Biological and Agricultural Engineering (BAEG)

Faculty
Thomas A. Costello, Associate Professor
Brian Edward Haggard, Professor
Christopher Garrett Henry, Assistant Professor
Jin-Woo Kim, Professor
Yanbin Li, Distinguished Professor, Tyson Endowed Chair in Biosensing Engineering
Yi Liang, Associate Professor
Otto J. Loewer Jr., Professor
Ranjitsinh Mane, Research Program Associate
Marty D. Matlock, Professor
G. Scott Osborn, Associate Professor
Benjamin R.K. Runkle, Assistant Professor
Sammy Sadaka, Assistant Professor
Bailey A. Sullivan, Instructor
Karl VanDevender, Professor
Lalit R. Verma, Professor
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Biological and Agricultural Engineering Website

Degrees Conferred:
M.S.B.E. (BENG) in Biological Engineering
M.S.En.E. (ENEG) in Environmental Engineering, in collaboration with Civil Engineering (See Environmental Engineering (http://catalog.uark.edu/graduatecatalog/programsofstudy/environmentalengineeringeng))
Ph.D. (BENG) in Engineering (See Engineering (http://catalog.uark.edu/graduatecatalog/programsofstudy/engineeringcollegeofengr))

Biological Engineering (BENG) (M.S.B.E.)
Primary Areas of Faculty Research:
The biological and agricultural engineering program is unique in that it is linked administratively to the College of Engineering and the Division of Agriculture. At present, the department is experiencing growth in teaching, research and service. In particular, departmental research continues to strengthen and expand in its two broad areas of concentration:

Biotechnology Engineering – biotechnology at the micro- and nano-scale, food processing, food safety and security, bio-energy, developing new products from biomaterials, biotransformation to synthesize industrial and pharmaceutical products, bioinstrumentation, bio-nano interfacing and molecular self-assembly, bio-nano plasmonics, and bio-nano sensing.

Ecological Engineering – Integrates ecological principles into the design of sustainable systems to treat, remediate, and prevent pollution to the environment. Applications include mathematical modeling of watershed process, stream restoration, watershed management, water and wastewater treatment design, ecological services management, urban greenway design and enclosed ecosystem design.

Admission to the Degree Program: Admission to the Biological Engineering graduate program is a three-step process. First, the prospective student must be admitted to graduate standing by the University of Arkansas Graduate School. Second, the student must be accepted into the department’s program, which depends on transcripts, recommendations, a statement of purpose, and the following additional requirements:

Students with an ABET-accredited or equivalent Engineering Degree
• Students to an M.S. program from a B.S. degree in engineering or to a Ph.D. program from a B.S. degree in engineering and an M.S. degree:
  1. A score of 301 or above (verbal and quantitative) on the Graduate Record Examination (GRE) (http://www.gre.org/ed).
  2. A TOEFL (http://test.uark.edu/toefl-ibt) score of at least 550 (paper-based) or 213 (computer-based) or 80 (Internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
  3. GPA of 3.00 or higher on the last 60 hours of a B.S. degree or B.S. and/or M.S. degrees.
  4. B.S. degree in engineering from an ABET accredited program or equivalent.

• Students to a Ph.D. program directly from a B.S. degree in engineering:
  1. A score of 307 or above (verbal and quantitative) on the GRE.
  2. A TOEFL (http://test.uark.edu/toefl-ibt) score of at least 550 (paper-based) or 213 (computer-based) or 80 (Internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
  3. A cumulative GPA of 3.5 or above for undergraduate work.
  4. B.S. degree in engineering from an ABET accredited program or equivalent.

Students without an Engineering Degree
• Students to an M.S. program from a non-engineering B.S. degree:
  1. A score of 301 or above (verbal and quantitative) on the GRE.
  2. A TOEFL (http://test.uark.edu/toefl-ibt) score of at least 550 (paper-based) or 213 (computer-based) or 80 (Internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
  3. GPA of 3.00 or higher on the last 60 hours of a BS degree.
  4. Completion of 18 hours of engineering course work.

• Students to a Ph.D. program from non-engineering B.S. plus M.S. degrees:
1. A score of 301 or above (verbal and quantitative) on the GRE.
2. A TOEFL (http://test.uark.edu/toefl-ibt) score of at least 550 (paper-based) or 213 (computer-based) or 80 (Internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor’s or Master’s degree from a U.S. institution.
3. GPA of 3.00 or higher on the last 60 hours of B.S. and/or M.S. degrees.
4. Completion of 18 hours of engineering course work.

- Students to a Ph.D. program directly from a non-engineering B.S. degree:
  1. A score of 307 or above (verbal and quantitative) with 155 (quantitative) and 4.5 or above in writing on the GRE.
  2. A TOEFL (http://test.uark.edu/toefl-ibt) score of at least 580 (paper-based) or 237 (computer-based) or 92 (Internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor’s or Master’s degree from a U.S. institution.
  3. A cumulative GPA of 3.5 or above for undergraduate work.
  4. Completion of 18 hours of engineering course work.

Finally, a member of the faculty who is eligible (graduate status of group II or higher) must agree to serve as the major adviser to the prospective student.

Detailed requirements are in the Biological and Agricultural Engineering Department Graduate Student Handbook, available at baeg.uark.edu.

Requirements for the Master of Science Degree: (Minimum 30 hours)
In addition to the requirements of the Graduate School and the graduate faculty in Engineering, the following departmental requirements must be satisfied for the M.S.B.E. degree:

1. Candidates are required to complete not less than 24 semester hours of course work acceptable to the committee and a minimum of six semester hours of thesis.
2. Earn a minimum cumulative grade-point average of 3.0 on all graduate courses attempted. The minimum acceptable grade on a graduate course is "C."
3. Prior to acceptance into the program a candidate must, in consultation with the department head, identify a professor who is willing to serve as the major professor. During the first semester, the candidate must, in consultation with the major professor and department head, select a graduate committee. The candidate will, in consultation with the committee, prepare a written graduate program of study that will achieve the candidate’s objectives.
4. Satisfactorily pass a final oral examination and complete and submit a thesis.
5. Candidates must prepare a paper suitable for submission to a refereed journal from research done for a thesis.

Detailed requirements are in the Biological and Agricultural Engineering Department Graduate Student Handbook, available at Graduate Handbook. (http://bio-ag-engineering.uark.edu/Academic/Graduate_Program)

Students should also be aware of Graduate School requirements with regard to master's degrees (http://catalog.uark.edu/graduatemastersdegree/graduatemastersdegree).

Requirements for the Doctor of Philosophy Degree: (Minimum 78 hours)
In addition to the requirements of the Graduate School, the department follows the College of Engineering’s requirements with an additional requirement:

1. All students must complete a minimum of 78 semester hours of graduate-level credit beyond the engineering bachelor’s degree, including a minimum of 48 semester hours of course work and a minimum of 30 semester hours of dissertation research credits.
2. A minimum of 30 semester hours of course work must be at the graduate level (5000 or above).
3. Upon recommendation of the student’s advisory committee, a student who has entered the Ph.D. program after a master’s degree in engineering may receive credit for up to 30 semester hours. If the 30 hours includes master’s thesis research, the advisory committee may credit up to 6 hours of thesis research toward the minimum dissertation research requirement.
4. Complete a minimum of nine semester credit hours of coursework in a set of coherent courses in a related subject area approved by the student’s advisory committee.
5. Earn a minimum cumulative grade-point average of 3.0 on all graduate courses attempted. The minimum acceptable grade on a graduate course is "C."
6. Satisfactorily pass a preliminary examination (Note that the Engineering College defines this examination as a qualifying examination). The purpose of the preliminary exam is to measure a candidate’s core competency and depth in a narrowly focused area of specialization sufficient to understand and advance the current state-of-the-art research. After completing the Ph.D. course requirements and at least six months before completing the Ph.D. proposal defense requirement, the prospective candidate must take the preliminary examination. Preliminary exam will be given by the student’s advisory committee. Students may retake a failed preliminary exam once, contingent upon approval of the student’s advisory committee. A student who fails the preliminary examination twice will be terminated from the program.
7. Satisfactorily pass a Ph.D. proposal defense. The purpose of the dissertation proposal defense is to assure that the candidate’s plans of researching their proposed dissertation research questions are complete and holds academic and scientific merits. All Ph.D. students are required to present a written and an oral proposal to their advisory committee for the purpose of defining their research program at least 6 months after completing the Ph.D. preliminary examination, and at least one year before completing all other requirements. Students may retake a failed proposal defense once, contingent upon approval of the student’s advisory committee. A student who fails the proposal defense twice will be terminated from the program.
8. Satisfactorily pass a final comprehensive oral examination and complete and submit a dissertation.

Detailed requirements are in the Biological and Agricultural Engineering Department Graduate Student Handbook, available at bio-ag-engineering.uark.edu.

Students should also be aware of Graduate School requirements with regard to doctoral degrees (http://catalog.uark.edu/graduatedoctoral/doctoralrequirements/#graduatedoctoraldregretext).
Courses

**BENG 4123. Biosensors & Bioinstrumentation (Odd years, Sp). 3 Hours.**
Principles of biologically based sensing elements and interfacing techniques. Design and analysis methods of biosensing and transducing components in biotechnology. Applications of biosensors and bioinstrumentation in bioprocessing, bioenvironmental, biomechanical and biomedical engineering. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: BIOL 2033 or BIOL 2553 and BENG 3113.

**BENG 452V. Special Topics in Biological Engineering (Irregular). 1-6 Hour.**
Special topics in biological engineering not covered in other courses. Prerequisite: Engineering student. May be repeated for up to 8 hours of degree credit.

**BENG 500V. Advanced Topics in Biological Engineering (Irregular). 1-6 Hour.**
Special problems in fundamental and applied research. Prerequisite: Graduate standing. May be repeated for up to 6 hours of degree credit.

**BENG 5103. Advanced Instrumentation in Biological Engineering (Even years, Sp). 3 Hours.**
Applications of advanced instrumentation in biological systems. Emphasis on updated sensing and transducing technologies, data acquisition and analytical instruments. Lecture 2 hours, lab 3 hours per week. Corequisite: Lab component. Prerequisite: BENG 3113.

**BENG 5253. Bio-Mems (Irregular). 3 Hours.**
Topics include the fundamental principles of microfluidics, Navier-Stokes Equation, bio/abio interfacing technology, bio/abio hybrid integration of microfabrication technology, and various biomedical and biological problems that can be addressed with microfabrication technology and the engineering challenges associated with it. Lecture 3 hour per week. Prerequisite: MEEG 3503 or CVEG 3213 or CHEG 2133. This course is cross-listed with MEEG 5253.

**BENG 5303. Fundamentals of Biomass Conversion (Fa). 3 Hours.**
Web-based overview of the technology involved in the conversion of biomass to energy, including associated sustainability issues. Overview of biomass structure and chemical composition; biochemical and thermochemical conversion platforms; issues, such as energy crop production related to water consumption and soil conservation. Further topics include: biomass chemistry, logistics and resources; biological processes; and thermochemical processes. Two web-based lectures/meetings per week. Prerequisite: Graduate standing or instructor consent.

**BENG 5313. Fundamentals of Bioprocessing (Sp). 3 Hours.**
This course covers the fundamentals of mass and energy balances, fluid dynamics, heat and mass transfer, as applied to Bioprocessing. The microbial growth, kinetics and fermenter operation as applicable to Bioprocessing will be covered in this course. Industrial Bioprocessing case studies that involve the integration of the course contents will be discussed. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: MATH 2554, CHEM 3813, and PHYS 2054.

**BENG 5323. Bioseparations (Even years, Sp). 3 Hours.**
Study of separations important in food and biochemical engineering such as leaching, extraction, expression, absorption, ion exchange, filtration, centrifugation, membrane separation, and chromatographic separations. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent.

**BENG 5333. Biochemical Engineering (Odd years, Sp). 3 Hours.**
The analysis and design of biochemical processing systems with emphasis on fermentation kinetics, continuous fermentations, aeration, agitation, scale up, sterilization, and control. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent Required.

**BENG 5343. Advanced Biomass Thermochemical Conversion (Odd years, Fa). 3 Hours.**
Advanced study, evaluation, and application of thermochemical conversion pathways in biofuel production. Specific topics include biomass gasification, pyrolysis, liquefaction, and heterogeneous catalysts. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent.

**BENG 5351. Sustainability Seminar (Su). 1 Hour.**
Topics in environmental sustainability, green engineering, life cycle analysis, sustainable development and sustainability science. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: CHEM 1123.

**BENG 5613. Simulation Modeling of Biological Systems (Irregular). 3 Hours.**
Application of computer modeling and simulation of discrete-event and continuous-time systems to solve biological and agricultural engineering problems. Philosophy and ethics of representing complex processes in simplified form. Deterministic and stochastic modeling of complex systems, algorithm development, application limits, and simulation interpretation. Emphasis on calibration, validation and testing of biological systems models for the purposes of system optimization, resource allocation, real-time control and/or conceptual understanding. Prerequisite: ((AGST 4023 or AGST 5023 (formerly AGST 4023) or STAT 4003 or INEG 2313.

**BENG 5623. Life Cycle Assessment (Sp). 3 Hours.**
This course will examine the process and methodologies associated with life cycle analysis (LCA). The course will explore the quantitatively rigorous methodology for life cycle inventory (LCI), LCA and life cycle impact assessment (LCIA). This course is offered on-line. The principal instructor will be a UA faculty member.

**BENG 5633. Linkages Among Technology, Economics and Societal Values (Sp, Fa). 3 Hours.**
Addresses how macro-level change is influenced by the linkages among technology, economics and societal values. Three major course initiatives: 1) Developing a conceptual model for understanding how macro-level change has occurred over history; 2) Examining recorded history in order to develop a contextual appreciation for Society's current situation; and 3) Using statistical data to identify six overriding world trends that are likely to greatly impact society's goal of achieving sustainable prosperity and well-being in the foreseeable future. Prerequisite: Graduate standing or instructor permission.
This course is cross-listed with OMGT 5633.

**BENG 5703. Design and Analysis of Experiments for Engineering Research (Irregular). 3 Hours.**
Principles of planning and design of experiments for engineering research. Propagation of experimental error. Improving precision of experiments. Analysis of experimental data for optimal design and control of engineering systems using computer techniques. Students must have an introductory background in statistics. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component.

**BENG 5733. Advanced Biotechnology Engineering (Odd years, Fa). 3 Hours.**
Applications of the principles of bioprocess/biochemical engineering to microbiological and biomedical problems. Topics include applied enzymology, metabolic engineering, molecular genetics and control, and bioinformatics and nanobiotechnology in addition to classical applied enzyme and cell-growth kinetics and advanced bioreactor design. Prerequisite: BENG 3733 or BENG 4703 or BENG 5743 or equivalent.
BENG 5743. Biotechnology Engineering (Fa). 3 Hours.
Introduction to biotechnology topics ranging from principles of microbial growth, mass balances, bioprocess engineering as well as emerging principles in the design of biologically based microbial and enzymatic production systems. Application areas such as biofuels, and fine and bulk chemical production. Lecture 2 hours, laboratory 3 hours per week. Students may not earn credit for both BENG 5743 and BENG 4703. Prerequisite: Graduate standing. Corequisite: Lab component.

BENG 5801. Graduate Seminar (Sp). 1 Hour.
Reports presented by graduate students on topics dealing with current research in biological engineering. Prerequisite: Graduate standing.

BENG 5923. Nonpoint Source Pollution Control and Modeling (Irregular). 3 Hours.
Control of hydrologic, meteorologic, and land use factors on nonpoint source (NPS) pollution in urban and agricultural watersheds. Discussion of water quality models to develop NPS pollution control plans and total maximum daily loads (TMDLs), with consideration of model calibration, validation, and uncertainty analysis. Prerequisite: CVEG 3223.

BENG 5933. Environmental and Ecological Risk Assessment (Sp). 3 Hours.

BENG 5953. Ecological Engineering Design (Fa). 3 Hours.
Design of low impact development techniques to enhance ecological services, reduce peak runoff, and capture sediments, nutrients and other pollutants resulting from urban development. Techniques may include: bio-swales, retention basins, filter strips. Design of sustainable ecological processes for the treatment and utilization of wastes/residues. Techniques may include: direct land application to soils/crops, composting systems, lagoons and constructed wetlands. Design goals include optimization of ecological services to maintain designated uses of land, water and air; including enhancement of habitat for wildlife and recreation, and the discovery of economically viable methods for co-existence of urban and agricultural land uses. Lecture 3 hours per week. Students may not earn credit for both BENG 5953 and BENG 4923.

BENG 600V. Master's Thesis (Sp, Su, Fa). 1-6 Hour.
Graduate standing required for enrollment. May be repeated for degree credit.

BENG 700V. Doctoral Dissertation (Sp, Su, Fa). 1-18 Hour.
Candidacy is required for enrollment. May be repeated for degree credit.