**LETTER OF NOTIFICATION – 3**

NEW OPTION, EMPHASIS, CONCENTRATION, or MINOR

(Maximum 21 semester credit hours of theory courses and 6 credit hours of practicum courses)

1. Institution submitting request.

University of Arkansas Fayetteville

1. Contact person/title.

Dr. Terry Martin, Vice Provost for Academic Affairs

1. Phone number/e-mail address.

(479) 575-2151/tmartin@uark.edu

1. Proposed effective date: Fall 2019
2. Title of existing degree program.

Bachelor of Science in Biological Engineering

1. CIP Code: 14.4501
2. Degree Code: 3505
3. Proposed name of new option/concentration/emphasis/minor.

Environmental Concentration

1. Reason for proposed action.

The issue of sustainability has been at the forefront of discussions in higher education in recent years. Certainly, sustainability has many facets ranging from public policy to improvements in technological efficiency and effectiveness. And, it is in the area of technology education that the UA College of Engineering is uniquely positioned in Arkansas to more fully embrace and support sustainability of the natural environment. Fortunately, many if not most of its departments have some aspect of environmental expertise within their programs. What is needed is at least one UA engineering department who wishes to shape its electives in a manner that offers credible, somewhat unique, and visible expertise related to sustainability of the natural environment while at the same time welcoming other like-minded engineering departments to do the same. Accordingly, the Biological and Agricultural Engineering (BAEG) Department is requesting that it be allowed to have an Environmental Concentration as part of its Biological Engineering (BENG) undergraduate program.

Any engineering department wishing to offer an Environmental Concentration will likely need to (a) to have a critical mass of credible environmentally-related courses within its disciplinary offerings; (b) be able to shape its individual offering of an Environmental Concentration by drawing upon complementary courses offered by other departments both inside and out of the UA College of Engineering; and (c) offer graduates with this concentration credible expertise that is both sought by employers and provided by the UA College of Engineering. BAEG easily satisfies all three conditions via the following:

* The BENG undergraduate program (and the agricultural engineering program that preceded it) has a long and distinguished history in areas related to sustainability such as irrigation, water quality and quantity, animal housing, animal waste management, soil erosion and crop preservation.
* The current BENG undergraduate program prepares students for an engineering career working with water, food and energy, in particular dealing with sustainable utilization of these global resources.
* Many of the core BENG topics address traditional areas of environmental concern, such as stormwater, watersheds and water quality, as well as emerging areas where engineering expertise is needed to include renewable and energy efficient systems, ecosystem services, and green design.
* As evidence of employer demand for an environmental concentration, some BENG students have elected to focus their elective courses in the environmental area, including courses in Civil Engineering and Environmental Sciences. Graduates with a BSBE degree who have chosen this path for their elective study~~,~~ have been successful in gaining employment with environmental consulting firms and have been successful in working toward professional registration in environmental engineering.
* Given the above, there is every reason to believe that the proposed Environmental Concentration within in the BS in Biological Engineering would provide undergraduates with the option to complete a focused set of elective choices in environmental engineering and other select environmental based courses, and to be recognized for this educational concentration on their transcripts~~,~~ as well as resumes distributed to potential employers.
  + This concentration and its designation would benefit students by directing their studies and providing evidence that they have completed the focused program.
  + Prospective employers will benefit from their ability to selectively recruit graduates who have completed the concentration.
  + The UA College of Engineering would benefit by being proactive with regard to offering this important concentration.
  + And, other Engineering Departments would be encouraged to participate as well if they wished, thus offering an even broader level of employee expertise throughout Arkansas and elsewhere.

The BENG faculty believe that given our current BENG curriculum with the addition of the required courses in CVEG and selection of other environmental sciences electives would create a strong environmental area of concentration that could be emulated by other engineering departments. This is especially important in that many departments within the College of Engineering do ‘environmental’ work, thus providing an educational base with electives to work in environmental industries. In fact, a state-funded environmental engineering grant has been split among four UA Engineering departments (BAEG, CHEG, CVEG and MEEG) for many years demonstrating the breadth of engineering expertise and level of cooperation associated with the environmental area.

Clearly, the BENG faculty firmly believe that an Environmental Concentration is not only beneficial to its department but also to a wide range of stakeholders to include UA students, employers, taxpayers, UA, and the UA College of Engineering and those of its departments that might also wish to add a similar area of concentration at a later time

The proposed Environmental Concentration in this document is specific to the BENG program, showing that students in our program have a specialized skill set and education as related to environmental issues. It also differentiates BENG students who have this Environmental Concentration from others in BENG who pursue a broader degree program with electives in food and energy systems, and other engineering and technical electives.

1. New option/emphasis/concentration objective.

The objective of the Environmental Concentration in BENG is to provide undergraduate BENG students with the option of a formal specialization by taking certain engineering and science courses related to the environment, and thereby offering prospective employers an engineering graduate with a well-defined, credible, and important area of specialized engineering expertise.

This Environmental Concentration will show prospective employers that graduates have a specialized skill set within biological engineering focused on addressing certain types of environmental issues. Completing the Environmental Concentration is not equivalent to receiving an “Environmental Engineering” degree, which has distinct program objectives within our engineering accreditation agency, ABET. Furthermore, an accredited Environmental Engineering Degree is not offered by the UA College of Engineering, but CVEG does offer a number of environmental engineering courses that focus on traditional water and wastewater treatment. Graduates who complete the BENG Environmental Concentration will be biological engineers with ABET-accredited Biological Engineering degrees. As such, having completed the Environmental Concentration, they will have significant, broad environmental capabilities that will be attractive to potential employers.

1. Provide the following:
   1. Curriculum outline - List of courses in new option/concentration/emphasis – Underline required courses:

The proposed Environmental concentration in BENG is not a proposal for an accredited Environmental Engineering undergraduate degree. However, the required courses in the B.S. degree in Biological Engineering do provide a background for students consistent with many of the traditional and emerging areas within environmental engineering, as defined by the American Academy of Environmental Engineers in the 2009 AAES publication on the Environmental Engineering Body of Knowledge (EnvEBoK). The BENG degree program also provides coverage of engineering subject areas included on the Fundaments of Engineering – Environmental Examination (FE-EnvE, the first step in professional registration). Here is a list of existing required BENG courses that contribute to a student’s expertise as related to the Environmental Concentration:

**Course\_**  **Contributes to EnvEBoK and FE-EnvE**

BENG 2632 B.E. Design Studio environmental systems and science

BENG 2643 Biol. Eng. Methods I GIS, surveying, technical drawing

BENG 3113 Measur. & Controls sensors, process controls

BENG 3663 Biol. Eng. Methods II probability and statistics, engineering economics

BENG 3653 Global Bio-Energy energy conservation, air quality, sustainable energy

BENG 3723 Unit Operations pumping and piping, fluid mechanics, air processes

BENG 3733 Transport Phenomena heat and mass transfer, reaction kinetics

BENG 4663 Sustain. Biosystems life cycle analysis and sustainability principles

BENG 4823 Senior Design in B.E. comprehensive capstone creative design

BENG 4831 Prof. in B.E. ethics and professional practice

BENG 4933 Sustainable Watershed water quality, watersheds, storm water management, ground water and soils, evapo-

transpiration, low impact development,

green infrastructure

With specified and restricted selections from the Biological Engineering electives lists, students will have the opportunity to strengthen their expertise by taking selected courses in engineering and science. Working from the base BENG curriculum (with significant environmental content as previously documented) and the 12 hours of electives allowed by the degree, the proposed Environmental Concentration will include the following.

The required engineering courses for the environmental concentration are:

CVEG 3243 Environmental Engineering

CVEG 4243 Environmental Engineering Design

These required engineering courses are 6 hours total, and no substitutions are allowed. These two required courses will fulfill the 3 hours of engineering elective, and 3 hours of technical elective on the BS in Biological Engineering (BSBE) degree plan.

The BSBE degree already has a strong set of science requirements that are needed for engineers working in environmental industries (including course sequences culminating in organic chemistry and microbiology). To further strengthen their environmental expertise, students must choose 3 hours from a biological electives list maintained by the department~~,~~ in order to fulfill the 3 hour biological elective on the BSBE. The list of allowable courses for the Environmental Concentration is:

BIOL 3863 Ecology

CSES 2203 Soil Science

ENSC 4023 Water Quality

Students must choose an additional 3 hours from an environmental concentration technical electives list maintained by the department, to fulfill the remaining 3 hour technical elective in the BSBE curriculum. The reduced list of allowable courses for the Environmental Concentration includes:

BIOL 3863 Ecology (if not chosen for the biological elective)

BENG 4963 Modeling Environmental Biophysics

BENG 4973 Practice in Water Quality Monitoring and Analysis

CSES 2203 Soil Science (if not chosen for the biological elective)

CHEM 3613 Organic Chemistry II

CVEG 4203 Environmental Permits and Regulations

CVEG 4223 Groundwater Hydrology

CVEG 4263 Air Pollution Control

CVEG 4273 Open Channel Flow

ENSC 4023 Water Quality (if not chosen for the biological elective)

ENSC 4034 Analysis of Environmental Contaminants

GEOL 1113 General Geology

INEG 2313 Engineering Statistics

INEG 2413 Engineering Economics

* 1. Provide degree plan that includes new option/emphasis/concentration/minor.

The eight semester degree plan for a BSBE with environmental concentration is:

**Fall Semester Year 1** (15 h)

1 GNEG 1111 Introduction to Engineering I

3 ENGL 1013 Composition I

3 CHEM 1103 University Chemistry I

4 MATH 2554 Calculus I

4 PHYS 2054 University Physics I

**Spring Semester Year 1** (15 h)

1 GNEG 1121 Introduction to Engineering II

3 ENGL 1023 Technical Composition II

4 CHEM 1123/21L University Chemistry II and Lab

4 MATH 2564 Calculus II

3 HIST 2003 or HIST 2013 or PLSC 2003

**Fall Semester Year 2** (17 h)

2 BENG 2632 Biological Engineering Design Studio

4 MATH 2574 Calculus III

4 PHYS 2074 University Physics II

4 BIOL 1543/1541L Principles of Biology and Lab

3 MEEG 2003 Statics

**Spring Semester Year 2** (17 h)

3 BENG 2643 Biological Engineering Methods I

4 MATH 2584 Differential Equations

4 BIOL 2013/2011L General Microbiology w/Lab

3 MEEG 2403 Thermodynamics (OR CHEG 2313)

3 Social Science Elective (from University/State core list)

**Fall Semester Year 3** (16 h)

3 BENG 3733 Transport Phenomena in Biological Systems

3 BENG 3653 Global Bio-Energy Engineering

3 BENG 3663 Biological Engineering Methods II

4 CHEM 3603/3601L Organic Chemistry I w/Lab, or

CHEM 2613/2611L Organic Physiological Chemistry w/Lab

3 CVEG 3213 Hydraulics (OR MEEG 3503 OR CHEG 2133)

**Spring Semester Year 3** (15 h)

3 BENG 3723 Unit Operations in Biological Engineering

3 BENG 3113 Measurements and Controls for Biological Systems

***3 Biological Elective\****

3 CVEG 3223 Hydrology

***3 Engineering Elective (CVEG 3243 Environmental Engineering)***

**Fall Semester Year 4** (15 h)

2 BENG 4812 Senior Biological Engineering Design I

1 BENG 4831 Biological Engineering Professionalism

3 BENG 4743 Food and Bio-Product Systems Engineering

3 BENG 4933 Sustainable Watershed Engineering

***3 Technical Elective (CVEG 4243 Environmental Engineering Design)***

3 Social Science Elective (from University/State core list)

**Spring Semester Year 4** (18 h)

3 BENG 4823 Senior Biological Engineering Design II

3 BENG 4663 Sustainable Biosystems Design

3 Humanities Elective (from University/State core list)

3 Fine Arts Elective (from University/State core list)

3 Social Science Elective (from University/State core list)

***3 Technical Elective\****

**128 hour total**

The above curriculum allows a student to graduate with a BSBE with Environmental Concentration in four years, while meeting all university, college and BENG requirements. The courses specific to the Environmental Concentration are highlighted in **bold** and *italics*. The electives marked (\*) must be chosen from Environmental Concentration electives lists maintained by the department.

* 1. Total semester credit hours required for option/emphasis/concentration/minor

(Option range: 9–27 semester credit hours).

The Environmental Concentration within Biological Engineering requires 12 hours.

* 1. New courses and new course descriptions.

None.

* 1. Goals and objectives of program option/emphasis/concentration/minor.

The goals and objectives of the Environmental Concentration are the same as the existing BENG undergraduate program, while expanding the students’ expertise in areas related to both engineering, as well as environmental sciences. A major benefit of this Environmental Concentration within BSBE is the ability of potential employers to recognize our students as having the needed expertise to address certain types of issues associated with the natural environment. This facilitates more efficient matching of potential employers with engineering graduate expertise, especially in the job market for entry level positions.

* 1. Expected student learning outcomes.

The expected student learning outcomes are the same as the ABET-accredited BSBE undergraduate program as it exists. The Environmental Concentration within the BSBE curriculum uses elective choices to expand our students’ understanding of environmental issues by providing a skillset that will help meet the needs of potential employers. It should also provide the students the foundation needed to pass the Fundamental of Engineering (FE) exam with the environmental focus.

* 1. Documentation that program option/emphasis/concentration/minor meets employer needs.

The BENG faculty have met with employers interested in an Environmental Concentration within the BSBE curriculum. These employers expressed a desire for BENG undergraduates to have education in traditional hydrology, microbiology, organic chemistry, water and wastewater treatment, engineering economics, modeling, statistics, and environmental regulations and permitting. The BENG curriculum with an Environmental Concentration addresses potential employer needs, as well as provides BENG students a means to be recognized as qualified for environmental positions during their job search. [Please see supplemental information showing letters of support from BENG alumni working in environmental consulting.]

* 1. Student demand (projected enrollment) for program option/emphasis/ concentration/minor.

Many of our undergraduate students already take the CVEG courses that are proposed to be required in the environmental concentration in order to fulfill their engineering/technical electives within the BENG curriculum. In a recent survey, roughly 10 current BENG students indicated that they intend to take both CVEG 3243 (Environmental Engineering) and CVEG 4243 (Environmental Engineering Design) in the coming academic year. However, current students do not receive ‘official’ recognition of having focused on acquiring environmental expertise on their transcript. The BENG program will be able to market this concentration to the Freshman Engineering Program (FEP), thereby likely growing our student base. We anticipate that perhaps 20 or more students would graduate each year with a BSBE with the environmental concentration, and we anticipate some growth over time to occur as we market this program not only within FEP but also to incoming freshman via social media, web materials and college recruiting efforts.

* 1. Name of institutions offering similar program or program option/emphasis/ concentration/minor and the institution(s) used as a model to develop the proposed program option/emphasis/concentration/minor.

The (128 credit hour) BS in Environmental Engineering at the University of Arkansas – Little Rock provides an education focused on the traditional environmental engineering body of knowledge; the UALR program is similar to those reviewed nationally, as well. While the B.S. in Biological Engineering with the Environmental Concentration does address some of the traditional and emerging areas of practice within Environmental Engineering, it also provides students with wider exposure to environmental sciences and applications in agriculture, watersheds and green infrastructure design – this makes the combination of the BSBE and Environmental Concentration unique.

1. Institutional curriculum committee review/approval date:

November 14, 2018

1. Will the new option/emphasis/concentration/minor be offered via distance delivery?

No.

1. Explain in detail the distance delivery methods/procedures to be used.

Not applicable.

1. Specify the amount of additional costs required for program implementation, the source of funds, and how funds will be used.

No funds required.

1. Provide additional program information if requested by ADHE staff.

President/Chancellor Approval Date: January 21, 2019

Board of Trustees Notification Date: March 28, 2019

Chief Academic Officer: James S. Coleman Date: January 10, 2019