BIological Systems Engineering, M.S.

Graduate work in the Department of Biological Systems Engineering (BSE) leads to the master of science and doctor of philosophy degrees. Graduates of the program help fill the need for highly educated engineers in industry, consulting firms, government agencies, and educational institutions.

Students who undertake graduate studies in BSE normally have as their goal a better understanding of the current theories, principles, issues, and problems in biological systems. They desire to learn how knowledge is generated, how it is critically evaluated, and how solutions to problems are generated and applied. Graduate studies improve the ability of students to think critically and creatively, and to synthesize, analyze, and integrate ideas for decision making and problem solving.

The department offers students an opportunity to undertake research and advanced study in different specializations such as biological systems, environmental quality and natural resource engineering, waste management, food and bioprocess engineering, nanotechnology and biosensing, machinery systems, bio-resources and bio-refining, and agricultural safety and health.

Graduate research assistantships, project assistantships, and fellowships are available on a highly competitive basis.

ADMISSIONS

Please consult the table below for key information about this degree program’s admissions requirements. The program may have more detailed admissions requirements, which can be found below the table or on the program’s website.

Graduate admissions is a two-step process between academic programs and the Graduate School. Applicants must meet the minimum requirements (https://grad.wisc.edu/apply/requirements/) of the Graduate School as well as the program(s). Once you have researched the graduate program(s) you are interested in, apply online (https://grad.wisc.edu/apply/).

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Deadline</td>
<td>June 1</td>
</tr>
<tr>
<td>Spring Deadline</td>
<td>August 1 for international applicants; October 1 for domestic applicants</td>
</tr>
<tr>
<td>Summer Deadline</td>
<td>March 1</td>
</tr>
<tr>
<td>GRE (Graduate Record Examinations)</td>
<td>May be required in certain cases; consult program.</td>
</tr>
<tr>
<td>English Proficiency Test</td>
<td>Every applicant whose native language is not English or whose undergraduate instruction was not in English must provide an English proficiency test score and meet the Graduate School minimum requirements (<a href="https://grad.wisc.edu/apply/requirements/#english-proficiency">https://grad.wisc.edu/apply/requirements/#english-proficiency</a>).</td>
</tr>
<tr>
<td>Other Test(s) (e.g., GMAT, MCAT)</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Letters of Recommendation Required

The department requires that students have a strong engineering background for admission to its graduate program. Most applicants have a bachelor of science degree from an ABET/EAC-accredited engineering program or an engineering undergraduate degree from an international institution. Applicants who do not have a bachelor of science degree from an ABET/EAC-accredited engineering program may be admitted with a stipulation that they complete supplemental work. Contact the department for details concerning additional requirements. Applicants are evaluated based on their academic record and educational objectives and letters of reference.

FUNDING

GRADUATE SCHOOL RESOURCES

Resources to help you afford graduate study might include assistantships, fellowships, traineeships, and financial aid. Further funding information (https://grad.wisc.edu/funding/) is available from the Graduate School. Be sure to check with your program for individual policies and restrictions related to funding.

REQUIREMENTS

MINIMUM GRADUATE SCHOOL REQUIREMENTS

Review the Graduate School minimum academic progress and degree requirements (http://guide.wisc.edu/graduate/#policiesandrequirementstext), in addition to the program requirements listed below.

MAJOR REQUIREMENTS

MODE OF INSTRUCTION

<table>
<thead>
<tr>
<th>Mode of Instruction Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerated: Accelerated programs are offered at a fast pace that condenses the time to completion. Students are able to complete a program with minimal disruptions to careers and other commitments.</td>
</tr>
<tr>
<td>Evening/Weekend: Courses meet on the UW–Madison campus only in evenings and/or on weekends to accommodate typical business schedules. Students have the advantages of face-to-face courses with the flexibility to keep work and other life commitments.</td>
</tr>
<tr>
<td>Face-to-Face: Courses typically meet during weekdays on the UW-Madison Campus.</td>
</tr>
<tr>
<td>Hybrid: These programs combine face-to-face and online learning formats. Contact the program for more specific information.</td>
</tr>
<tr>
<td>Online: These programs are offered 100% online. Some programs may require an on-campus orientation or residency experience, but the courses will be facilitated in an online format.</td>
</tr>
</tbody>
</table>
CURRICULUM REQUIREMENTS

**Requirements Detail**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>Minimum Credit Requirement</td>
<td>30</td>
</tr>
<tr>
<td>Minimum Residence Credit Requirement</td>
<td>16</td>
</tr>
<tr>
<td>Minimum Graduate Coursework Credit requirement</td>
<td>At least 50% of credits applied toward the graduate degree</td>
</tr>
</tbody>
</table>

**Overall Graduate GPA Requirement**

3.00 GPA required.

**Other Grade Requirements**

Graduate students in BSE must maintain a minimum overall B average (3.0 GPA) during their graduate studies. Seminars, research, or other special problems credits may not be used to offset BC or C grades. No grade below a C will be accepted for fulfilling course work requirements for the degree.

**Assessments and Examinations**

All students must complete a graduation checklist and be certified by the GIRC before taking their final oral examination.

**Language Requirements**

n/a

**REQUIRED COURSES**

**Thesis Track**

If your objective is to pursue a Ph.D. degree and/or research-oriented career, you are strongly encouraged to select the thesis option.

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<tbody>
<tr>
<td>Total Credits</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Letter-graded UW-Madison course credits</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>Independent study credits</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Graduate seminar credits</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Biological Systems Engineering course credits</td>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>

1. These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

2. Not including course credits taken to satisfy admission requirements.

3. At least six credits must be from coursework at the 500-level and above in science/engineering classes; can include up to six credits of science/engineering classes taken at 400-level and above as UW-Madison undergraduate.

4. For the two required graduate seminar credits, students typically take BSE 900 Seminar and BSE 901 Graduate Research Seminar.

Non-Thesis Track

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GRADUATE SCHOOL POLICIES

The Graduate School’s Academic Policies and Procedures (https://grad.wisc.edu/acadpolicy/) provide essential information regarding general university policies. Program authority to set degree policies beyond the minimum required by the Graduate School lies with the degree program faculty. Policies set by the academic degree program can be found below.

MAJOR-SPECIFIC POLICIES

PRIOR COURSEWORK

Graduate Work from Other Institutions

With approval of the Graduate Research and Instructions Committee, students are allowed to count no more than 9 credits of graduate coursework from other institutions. Coursework earned five or more years prior to admission to a master’s degree is not allowed to satisfy requirements.
**UW-Madison Undergraduate**
Students may count up to 6 credits of coursework 400-level and above from a UW-Madison undergraduate degree toward the degree. Coursework earned five or more years prior to admission to a master's degree is not allowed to satisfy requirements.

**UW-Madison University Special**
With approval of the Graduate Research and Instructions Committee, students are allowed to count no more than 9 credits of coursework numbered 300 or above taken as a UW-Madison University Special student. Coursework earned five or more years prior to admission to a master's degree is not allowed to satisfy requirements.

**PROBATION**
The Graduate School regularly reviews the record of any student who earned grades of BC, C, D, F, or Incomplete in a graduate course (300 or above), or grade of U in research credits. This review could result in academic probation with a hold on future enrollment or in being suspended from the Graduate School.

**ADVISOR / COMMITTEE**
Every graduate student is required to have an advisor. To ensure that students are making satisfactory progress toward a degree, the Graduate School expects them to meet with their advisor on a regular basis.

An advisor generally serves as the thesis advisor. In many cases, an advisor is assigned to incoming students. Students can be suspended from the Graduate School if they do not have an advisor. An advisor is a faculty member, or sometimes a committee, from the major department responsible for providing advice regarding graduate studies.

A committee often accomplishes advising for the students in the early stages of their studies.

**CREDITS PER TERM ALLOWED**
12 credits

**TIME CONSTRAINTS**
Master's degree students who have been absent for five or more consecutive years lose all credits that they have earned before their absence. Individual programs may count the coursework students completed prior to their absence for meeting program requirements; that coursework may not count toward Graduate School credit requirements.

**GRIEVANCES AND APPEALS**
These resources may be helpful in addressing your concerns:

- Bias or Hate Reporting (https://doso.students.wisc.edu/bias-or-hate-reporting/)
- Graduate Assistantship Policies and Procedures (https://hr.wisc.edu/policies/gapp/#grievance-procedure)
- Hostile and Intimidating Behavior Policies and Procedures (https://hr.wisc.edu/hib/)
  - Office of the Provost for Faculty and Staff Affairs (https://facstaff.provost.wisc.edu/)
- Dean of Students Office (https://doso.students.wisc.edu/) (for all students to seek grievance assistance and support)
- Employee Assistance (http://www.eao.wisc.edu/) (for personal counseling and workplace consultation around communication and conflict involving graduate assistants and other employees, post-doctoral students, faculty and staff)
- Employee Disability Resource Office (https://employeedisabilities.wisc.edu/) (for qualified employees or applicants with disabilities to have equal employment opportunities)
- Graduate School (https://grad.wisc.edu/) (for informal advice at any level of review and for official appeals of program/departmental or school/college grievance decisions)
- Office of Compliance (https://compliance.wisc.edu/) (for class harassment and discrimination, including sexual harassment and sexual violence)
- Office of Student Conduct and Community Standards (https://conduct.students.wisc.edu/) (for conflicts involving students)
- Ombuds Office for Faculty and Staff (http://www.ombuds.wisc.edu/) (for employed graduate students and post-docs, as well as faculty and staff)
- Title IX (https://compliance.wisc.edu/titleix/) (for concerns about discrimination)

### College of Agricultural and Life Sciences: Grievance Policy

In the College of Agricultural and Life Sciences (CALS), any student who feels unfairly treated by a member of the CALS faculty or staff has the right to complain about the treatment and to receive a prompt hearing. Some complaints may arise from misunderstandings or communication breakdowns and be easily resolved; others may require formal action. Complaints may concern any matter of perceived unfairness.

To ensure a prompt and fair hearing of any complaint, and to protect the rights of both the person complaining and the person at whom the complaint is directed, the following procedures are used in the College of Agricultural and Life Sciences. Any student, undergraduate or graduate, may use these procedures, except employees whose complaints are covered under other campus policies.

1. The student should first talk with the person at whom the complaint is directed. Most issues can be settled at this level. Others may be resolved by established departmental procedures.
2. If the student is unsatisfied, and the complaint involves any unit outside CALS, the student should seek the advice of the dean or director of that unit to determine how to proceed.
   a. If the complaint involves an academic department in CALS the student should proceed in accordance with item 3 below.
   b. If the grievance involves a unit in CALS that is not an academic department, the student should proceed in accordance with item 4 below.
3. The student should contact the department’s grievance advisor within 120 calendar days of the alleged unfair treatment. The departmental administrator can provide this person's name. The grievance advisor will attempt to resolve the problem informally within 10 working days of receiving the complaint, in discussions with the student and the person at whom the complaint is directed.
   a. If informal mediation fails, the student can submit the grievance in writing to the grievance advisor within 10 working days of the date the student is informed of the failure of the mediation attempt by the grievance advisor. The grievance advisor will provide a copy to the person at whom the grievance is directed.
   b. The grievance advisor will refer the complaint to a department committee that will obtain a written response from the person at whom the complaint is directed, providing a copy to the student. Either party may request a hearing before the committee. The grievance advisor will provide both parties a written decision...
within 20 working days from the date of receipt of the written complaint.

c. If the grievance involves the department chairperson, the grievance advisor or a member of the grievance committee, these persons may not participate in the review.

d. If not satisfied with departmental action, either party has 10 working days from the date of notification of the departmental committee action to file a written appeal to the CALS Equity and Diversity Committee. A subcommittee of this committee will make a preliminary judgement as to whether the case merits further investigation and review. If the subcommittee unanimously determines that the case does not merit further investigation and review, its decision is final. If one or more members of the subcommittee determine that the case does merit further investigation and review, the subcommittee will investigate and seek to resolve the dispute through mediation. If this mediation attempt fails, the subcommittee will bring the case to the full committee. The committee may seek additional information from the parties or hold a hearing. The committee will present a written recommendation to the dean who will provide a final decision within 20 working days of receipt of the committee recommendation.

4. If the alleged unfair treatment occurs in a CALS unit that is not an academic department, the student should, within 120 calendar days of the alleged incident, take his/her grievance directly to the Associate Dean of Academic Affairs. The dean will attempt to resolve the problem informally within 10 working days of receiving the complaint. If this mediation attempt does not succeed the student may file a written complaint with the dean who will refer it to the CALS Equity and Diversity Committee. The committee will seek a written response from the person at whom the complaint is directed, subsequently following other steps delineated in item 3d above.

OTHER

Funding decisions are made by faculty supervisors of the admitted students based on the funding availability and project need.

PROFESSIONAL DEVELOPMENT

GRADUATE SCHOOL RESOURCES

Take advantage of the Graduate School’s professional development resources (https://grad.wisc.edu/pd/) to build skills, thrive academically, and launch your career.

LEARNING OUTCOMES

1. Articulates, critiques, or elaborates the theories, research methods, and approaches to inquiry or schools of practice in the field of study.
2. Identifies sources and assembles evidence pertaining to questions or challenges in the field of study.
3. Demonstrates understanding of the primary field of study in a historical, social, or global context.
4. Selects and/or utilizes the most appropriate methodologies and practices.
5. Evaluates or synthesizes information pertaining to questions or challenges in the field of study.
6. Recognizes and applies principles of ethical and professional conduct.

PEOPLE

Professor Robert Anex
Biological systems analysis and assessment; life cycle assessment; techno-economic analysis

Professor Christopher Choi
Heat and mass transfer and computational fluid dynamics (CFD); controlled environments – livestock housing and greenhouse; water distribution system modeling and water quality; experimental methods, data acquisition, and systems optimization in biological systems

Assistant Professor Matthew Digman
Impact of autonomy on agricultural machine forms; application of sensors to predict chemical and physical properties of agricultural materials

Professor Sundaram Gunasekaran
Engineering properties and quality of food and biomaterials; rheology of food and other macromolecular systems and hydrogels; structure function relationships in foods; novel and value-added bioprocess engineering

Professor K.G. Karthikeyan
Fate, removal, and transport of nutrients and contaminants in surface/subsurface environments; water quality chemistry; land application of agricultural/municipal/industrial waste; applications of GIS/water quality models; physical and chemical processes for water, wastewater, and waste treatment; soil decontamination

Associate Professor Rebecca Larson
Biological waste; manure management; handling and treatment of agricultural and food processing waste; agricultural sustainability; land application of various waste streams, including runoff and leaching; waste-to-energy technologies, including biogas production from anaerobic digestion; composting

Assistant Professor Brian Luck
Machine management, variable rate technology; agricultural “Big Data” management; remote sensing

Professor Xuejun Pan
Biomechanics of machine milking; sustainable development of bio-energy systems; renewable energy technology and policy; biosensors for milk

Professor Douglas Reinemann
Biotechnological processes; lignocellulose and lignocellulosic biomass for bioconversion to chemicals and fuels; enzymatic and non-enzymatic saccharification of cellulose and lignocellulose; catalytic conversion of lignocellulose to drop-in hydrocarbon fuel; platform chemicals from biomass; functional materials from cellulose, lignin, hemicellulose, and extractives.
quality analysis; effects of the electrical environment on farm animals; integral thought and philosophy

**Associate Professor and Department Chair Troy Runge**

Bioenergy – biomass composition impact on bioprocessing systems, including anaerobic digestion, combustion, gasification, and catalysis; Biomaterials – pulp, paper, bio-based chemicals, cellulose composites and nonwoven structures

**Professor Kevin Shinners**

Engineering aspects of systems to cut, dry, harvest, package, store, fractionate and process biological plant material to be used as ruminant animal feed or as a biomass feedstock for production of bio-energy and bio-products; sensors and sensor systems to measure machine performance and crop material properties for Precision Farming systems as applied to hay, forage, and bio-mass crops

**Professor John Shutske**

Safety engineering and education related to occupational and public health hazards in agricultural and food systems; multidisciplinary approaches for solving complex risk-related problems; design and evaluation of sensors and control systems to mitigate environmental and machine risks; risk communication methods and limitations.

**Associate Professor Paul Stoy**

Surface-atmosphere exchange; ecosystem ecology; natural resource management

**Professor Anita Thompson**

Hydrologic implications of land use change; urban hydrology and stormwater management; water quality impacts of biofuel crop production; cold regions hydrology; hydrologic modeling; sediment, nutrient and pathogen transport; polyacrylamides and biosolids for fertilizer and erosion management

**Assistant Professor Zhou Zhang**

Multi-source remote sensing data fusion (e.g., hyperspectral, LiDAR, RGB); machine learning for high dimensional data analysis; UAV-based imaging platform developments for precision agriculture; crop yield prediction using remote sensing and machine learning; high-throughput image-based plant phenotyping.

**AFFILIATE FACULTY**

**Assistant Professor Grace Bulltail, Nelson Institute**

**Professor Mark Etzel, Dept. of Food Science**

**Professor Awad Hanna, Dept. of Civil Engineering**

**Professor Richard Hartel, Dept. of Food Engineering**

**Professor John Ralph, Dept. of Biochemistry**