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 environmental and water resources 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 environmental and water resources engineering might restore streams, lakes and wetlands; manage ecosystems; minimize nonpoint source pollution; or design systems for animal waste management.

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

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

The Department of Biological Systems Engineering is located in Chase Hall on East Campus. BSEN students participate in classes and laboratories on both 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 Soil and Water Resources Club, the Biomedical Engineering Society, the Nebraska Society of Professional Engineers and the Society for Women Engineers.

Major Department Admission

Pre-professionally admitted College of Engineering (COE) students majoring in biological systems engineering (BSEN) have their records examined for advancement to professionally-admitted status during the fall, spring, and summer immediately following the term in which:

- 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://catalog.unl.edu/undergraduate/engineering/biological-systems/ace.unl.edu).

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

College Requirements

College Admission

College Entrance Requirements

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

1. Mathematics – 4 units: 2 of algebra, 1 of geometry, and 1 of precalculus and trigonometry
2. English – 4 units
3. Natural sciences – 3 units that must include 1 unit of physics and 1 unit of chemistry (chemistry requirement waived for students in construction management)
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.
7. Students having an ACT score of 19 or less in English (or equivalent SAT score) must take ENGL 150 Writing and Inquiry or ENGL 151 Writing and Argument.

A total of 16 units is required for admission.

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

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

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

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

Other Admission Requirements

Students who transfer to the University of Nebraska–Lincoln from other accredited colleges or universities and wish to be admitted to the College of Engineering (COE) must meet COE freshman entrance requirements and have a minimum cumulative GPA of 2.5 and be calculus-ready. Students not meeting either of these requirements must enroll in the Explore Center or another University college until they meet COE admission requirements. 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 at Kearney and at Omaha, not all majors in the COE accept such low grades. Students must conform to the requirements of their intended major and, in any case, are strongly encouraged to repeat courses with a grade of C- or less.

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

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

College Degree Requirements

Grade Rules

Grade Appeals

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

Catalog Rule

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

Learning Outcomes

Graduates of the biological systems engineering program will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

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

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

Major Requirements

Specific Major Requirements

First Semester		
BSEN 100 / AGEN 100	Introduction to Biological Engineering and Agricultural Engineering	1
CHEM 113	Fundamental Chemistry I [1]	4
ENGR 10	Freshman Engineering Seminar	0
MATH 106	Calculus I	5
CSCE 155N	Computer Science I: Engineering and Science Focus	3
ENGR 100	Interpersonal Skills for Engineering Leaders	3
Credit Hours Subtotal:		16
Second Semester		
BSEN 112 / AGEN 112	Computer-Aided Problem-Solving	2
CHEM 114	Fundamental Chemistry II [2]	3
MATH 107	Calculus II	4
PHYS 211	General Physics I	4
BSEN 130	Computer-Aided Design	2
Credit Hours Subtotal:		15
Third Semester		
BSEN 225 / AGEN 225	Engineering Properties of Biological Materials	3
Select one sequence from the following:		4
CHEM 251 & CHEM 253	Organic Chemistry I and Organic Chemistry I Laboratory	
CHEM 255 & CHEM 257	Biological Organic Chemistry and Biological Organic Chemistry Laboratory	
CHEM 261 & CHEM 263	Organic Chemistry and Organic Chemistry Laboratory	
ENGR 20	Sophomore Engineering Seminar	0
PHYS 212	General Physics II	4
MATH 208	Calculus III	4
MECH 223	Engineering Statics	3
Credit Hours Subtotal:		18
Fourth Semester		
BSEN 260	Instrumentation I for Agricultural and Biological Systems Engineering	3
BSEN 244	Thermodynamics of Living Systems	3
LIFE 120 & LIFE 120L	Fundamentals of Biology I and Fundamentals of Biology I laboratory	4
MATH 221	Differential Equations	3
MECH 373	Engineering Dynamics	3
Credit Hours Subtotal:		16
Fifth Semester		
LIFE 121 & LIFE 121L	Fundamentals of Biology II and Fundamentals of Biology II Laboratory	4
MECH 310	Fluid Mechanics	3
or CIVE 310	Fluid Mechanics	
BSEN 460 / AGEN 460	Instrumentation and Controls	3
JGEN 200	Technical Communication I	3
BSEN Emphasis Elective:		
Select 3 hours		3
Credit Hours Subtotal:		16
Sixth Semester		
BIOC 401	Elements of Biochemistry	3
BSEN 344 / AGEN 344	Biological and Environmental Transport Processes	3
Statistics Elective		
Select one of the following:		3
MECH 321	Engineering Statistics and Data Analysis	
STAT 380	Statistics and Applications	
ACE Elective:		
Select one course from not yet satisfied ACE outcomes 5, 6, 7, or 9		3
BSEN Emphasis Elective:		
Select 3 hours		3
Credit Hours Subtotal:		15
Seventh Semester		
BSEN 206 / CONE 206	Engineering Economics	3
BSEN 470 / AGEN 470	Design I in Agricultural and Biological Systems Engineering	1
ACE Electives:		
Select two courses from not yet satisfied ACE outcomes 5, 6, 7, or 9		6
BSEN Emphasis Elective: [3]		
Select 3 hours		3
Biological or Science Emphasis Elective:		
Select 3 hours		3
Credit Hours Subtotal:		16
Eighth Semester		
BSEN 480 / AGEN 480	Design II in Agricultural and Biological Systems Engineering	3
ACE Elective:		

Select one course from not yet satisfied ACE outcomes 5, 6, 7, or 9	3
BSEN Emphasis Elective:	
Select 3 hours	3
Engineering or Science Emphasis Elective:	
Select 3 hours	3
Engineering Emphasis Elective:	
Select 3 hours	3
Credit Hours Subtotal:	15
Total Credit Hours	127

1 CHEM 109 *may be substituted with permission of advisor.*

2 CHEM 110 *may be substituted with permission of advisor.*

3 BIOS 203 *is not acceptable.*

Emphasis Area Requirements

An emphasis area requires a student to take 18 hours of engineering and science-based courses. A minimum of 15 hours must be selected from courses offered by the College of Engineering. Within the 15 hours, a minimum of 12 hours must be BSEN courses or engineering courses crosslisted with BSEN. Of the BSEN or BSEN-crosslisted courses, one must be a 300-level course of a primary emphasis area, one must be a 300-level course of a secondary emphasis area and one must be a 400-level course of a primary emphasis area. Food and Bioprocess Engineering emphasis requires BSEN 303 Principles of Process Engineering, Biomedical Engineering emphasis requires BSEN 317 Introduction to Biomedical Engineering, Environmental and Water Resources emphasis requires BSEN 350 Soil and Water Resources Engineering and either BSEN 326 Introduction to Environmental Engineering or BSEN 355 Introduction to Ecological Engineering as primary emphasis area courses.

Food and Bioprocess Engineering

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

Biomedical Engineering

BSEN 317	Introduction to Biomedical Engineering	3
Select two of the following:		6
BSEN 311	Biomedical Signal and System Analysis	
BSEN 412	Rehabilitation Engineering	
BSEN 414	Medical Imaging Systems	
BSEN 416	Introduction to Biomaterials	
BSEN 418	Tissue Engineering	
Total Credit Hours		9

Environmental and Water Resources Engineering

BSEN 350 / AGEN 350	Soil and Water Resources Engineering	3
Select one of the following:		3
BSEN 326 / CIVE 326	Introduction to Environmental Engineering	
BSEN 355	Introduction to Ecological Engineering	
Select one of the following:		3
BSEN 441 / AGEN 441	Animal Waste Management	
BSEN 453 / AGEN 453	Irrigation and Drainage Systems Engineering	
BSEN 455 / CIVE 455	Nonpoint Source Pollution Control Engineering	
BSEN 458 / CIVE 458	Groundwater Engineering	
BSEN 468	Wetlands	
Total Credit Hours		9

Additional Major Requirements

Written Communications Requirement

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

Grade Rules

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

Catalog to Use

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

BSEN 100 Introduction to Biological Engineering and Agricultural Engineering
Crosslisted with: AGEN 100
Description: Description of careers in biomedical, environmental, water resources, food and bioproducts, and agricultural engineering. The human, economic and environmental impacts of engineering in society. Communication, design, teamwork, and the role of ethics and professionalism in engineering work.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Grading Option: Graded with Option

BSEN 112 Computer-Aided Problem-Solving
Crosslisted with: AGEN 112
Prerequisites: MATH 106 or parallel.
Description: Problem solving techniques and procedures through the use of Excel, MATLAB, and graphical methods. Emphasis on problem/solution communications with topics and problems from agricultural engineering and biological systems engineering.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded with Option
Offered: SPRING

BSEN 130 Computer-Aided Design
Description: Use of computer-aided design software to communicate engineering ideas. Specifications, dimensioning, tolerancing, 2- and 3-D model development, topographic mapping, and process layout with environmental, bioprocess, and biomedical emphases.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded with Option
Offered: FALL/SPR

BSEN 206 Engineering Economics
Crosslisted with: CONE 206
Prerequisites: Sophomore standing
Description: Introduction to methods of economic comparisons of engineering alternatives: time value of money, depreciation, taxes, concepts of accounting, activity-based costing, ethical principles, civics and stewardship, and their importance to society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CNST 476, CONE 476; CONE 319; MECH 343
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 110 or 114; MATH 107; PHYS 211; LIFE 120 or parallel
Description: Introduction to the laws of thermodynamics and their application to biological and environmental systems. Zeroth, first, second, and third laws; open and closed systems; enthalpy and specific heat; and Gibb's free energy and chemical potential for biological and environmental systems. Applications to biochemical potentials, water potential, absorption, osmosis, radiation, membranes, surface tension, and fugacity. Thermodynamic cycles as they apply to living systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
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; and BSEN 212A 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

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

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

BSEN 327 Environmental Engineering Laboratory
Crosslisted with: CIVE 327
Prerequisites: CIVE/BSEN 326 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 with Option

BSEN 344 Biological and Environmental Transport Processes
Crosslisted with: AGEN 344
Prerequisites: BSEN 244 or MECH 200; MATH 221; MECH/CIVE 310 or CHME 332 or parallel
Description: Introduction to concurrent transport of energy and mass in biological and environmental processes. Modes of heat transfer, steady and non-steady state heat conduction, convective heat transfer, radiative heat transfer, and heat transfer with phase change. Equilibrium, kinetics, and modes of mass transfer, diffusion, dispersion, and convective mass transfer. Soil freezing and thawing, energy and mass balances of crops, diffusivities of membranes, photosynthesis, human and animal energy balances, and respiration.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

BSEN 350 Soil and Water Resources Engineering
Crosslisted with: AGEN 350
Prerequisites: MATH 221; and parallel: MECH 310 or CIVE 310 or CHME 332
Description: Introduction to soil and water resources and the engineering processes used to analyze watersheds. Soil water relations, evapotranspiration, precipitation, runoff, erosion, flow in natural waterways and through reservoirs, wetland and groundwater hydrology, and water quality. Geographic information system utilized to develop maps and analyze watershed characteristics. A selected watershed is investigated.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: FALL

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

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

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 425 Process Design in Water Supply and Wastewater Treatment
Crosslisted with: CIVE 425
Prerequisites: CIVE/BSEN 326 and CIVE/MECH 310.
Description: Design of unit operations and processes associated with drinking water and wastewater treatment facilities.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
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: BIOC 401 or BIOC 431; BSEN 303, BSEN 344
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, MSYM 854; AGEN 953

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

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

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

BSEN 468 Wetlands
Crosslisted with: BIOS 458, NRES 468, NRES 868, WATS 468, BSEN 868
Prerequisites: CHEM 109 and CHEM 110, or CHEM 105 and CHEM 106; 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

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: AGEN 480, BSEN 480

BSEN 479 Hydroclimatology
Crosslisted with: NRES 479, METR 479, WATS 479, NRES 879, METR 879, BSEN 879
Prerequisites: NRES 208 or METR 100 or METR/NRES 370.
Notes: Offered spring semester of even-numbered calendar years.
Description: Interaction between earth's climate and the hydrologic cycle. Energy and water fluxes at the land-atmosphere interface. Atmospheric moisture transport, precipitation, evaporation, snowmelt, and runoff. Impacts of climate variability and change on the hydrologic cycle.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
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
ACE: ACE 10 Integrated Product

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

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

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

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

Career Information

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

Jobs of Recent Graduates

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

Internships

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

Graduate & Professional Schools

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