Biological and Irrigation Engineering

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Degrees offered: Bachelor of Science (BS), Master of Science (MS), and Doctor of Philosophy (PhD) in Biological Engineering; MS and PhD in Irrigation Engineering

Undergraduate options: *BS*—Bioprocess; Bioenvironmental; Biomedical; and Soil and Water Resource Systems Engineering

Graduate specializations: *MS, PhD*—Agricultural Hydrology; Crop Water-Yield Analysis; Drainage; Evapotranspiration; Groundwater Management and Simulation; Irrigation Conveyance and Control Structures; Irrigation Project Planning, Design, and Operation and Management; Molecular Biology; On-Farm Water Management; Remote Sensing and Geographical Information Systems; Surface, Sprinkle, and Trickle Irrigation Methods

Mission

The mission of the Department of Biological and Irrigation Engineering (BIE) is to teach students preparing to become biological engineers how to apply engineering principles and the knowledge of biological sciences to the solutions of bioresource and biotechnology problems. The department also prepares students for entry into other professions, such as biomedical engineering, medicine, and law.

The BIE program is designed to help students learn to manipulate biological materials for useful purposes, understand the biological literature, and be able to communicate with biological scientists. Biological engineering encompasses engineering applications in a broad range of biological systems. The biological engineering curriculum at USU emphasizes bioprocess and biomedical engineering, as well as soil and water resource systems engineering. The curriculum at both the Bachelor of Science and graduate levels is designed to prepare students for a wide variety of professional jobs related to the utilization, management, and protection of bioresources from nanoscale to watershed scale.

Scope and Objectives

The objective of the Biological Engineering Program is to provide students with broad-based engineering skills necessary to solve biological-based problems. Students first learn to integrate biological sciences with conventional studies in mathematics and chemistry. These skills are broadened with a liberal exposure to humanities and social sciences, then sharpened with the study of engineering topics that develop practical problem-solving abilities; expand a sensitivity to the economic, social, and legal dimensions of technical problems; provide an understanding of ethics and professional responsibility; and stimulate a desire for life-long learning.

Outcomes

The Biological Engineering curriculum emphasizes three important outcomes:

1. The knowledge needed to identify, formulate, and perform the functions of a biological engineer.

2. The intellectual skills and creative abilities graduates should possess in order to design systems and conduct experiments in an interdisciplinary team setting, as well as the ability to use these skills in modern engineering practice.

3. The specific career-preparation competencies of ethical responsibility, effective communications, comprehension of engineering in the global context, and a commitment to life-long learning and self-improvement.

Assessment and Evaluation

The BIE Department is committed to an assessment process aimed at evaluating the effectiveness of BIE programs in preparing graduates as productive professionals. The foundation of departmental assessment is the undergraduate accreditation by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET).

The accreditation activities performed every six years by the EAC/ABET provide the only formal and external review of the undergraduate program. This assessment ensures that the USU program meets an overall objective and structure consistent with similar programs in the U.S. and Canada.

The biological engineering program is continuously improved through integrating the results of this formal assessment with the day-to-day assessments obtained from both students and faculty. To ensure the overall quality of the program, the department conducts several specific assessments. These are:

1. Annual faculty survey
2. Teaching evaluations
3. Graduating student exit interviews
4. Fundamentals of Engineering Examination performances
5. Biological and Irrigation Engineering Advisory Board, involving employer responses and board reviews
6. Alumni survey

Undergraduate Programs

General biological engineering concepts include the properties of biological materials, electronics and bio-instrumentation, computer use and programming, engineering mechanics, thermodynamics, computer-aided drafting, bio-environmental transport phenomena, and fluid mechanics.

Students gain a strong foundation in biological, chemical, and physical sciences. Each student then selects an option within the field, based on personal interest. These areas of study are tailored for each student with 24 semester credits of technical electives and one-on-one academic advisement with a member of the faculty. Design is a major theme of both the student's general coursework and specialization, with most courses including open-ended design problems. The entire design experience is brought together in a capstone design course.

The Biological Engineering Program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (EAC/ABET).

Requirements

Admission and Graduation Requirements. The student who is majoring in or planning to major in Biological Engineering needs to be aware of the College of Engineering requirements concerning admission to the college, pre-engineering, admission to the professional engineering school, general education, and other academic requirements. Additional information concerning these items is given in the College of Engineering requirements on pages 107-109. It is the responsibility of the student to be aware of these rules and regulations.

Biological Engineering Curriculum

Biological Engineering is divided into a preprofessional and a professional program involving either a four-year or a five-year schedule that will satisfy the requirements for a BS degree in Biological Engineering. Students receiving credit from the College Level Examination Program (CLEP) or from Advanced Placement (AP) may complete a BS degree program in less than four years. The academic work, particularly in the junior and senior years, is supplemented by hands-on laboratories which are required as part of the coursework. Modification in the program to meet special needs and priorities of a student may be obtained with the approval of the department head and advisor.

Preprofessional Program: BIE 1880, 2330; CHEM 1210, 1230, 2300, 2330; ENGR 1010, 2000, 2020, 2200; BIOL 1210; ENGL 2010; ITE 2270; MAE 2400; MATH 1210, 1220, 2250; PHYX 2200; and three credits of Communications Literacy.

Professional Program: BIE 3000, 3200, 3670, 3870, 4880, 4890; BIOL 3300, 5200; CEE 3500; CHEM 3700, 3710; STAT 3000; ECE 2200; Biological Engineering Electives (6-21 credits); Engineering Electives (0-15 credits); Technical Electives (0-12 credits); and University Studies (18 credits).

Additional Information

For more information about the Bachelor of Science requirements and the sequence in which courses should be taken, see major requirement sheet, available from the Biological and Irrigation Engineering Department.

Financial Support

Scholarships, assistantships, grants-in-aid, and work-study programs are available through the University. In addition, the department employs students to assist in engineering research and development. Cooperative education and industrial employment opportunities for students are coordinated by the University Placement Office.

Concurrent BS/Master's Program

The concurrent BS/Master's program allows engineering students to begin taking graduate-level classes during their senior year. This permits them to complete requirements for *both* the BS degree *and* the master's degree concurrently during two years. Students in this program have a greater selection of graduate courses, since many graduate courses are taught during alternate years. In addition, the student's senior design project could be a start for a graduate design project or thesis. After completing their BS degree, students in the program can earn a master's degree in only one additional year. Both the BS and the master's degree can generally be earned with 150 total credits, although students should note that a Plan C MS requires 3 extra credits. Finally, students with a master's degree can expect a much higher starting salary following graduation. (For more information, see *College of Engineering* section of this catalog, page 109.)

Graduate Programs

Admission Requirements

See general admission requirements identified in this catalog. Admission committees also consider experience, undergraduate record and curriculum, and formal recommendations. A student without an undergraduate engineering background will be required to complete selected undergraduate courses prior to or concurrently with enrollment in graduate courses.

Prerequisites for Matriculation. Students who are admitted provisionally or who have been changed from matriculated to probationary matriculated status will have their records reviewed by a faculty committee when they have completed 12 credits of coursework (among which must be formal engineering courses) or at the end of their second semester at USU. Those students who have earned a 3.0 GPA at that time and desire to be matriculated may apply to the department to have their status changed. If they meet all other academic requirements of the School of Graduate Studies and the department, they will be matriculated and admitted to the degree program. When a student is admitted as a degree candidate, the committee may allow up to 12 credits taken while on nonmatriculated status to be transferred. Nonmatriculated students may continue to study at USU but without degree candidate status. At the end of their studies, nondegree students are granted a Certificate of Completion.

Prerequisite Requirements. All students must have had **formal** courses in engineering and computer programming, as well as at least one year of calculus. Students without this background can satisfy these requirements by taking the appropriate undergraduate courses at USU. An additional year of calculus (MATH 1210, 1220, and 2250, or equivalent) is required for the MS degree in Irrigation Engineering and for all PhD programs. These background courses will not be counted toward the degree credit requirements.

MS in Biological Engineering and in Irrigation Engineering

Students must have a BS from an ABET-accredited engineering program in the U.S. or its equivalent in their home countries or must take the make-up coursework required for a BS in engineering at USU. It is assumed that the bachelor's degree mathematical training includes courses in calculus, linear analysis, and differential equations.

Three MS options are available: research (Plan A), technical practice (Plan B), and training/extension (Plan C). All MS students are admitted initially into the technical practice (Plan B) option. They may subsequently transfer to one of the other two options depending upon interests and skills.

Research Option. Students wishing to gain experience in research may select the research option, particularly if they have a long-term goal of PhD study. The minimum requirements for this option are 30 credits, of which 8 may be awarded for the thesis.

Technical Practice Option. Some students may not be interested in pursuing a PhD degree or in doing the research necessary for a thesis. For such students, the technical practice (Plan B) option is offered. The requirements for the degree are similar to those for the research option, with the exception of the thesis. The 8 thesis credits are replaced by 4 credits for a significant engineering report or design project and 4 additional credits of coursework. The minimum course requirement for the technical practice option is 30 approved graduate credits.

Training/Extension Option. Students expecting to terminate their graduate studies at the MS level and wishing to develop an emphasis in the training and/or extension fields of biological engineering or irrigation engineering, may choose the training/extension option (Plan C). The same engineering BS or equivalent requirements noted under the Plan A option apply. The minimum requirements for this degree are 30 approved graduate credits. No report or thesis is required. The degree requirements under this option can be met by taking courses.

Doctor of Philosophy

Two PhD programs are offered in the department: (1) **Biological Engineering** and (2) **Irrigation Engineering**. Students who have completed an MS with a thesis (Plan A or equivalent) in an engineering discipline are eligible to apply for admission to a PhD program. Admission will be based on the students' prior academic records and, if they are graduates of USU, the recommendations of their graduate committees. It is assumed that students are adequately prepared in mathematics and engineering design courses to compete at the PhD level. If such is not the case, a program of courses to make up the deficiency will be required.

In addition to any prescribed review courses and seminars, the minimum requirements for a PhD program include 60 credits of approved graduate courses beyond a master's degree, satisfactory completion of the comprehensive examinations after completion of the formal coursework, and the writing of a dissertation based on an original research project. The degree requirements beyond a master's degree can be met by taking courses in engineering design, synthesis, and systems; mathematics; and related science.

Research

In more than 80 years of irrigation engineering experience, USU has attained worldwide prestige through the successful professional records of its many graduates.

The department is heavily involved in overseas research and training activities concerned with managing irrigation systems, on-farm water management, and water resource development.

Research projects in several areas of irrigation and drainage engineering are currently being conducted by the department. Hence, graduate students have the opportunity to conduct research for their degree programs and obtain financial support. Current projects include hydraulics of surface irrigation, consumptive use, return flow quantity and quality of irrigation waters and application techniques, transient flow in tile drainage systems, drain envelopes, sprinkler irrigation, trickle irrigation, crop production and water requirements, salt movement, regional groundwater modeling for optimizing sustainable yield, conveyance system modeling and control, and remote sensing.

Specific research projects in the biological engineering option include tissue and biomedical engineering, biosensor design and development, microbial fermentations, environmental control of livestock buildings, the contribution of rural municipalities to nonpoint source pollution, agricultural waste management, and land-based waste treatment systems.

Land application of food processing wastes, extrusion of dairy-based foods, multi-stage anaerobic digestion of biological materials, functional properties of foods, and biological detoxification of metals are some of the topics researched in food engineering.

Financial Assistance

The large departmental research programs make it possible to offer graduate students financial support in the form of assistantships and traineeships. The financial support is mainly available to U.S. citizens with a small number of assistantships for others. The traineeships and assistantships are attached to research projects on the Logan campus and overseas. Traineeships carry tuition waivers and additional financial support.

Additional Information

Two guides are available from the department to assist students: (1) *Report, Thesis, and Dissertation Format Guidelines and Policies*, and (2) *Policies and Procedures for Graduate Study*.

Biological and Irrigation Engineering Faculty

Professors

Conly L. Hansen, food engineering

Thomas B. Hardy, natural systems

Robert W. Hill, irrigation and water resource extension

Christopher M. U. Neale, remote sensing

Richard C. Peralta, groundwater

Linda S. Powers, bioprocess engineering

Ronald C. Sims, biological process engineering

Wynn R. Walker, surface irrigation, Associate Dean of College of Engineering

Research Professors

Darwin L. Sorensen, soil microbiology

L. Humberto Yap-Salinas, drainage

Adjunct Professor

Bart C. Weimer, microbiology, Director of Center for Integrated BioSystems

Professors Emeritus

Richard E. Griffin, irrigation extension

George H. Hargreaves, crop water requirements

Jack Keller, sprinkle and drip irrigation

Howard B. Peterson, water quality

Gaylord V. Skogerboe, waterlogging and salinity

Glen E. Stringham, surface irrigation

Lyman S. Willardson, drainage

Associate Professors

Gary P. Merkley, conveyance systems

Timothy A. Taylor, bioprocessing

Research Associate Professors

Joan E. McLean, soil chemistry

Judith L. Sims, soil biology

Adjunct Associate Professor

Daryll B. DeWald, cell biology, Associate Director of Center for Integrated BioSystems

Associate Professor Emeritus

Edwin C. Olsen III, international irrigation, water management

Assistant Professors

David W. Britt, biomedical engineering

Kytai T. Nguyen, biomedical engineering

Anhong Zhou, nanobiotechnology

Research Assistant Professors

Arnulfo González-Meza, irrigation system transfer

Babukannan Kasilingam, canal hydraulics

Adjunct Research Assistant Professor

Charles D. Miller, biology

Research Assistant Professor Emeritus

R. Kern Stutler, irrigation structures

Course Descriptions

Biological and Irrigation Engineering (BIE), pages 347-349