Biological and Agricultural Engineering (BAEG)

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Biological and Agricultural Engineering Website (http://bio-ag-engineering.uark.edu/)

Degrees Conferred:
M.S.B.E. (BENGMS) in Biological Engineering
Ph.D. (BENGPH) in Engineering

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:

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.

M.S.B.E. in Biological Engineering

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 on the basis of academic transcripts, three letters of recommendation, a statement of purpose, a resume, and standardized test scores. Students with a non-engineering degree or a non-ABET accredited engineering degree must complete the minimum deficiency coursework for non-engineering majors. A general summary of admission requirements is given below:

1. B.S. degree in engineering from an ABET accredited program or equivalent.
2. GPA of 3.00 or higher on the last 60 hours of a B.S. degree.
3. Competitive scores of the Graduate Record Examination (GRE) (http://www.gre.org/ed).
4. Students whose first language is not English must demonstrate English-language proficiency as required by the Graduate School. Find out more about English-language proficiency (https://international-admissions.uark.edu/graduate-studies/english-proficiency.php).

Finally, a member of the faculty who is eligible (graduate status of group III 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 bio-ag-engineering.uark.edu (https://bio-ag-engineering.uark.edu/).

Requirements for the Master of Science Degree: (Minimum 30 hours) Both thesis and non-thesis options are available for the M.S.B.E. degree. In general, pursuing the thesis option is supported by research or teaching assistantships and conducting research under the guidance of a major advisor. Students pursuing the non-thesis options are typically not sponsored. For either option, all coursework must be approved by the student's program advisory committee. Students with a non-engineering degree or a non-ABET accredited engineering degree must complete the minimum deficiency coursework for non-engineering majors (see below). A general summary of degree requirements is given below. Detailed requirements may be obtained from the Biological and Agricultural Engineering Department Graduate Student Handbook, available at bio-ag-engineering.uark.edu (https://bio-ag-engineering.uark.edu/). Students should also be aware of Graduate School requirements with regard to M.S. degree (catalog.uark.edu (http://catalog.uark.edu/graduatecatalog/degreerequirements/#mastersdegreestext)).

- **M.S.B.E. Thesis Option:** A minimum of 24 hours of acceptable course credit is required beyond the B.S. Degree plus 6 semester hours of BENG 6000V Master's Thesis. Except for those enrolled in the accelerated M.S.B.E. program, courses taken prior to acceptance for graduate study cannot be used to meet this requirement. The following describes the general requirement of M.S.B.E. Thesis Option:

1. Complete not less than 24 semester hours of coursework and a minimum of 6 semester hours of thesis (BENG 6000V). Of the 24 hours required for the M.S. degree, no more than 12 semester hours of coursework presented for the MS degree can be at the 4000 level. All 4000-level courses used toward the M.S. degree must be approved by the Graduate School. All students should meet the following requirements:
   a. At least one advanced mathematics or statistics course.
   b. 1 hour of BENG 58001 Graduate Seminar.
   c. At least 9 hours of formal coursework at the 5000 level or higher (excluding Thesis and Seminar) in Biological Engineering (BENG). This course work will need to include two of the three following courses: BENG 51003 Advanced Instrumentation in Biological Engineering, BENG 56103 Simulation Modeling of Biological Systems, and BENG 57003 Design and Analysis of Experiments for Engineering Research.
   d. At least 6 hours of BENG 6000V Master's 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. Select, in consultation with the major advisor, Program Advisory Committee and prepare, in consultation with the committee, a written Program of Study within the first semester.
4. Satisfactorily pass a written thesis research proposal at least one semester before completing all other requirements.
5. Satisfactorily pass a final oral examination and complete and submit a thesis.
6. Prepare a paper suitable for submission as a refereed article from research done for a thesis. It is not required that the paper be submitted for publication, but it must be prepared and approved by the major professor.
7. Complete Exit Review.

- **M.S.B.E. Non-thesis Option:** A minimum of 30 hours of acceptable course credit is required beyond the B.S. Degree and should include 3 semester hours of technical project and report. Except for those enrolled in the accelerated M.S.B.E. program, courses taken prior to acceptance for graduate study cannot be used to meet this requirement.

1. Complete not less than 30 semester hours of coursework acceptable to the committee that includes 3 semester hours of technical project and report (BENG 5000V). No more than 12 semester hours of coursework presented for the MS degree can be at the 4000 level. All 4000-level courses used toward the M.S. degree must be approved by the Graduate School. All students should meet the following requirements:
   a. At least one advanced mathematics or statistics course.
   b. 1 hour of BENG 58001 Graduate Seminar.
   c. At least 9 hours of formal coursework at the 5000 level or higher (excluding Technical Project and Report, and Seminar) in Biological Engineering (BENG). This coursework will need to include two of the three following courses: BENG 51003 Advanced Instrumentation in Biological Engineering, BENG 56103 Simulation Modeling of Biological Systems, and BENG 57003 Design and Analysis of Experiments for Engineering Research.
   d. At least 3 hours of BENG 5000V Advanced Topics in Biological Engineering.
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. Complete Exit Review.

Deficiency Course Requirement for Students with non-Engineering Degree: Prior to completing the above-listed M.S. degree requirements, students admitted to the M.S.B.E. program without an ABET-accredited or equivalent engineering degree must demonstrate engineering competence by passing 18 hours of the following deficiency engineering course work. The deficiency coursework does not count toward the course requirements of the M.S.B.E. degree. The required deficiency courses are:

1. A minimum of 15 credit hours of 2000 level or above of engineering courses (with course prefix BENG, BMEG, CHEG, CVEG, CENG, ELEG, INEG, or MEEG) currently allowed for credit within the BENG undergraduate program.
2. Minimum of 3 credit hours of one of the following BENG courses: BENG 36503 Global Bio-Energy Engineering, BENG 47403 Food and Bio-Product Systems Engineering, BENG 49303 Sustainable Watershed Engineering, or BENG 46603 Sustainable Biosystems Designs.

Specific deficiency courses are to be determined in consultation with the student’s major advisor and advisory committee. Please note that courses in addition to those listed above may be required for students without required prerequisites for the deficiency courses (such as life sciences and/or math/physics/chemistry prerequisite courses).

Accelerated M.S.B.E. Degree

High-achieving undergraduate students seeking a Bachelor of Science degree in biological engineering (B.S.B.E.) at the University of Arkansas, who choose to pursue graduate studies in biological engineering (BENG), may participate in the accelerated Master of Science program in BENG (M.S.B.E.). Eligible B.S.B.E. students can count up to 12 credit hours of BENG or science elective courses towards their M.S.B.E. degree. The 12 credit hours must be from the courses that satisfy the M.S.B.E. degree requirements and must be taken during the final 12-month period of their undergraduate degree on the Fayetteville campus of the University of Arkansas. They may include a maximum of 6 hours of 4000-level courses, but the remaining hours must be that of 5000-level courses. All 4000-level courses used toward the M.S. degree must be approved by the Graduate School.

The degree requirements of the accelerated M.S.B.E. program are identical to those of the M.S.B.E. program (thesis and non-thesis options). Students must complete either at least 24 hours of coursework and at least 6 hours of BENG 6000V Master's Thesis (thesis option) or at least 27 hours of coursework and at least 3 hours of BENG 5000V Advanced Topics in Biological Engineering (non-thesis option). The coursework hours (24 or 27 hours) include up to 12 hours transferred from the B.S.B.E. degree.

Biological engineering undergraduate students interested in the accelerated M.S.B.E. degree should apply to the program prior to starting the second-to-last semester of their undergraduate program. To be eligible, students must have a 3.5 cumulative GPA or higher, and submit the normal application materials required by the graduate school for the M.S.B.E. degree program. For students that have a cumulative GPA of 3.5 or higher, the submission of GRE score is waived.

Detailed requirements may be obtained from the Biological and Agricultural Engineering Department Graduate Student Handbook, available at bio-ag-engineering.uark.edu. (http://bio-ag-engineering.uark.edu/Academic/Graduate_Program/BAEG_Graduate_Handbook_May_2017BAEG.pdf) Students should also be aware of Graduate School requirements with regard to M.S. degrees (catalog.uark.edu (http://catalog.uark.edu/graduatecatalog/degreerequirements/#mastersdegreestext)).

Ph.D. in Engineering

Admission to 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 on the basis of academic transcripts, three letters of recommendation, a statement of purpose, a resume, and standardized test scores. Finally, a member of the faculty who is eligible (graduate faculty status of group I) must agree to serve as the major advisor to the prospective student. Students holding either engineering or non-engineering degrees are eligible to apply. Eligibility criteria are as follow:

- Engineering academic background: Students with a B.S. or M.S. degree in engineering or engineering equivalent are eligible to apply for the Ph.D. program.
- Non-engineering academic background: Students with a non-engineering background may be admitted into the Ph.D. program; however, must complete the minimum deficiency coursework for non-engineering majors.

An explanation of admission requirements and procedures can be found in the Biological and Agricultural Engineering Department Graduate Student Handbook, available at bio-ag-engineering.uark.edu (https://bio-ag-engineering.uark.edu/).

Degree Requirements for the Doctor of Philosophy in Engineering with a Concentration in Biological Engineering: (Minimum 78 hours). Degree requirements are given below, however, explanation of requirements and procedures may be obtained from the Biological and Agricultural Engineering Department Graduate Student Handbook, available at bio-ag-engineering.uark.edu (https://bio-ag-engineering.uark.edu/). Students should also be aware of Graduate School requirements with regard to doctoral degrees (catalog.uark.edu (https://catalog.uark.edu/graduatecatalog/degreerequirements/#phdandedddegreestext)).

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 coursework and a minimum of 30 semester hours of dissertation research credits.
   a. **Students entering directly with a B.S. degree**: Of the 78 hours required for the Ph.D. degree, up to 12 semester hours of 4000-level courses may be taken for graduate credit in the first 30 semester hours of coursework. The remaining credits (minimum of 66 semester hours, 36 semester hours of coursework and 30 semester hours of dissertation) must be at the 5000 level or above.
   b. **Students entering with a master's degree**: Upon recommendation of the student's advisory committee, a student who has entered the Ph.D. program after a master's degree may receive credit for up to 30 semester hours toward the required 78 credit 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. All subsequent coursework presented for the Ph.D. degree must be at the 5000 level or above.
   c. **Students with a non-engineering B.S. and/or M.S. degrees**: In addition to the requirements in 1 or 2 above, students must complete 18 hours of deficiency engineering coursework to demonstrate engineering competence.
2. 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.
3. 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."
4. Satisfactorily pass a preliminary examination (Note that the Engineering College defines this examination as a qualifying examination). After completing the course requirements, the prospective candidate must take the preliminary examination. 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.
5. Satisfactorily pass a proposal defense. The prospective candidate must present the dissertation research proposal to the advisory committee after completing the 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.
6. Satisfactorily pass a final comprehensive oral examination and complete and submit a dissertation.
7. Candidates must prepare a paper suitable for submission to a refereed journal from research done for a dissertation.
8. Complete Exit Review.

Deficiency Course Requirement for Students with non-Engineering Degree: Prior to completing the above-listed Ph.D. degree requirements, students admitted to the Ph.D. program without an ABET-accredited or equivalent engineering B.S. and/or M.S. degrees must demonstrate engineering competence by passing 18 hours of the following deficiency engineering coursework. The deficiency course work does not count toward the course requirements of the Ph.D. degree. The required deficiency courses are:

1. A minimum of 15 credit hours of 2000 level or above of engineering courses (with course prefix BENG, BMEG, CHEG, CVEG, CENG, ELEG, INEG, or MEEG) currently allowed for credit within the BENG undergraduate program.
2. Minimum of 3 credit hours of one of the following BENG courses: BENG 36503 Global Bio-Energy Engineering, BENG 47403 Food and Bio-Product Systems Engineering, BENG 49303 Sustainable Watershed Engineering, and BENG 46603 Sustainable Biosystems Designs.

Specific deficiency courses are to be determined in consultation with the student's major advisor and advisory committee. Note that courses in addition to those listed above may be required for students without required prerequisites for the deficiency courses (such as life sciences and/or math/physics/chemistry prerequisite courses).

Detailed requirements may be obtained from the Biological and Agricultural Engineering Department Graduate Student Handbook, available at bio-ag-engineering.uark.edu (http://baeg.uark.edu/). Students should also be aware of Graduate School requirements with regard to doctoral degrees (catalog.uark.edu (https://catalog.uark.edu/graduatecatalog/degreerequirements/#phdandedddegreestext)).

Graduate Faculty

Costello, Thomas A., Ph.D. (Louisiana State University), M.S.Ag.E., B.S.Ag.E. (University of Missouri-Columbia), Associate Professor, 1986, 1992.
Haggard, Brian Edward, Ph.D. (Oklahoma State University), M.S. (University of Arkansas), B.S. (Missouri University of Science and Technology), Professor, 2006, 2011.
Henry, Christopher Garrett, Ph.D. (University of Nebraska-Lincoln), M.S., B.S. (Kansas State University), Associate Professor, 2011, 2018.
Kim, Jin-Woo, Ph.D. (Texas A&M University), M.S. (University of Wisconsin-La Crosse), B.S. (University of Iowa), Professor, 2001, 2011.
Koparan, Cengiz, Ph.D., M.S. (Clemson University), M.B.M. (Cambridge College), B.S. (Ankara University), Assistant Professor, 2023.
Li, Yanbin, Ph.D. (Pennsylvania State University), M.S. (University of Nebraska-Lincoln), B.S. (Shenyang Agricultural University), Distinguished Professor, Tyson Endowed Chair in Biosensing Engineering, 1989, 2003.

Liang, Yi, Ph.D. (University of Alberta, Canada), M.S., B.S. (China Agricultural University, Beijing, China), Associate Professor, 2007, 2014.
Matlock, Marty D., Ph.D., M.S., B.S. (Oklahoma State University), Professor, 2001, 2009.
Osborn, G. Scott, Ph.D. (North Carolina State University), M.S., Ag.E., B.S. (University of Kentucky), Associate Professor, 2001, 2007.
Runkle, Benjamin R.K., Ph.D., M.S. (University of California–Berkeley), B.S. (Princeton University), Assistant Professor, 2014.
Ubeyitogullari, Ali, Ph.D. (University of Nebraska-Lincoln), M.S., B.S. (Middle East Technical University, Turkey), Assistant Professor, 2021.
VanDevender, Karl, Ph.D. (University of Arkansas), M.S., B.S. (Mississippi State University), Professor, 1995, 2004.
Verma, Lalit R., Ph.D. (University of Nebraska-Lincoln), M.S. (University of Montana), B. Tech. (J.N. Agricultural University, Jabalpub, India), Professor, 2000.
Wang, Dongyi, Ph.D. (University of Maryland), B.S. (Fundan University, Shanghai, China), Assistant Professor, 2021.
Zhu, Jun, Ph.D. (University of Illinois at Urbana-Champaign), M.S., B.S. (Zhejiang University, Hangzhou, China), Professor, 2013.

Courses

BENG 5000V. Advanced Topics in Biological Engineering. 1-6 Hour.
Special problems in fundamental and applied research. Prerequisite: Graduate standing. (Typically offered: Irregular) May be repeated for up to 6 hours of degree credit.

BENG 51003. Advanced Instrumentation in Biological Engineering. 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 31103. (Typically offered: Spring Even Years)

BENG 52503. Bio-Mems. 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 35003 or CVEG 32103 or CHEG 21303. (Typically offered: Irregular)
This course is cross-listed with MEEG 52503.

BENG 56103. Simulation Modeling of Biological Systems. 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 50203 or (STAT 30043 or STAT 50133) or INEG 23104. (Typically offered: Irregular)

BENG 56203. Life Cycle Assessment. 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. (Typically offered: Spring)

BENG 56303. Linkages Among Technology, Economics and Societal Values. 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. (Typically offered: Fall and Spring)

BENG 57003. Design and Analysis of Experiments for Engineering Research. 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. (Typically offered: Irregular)

BENG 58001. Graduate Seminar. 1 Hour.
Reports presented by graduate students on topics dealing with current research in biological engineering. Prerequisite: Graduate standing. (Typically offered: Spring)

BENG 59203. Nonpoint Source Pollution Control and Modeling. 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 32203. (Typically offered: Irregular)

BENG 59303. Environmental and Ecological Risk Assessment. 3 Hours.
Process and methodologies associated with human-environmental and ecological risk assessments. Environmental risk assessments based on human receptors as endpoints, addressing predominantly abiotic processes. Ecological risk assessments based on non-human receptors as endpoints. Approach using hazard definition, effects assessment, risk estimation, and risk management. Application of methods to student projects to gain experience in defining and quantifying uncertainty associated with human perturbation, management and restoration of environmental and ecological processes. (Typically offered: Spring)

BENG 59603. Modeling Environmental Biophysics. 3 Hours.
Interactions between the biosphere and the atmosphere. Connecting the physical environment of solar energy, wind, soil, and hydrology to the biosphere through plant ecophysiology. Boundary layer meteorology, photosynthesis and boundary layer modeling strategies, and the soil-plant-atmosphere continuum. Instrumentation, measurement and modeling strategies for understanding leaf-, landscape- and regional behaviors; and, the transfer, kinetics, and balance of momentum, energy, water vapor, CO2, and other atmospheric trace gases between the landscape (vegetation and soil) and the atmosphere. Applications in sustainable agriculture, irrigation, land and water resources, and modeling plant water use and carbon uptake strategies. A working knowledge of calculus and a discipline related to the course is expected. Three hours of lecture per week. Students may not earn degree credit for both BENG 49603 and BENG 59603. Prerequisite: Instructor consent. (Typically offered: Spring Even Years)

BENG 59703. Advanced Practice in Water Quality Monitoring and Analysis. 3 Hours.
Application of water quality principles to a real world problem. Team project experience leading and developing quality assurance project plans, designing monitoring systems, selecting chemical analysis methods, estimating loads, performing trend analysis, basic model calibration and validation, team management, and technical report writing and oral presentations. Working with various clientele to analyze water quality data in the context of evaluating real-world problems and issues. Three hours of lecture per week. Prerequisite: Graduate standing. (Typically offered: Spring Odd Years)

BENG 6000V. Master's Thesis. 1-6 Hour.
Graduate standing required for enrollment. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

BENG 7000V. Doctoral Dissertation. 1-18 Hour.
Candidacy is required for enrollment. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.