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 freshman entrance 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
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<tr>
<th>Semester</th>
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<th>Course Title</th>
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<td>Introduction to Biological Engineering and</td>
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<td>AGEN 100</td>
<td>Agricultural Engineering</td>
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<td>CHEM 113</td>
<td>Fundamental Chemistry I</td>
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<td>CSCE 155N</td>
<td>Computer Science I: Engineering and Science Focus</td>
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<td>ENGR 100</td>
<td>Interpersonal Skills for Engineering Leaders</td>
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<td>Computer-Aided Problem-Solving</td>
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<td>AGEN 112</td>
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<td>CHEM 114</td>
<td>Fundamental Chemistry II</td>
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<td>PHYS 211</td>
<td>General Physics I</td>
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<td>BSEN 130</td>
<td>Computer-Aided Design</td>
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<td>CIVE 130</td>
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<td>BSEN 225</td>
<td>Engineering Properties of Biological Materials</td>
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<td>AGEN 225</td>
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<td>CHEM 255</td>
<td>Biological Organic Chemistry</td>
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<td>Instrumentation I for Agricultural and Biological</td>
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<td>Systems Engineering</td>
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<td>BSEN 244</td>
<td>Thermodynamics of Living Systems</td>
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<td>LIFE 120</td>
<td>Fundamentals of Biology I</td>
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<td>and Fundamentals of Biology I laboratory</td>
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<td>MATH 221</td>
<td>Differential Equations</td>
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<td>MECH 310</td>
<td>Fluid Mechanics</td>
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<td>BSEN 460 /</td>
<td>Instrumentation and Controls</td>
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<td>Sixth</td>
<td>BIOC 321</td>
<td>Elements of Biochemistry</td>
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<td>Structure and Metabolism</td>
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<td>BSEN 344 /</td>
<td>Biological and Environmental Transport</td>
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<td>AGEN 344</td>
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<td>MECH 321</td>
<td>Engineering Statistics and Data Analysis</td>
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<td>MATH 380</td>
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<td>Seventh</td>
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<td>BSEN 470</td>
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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.

**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 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 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**

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<tr>
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<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BSEN 303 /</td>
<td>Principles of Process Engineering</td>
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<td>AGEN 303</td>
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<td>BSEN 446 /</td>
<td>Unit Operations of Biological Processing</td>
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<tr>
<td>AGEN 446</td>
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<td>BSEN 444</td>
<td>Biomass and Bioenergy Engineering</td>
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**Total Credit Hours**: 9

**Biomedical**

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<th>Course Title</th>
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<td>BSEN 317</td>
<td>Introduction to Biomedical Engineering</td>
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<td>BSEN 311</td>
<td>Biomedical Signal and System Analysis</td>
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<td>BSEN 414</td>
<td>Medical Imaging Systems</td>
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<td>BSEN 416</td>
<td>Introduction to Biomaterials</td>
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<td>BSEN 418</td>
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**Total Credit Hours**: 9

**Water and Environment**

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<td>BSEN 326 /</td>
<td>Introduction to Environmental Engineering</td>
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<td>CIVE 326</td>
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<td>BSEN 355</td>
<td>Introduction to Ecological Engineering</td>
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Select one of the following:

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<tbody>
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<td>BSEN 441 /</td>
<td>Animal Waste Management</td>
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<td>AGEN 441</td>
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<tr>
<td>BSEN 453 /</td>
<td>Irrigation and Drainage Systems</td>
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<td>AGEN 453</td>
<td>Engineering</td>
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<td>BSEN 455 /</td>
<td>Nonpoint Source Pollution Control</td>
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<td>CIVE 455</td>
<td>Engineering</td>
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<tr>
<td>BSEN 458 /</td>
<td>Groundwater Engineering</td>
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<td>CIVE 458</td>
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**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 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 Gibbs'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 BSEN212A or equivalent  
**Description:** Mathematical modeling of biophysical systems. Continuous and discrete signals. Signal representation, system classification, impulse response, convolution, Fourier analysis, transfer functions, difference-equation approximations of differential equations. Basic filtering concepts.  
**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 ELEC 211, and MECH/CIVE 310 or CHME 332 or parallel or permission.  
**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 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 455, BSEN 855, CIVE 455, CIVE 855; CIVE 431, CIVE 831  
**BSEN 327 Environmental Engineering Laboratory**  
**Crosslisted with:** CIVE 327  
**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; or permission  
**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
Prerequisite for: BSEN 455, BSEN 855, CIVE 455, CIVE 855

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 ELEC 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: BSEN 416/816 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: BSEN 418/818 uses case studies to demonstrate clinical implementation of engineered tissues.
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

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 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.  
**Description:** Interaction between earth's climate and the hydrologic cycle. Energy and water fluxes at the land-atmosphere interface. Atmospheric moisture transport, precipitation, evaporation, snowmelt, and runoff. Impacts of climate variability and change on the hydrologic cycle.  
**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.

**Icon Legend:** Critical

### 16 HR TERM 1

**Engineering**

complete BSEN 100  
1hr  
C-

**ACE 4 Chemistry**  
complete either CHEM 113 or CHEM 109  
4hr  
C-

**Freshman Seminar**  
complete ENGR10#  
0hr  
ENGR 10 becomes critical to your success in the major if not completed by the end of the first term of enrollment.

**Math/Science**  
complete MATH 106  
5hr  
C

**ACE 5 Humanities**
Biological Systems Engineering

10

complete 1 from ACE5

3hr

Complete an ACE 5, 6, 7, or 9 requirement this term.

ACE 6 Social Sciences

complete 1 from ACE6

3hr

Complete an ACE 5, 6, 7, or 9 requirement this term.

17 HR TERM 2

Engineering

complete BSEN 112

BSEN 112 becomes critical to your success in the major if not completed by the end of the second term of enrollment.

ACE 4 Chemistry

complete either CHEM 114 or CHEM 110

4hr

MATH 107 and PHYS 211 both become critical to your success in the major if not completed by the end of the third term of enrollment.

Math/Science

complete MATH 107, PHYS 211

8hr

Math/Science

complete MATH 208

4hr

MATH 208 becomes critical to your success in the major if not completed by the end of the fourth term of enrollment.

See advisor for list.

17 HR TERM 3

Engineering

complete BSEN 225

BSEN 225 becomes critical to your success in the major if not completed by the end of the third term of enrollment.

Engineering Statics

complete MECH 223

3hr

C

MECH 223 becomes critical to your success in the major if not completed by the end of the fourth term of enrollment.

Organic Chemistry Reqd

complete 2 from CHEM 251, CHEM 253, CHEM 255, CHEM 257, CHEM 261, CHEM 263

4hr

Complete one set - lecture and lab.

Sophomore Seminar

complete ENGR20#

4hr

ENGR 20 becomes critical to your success in the major if not completed by the end of the fifth term of enrollment.

ACE 1 Written Texts

complete JGEN 200

3hr

Math/Science

complete MATH 208

4hr

C

Math/Science

complete MATH 208

4hr

C

MATH 208 becomes critical to your success in the major if not completed by the end of the fourth term of enrollment.

16 HR TERM 4

Engineering

complete 3 from BSEN 130, MECH 373, BSEN 212E, BSEN 212B, BSEN 212A

6hr

C
Complete both BSEN 130 and MECH 373 and choose one between BSEN 212A, 212B, or 212E.

**Engineering**

complete BSEN 244

BSEN 244 becomes critical to your success in the major if not completed by the end of the fifth term of enrollment.

**ACE 4 Biological Science**

complete LIFE 120, LIFE 120L

**Math/Physics**

complete MATH 221

**17 HR TERM 5**

**ACE 4 Biological Science**

complete either LIFE 121 or LIFE 121L

**Engineering**

complete 1 from CIVE 310, CHME 332, MECH 310

CIVE 310 or MECH 310 becomes critical to your success in the major if not completed by the end of the sixth term of enrollment.

**Math/Physics**

complete 2 from MECH 321, MATH 380, PHYS 212

Complete PHYS 212 and either MECH 321 or MATH 380.

**BSEN Courses 12 Hrs**

recommend 1 or more courses

3hr

C-

Select a course towards an Emphasis Elective.

### Milestones

1. Professional Admission into College.

**18 HR TERM 6**

**Biochemistry**

complete either BIOC321# or BIOC 431

**Engineering**

complete BSEN 344

3hr

C-

BSEN 344 becomes critical to your success in the major if not completed by the end of the sixth term of enrollment.

**ACE 7 Arts**

complete 1 from ACE7

4hr

C-

Complete an ACE 5, 6, 7, or 9 requirement this term.

**BSEN Courses 12 Hrs**

recommend 1 or more courses

3hr

C-

Select a course towards an Emphasis Elective.

**ACE 2 Communication Skill**

complete 1 from ALEC 102, COMM 209, COMM 283, COMM 286, ENGR 100, GERM 303, JAPN 202, JGEN 300, RUSS 304, SPAN 303

**Engineering**

complete ECEN 211

3hr
16 HR TERM 7
Engineering
complete BSEN 206, BSEN 460, BSEN 470

ACE 9 Global/Human Divers
complete 1 from ACE9

Complete an ACE 5, 6, 7, or 9 requirement this term.

BSEN Courses 12 Hrs
recommend 1 or more courses

Select a course towards an Emphasis Elective.

Suggested Science
recommend 1 or more courses

Select two courses towards an Engineering or Science Emphasis Electives.

Graduation Requirements
1. 133 hours required for graduation.
2. 2.40 GPA required for graduation.
3. 30 of the last 36 hours must be taken at UNL/UNO.

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
• Civil Design Engineer, US Army Corps of Engineers - Kansas City KS
• Environmental Engineer, Koch Industries - Enid OK
• Process Engineer, Novozymes, Inc. - Blair NE
• Environmental Sales Associate, LI-COR Biosciences, Inc. - Lincoln NE
• Applications Engineer, National Instruments - Austin TX
• Environmental Engineering Volunteer, Peace Corps - Panama City, Panama
• Project Engineer, Becton Dickinson - Columbus NE
• Water Resource Engineer, HDR - Denver CO
• Production Management Engineer, Cargill - Raleigh NC
• Project Management, Epic Systems Corporation - Madison WI

Internships
• BSEN Co-op, NASA - Johnson Space Center - Houston TX
• R&D Hematology Intern, Streck - Omaha NE
• Water Resources Intern, Olsson Associates - Lincoln NE
• Environmental Intern, Kiewitt - Omaha NE
• BSE Co-op, ConAgra Foods - Omaha NE
• Microbiology Intern, Becton Dickinson - Broken Bow NE
• Ecology Intern, Auckland University of Technology - Auckland, New Zealand
• Biomedical Engineering Summer Associate, Medtronic - Minneapolis MN
• Commercial Product Training Specialist Intern, Case New Holland Industrial - Racine WI
• Hyrologic Student Intern, United States Geological Survey - Lincoln NE

Grad Schools
• Doctor of Medicine, UNMC College of Medicine - Omaha NE
• Masters in Prosthetics and Orthotics, University of Texas Southwestern Medical Center - Dallas TX
• Medical Scientist Training Program/M.D. and Ph.D., University of Wisconsin-Madison - Madison WI
• Biological Engineering, Ph.D., UNL - Lincoln NE
• Pharmacy, University of Nebraska Medical Center - Omaha NE
• Dental School, UNMC Dental School - Lincoln NE
• Juris Doctor, George Washington University Law School - Washington DC
• Bioengineering PhD, University of California-Berkeley - Berkeley CA
• Veterinary School, Iowa State University - Ames IA
• Biomedical Engineering PhD, University of Minnesota - Minneapolis MN