: Engineering and Science Focus
- **ENGR 100**
  - Interpersonal Skills for Engineering Leaders

Credit Hours Subtotal: 16

### Second Semester
- **BSEN 112 / AGEN 112**
  - Computer-Aided Problem-Solving
- **CHEM 114**
  - Fundamental Chemistry II 2
- **MATH 107**
  - Calculus II
- **PHYS 211**
  - General Physics I
- **BSEN 130 / CIVE 130**
  - Computer-Aided Design

Credit Hours Subtotal: 15

### Third Semester
- **BSEN 225 / AGEN 225**
  - Engineering Properties of Biological Materials
- **Select one of the following:**
  - **CHEM 251 & CHEM 253**
    - Organic Chemistry I and Organic Chemistry I Laboratory
  - **CHEM 255 & CHEM 257**
    - Biological Organic Chemistry and Biological Organic Chemistry Laboratory
  - **CHEM 261 & CHEM 263**
    - Organic Chemistry and Organic Chemistry Laboratory
- **ENGR 20**
  - Sophomore Engineering Seminar
- **PHYS 212**
  - General Physics II
- **MATH 208**
  - Calculus III
- **MECH 223**
  - Engineering Statics

Credit Hours Subtotal: 18

### Fourth Semester
- **BSEN 260**
  - Instrumentation I for Agricultural and Biological Systems Engineering
- **BSEN 244**
  - Thermodynamics of Living Systems
- **LIFE 120 & LIFE 120L**
  - Fundamentals of Biology I and Fundamentals of Biology I laboratory
- **MATH 221**
  - Differential Equations
- **MECH 373**
  - Engineering Dynamics

Credit Hours Subtotal: 16

### Fifth Semester
- **LIFE 121 & LIFE 121L**
  - Fundamentals of Biology II and Fundamentals of Biology II Laboratory
- **MECH 310**
  - Fluid Mechanics
- **or CHME 332**
  - Transport Operations I
- **BSEN 460 / AGEN 460**
  - Instrumentation and Controls

### Sixth Semester
- **BIOC 321**
  - Elements of Biochemistry or BIOS 431
  - Structure and Metabolism
- **BSEN 344 / AGEN 344**
  - Biological and Environmental Transport Processes

### Statistics Elective
- **Select one of the following:**
  - **MECH 321**
    - Engineering Statistics and Data Analysis
  - **MATH 380**
    - Statistics and Applications

### ACE Elective
- **Select one course from not yet satisfied ACE outcomes 5, 6, 7, or 9:**
  - ** Bios 203 Bioethics is not acceptable.**

### Seventh Semester
- **BSEN 206 / CONE 206**
  - Engineering Economics
- **BSEN 470 / AGEN 470**
  - Design I in Agricultural and Biological Systems Engineering

### Eighth Semester
- **BSEN 480 / AGEN 480**
  - Design II in Agricultural and Biological Systems Engineering

### Emphasis Area Requirements
An emphasis area requires a student to take 18 hours of engineering and science-based courses. A minimum of 15 hours must be selected

1. CHEM 109 may be substituted with permission of advisor.
2. CHEM 110 may be substituted with permission of advisor.
3. BIOS 203 Bioethics is not acceptable.
from courses offered by the College of Engineering. Within the 15 hours, a minimum of 12 hours must be BSEN courses or engineering courses crosslisted with BSEN. Of the BSEN or BSEN crosslisted courses, one must be a 300-level course of a primary emphasis area, one must be a 300-level course of a secondary emphasis area and one must be a 400-level course of a primary emphasis area. Water and Environment emphasis requires BSEN 350 Soil and Water Resources Engineering and either BSEN 326 Introduction to Environmental Engineering or BSEN 355 Introduction to Ecological Engineering. Bioenergy and Food emphasis requires BSEN 303 Principles of Process Engineering, and Biomedical emphasis requires BSEN 317 Introduction to Biomedical Engineering as primary emphasis area courses.

**BSEN Primary Emphasis Area Courses**

**Bioenergy and Food**

BSEN 303 / AGEN 303  
Principles of Process Engineering 3

BSEN 446 / AGEN 446  
Unit Operations of Biological Processing 3

BSEN 444  
Biomass and Bioenergy Engineering 3

**Total Credit Hours** 9

**Biomedical**

BSEN 317  
Introduction to Biomedical Engineering 3

Select two of the following: 6

- BSEN 311  
Biomedical Signal and System Analysis
- BSEN 414  
Medical Imaging Systems
- BSEN 416  
Introduction to Biomaterials
- BSEN 418  
Tissue Engineering

**Total Credit Hours** 9

**Water and Environment**

BSEN 350 / AGEN 350  
Soil and Water Resources Engineering 3

Select one of the following: 3

- BSEN 326 / CIVE 326  
Introduction to Environmental Engineering
- BSEN 355  
Introduction to Ecological Engineering

Select one of the following: 3

- BSEN 441 / AGEN 441  
Animal Waste Management
- BSEN 453 / AGEN 453  
Irrigation and Drainage Systems
- BSEN 455 / CIVE 455  
Nonpoint Source Pollution Control
- BSEN 458 / CIVE 458  
Groundwater Engineering

**Total Credit Hours** 9

**Additional Major Requirements**

**Grade Rules**

A grade of C- or better is required for all biological systems engineering required courses and electives that are to count toward graduation, with the exception of ACE 5, 6, 7, and 9 electives.

**Catalog to Use**

In addition to the "Catalog Rule" of the College of Engineering, students transferring into the Department of Biological Systems Engineering must follow the catalog in effect at the time of their transfer into the department.

**BSEN 100 Introduction to Biological Engineering and Agricultural Engineering**

**Crosslisted with:** AGEN 100

**Description:** Description of careers in biomedical, environmental, water resources, food and bioproducts, and agricultural engineering. The human, economic and environmental impacts of engineering in society. Communication, design, teamwork, and the role of ethics and professionalism in engineering work.

**Credit Hours:** 1

- Max credits per semester: 1
- Max credits per degree: 1

**Format:** LEC

**BSEN 112 Computer-Aided Problem-Solving**

**Crosslisted with:** AGEN 112

**Prerequisites:** MATH 106 or parallel.

**Description:** Problem solving techniques and procedures through the use of Excel, MATLAB, and graphical methods. Emphasis on problem/solution communications with topics and problems from agricultural engineering and biological systems engineering.

**Credit Hours:** 2

- Max credits per semester: 2
- Max credits per degree: 2

**Format:** LEC

**Offered:** SPRING

**Prerequisite for:** BSEN 212A, AGEN 212A; BSEN 212B, AGEN 212B; BSEN 212E, AGEN 212E

**BSEN 130 Computer-Aided Design**

**Crosslisted with:** CIVE 130

**Description:** Use of computer-aided design software to communicate engineering ideas. Specifications, dimensioning, tolerancing, 2- and 3-D model development, topographic mapping, and process layout with environmental, bioprocess, and biomedical emphases.

**Credit Hours:** 2

- Max credits per semester: 2
- Max credits per degree: 2

**Format:** LEC

**BSEN 206 Engineering Economics**

**Crosslisted with:** CONE 206

**Prerequisites:** Sophomore standing

**Description:** Introduction to methods of economic comparisons of engineering alternatives: time value of money, depreciation, taxes, concepts of accounting, activity-based costing, ethical principles, civics and stewardship, and their importance to society.

**Credit Hours:** 3

- Max credits per semester: 3
- Max credits per degree: 3

**Format:** LEC

**Prerequisite for:** MECH 343

**ACE:** ACE 8 Civic/Ethics/Stewardship
BSEN 212A Computational Tools & Modeling for Agricultural & Biological Systems Eng: MATLAB
Crosslisted with: AGEN 212A
Prerequisites: AGEN/BSEN 112
Description: Introduction to tools needed to develop computation-intense solutions for a wide variety of problems relevant to agricultural and biological systems engineering. Advanced problem solving techniques are illustrated using examples of scripts.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC
Offered: SPRING
Prerequisite for: BSEN 311; MECH 350

BSEN 212B Computational Tools & Modeling for Ag & Biological Sys Engr: Control Systems
Crosslisted with: AGEN 212B
Prerequisites: AGEN/BSEN 112
Notes: This is a 5-week mini-course in which the lab time entails a combination of a 2nd lecture and followup laboratory applications.
Description: Introduction to microcontroller based embedded systems for agricultural and biological applications. Fundamental principles of microcontrollers and embedded systems through binary and hexadecimal number systems, digital logic, programming in integrated development environment, and microcontroller peripherals. Common agricultural and biological microcontroller input and output devices.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC
Offered: SPRING
Prerequisite for: MECH 350

BSEN 212E Computational Tools & Modeling for Agricultural & Biological Systems Eng: LabVIEW
Crosslisted with: AGEN 212E
Prerequisites: AGEN/BSEN 112
Description: Introduction to tools needed to develop computation-intense solutions for a wide variety of problems relevant to agricultural and biological systems engineering. Advanced problem solving techniques are illustrated using examples of scripts, simulation methods, graphical programming, and their combination.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC
Offered: FALL/SPR
Prerequisite for: MECH 350

BSEN 225 Engineering Properties of Biological Materials
Crosslisted with: AGEN 225
Prerequisites: MATH 106
Description: Physical properties important to the design of harvesting, storage, and processing systems for agricultural crops; principles and techniques for measurement of properties including frictional effects, particle size, strength, moisture content, specific heat, and thermal conductivity.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: AGEN 324, BSEN 324; BSEN 416, BSEN 816; BSEN 446, BSEN 846, AGEN 446, AGEN 846

BSEN 244 Thermodynamics of Living Systems
Prerequisites: CHEM 110 or 114; MATH 107; PHYS 211; LIFE 120 or parallel
Description: Introduction to the laws of thermodynamics and their application to biological and environmental systems. Zeroth, first, second, and third laws; open and closed systems; enthalpy and specific heat; and Gibb's free energy and chemical potential for biological and environmental systems. Applications to biochemical potentials, water potential, absorption, osmosis, radiation, membranes, surface tension, and fugacity. Thermodynamic cycles as they apply to living systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Offered: SPRING
Prerequisite for: AGEN 344, BSEN 344

BSEN 260 Instrumentation I for Agricultural and Biological Systems Engineering
Crosslisted with: AGEN 260
Prerequisites: MATH 221 or parallel
Description: Developing concepts in instrumentation relevant to agricultural and biological systems. Fundamental concepts of charge, current, voltage, impedance, power, and circuit analysis within the context of biological engineering. Introduction to sensors and their applications. Data collection using modern acquisition hardware and software. Electrical safety and effects of electricity on the human body.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Offered: SPRING

BSEN 303 Principles of Process Engineering
Crosslisted with: AGEN 303
Prerequisites: MATH 221
Notes: MECH 310 or CIVE 310 or CHME 332 is recommended as prereq or parallel.
Description: Introduction to performance parameters and characteristics of pumps, fans, presses, and solids handling, size reduction, separation and agitation equipment. Application of the various technologies studied with analysis of example systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
BSEN 311 Biomedical Signal and System Analysis
Prerequisites: MATH 221; and BSEN 212A or equivalent
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 317 Introduction to Biomedical Engineering
Prerequisites: PHYS 211; MATH 221 or parallel; and LIFE 120 or BIOS 101
Description: Research areas and applications related to biomedical engineering including bioelectricity, biosensors, biomechanics, cardiovascular mechanics, tissue engineering, biotechnology, and medical imaging. Identifying engineering methods used to develop biomedical technologies and communicating technical knowledge to a wide variety of audiences.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Offered: FALL

BSEN 324 Mechanics of Materials for Agricultural and Biological Systems Engineering
Crosslisted with: AGEN 324
Prerequisites: AGEN/BSEN 225, MECH 223
Description: Development of the concepts of stress and strain relevant to agricultural and biological systems. Stress analysis of axial, torsional, and bending stresses, combined loading analysis, deflection evaluation, static and dynamic failure theory. Practical applications in agricultural and biological systems will be discussed.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: AGEN 424, AGEN 824; AGEN 443

BSEN 325 Power Systems Design
Crosslisted with: AGEN 325
Prerequisites: PHYS 212 or ECEN 211, and MECH/CIVE 310 or CHME 332 or parallel.
Description: Fundamentals of Power systems for machines. Introduction to fluid power (hydraulics, pneumatics), pumps, motors, cylinders, control devices and system design. Selection of electric motors as power sources, operating characteristics and circuits. Selection of internal combustion engines as power sources.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 326 Introduction to Environmental Engineering
Crosslisted with: CIVE 326
Prerequisites: CHEM 109 or 110 or 111 or 113, and MATH 221.
Description: Introduction to principles of environmental engineering including water quality, atmospheric quality, pollution prevention, and solid and hazardous wastes engineering. Design of water, air, and waste management systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: BSEN 327, CIVE 327; BSEN 425, CIVE 425; BSEN 455, BSEN 855, CIVE 455, CIVE 855, CIVE 431, CIVE 831

BSEN 326H Honors: Introduction to Environmental Engineering
Crosslisted with: CIVE 326H
Prerequisites: Good standing in the University Honors Program or by invitation: CHEM 109 or 110 or 111 or 113, MATH 221
Description: Introduction to principles of environmental engineering including water quality, atmospheric quality, pollution prevention, and solid and hazardous wastes engineering. Design of water, air, and waste management systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: BSEN 327, CIVE 327; BSEN 425, BSEN 855, CIVE 455, CIVE 855, CIVE 431, CIVE 831

BSEN 327 Environmental Engineering Laboratory
Crosslisted with: CIVE 327
Prerequisites: CIVE/BSEN 326 or parallel
Notes: Parallel or prereq: CIVE/BSEN 326.
Description: Environmental engineering experiments, demonstrations, field trips, and projects. Experiments include the measurement and determination of environmental quality parameters such as solids, dissolved oxygen, biochemical and chemical oxygen demand, and alkalinity.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LAB
BSEN 344 Biological and Environmental Transport Processes
Crosslisted with: AGEN 344
Prerequisites: BSEN 244 or MECH 200; MATH 221; MECH/CIVE 310 or CHME 332 or parallel
Description: Introduction to concurrent transport of energy and mass in biological and environmental processes. Modes of heat transfer, steady and non-steady state heat conduction, convective heat transfer, radiative heat transfer, and heat transfer with phase change. Equilibrium, kinetics, and modes of mass transfer, diffusion, dispersion, and convective mass transfer. Soil freezing and thawing, energy and mass balances of crops, diffusivities of membranes, photosynthesis, human and animal energy balances, and respiration.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: BSEN 446, BSEN 846, AGEN 446, AGEN 846
BSEN 350 Soil and Water Resources Engineering  
Crosslisted with: AGEN 350  
Prerequisites: MATH 221; and parallel: MECH 310 or CIVE 310 or CHME 332  
Description: Introduction to soil and water resources and the engineering processes used to analyze watersheds. Soil water relations, evapotranspiration, precipitation, runoff, erosion, flow in natural waterways and through reservoirs, wetland and groundwater hydrology, and water quality. Geographic information system utilized to develop maps and analyze watershed characteristics. A selected watershed is investigated.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC  
Offered: FALL  
Prerequisite for: AGEN 957, BSEN 957, CIVE 957, GEOL 957; BSEN 455, BSEN 855, CIVE 455, CIVE 855

BSEN 355 Introduction to Ecological Engineering  
Prerequisites: CHEM 110 or CHEM 111 or CHEM 114; and MATH 104 or MATH 106.  
Notes: Recommended: AGEN/BSEN 350 or CIVE 352 or CIVE 353 or MSYM/WATS 354; and BIOS 101 or LIFE 121 or NRES 220.  
Description: Introduction to principles of ecological engineering including ecosystems ecology, river restoration, constructed wetlands, green infrastructure stormwater management, and environmental restoration. Ecological design of water and land protection practices. Includes introduction to water pollution and contaminant fate and remediation.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC  
Offered:  
Prerequisite for: AGEN 350, BSEN 855, CIVE 352, CIVE 353 or MSYM/WATS 354 or CHEM 110 or CHEM 111 or CHEM 114

BSEN 395 Internship in Agricultural and Biological Systems Engineering  
Crosslisted with: AGEN 395  
Prerequisites: Permission  
Description: Practical experience, directed learning, and career exploration and development in a selected business, industry, agency, or educational institution. Activities must include a significant engineering component.  
Credit Hours: 1-3  
Min credits per semester: 1  
Max credits per semester: 3  
Max credits per degree: 3  
Format: FLD

BSEN 414 Medical Imaging Systems  
Crosslisted with: BSEN 814  
Prerequisites: BSEN 311 or ECEN 304  
Description: Underlying physics, instrumentation, and signal analysis of biomedical and biological imaging modalities. MRI, X-ray, CT, ultrasound, nuclear medicine, and the human visual system. Energy-tissue interactions. Resolution, point spread function, contrast, diffraction, comparisons. Information content in images for biological systems.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC

BSEN 416 Introduction to Biomaterials  
Crosslisted with: BSEN 816  
Prerequisites: BSEN/AGEN 225 or MECH 325; BIOC 321 or BIOC 431  
Notes: Requires the evaluation of current primary literature in the field.  
Description: Introduction to all types of bio-materials, metals, ceramics, polymers, and natural materials. Characterization of biomaterials, mechanical and physical properties, cell-biomaterials interactions, degradation, and host reaction to biomaterials. FDA testing and applications of biomaterials, implants, tissue engineering scaffolds, artificial organs, drug delivery, and adhesives.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC  
Prerequisite for: BSEN 418, BSEN 818

BSEN 418 Tissue Engineering  
Crosslisted with: BSEN 818  
Prerequisites: BSEN 416/816 or equivalent  
Notes: Requires the evaluation of current primary literature in the field.  
Description: Introduction to engineering biological substitutes that can restore, maintain or improve organ function in therapy of diseases. Engineering methods and principles to design tissues and organs, cell and tissue biology, tissue growth and development, biomaterial scaffolds, growth factor and drug delivery, scaffold-cell interactions, and bioreactors.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC

BSEN 422 Pollution Prevention: Principles and Practices  
Crosslisted with: BSEN 822, CIVE 422, CIVE 822  
Prerequisites: Permission  
Description: Introduction to pollution prevention (P2) and waste minimization methods. Practical applications to small businesses and industries. Legislative and historical development of P2 systems analysis, waste estimation, P2 methods, P2 economics, and sources of P2 information.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC

BSEN 425 Process Design in Water Supply and Wastewater Treatment  
Crosslisted with: CIVE 425  
Prerequisites: CIVE/BSEN 326 and CIVE/MECH 310.  
Description: Design of unit operations and processes associated with drinking water and wastewater treatment facilities.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC
BSEN 441 Animal Waste Management
Crosslisted with: AGEN 441, AGEN 841, BSEN 841
Prerequisites: Senior standing.
Description: Characterization of wastes from animal production. Specification and design of collection, transport, storage, treatment, and land application systems. Air and water pollution, regulatory and management aspects.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 444 Biomass and Bioenergy Engineering
Crosslisted with: BSEN 844
Prerequisites: Senior/graduate standing in engineering; BIOC 321 or 431
Description: Engineering processes for biomass conversion and bioenergy production. Topics include biomass chemistry, conversion reactions, current and emerging bioenergy technologies, feedstock logistics, life cycle assessment. Analysis of primary research literature required for graduate credit.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 446 Unit Operations of Biological Processing
Crosslisted with: BSEN 846, AGEN 446, AGEN 846
Prerequisites: AGEN/BSEN 225; and AGEN/BSEN 344
Description: Application of heat, mass, and moment transport in analysis and design of unit operations for biological and agricultural materials. Evaporation, drying, distillation, extraction, leaching, thermal processing, membrane separation, centrifugation, and filtration.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Offered: SPRING
Prerequisite for: BSEN 935

BSEN 453 Irrigation and Drainage Systems Engineering
Crosslisted with: AGEN 453, AGEN 853, BSEN 853
Prerequisites: CIVE 310 or MECH 310; AGEN 344 or BSEN 344.
Description: Analytical and design consideration of evapotranspiration, soil moisture, and water movement as related to irrigation and drainage systems; analysis and design of components of irrigation and drainage systems including water supplies, pumping plants, sprinkler systems, and center pivots.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: AGEN 854, MSYM 854

BSEN 455 Nonpoint Source Pollution Control Engineering
Crosslisted with: BSEN 855, CIVE 455, CIVE 855
Prerequisites: BSEN 326/CIVE 326 or BSEN 355; AGEN/BSEN 350 or CIVE 352 as prerequisite or parallel.
Description: Identification, characterization, and assessment of nonpoint source pollutants; transport mechanisms and remediation technologies; design methodologies and case studies.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 458 Groundwater Engineering
Crosslisted with: BSEN 858, CIVE 458, CIVE 858
Prerequisites: CIVE 352 or AGEN 350 or BSEN 350.
Description: Application of engineering principles to the movement of groundwater. Analysis and design of wells, well fields, and artificial recharge. Analysis of pollutant movement..
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: AGEN 955, AGRO 955, CIVE 955, GEOL 985

BSEN 460 Instrumentation and Controls
Crosslisted with: AGEN 460, AGEN 860, BSEN 860
Prerequisites: ELEC 211 or ELEC 215
Description: Analysis and design of instrumentation and controls for agricultural and biological production, management and processing. Theory of basic sensors and transducers, analog and digital electrical control circuits, and the interfacing of computers with instruments and controls. Emphasis on signal analysis and interpretation for improving system performance.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 468 Wetlands
Crosslisted with: BIOS 458, NRES 468, NRES 868, WATS 468, BSEN 868
Prerequisites: 12 hrs biological sciences; BIOS 220, CHEM 109 and 110.
Notes: Offered even-numbered calendar years.
Description: Physical, chemical and biological processes that occur in wetlands; the hydrology and soils of wetland systems; organisms occurring in wetlands and their ecology wetland creation, delineation, management and ecotoxicology.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
BSEN 470 Design I in Agricultural and Biological Systems Engineering  
Crosslisted with: AGEN 470  
Prerequisites: Professional admission into AGEN or BSEN; and permission.  
Description: Definition, scope, analysis, and synthesis of a comprehensive design problem within the areas of emphasis in the Department of Biological Systems Engineering. Identification of a client's engineering problem to solve, and development of objectives and anticipated results.  
Credit Hours: 1  
Max credits per semester: 1  
Max credits per degree: 1  
Format: LEC  
Offered: FALL/SPR  
Prerequisite for: AGEN 480, BSEN 480

BSEN 479 Hydroclimatology  
Crosslisted with: NRES 479, METR 479, WATS 479, NRES 879, METR 879, BSEN 879  
Prerequisites: NRES 208 or METR 100 or METR/NRES 370.  
Notes: Offered spring semester of even-numbered calendar years.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC  

BSEN 480 Design II in Agricultural and Biological Systems Engineering  
Crosslisted with: AGEN 480  
Prerequisites: BSEN/AGEN 470  
Description: Definition, scope, analysis, and synthesis of a comprehensive engineering problem in an engineering area of emphasis within the Department of Biological Systems Engineering. Design activity using the team approach to develop a solution.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LAB  
ACE: ACE 10 Integrated Product

BSEN 492 Special Topics  
Crosslisted with: BSEN 892  
Prerequisites: Permission  
Description: Subject matter in emerging areas of Biological Systems Engineering not covered in other courses within the curriculum. Topics, activities, and delivery methods vary.  
Credit Hours: 1-6  
Min credits per semester: 1  
Max credits per semester: 6  
Max credits per degree: 6  
Format: LEC

BSEN 496 Independent Study  
Crosslisted with: AGEN 496  
Prerequisites: Permission  
Notes: Topics vary.  
Description: Investigation and written report on engineering problems not covered in sufficient depth through existing courses.  
Credit Hours: 1-6  
Min credits per semester: 1  
Max credits per semester: 6  
Max credits per degree: 6  
Format: IND  

BSEN 499H Honors Thesis  
Crosslisted with: AGEN 499H  
Prerequisites: Senior or junior standing, admission to the University Honors Program.  
Description: Independent project which meets the requirements of the University Honors Program, conducted under the guidance of a faculty member in the Department of Biological Systems Engineering. The project should contribute to the advancement of knowledge in the field. Written thesis and formal presentation required.  
Credit Hours: 1-6  
Min credits per semester: 1  
Max credits per semester: 6  
Max credits per degree: 6  
Format: IND

PLEASE NOTE  
This document represents a sample 4-year plan for degree completion with this major. Actual course selection and sequence may vary and should be discussed individually with your college or department academic advisor. Advisors also can help you plan other experiences to enrich your undergraduate education such as internships, education abroad, undergraduate research, learning communities, and service learning and community-based learning.

Career Information  
The following represents a sample of the internships, jobs and graduate school programs that current students and recent graduates have reported.

Jobs of Recent Graduates  
- Project Manager/Implementation Consultant, Epic - Madison WI  
- Design Engineer, ScanMed - Omaha NE  
- Process Engineer, Novozymes, Inc. - Blair NE  
- Environmental Sales Associate, LI-COR Biosciences - Lincoln NE  
- Research Associate, Mayo Clinic - Rochester MN  
- Environmental Engineering Volunteer, Peace Corps - Panama City, Panama  
- Project Engineer, Becton Dickinson - Columbus OH  
- Water Resource Engineer, HDR - Denver CO  
- Production Management Engineer, Cargill - Raleigh NC  
- Applications Engineer, National Instruments - Austin TX  
- Environmental Engineer, Koch Industries - Enid OK  
- Project Engineer Specialist, Streck - Omaha NE  
- Environmental Engineer, United States Air Force - Lincoln NE  
- Environmental Engineer, Flint Hills Resources - Wichita KS  
- Water Resources Engineer, Barr Engineering - Minneapolis MN  
- Environmental Engineer 1, Tetra Tech - Kansas City MO  
- Maintenance and Reliability Engineer, Zoetis - Lincoln NE
• Technician II, EA Engineering Science and Technology - Lincoln NE
• Project Management Engineer, Cargill - Blair NE
• Production Engineer, Archer Daniels Midland - Des Moines IA
• Biological Engineer, MatMaCorp - Lincoln NE
• Civil Analyst, Kimley Horn and Associates - McKinney TX
• Research Assistant, Madonna Movement and Neurosciences Institute - Lincoln NE
• Environmental Engineer, FYRA Engineering - La Vista NE
• Associate Engineer, Olsson Associates - Lincoln NE

**Internships**

• Biological Systems Engineering Co-op, NASA - Johnson Space Center - Houston TX
• R&D Hematology Intern, Streck - Omaha NE
• Water Resources Intern, Olsson Associates - Lincoln NE
• BioTDC Research and Development Intern, Cargill - Eddyville IA
• Biological Systems Engineering Co-op Researcher, Washington University in St. Louis - St. Louis MO
• Bioenergy Research Assistant, Penn State University - State College PA
• Environmental Science Intern, HDR - Omaha NE
• Biomedical Engineering Summer Associate, Medtronic - Minneapolis MN
• Project Manager Assistant, LI-COR Biosciences - Lincoln NE
• Hydrologic Student Intern, United States Geological Survey - Lincoln NE
• Environmental Intern, Kiewit - Omaha NE
• Intern, Wake Forest Institute for Regenerative Medicine - Winston-Salem NC
• Summer Scholar, Children’s Mercy Hospital - Kansas City MO
• Environmental, Health & Safety Intern, Growmark - Council Bluffs IA
• Microbiology Intern, Becton Dickinson - Broken Bow NE
• Ecology Intern, Auckland University of Technology - Auckland, New Zealand
• Summer Apprenticeship Program, Biomedical Research Institute - Houston TX
• Operations Intern, Smithfield Farmland - Crete NE
• Engineering Intern, U.S. Army Corps of Engineers - Omaha NE
• Commercial Product Training Specialist Intern, Case New Holland Industrial - Racine WI
• Biological Student Aide, USDA-ARS - Lincoln NE
• R&D Intern, Medtronic - Sunnyvale CA
• Undergraduate Research - Pediatric Surgical Clinical Research, University of Nebraska Medical Center and Methodist Children's Hospital - Omaha NE
• Water Resources Intern, JEO Consulting - Lincoln NE
• Research Experience for Undergraduates, Rice University - Houston TX

**Graduate & Professional Schools**

• Doctor of Medicine, University of Nebraska Medical Center - Omaha NE
• Prosthetics and Orthotics, M.S., University of Texas Southwestern Medical Center - Dallas TX
• Medical Scientist Training Program/M.D. and Ph.D., University of Wisconsin-Madison - Madison WI
• Biological Systems Engineering, Ph.D., University of Nebraska-Lincoln - Lincoln NE
• Bioengineering, Ph.D. and Medical Science Training Program, Rice University - Houston TX
• Doctor of Dental Surgery, University of Nebraska Medical Center - Lincoln NE
• Juris Doctor, George Washington University Law School - Washington DC
• Bioengineering, Ph.D., University of California-Berkeley - Berkeley CA
• Doctor of Veterinary Medicine, Iowa State University - Ames IA
• Biomedical Engineering, Ph.D., University of Minnesota - Minneapolis MN
• Food Engineering, M.S., Michigan State University - East Lansing MI
• Doctorate of Chiropractic, Palmer College of Chiropractic - Davenport IA
• Environmental Engineering, M.S., University of Nebraska-Lincoln - Lincoln NE
• Medical Scientist Training Program, Emory University/Georgia Institute of Technology - Atlanta GA
• Plant Biological Sciences, Ph.D., University of Minnesota-Twin Cities - Minneapolis MN
• Doctor of Pharmacy, University of Nebraska Medical Center - Omaha NE
• Biomedical Sciences Research Program, Ph.D., Kansas City University of Medicine and Biosciences - Kansas City MO
• Juris Doctorate, University of Kansas - Lawrence KS
• Biological Systems Engineering, Ph.D., Johns Hopkins University - Baltimore MD
• Accelerated Bachelors of Nursing, Creighton University - Omaha NE
• Atmosphere and Energy, M.S., Stanford University - Stanford CA
• Civil Engineering, M.S., University of Nebraska-Lincoln - Lincoln NE
• Bioengineering, Ph.D., University of Washington - Seattle WA
• Biomedical Research Training Program, University of Nebraska Medical Center - Lincoln NE
• Engineering Education, Ph.D., Virginia Tech - Blacksburg VA