

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 Husker Precision Water Team, the Husker Robotics, and the Society for Women Engineers.

Accreditation

The Biological Systems Engineering (BSBS) program is accredited by the Engineering Accreditation Commission of ABET, <https://www.abet.org>, under the commission's General Criteria and Program Criteria for Biological and Similarly Named Engineering Programs.

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/>).

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 meet both the University and College of Engineering entrance requirements. The following includes both the University and College of Engineering 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 for Change.

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 from colleges outside of the NU system. Although the University of Nebraska–Lincoln and the College of Engineering in general accepts C- and 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

Requirements for the Degree

Biological Systems Engineering Major Core

| | | |
|------------------------|---|---|
| BSEN 100 / AGEN 100 | Introduction to Biological Engineering and Agricultural Engineering | 1 |
| BSEN 112 / AGEN 112 | Computer-Aided Problem-Solving | 2 |
| BSEN 130 | Computer-Aided Design | 2 |
| BSEN 206 / CONE 206 | Engineering Economics (ACE 8) | 3 |
| BSEN 225 / AGEN 225 | Engineering Properties of Biological Materials | 3 |
| BSEN 244 | Thermodynamics of Living Systems | 3 |
| BSEN 260 | Instrumentation I for Agricultural and Biological Systems Engineering | 3 |
| BSEN 344 / AGEN 344 | Biological and Environmental Transport Processes | 3 |

| | | |
|------------------------|---|---|
| BSEN 460 / AGEN 460 | Instrumentation and Controls | 3 |
| BSEN 470 / AGEN 470 | Design I in Agricultural and Biological Systems Engineering | 1 |
| BSEN 480 / AGEN 480 | Design II in Agricultural and Biological Systems Engineering (Capstone, ACE 10) | 3 |

Engineering Seminars

| | | |
|-----------------------|---|---|
| ENGR 10 or ENGR 30 | Freshman Engineering Seminar ¹ Transfer Student Engineering Seminar | 0 |
| ENGR 20 | Sophomore Engineering Seminar ² | 0 |

¹ ENGR 193 may apply for ENGR 10 (students must be in the Kiewit Scholars Program to take the course).

² ENGR 493 may apply for ENGR 20 (students must be in the Kiewit Scholars Program to take the course).

Engineering Core

| | | |
|-------------------------|---|---|
| CSCE 155N | Computer Science I: Engineering and Science Focus | 3 |
| MECH 223 | Engineering Statics | 3 |
| MECH 310 or CIVE 310 | Fluid Mechanics Fluid Mechanics | 3 |
| MECH 373 | Engineering Dynamics | 3 |

Mathematics and Statistics

| | | |
|-------------------------|---|---|
| MATH 106 | Calculus I | 5 |
| MATH 107 | Calculus II | 4 |
| MATH 208 | Calculus III | 4 |
| MATH 221 | Differential Equations | 3 |
| STAT 380 or MECH 321 | Statistics and Applications Engineering Statistics and Data Analysis | 3 |

Basic Sciences

| | | |
|---|---|---|
| LIFE 120 & 120L | Fundamentals of Biology I and Fundamentals of Biology I laboratory | 4 |
| LIFE 121 & 121L | Fundamentals of Biology II and Fundamentals of Biology II Laboratory | 4 |
| PHYS 211 | General Physics I | 4 |
| PHYS 212 | General Physics II | 4 |
| CHEM 109A & CHEM 109L | General Chemistry I and General Chemistry I Laboratory | 4 |
| CHEM 110A & CHEM 110L | General Chemistry II and General Chemistry II Laboratory | 4 |
| Select one organic chemistry sequence from the following: | | 4 |
| CHEM 251 & CHEM 253 | Organic Chemistry I and Organic Chemistry I Laboratory | |
| CHEM 261 & CHEM 263 | Mechanistic Organic Chemistry I and Mechanistic Organic Chemistry I Laboratory | |
| Select one of the following biochemistry courses: | | 3 |
| BIOC 401 or BIOC 431 | Elements of Biochemistry Biochemistry I: Structure and Metabolism | |

Biological Science Electives

Select three credits from the following:

ASCI 240, ASCI 370, BIOC 401L, BIOC 433, BIOS 115, BIOS 116, BIOS 201, BIOS 202, BIOS 207, BIOS 213, BIOS 213L, BIOS 214, BIOS 300, BIOS 312, BIOS 314, BIOS 381, BIOS 385, BIOS 424, BIOS 426, BIOS 434, BIOS 456, BIOS 462, BIOS 471, BIOS 475, BIOS 475L, BIOS 477, BIOS 487, BIOS 489, ENTO 401, ENTO 402, NRES 211, NRES 220, NRES 222, NRES 386, NRES 463, NRES 470, NUTR 250, PLAS 215, PLAS 435, PLPT 270, PLPT 400, PLPT 400L

Communication and Leadership

| | | |
|-------------|--|---|
| ENGL 150 | Writing and Inquiry | 3 |
| or ENGL 151 | Writing for Change | |
| or ENGL 254 | Writing and Communities | |
| or JGEN 200 | Technical Communication I | |
| ENGR 100 | Interpersonal Skills for Engineering Leaders | 3 |

Biological Systems Engineering Emphasis Area Requirements

Students majoring in Biological Systems Engineering will complete the requirements of at least one of the emphases listed below:

- Food and Bioprocess Engineering
- Biomedical Engineering
- Ecological and Environmental Engineering

Food and Bioprocess Engineering

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|------------------------|--|---|
| BSEN 303 / AGEN 303 | Principles of Process Engineering | 3 |
| BSEN 446 / AGEN 446 | Unit Operations of Biological Processing | 3 |

Select one of the following:

- | | |
|----------|-----------------------------------|
| BSEN 444 | Biomass and Bioenergy Engineering |
| BSEN 445 | Bioprocess Engineering |

Select one of the following:

- | | |
|------------------------|--|
| BSEN 317 | Introduction to Biomedical Engineering |
| BSEN 350 / AGEN 350 | Natural Resources Engineering |
| BSEN 355 | Introduction to Ecological Engineering |

Biomedical Engineering

| | | |
|----------|--|---|
| BSEN 317 | Introduction to Biomedical Engineering | 3 |
|----------|--|---|

Select two of the following:

- | | |
|----------|---------------------------------------|
| 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 |

Select one of the following:

- | | |
|------------------------|--|
| BSEN 303 | Principles of Process Engineering |
| BSEN 350 / AGEN 350 | Natural Resources Engineering |
| BSEN 355 | Introduction to Ecological Engineering |

Ecological and Environmental Engineering

| | | |
|------------------------|--|---|
| BSEN 350 / AGEN 350 | Natural Resources Engineering | 3 |
| BSEN 355 | Introduction to Ecological Engineering | 3 |

Select one of the following:

- | | |
|------------------------|--|
| 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 456 / AGEN 456 | GIS and Ecohydrological Modeling for Natural Resources |
| BSEN 458 / CIVE 458 | Groundwater Engineering |
| BSEN 468 | Wetlands |
| BSEN 479 | Hydroclimatology |

Select one of the following:

- | | |
|----------|--|
| BSEN 303 | Principles of Process Engineering |
| BSEN 317 | Introduction to Biomedical Engineering |

In addition to meeting the requirements for one of the emphasis areas, students need to complete an additional 6 credits from the courses below. At least 3 must come from the Engineering Elective list and the remaining 3 credits may come from the Engineering Elective or the Engineering or Science Elective lists.

Engineering Elective

AGEN 424, AGEN 431, AGEN 436, AGEN 443, AGEN 453, BSEN 303, BSEN 311, BSEN 317, BSEN 321, BSEN 321L, BSEN 324, BSEN 325, BSEN 350, BSEN 355, BSEN 410, BSEN 412, BSEN 414, BSEN 416, BSEN 418, BSEN 422, BSEN 441, BSEN 444, BSEN 445, BSEN 446, BSEN 453, BSEN 455, BSEN 458, BSEN 468, BSEN 479, BSEN 492, BSEN 496, CHME 2**, CHME 3**, CHME 4** (not from: CHME 202, CHME 223, CHME 332, CHME 452), CIVE 2**, CIVE 3**, CIVE 4** (not from: CIVE 310, CSCE 2**, CSCE 3**, CSCE 4**, ECEN 2**, ECEN 3**, ECEN 4** (not from: ECEN 211, ECEN 215), MECH 3**, MECH 4** (not from: MECH 310, MECH 321, MECH 324, MECH 351), MATL 2**, MATL 3**, MATL 4**

Engineering or Science Elective

ASCI 240, ASCI 320, ASCI 341, BIOC 432, BIOC 434, BIOC 435, BIOC 486, BIOS 2**, BIOS 3**, BIOS 4** (not from: BIOS 291, BIOS 296, BIOS 310, BIOS 395, BIOS 397, BIOS 397A, BIOS 430, BIOS 491, BIOS 498), CHEM 2**, CHEM 3**, CHEM 4** (not from: CHEM 391, CHEM 396, CHEM 398, CHEM 431, CHEM 486, CHEM 499), FDST 367, FDST 403, FDST 405, FDST 406, FDST 412, FDST 420, FDST 455, FDST 455L, FDST 470, MATH 310, MATH 314, MATH 325, MATH 417, MATH 423, MATH 424, MATH 425, MATH 428, MATH 430, MATH 433, MATH 439, MATH 440, MATH 445, MATH 447, MATH 450, MATH 452, NRES 211, NRES 218, NRES 220, NRES 300, NRES 311, NRES 330, NRES 408, NRES 419, NRES 468, NUTR 250, NUTR 372, PHYS 2**, PHYS 3**, PHYS 4** (not from: PHYS 231, PHYS 292, PHYS 398, PHYS 492, PHYS 499)

ACE Elective

Select one course from each of not yet satisfied ACE outcomes 5, 6, 7, and 9.

Grade Rules

C- and D Grades

A grade of C or better is required for all biological systems engineering required courses and electives that are to count toward graduation, except for 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

Prerequisite for: MECH 342

BSEN 206 Engineering Economics

Crosslisted with: CONE 206

Prerequisites: Sophomore standing. Credit toward the degree may be earned in only one of BSEN 206/CONE 206 or CHME 452

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: 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

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; CIVE 821; ENVE 322; ENVE 401; ENVE 410; ENVE 430**BSEN 321H Honors: Principles of Environmental Engineering****Crosslisted with:** CIVE 321H**Prerequisites:** Good standing in the Univ. Hons Program or by invitation; CHEM109A(C or better) & CHEM 109L or 110A(C or better) & CHEM110L or CHEM113A(C or better) & CHEM 113L & MATH 107(C or better). Credit toward the degree cannot be earned in both CIVE/BSEN 321 & 321H.**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; CIVE 821; 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 310 or 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 310 or 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 351 or AGST 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; AGST 855**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 351 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 456 GIS and Ecohydrological Modeling for Natural Resources****Crosslisted with:** AGEN 456, AGEN 856, BSEN 856**Prerequisites:** AGEN/BSEN 350 or CIVE 351 or AGST 354 or NRES 453**Description:** Use of GIS to create inputs to models such as HEC-HMS and SWAT. Processes to simulate hydrology and erosion in models. Development and calibration of models based on student's area of interest.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**Offered:** SPRING**BSEN 458 Groundwater Engineering****Crosslisted with:** BSEN 858, CIVE 458, CIVE 858**Prerequisites:** CIVE 351 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, 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, 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

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