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 degree 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. 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 any 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 any academic year in which they are first admitted at the University of Nebraska–Lincoln. 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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BSEN 100</td>
<td>Introduction to Biological Engineering</td>
<td>1</td>
</tr>
<tr>
<td>AGEN 100</td>
<td>Agricultural Engineering</td>
<td></td>
</tr>
<tr>
<td>BSEN 112</td>
<td>Computer-Aided Problem-Solving</td>
<td>2</td>
</tr>
<tr>
<td>AGEN 112</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BSEN 130</td>
<td>Computer-Aided Design</td>
<td>2</td>
</tr>
<tr>
<td>BSEN 206</td>
<td>Engineering Economics</td>
<td>3</td>
</tr>
<tr>
<td>CONE 206</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BSEN 225</td>
<td>Engineering Properties of Biological Materials</td>
<td>3</td>
</tr>
<tr>
<td>AGEN 225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BSEN 244</td>
<td>Thermodynamics of Living Systems</td>
<td>3</td>
</tr>
<tr>
<td>BSEN 260</td>
<td>Instrumentation I for Agricultural and Biological Systems Engineering</td>
<td>3</td>
</tr>
<tr>
<td>BSEN 344</td>
<td>Biological and Environmental Transport Processes</td>
<td>3</td>
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<tr>
<td>AGEN 344</td>
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<td></td>
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<tr>
<td>BSEN 460</td>
<td>Instrumentation and Controls</td>
<td>3</td>
</tr>
<tr>
<td>AGEN 460</td>
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**Engineering Seminars**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 10</td>
<td>Freshman Engineering Seminar</td>
<td>0</td>
</tr>
<tr>
<td>ENGR 20</td>
<td>Sophomore Engineering Seminar</td>
<td>0</td>
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</table>

**Engineering Core**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 155N</td>
<td>Computer Science I: Engineering and Science Focus</td>
<td>3</td>
</tr>
<tr>
<td>MECH 223</td>
<td>Engineering Statics</td>
<td>3</td>
</tr>
<tr>
<td>MECH 310</td>
<td>Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>or CIVE 310</td>
<td>Fluid Mechanics</td>
<td></td>
</tr>
<tr>
<td>MECH 373</td>
<td>Engineering Dynamics</td>
<td>3</td>
</tr>
</tbody>
</table>

**Mathematics and Statistics**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 106</td>
<td>Calculus I</td>
<td>5</td>
</tr>
<tr>
<td>MATH 107</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 208</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 221</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>STAT 380</td>
<td>Statistics and Applications</td>
<td>3</td>
</tr>
<tr>
<td>or MECH 321</td>
<td>Engineering Statistics and Data Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

**Basic Sciences**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIFE 120</td>
<td>Fundamentals of Biology I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; LIFE 120L</td>
<td>Fundamentals of Biology I laboratory</td>
<td>4</td>
</tr>
<tr>
<td>LIFE 121</td>
<td>Fundamentals of Biology II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; LIFE 121L</td>
<td>Fundamentals of Biology II Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 109A</td>
<td>General Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; CHEM 109L</td>
<td>General Chemistry I Laboratory</td>
<td></td>
</tr>
<tr>
<td>CHEM 110A</td>
<td>General Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; CHEM 110L</td>
<td>General Chemistry II Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

Select one sequence from the following:

- CHEM 251  Organic Chemistry I
- CHEM 253  Organic Chemistry I Laboratory
- CHEM 261  Mechanistic Organic Chemistry I
- CHEM 263  Mechanistic Organic Chemistry I Laboratory
- BIOC 401  Elements of Biochemistry
- BIOC 431  Biochemistry I: Structure and Metabolism
- PHYS 211  General Physics I
- PHYS 212  General Physics II

**Biological Science Electives**

Select three credits from the following:

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
BSN 303 / AGN 303 Principles of Process Engineering
BSN 446 / AGN 446 Unit Operations of Biological Processing

Select one of the following:
- BSN 444 Biomass and Bioenergy Engineering
- BSN 445 Bioprocess Engineering

Select one of the following:
- BSN 311 Biomedical Signal and System Analysis
- BSN 317 Introduction to Biomedical Engineering
- BSN 350 / AGN 350 Natural Resources Engineering
- BSN 355 Introduction to Ecological Engineering

Biomedical Engineering
BSN 317 Introduction to Biomedical Engineering

Select two of the following:
- BSN 311 Biomedical Signal and System Analysis
- BSN 412 Rehabilitation Engineering
- BSN 414 Medical Imaging Systems
- BSN 416 Introduction to Biomaterials
- BSN 418 Tissue Engineering

Select one of the following:
- BSN 303 Principles of Process Engineering
- BSN 350 / AGN 350 Natural Resources Engineering
- BSN 355 Introduction to Ecological Engineering

Ecological and Environmental Engineering
BSN 350 / AGN 350 Natural Resources Engineering

Select three of the following:
- BSN 441 / AGN 441 Animal Waste Management
- BSN 453 / AGN 453 Irrigation and Drainage Systems Engineering
- BSN 455 / CIVE 455 Nonpoint Source Pollution Control Engineering
- BSN 458 / CIVE 458 Groundwater Engineering
- BSN 468 Wetlands
- BSN 479 Hydroclimatology

Select one of the following:

In addition to meeting the requirements for one of the emphasis areas, students need to complete an additional 6 credits of engineering and science classes of which 3 hours must be engineering courses from the list below:

Engineering Elective
Select three credits from:

Engineering or Science Elective
Select three credits from:

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

Additional Major Requirements
Written Communications Requirement
Three (3) hours of English composition (ENGL 150, ENGL 151, ENGL 254) may be substituted for the written communications requirement (JGEN 200) in the biological systems engineering program.

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.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Description</th>
<th>Credit Hours</th>
<th>Offered</th>
<th>Grading Option</th>
<th>Max credits per semester</th>
<th>Max credits per degree</th>
<th>Crosslisted with</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSEN 100</td>
<td>Introduction to Biological Engineering and Agricultural Engineering</td>
<td>AGEN 100</td>
<td>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.</td>
<td>1</td>
<td></td>
<td>Graded with Option</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>BSEN 112</td>
<td>Computer-Aided Problem-Solving</td>
<td>AGEN 112</td>
<td>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.</td>
<td>2</td>
<td>SPRING</td>
<td>Graded with Option</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>BSEN 130</td>
<td>Computer-Aided Design</td>
<td></td>
<td>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.</td>
<td>2</td>
<td>FALL/SPR</td>
<td>Graded with Option</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>BSEN 206</td>
<td>Engineering Economics</td>
<td>CONE 206</td>
<td>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.</td>
<td>3</td>
<td></td>
<td>Graded with Option</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BSEN 225</td>
<td>Engineering Properties of Biological Materials</td>
<td>AGEN 225</td>
<td>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.</td>
<td>3</td>
<td></td>
<td>Graded with Option</td>
<td>3</td>
<td>3</td>
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<tr>
<td>BSEN 244</td>
<td>Thermodynamics of Living Systems</td>
<td>CHEM 110A and 110L or CHEM 114; MATH 107; PHYS 211; LIFE 120 or BIOS 101 or parallel</td>
<td>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.</td>
<td>3</td>
<td></td>
<td>Graded with Option</td>
<td>3</td>
<td>3</td>
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<tr>
<td>BSEN 260</td>
<td>Instrumentation I for Agricultural and Biological Systems</td>
<td></td>
<td>Crosslisted with: AGEN 260 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.</td>
<td>2</td>
<td>SPRING</td>
<td>Graded with Option</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>BSEN 303</td>
<td>Principles of Process Engineering</td>
<td>AGEN 303</td>
<td>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.</td>
<td>3</td>
<td></td>
<td>Graded with Option</td>
<td>3</td>
<td>3</td>
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<tr>
<td>BSEN 311</td>
<td>Biomedical Signal and System Analysis</td>
<td>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.</td>
<td>3</td>
<td></td>
<td>Graded with Option</td>
<td>3</td>
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</tbody>
</table>
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 401; 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, radiant 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

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 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 456 GIS and Ecological Modeling for Natural Resources
Crosslisted with: AGEN 456, AGEN 856, BSEN 856
Prerequisites: AGEN/BSEN 350 or CIVE 352 or AGST/WATS 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 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, 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.
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**

- Ph.D., Engineering Education, Virginia Tech - Blacksburg, VA
- 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