

Program Planning Summary

Bachelor of Science Degree in Environmental Engineering

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Classification

Program Title : Bachelor of Science (BS) Degree in Environmental Engineering

Academic units

- 1) Clemson University, College of Engineering and Science, Department of Environmental Engineering and Earth Sciences (EEES); and
- 2) College of Agriculture, Forestry and Life Sciences, Department of Agricultural and Biological Engineering (ABE)

Designation, type, and level of degree: Bachelor's degree, 4-year program

Proposed date of implementation: August 2010

CIP code from the current USDOE's Classification of Instructional Programs: 14.1401

Identification of Program as New or Modification: New

Site: Clemson University

Program qualifies for supplemental Palmetto Fellows Scholarship and LIFE Scholarship awards: Yes

Delivery mode: Traditional, on the Clemson University campus

JustificationStatement of the purposes and objectives

The overall purpose of the new degree is to provide students with training in an engineering discipline that will see rapid growth over the next several decades. Environmental engineering is only one of two engineering disciplines which the U.S. Bureau of Labor Statistics predicts will have "much faster than average growth" over the next 10 years. Given the many critical environmental issues facing the state and nation, and the commitment of many high school students to helping solve these problems, we anticipate a strong and talented pool of students with an interest in this new degree.

The goals for the degree include:

1. To provide students with the education needed for a rewarding career;
2. To provide an intellectually rigorous undergraduate education that emphasizes fundamental engineering and life sciences; and
3. To train a workforce to sustain a growing environmental engineering industry in the United States and participate in the economic development of the State of South Carolina.

Need for the program

Nationwide, at least 38 universities offer a BS degree in Environmental Engineering, but none in the state of South Carolina. Both Clemson University and the University of South Carolina (USC) have graduate programs leading to a Masters degree in Environmental Engineering and Science, and Clemson offers a PhD degree, thus the resources are available.

Until relatively recently, the supply of environmental engineers in the United States was being met via students with graduate degrees or with degrees from related disciplines. For industry and

consulting engineering, a Masters degree has often been considered the entry level degree for practitioners. Most students who obtain their MS degree in environmental engineering have an undergraduate degree in another engineering discipline (most commonly civil, chemical, biosystems, or mechanical engineering) or in one of the sciences (most commonly chemistry or biology). Although this system worked well for several decades, environmental engineering has now emerged as a separate discipline worthy of specific training that begins at the undergraduate level. This recognition is driven by a number of factors, including:

- Environmental engineering is a recognized specialty on professional engineering licensing exams.
- The U.S. Bureau of Labor Statistics counts over 54,000 environmental engineers employed in the U.S. and Jones et al. (2005) reported the upper range may be as high as 100,000.
- As a profession, environmental engineering is larger than biomedical, materials, and chemical engineering (which employed 14,000, 22,000, and 30,000 engineers, respectively, in 2006).
- Environmental engineering is only one of two engineering disciplines which the U.S. Bureau of Labor Statistics predicts will have “much faster than average growth” over the next 10 years.
- The projected 25% growth in environmental engineers to 68,000 by 2016 is the largest of any engineering discipline. In contrast, overall engineering growth will be 11%.

Other universities have recognized the growing demand for environmental engineers with training at the Bachelor of Science level. Clemson University is well positioned to enter the ranks of these universities by offering a new undergraduate degree in environmental engineering via the joint efforts of the Department of Environmental Engineering and Earth Sciences (EEES) and the Department of Agricultural and Biological Engineering (ABE). The graduate program in Environmental Engineering and Science at Clemson, within EEES, has consistently been ranked among the top 25 programs nationwide (according to the U.S. News and World rankings), and several times has been ranked in the top 15. There is a very strong tradition of excellence in this program. The SC Commission on Higher Education awarded EEES a Commendation of Excellence in July 2001, as part of its statewide Review of Existing Academic Programs in Engineering at the MS and PhD level. EEES is the only program in the country that has had three faculty (emeritus faculty Gene Rich, Tom Keinath and Les Grady) receive the prestigious Founders Award of the Association of Environmental Engineering and Science Professors (AEESP). This department has a long and deep tradition in educating students in environmental engineering and science at the graduate level. It is now timely that this be extended to the undergraduate level.

The ABE Department currently offers an ABET accredited program in Biosystems Engineering with concentrations in Natural Resources and Environment (NRE) and in Applied Biotechnology. Masters of Science and PhD degrees are also offered. ABE has been active in the natural resources and environment area via academic programs, research and Extension (outreach) for over 60 years. The undergraduate NRE concentration emphasizes watershed hydrology, storm water and related non-point source pollutants, and water quality as affected by agriculture and changing land use. Graduates of this program have found employment with engineering consulting firms and engineering registration as civil, environmental, agricultural and/or biological engineers. The core of the NRE program will be moved to the new Environmental Engineering curriculum and exist as a concentration entitled Natural Systems, providing graduates with a degree accredited in the field that most have pursued in their career.

Anticipated program demand and productivity

EEES at Clemson University currently consists of 18 full-time tenure-track faculty members, 11 of whom are primarily associated with teaching and research in environmental engineering and science. The other faculty members have teaching and research interests that are mainly associated with geology and hydrogeology, although there is considerable overlap in both teaching and research interests among both groups of faculty. In addition, the ABE Department has 15 faculty and will add five new faculty within the 2008-09 academic year. Of these 20 faculty, five are likely contributors to the proposed program in Environmental Engineering, adding specific expertise as well as the ability to contribute to teaching a number of core courses.

The environmental engineering and science program at Clemson University already offers nine courses at the 400/600 level. These courses may be taken by advanced undergraduates and by beginning graduate students, and typically enroll a significant number of undergraduate students. Clemson undergraduates are currently able to minor in environmental engineering, by taking several of these EEES courses plus relevant electives from other departments. One of the most popular classes, Introduction to Environmental Engineering, is actually a requirement for majors in Civil Engineering. This reflects the importance of a working basic knowledge of environmental engineering for civil engineers. In addition, ABE offers six courses that are directly relevant to the new major, especially the proposed Natural Systems concentration.

At the 2007 National Conference on Research and Education in Environmental Engineering and Science sponsored by AEESP, one of the plenary lectures presented a survey of environmental engineering courses taught at various programs nationwide. The courses surveyed covered topics such as water and wastewater treatment, air pollution control, solid waste management, hazardous waste management, pollution prevention, and risk assessment. Very few programs offered courses on all of these topics, including some that offer a BS degree in environmental engineering. Interestingly, Clemson University offers all of them. This signifies that we are well positioned to offer an undergraduate degree in environmental engineering. Indeed, someone looking at our course offerings may well wonder why we don't already do so.

In terms of demand, most current programs graduate between 15 and 30 students annually. Initially, we expect similar numbers. However, as the demand for environmental engineers continues to grow, we expect to see a commensurate growth in enrollment. An analysis by The Bureau of Labor Statistics concluded that the demand for environmental engineers is driven in part by an interesting demographic event. The major pieces of environmental legislation were passed approximately 30 to 40 years ago. These include the Clean Water Act, Clean Air Act, Safe Drinking Water Act, Resource Conservation and Recovery Act, and the Comprehensive Environmental Response, Compensation and Liability Act (better known as Superfund). With the passage of these laws came regulations that required changes in environmental management, leading in turn to a large influx of environmental engineers into consulting, industry, and government. Most of the engineers who came into the field 30 to 40 years ago are now approaching retirement. This, combined with a steady increase in overall demand, has led to the forecast mentioned above, i.e., 25% growth in the number of environmental engineers by 2016. Based on this measure, it is reasonable to expect increasing enrollment over the next several decades.

We expect the degree to attract students with a variety of interests since both the life sciences and the physical sciences are at the core of environmental engineering. Given the many issues facing the nation, and the commitment of many high school students to helping solve these problems, we anticipate a strong and talented pool of students with an interest in this new degree. Students who

graduate from the program will find immediate employment opportunities with consulting firms, industry and government. We will also promote the option of obtaining a graduate degree for those who wish to gain further leverage in the workplace.

Relationship to the mission of Clemson University

The BS in Environmental Engineering supports several aspects of Clemson's mission as outlined in the Academic Plan. This document lists Sustainable Environment as one of the eight "emphasis areas" that faculty and administrators have identified as key to the future. The new degree is fully consistent with this emphasis area and fills a void in engineering education at the undergraduate level. The new degree also supports Clemson's vision of becoming one of the nation's top 20 public universities by increasing the range of degrees offered, especially in an area that is expected to see a high rate of growth in employment.

Assessment of extent to which the proposed program duplicates existing programs in the state

A BS degree in environmental science was approved at the University of South Carolina during this fiscal year, but no environmental engineering program is taught in the state.

Relationship of the proposed program to existing programs at Clemson

This degree program is unique at Clemson University. However, several existing programs provide a considerable base from which to build the curriculum. In particular, a number of the required engineering courses are already offered through the Departments of Civil Engineering, ABE, and EEES. For students who start their studies in Chemical Engineering but then choose to switch majors, a number of the Chemical Engineering courses may be used as substitutes for the basic requirements towards the Environmental Engineering degree.

Relationship of the proposed program to other institutions via inter-institutional cooperation

As mentioned above, no other institutions within the State offer a BS in environmental engineering. At the graduate level, EEES does cooperate with USC's Department of Civil and Environmental Engineering and the Arnold School of Public Health to co-sponsor lectureships offered by the AEESP as well as the American Academy of Environmental Engineering. The Department of Civil and Environmental Engineering at the Georgia Institute of Technology has also co-sponsored these events. The lectures offered at Clemson University are broadcast via the Internet to USC and Georgia Tech so that they can participate without having to make the trip in person. We anticipate that similar activities oriented towards the undergraduates interested in environmental engineering will be shared with USC and Georgia Tech.

Total New Cost Associated with Implementing the Proposed Program.

No new faculty positions are required for the degree program. The five year total new costs are estimated at \$223,000 and includes supplies and materials and graduate teaching assistants.

Sources:

- Fisher, A., 2005 (March 21). Hot Careers for the Next 10 Years: The U.S. will start exporting environmental expertise. *Fortune Magazine*, 151(6):131.
- Jones, S., et al. 2005. An Initial Effort to Count Environmental Engineers in the USA, *Environmental Engineering Science*, 22(6):772-787, 2005.
- U.S. Bureau of Labor Statistics, <http://www.bls.gov/oco/ocos027.htm>