

# 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. Biological systems engineers need to understand biological phenomena and apply engineering principles to solve challenges faced by society. To solve complex problems, a biological systems engineer needs not only to develop expertise in a specific discipline but also be prepared to work across disciplinary boundaries in diverse professional communities. As such, BSEN students develop both depth through engineering coursework in one of three emphasis areas (biomedical engineering, food, and bioprocess engineering, or ecological and environmental engineering) and breadth through purposefully selected coursework in the other areas. Biological systems engineers with an emphasis in biomedical engineering might work on systems to micropropagate tissue culture, design devices for monitoring and correcting heart arrhythmias, or develop biological sensors and imaging devices for detecting diseases in humans. Biological systems engineers with an emphasis in food and bioprocess engineering might advance products and manufacturing practices through the design of equipment and processes for producing foods and biofuels. Biological systems engineers with an emphasis in ecological and environmental engineering might restore streams, lakes, and wetlands; design and manage ecosystems; minimize nonpoint source pollution; or design systems for stormwater bioretention or animal waste management.

By three to five 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, ecological and environmental engineering, food and bioprocess engineering, or other professional endeavors such as business, law, or medicine. In doing so, our graduates will be:

- Confidently using engineering skills in solving problems and providing design solutions in the context of agricultural systems.
- Continuing their professional development, and professional and community service through various opportunities provided by institutions, professional organizations, and other venues in an inclusive manner respecting diversity.
- Responsibly addressing issues of health and safety, ethics, and environmental impacts of engineering decisions in the context of agricultural systems.

The Department of Biological Systems Engineering is located in Chase Hall on East Campus. BSEN students participate in classes and laboratories on both East and City Campuses. BSEN courses are offered on East Campus. Basic courses in math, chemistry, physics, engineering sciences, computers, and electives in mechanical, civil, electrical, and chemical engineering are taken on 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 UNL Soil and Water Resources Club, the Biomedical Engineering Society, the Nebraska Society of Professional Engineers, the Fountain Wars Club, 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:

- They have completed 43 credit hours applicable to the degree including 6 hours of BSEN subject coursework.
- Are enrolled in or have completed MECH 223.
- Have removed all admissions deficiencies, except they may be currently completing the last class to remove the foreign language deficiency.

**Students must be professionally admitted in order to enroll in some upper-division courses including AGEN 470/BSEN 470 Design I in Agricultural and Biological Systems Engineering.**

To be professionally admitted to BSEN, the student must meet the general professional admission criteria of the College of Engineering and not already have been denied admission by two other engineering majors or twice by the BSEN program, and have removed all admissions deficiencies within the first 30 hours of enrollment at Nebraska, except for the foreign language deficiency which must be completed within the first 60 hours of enrollment at Nebraska.

- Students who meet the above criteria with a cumulative GPA of 2.8 or greater will be professionally admitted without further review.
- Students with a cumulative GPA of at least 2.5 but less than 2.8 will have their record reviewed by Department faculty for a decision of professional admission, conditional professional admission, or denial of professional admission.
- Students with a cumulative GPA less than 2.5 will be denied professional admission to the BSEN program.

Students who have been denied professional admission to the BSEN program once and not also been denied professional admission to another engineering program may continue taking courses in the BSEN program and will be reconsidered for professional admission again the next term. Students who have twice been denied professional admission to the BSEN program are not allowed to continue in the program.

**The Department faculty may recommend conditional admission and specify deficiencies and performance criteria required to transition out of conditional status. If a student has not met the professional 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 degreed engineers, they may be denied professional admission to the degree program. The student may appeal this decision to the biological systems engineering**

department head and then, if necessary, to the College of Engineering Curriculum and Academic Standards Committee.

## ACE Requirements

All students must fulfill the Achievement-Centered Education (ACE) requirements. Information about the ACE program may be viewed at [ace.unl.edu](https://ace.unl.edu) (<https://ace.unl.edu/>).

The minimum requirements of the BSEN program include courses involving ACE outcomes 1, 2, 3, 4, 8, and 10. Students should work with their advisor to select courses that satisfy ACE outcomes 5, 6, 7, and 9.

## College Requirements

### College Admission

#### College Entrance Requirements

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

1. Mathematics – 4 units: 2 of algebra, 1 of geometry, and 1 of precalculus and trigonometry
2. English – 4 units
3. Natural sciences – 3 units that must include 1 unit of physics and 1 unit of chemistry (chemistry requirement waived for students in construction management or computer science)
4. Foreign language – 2 units of a single foreign language
5. Social studies – 3 units
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. Students without test scores who are missing a full unit of trigonometry/pre-calculus/calculus or chemistry or physics will be evaluated through College Review.
7. Students having an ACT score of 19 or less in English (or equivalent SAT score) or a grade lower than B in high school English, must take ENGL 150 Writing and Inquiry or ENGL 151 Writing and Argument.

A total of 16 units is required for admission.

Engineering requires that student performance meet one of the following standards: composite ACT of 24, SAT of 1180, ACT Math subscore of 24, SAT Math subscore of 580, or a 3.5 cumulative GPA.

Any domestic first-year student who does not gain admission to Engineering but does gain admission to the University of Nebraska-Lincoln (UNL) will be reviewed through College Review. College Review is conducted through the College Review Committee which considers factors beyond standardized testing. Any first-year student who is not admitted through college review is placed in Pre-Engineering (PENG) with the Exploratory and Pre-Professional Advising Center (Explore Center). Students in the Explore Center can transfer to the College of Engineering once college admission requirements are met.

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 Explore Center or other colleges at UNL.

Students should consult their advisor, their department chair, or Engineering Student Services (ESS) 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 first-year student entrance requirements, 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. Students transferring from UNO, UNL, or UNK to the College of Engineering must be in good academic standing with their institution.

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 Kearney and the University of Nebraska 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.

Students who were previously admitted to COE and are returning to the College of Engineering must demonstrate a cumulative GPA of 2.5 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 their instructor, and appropriate department chair or school director (in that order). If a satisfactory solution is not achieved, the student may appeal their case through the College Academic Appeals Subcommittee.

## 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.

Students who have transferred from a community college may be eligible to fulfill the requirements as stated in the catalog for an academic year in which they were enrolled at the community college prior to attending the University of Nebraska-Lincoln. This decision should be made in consultation with the student's College of Engineering academic advising team (e.g., ESS professional advisor and the chief faculty advisor for the student's declared degree program). The chief faculty advisor has the final authority for this decision. Eligibility is based on a) enrollment in a community college during the catalog year the student wishes to utilize, b) maintaining continuous enrollment of at least 12 credit hours per semester at the previous institution for at least 2 semesters, and c) continuous enrollment at the University of Nebraska-Lincoln within 1 calendar year from the student's last term at the previous institution.

#Students must complete all degree requirements from a single catalog year and within the timeframe allowable for that catalog year.

## Learning Outcomes

Graduates of the biological systems engineering program will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The above student outcomes have been approved by the ABET Engineering Area Delegation for use beginning with the 2019-20 academic year, and have been adopted by the faculty of the Department of Biological Systems Engineering.

## Major Requirements

### Specific Major Requirements

#### First Semester

BSEN 100 / AGEN 100	Introduction to Biological Engineering and Agricultural Engineering	1
CHEM 113A & CHEM 113L	Fundamental Chemistry I and Fundamental Chemistry I Laboratory <sup>1</sup>	4
ENGR 10	Freshman Engineering Seminar	0
MATH 106	Calculus I	5
CSCE 155N	Computer Science I: Engineering and Science Focus	3
ENGR 100	Interpersonal Skills for Engineering Leaders	3
Credit Hours Subtotal:		16

#### Second Semester

BSEN 112 / AGEN 112	Computer-Aided Problem-Solving	2
CHEM 114	Fundamental Chemistry II <sup>2</sup>	3
MATH 107	Calculus II	4
PHYS 211	General Physics I	4
BSEN 130	Computer-Aided Design	2
Credit Hours Subtotal:		15

#### Third Semester

BSEN 225 / AGEN 225	Engineering Properties of Biological Materials	3
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Select one sequence from the following: 4

CHEM 251 & CHEM 253	Organic Chemistry I and Organic Chemistry I Laboratory	
CHEM 261 & CHEM 263	Organic Chemistry and Mechanistic Organic Chemistry I Laboratory	
ENGR 20	Sophomore Engineering Seminar	0
PHYS 212	General Physics II	4
MATH 208	Calculus III	4
MECH 223	Engineering Statics	3
Credit Hours Subtotal:		18

#### Fourth Semester

BSEN 260	Instrumentation I for Agricultural and Biological Systems Engineering	3
BSEN 244	Thermodynamics of Living Systems	3
LIFE 120 & LIFE 120L	Fundamentals of Biology I and Fundamentals of Biology I laboratory	4
MATH 221	Differential Equations	3
MECH 373	Engineering Dynamics	3
Credit Hours Subtotal:		16

#### Fifth Semester

LIFE 121 & LIFE 121L	Fundamentals of Biology II and Fundamentals of Biology II Laboratory	4
MECH 310 or CIVE 310	Fluid Mechanics Fluid Mechanics	3
BSEN 460 / AGEN 460	Instrumentation and Controls	3
JGEN 200	Technical Communication I <sup>3</sup>	3

#### BSEN Emphasis Elective:

Select 3 hours	3
Credit Hours Subtotal:	16

#### Sixth Semester

BIOC 401 or BIOS 431	Elements of Biochemistry <sup>4</sup> Biochemistry I: Structure and Metabolism	3
BSEN 344 / AGEN 344	Biological and Environmental Transport Processes	3

#### Statistics Elective

Select one of the following:		3
MECH 321	Engineering Statistics and Data Analysis	
STAT 380	Statistics and Applications	

#### ACE Elective:

Select one course from not yet satisfied ACE outcomes 5, 6, 7, or 9	3
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#### BSEN Emphasis Elective:

Select 3 hours	3
Credit Hours Subtotal:	15

#### Seventh Semester

BSEN 206 / CONE 206	Engineering Economics	3
BSEN 470 / AGEN 470	Design I in Agricultural and Biological Systems Engineering	1

#### ACE Electives:

Select two courses from not yet satisfied ACE outcomes 5, 6, 7, or 9	6
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<b>BSEN Emphasis Elective:</b>		
Select 3 hours		3
<b>Biological or Science Elective:</b>		
Select 3 hours		3
Credit Hours Subtotal:		16
<b>Eighth Semester</b>		
BSEN 480 / AGEN 480	Design II in Agricultural and Biological Systems Engineering	3
<b>ACE Elective:</b>		
Select one course from not yet satisfied ACE outcomes 5, 6, 7, or 9		3
<b>BSEN Emphasis Elective:</b>		
Select 3 hours		3
<b>Engineering or Science Emphasis Elective:</b>		
Select 3 hours		3
<b>Engineering Emphasis Elective:</b>		
Select 3 hours		3
Credit Hours Subtotal:		15
<b>Total Credit Hours</b>		<b>127</b>

<sup>1</sup> CHEM 109A and CHEM 109L may be substituted with permission of advisor.

<sup>2</sup> CHEM 110A and CHEM 110L may be substituted with permission of advisor.

<sup>3</sup> See Written Communication Requirement Information below.

<sup>4</sup> Premed students should take BIOC 431.

## 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 400-level course of a primary emphasis area. Food and Bioprocess Engineering emphasis requires BSEN 303 Principles of Process Engineering and BSEN 446 Unit Operations of Biological Processing, Biomedical Engineering emphasis requires BSEN 317 Introduction to Biomedical Engineering, Ecological and Environmental Engineering emphasis requires BSEN 350 Natural Resources Engineering and BSEN 355 Introduction to Ecological Engineering as primary emphasis area courses.

### Food and Bioprocess Engineering

BSEN 303 / AGEN 303	Principles of Process Engineering	3
BSEN 446 / AGEN 446	Unit Operations of Biological Processing	3
Select one of the following		3
BSEN 444	Biomass and Bioenergy Engineering	
BSEN 445	Bioprocess Engineering	
<b>Total Credit Hours</b>		<b>9</b>

### Biomedical Engineering

BSEN 317	Introduction to Biomedical Engineering	3
Select two of the following:		6

BSEN 311	Biomedical Signal and System Analysis	
BSEN 412	Rehabilitation Engineering	
BSEN 414	Medical Imaging Systems	
BSEN 416	Introduction to Biomaterials	
BSEN 418	Tissue Engineering	
<b>Total Credit Hours</b>		<b>9</b>
<b>Ecological and Environmental Engineering</b>		
BSEN 350 / AGEN 350	Natural Resources Engineering	3
BSEN 355	Introduction to Ecological Engineering	3
Select one of the following:		3
BSEN 441 / AGEN 441	Animal Waste Management	
BSEN 453 / AGEN 453	Irrigation and Drainage Systems Engineering	
BSEN 455 / CIVE 455	Nonpoint Source Pollution Control Engineering	
BSEN 458 / CIVE 458	Groundwater Engineering	
BSEN 468	Wetlands	
BSEN 479	Hydroclimatology	
<b>Total Credit Hours</b>		<b>9</b>

## Additional Major Requirements

### Written Communications Requirement

Six hours of English composition (e.g., two from ENGL 150, ENGL 151, ENGL 254) may be substituted for the written communications requirement (JGEN 200) in the biological systems engineering program.

### 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

**Grading Option:** Graded with Option

**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**Grading Option:** Graded with Option**Offered:** SPRING**BSEN 130 Computer-Aided Design****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**Grading Option:** Graded with Option**Offered:** FALL/SPR**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**Grading Option:** Graded with Option**Prerequisite for:** CNST 476, CONE 476; CONE 319; MECH 446; MECH 446H**ACE:** ACE 8 Civic/Ethics/Stewardship**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**Grading Option:** Graded with Option**Prerequisite for:** AGEN 324, BSEN 324**BSEN 244 Thermodynamics of Living Systems****Prerequisites:** CHEM 110A and 110L or CHEM 114; MATH 107; PHYS 211; LIFE 120 or BIOS 101 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**Grading Option:** Graded with Option**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**Grading Option:** Graded**Offered:** SPRING**Prerequisite for:** AGEN 325, BSEN 325**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**Grading Option:** Graded with Option**BSEN 311 Biomedical Signal and System Analysis****Prerequisites:** MATH 221; CSCE 155N 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**Grading Option:** Graded with Option**Offered:** SPRING



**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**Grading Option:** Graded with Option**Offered:** FALL**BSEN 321 Principles of Environmental Engineering****Crosslisted with:** CIVE 321**Prerequisites:** CHEM 109A (grade of C or better) & CHEM 109L or CHEM 110A (grade of C or better) & CHEM 110L or CHEM 113A (grade of C or better) & CHEM 113L, and MATH 107 (grade of C or better)**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**Grading Option:** Graded**Prerequisite for:** BSEN 321L, CIVE 321L; CIVE 401; CIVE 420; ENVE 322; ENVE 401; ENVE 410; ENVE 430**BSEN 321H Honors: Principles of Environmental Engineering****Crosslisted with:** CIVE 321H**Prerequisites:** Good standing in the University Honors Program or by invitation; CHEM 109A (grade of C or better) & CHEM 109L or CHEM 110A (grade of C or better) & CHEM 110L or CHEM 113A (grade of C or better) & CHEM 113L, and MATH 107 (grade of C or better)**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**Grading Option:** Graded**Prerequisite for:** BSEN 321L, CIVE 321L; CIVE 401; CIVE 420; ENVE 322; ENVE 410; ENVE 430**BSEN 321L Environmental Engineering Laboratory****Crosslisted with:** CIVE 321L**Prerequisites:** CIVE 321 or parallel**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**Grading Option:** Graded**Course and Laboratory Fee:** \$50**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**Grading Option:** Graded**Prerequisite for:** AGEN 443**BSEN 325 Power Systems Design****Crosslisted with:** AGEN 325**Prerequisites:** PHYS 212 or ECEN 211 or AGEN/BSEN 260, and MECH/CIVE 310 or CHME 332 or parallel, and professionally admitted engineering student.**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**Grading Option:** Graded**Offered:** SPRING**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**Grading Option:** Graded with Option

**BSEN 350 Natural 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**Grading Option:** Graded with Option**Offered:** FALL**Prerequisite for:** ENVE 401**BSEN 355 Introduction to Ecological Engineering****Prerequisites:** CHEM 110A and 110L or CHEM 114; and MATH 104 or MATH 106.**Notes:** Recommended: AGEN/BSEN 350 or CIVE 352 or CIVE 353 or AGST/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**Grading Option:** Graded**BSEN 410 Biomechanics of Human Movement****Prerequisites:** PHYS 211, MECH 223, and MECH 373**Description:** Introduction to basic human movement involving kinematics, kinetics, and other quantitative analysis including linear and angular position, velocity, and acceleration. Emphasis on the muscular and skeletal systems as well as other basic human systems. Human capabilities and injuries will demonstrate the limitations of the human body.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded**Offered:** SPRING**BSEN 412 Rehabilitation Engineering****Crosslisted with:** BSEN 812**Description:** Application of engineering methods to the development of assistive technology for people with injuries and disabilities. Characterization of the physical and mental capabilities of people with impairment, universal design, assistive technologies associated with seating, transportation, communication, and recreation. Integration of engineering design principles in a rehabilitation design project.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded**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**Grading Option:** Graded with Option**BSEN 416 Introduction to Biomaterials****Crosslisted with:** BSEN 816**Prerequisites:** BSEN/AGEN 225 or MECH 325; BIOC 401 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**Grading Option:** Graded with Option**Prerequisite for:** BSEN 418, BSEN 818**BSEN 418 Tissue Engineering****Crosslisted with:** BSEN 818**Prerequisites:** BSEN 416/816 or equivalent**Notes:** 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**Grading Option:** Graded with Option**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**Grading Option:** Graded with Option

**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**Grading Option:** Graded with Option**BSEN 444 Biomass and Bioenergy Engineering****Crosslisted with:** BSEN 844**Prerequisites:** Senior/graduate standing in engineering; BIOC 401 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**Grading Option:** Graded with Option**BSEN 445 Bioprocess Engineering****Crosslisted with:** BSEN 845**Prerequisites:** BSEN 344 or CHME 333**Description:** Engineering topics related to processing of biological materials into valuable products. Enzyme kinetics, microbial kinetics, application of enzymes in industrial processes, bioreactor design, equipment scale-up, gas transfer in reactors and bioseparations.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded**Offered:** FALL**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**Grading Option:** Graded with Option**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**Grading Option:** Graded with Option**Prerequisite for:** AGEN 854, AGST 854; AGEN 953**BSEN 455 Nonpoint Source Pollution Control Engineering****Crosslisted with:** BSEN 855, CIVE 455, CIVE 855**Prerequisites:** BSEN 321/CIVE 321 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**Grading Option:** Graded with Option**Offered:** FALL**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**Grading Option:** Graded with Option**BSEN 460 Instrumentation and Controls****Crosslisted with:** AGEN 460, AGEN 860, BSEN 860**Prerequisites:** ECEN 211 or ECEN 215 or AGEN/BSEN 260**Description:** Analysis and design of instrumentation and controls for agricultural, biological, and biomedical applications. Theory of basic sensors and transducers, analog and digital electrical control circuits, and the interfacing of computers with instruments and controls. LabVIEW Programming. Emphasis on signal analysis and interpretation for improving system performance.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**Offered:** FALL



**BSEN 468 Wetlands**

**Crosslisted with:** BIOS 458, NRES 468, NRES 868, WATS 468, BSEN 868

**Prerequisites:** CHEM 109A and 109L and CHEM 110A and 110L, or CHEM 105A and 105L and CHEM 106A and 106L; Junior or Senior Standing.

**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

**Grading Option:** Graded with Option

**Course and Laboratory Fee:** \$40

**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

**Grading Option:** Graded with Option

**Offered:** FALL/SPR

**Prerequisite for:** BSEN 480, AGEN 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

**Grading Option:** Graded with Option

**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

**Grading Option:** Graded with Option

**Offered:** SPRING

**ACE:** ACE 10 Integrated Product

**Experiential Learning:** Case/Project-Based Learning

**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

**Grading Option:** Graded

**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

**Grading Option:** Graded with Option

**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

**Grading Option:** Graded

**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, NE

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