

CLEMSON UNIVERSITY
REQUESTING TO MODIFY AN EXISTING PROGRAM
Bachelor of Science
in
Chemical Engineering
Adding a concentration in Biomolecular Engineering

Submitted to the South Carolina Commission on Higher Education

College of Engineering and Science
Clemson University

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Program Modification: Bachelor of Science Degree in Chemical Engineering

Add Concentration in: Biomolecular Engineering

Proposed Date of Implementation: August, 2007.

Justification of need for the proposed program:

The discipline of Chemical Engineering is one of the core, founder society, engineering disciplines (along with mechanical, electrical and civil engineering), and has historically been built upon a foundation of mathematics, chemistry and physics. Chemical Engineering, unlike the other founder engineering disciplines, focuses on molecular phenomena that manifests on scales that range from individual molecules to their large scale production. Chemical Engineers have had a long history of engagement with such biological processes as fermentation and pharmaceutical production. In recent years, paralleling the growth in the molecular basis of biology, there has been an acknowledgement within the discipline that biology must be incorporated as a fourth enabling foundation. This has been confirmed through national workshops sponsored by the National Science Foundation (NSF) and the Council for Chemical Research (CCR). At the undergraduate level, a fundamental understanding of biological molecules and biochemistry, for example, is now seen nationwide as a necessary requirement in the preparation of B.S. Chemical Engineers who are capable of solving problems and making contributions to their employers in the biopharmaceutical and biotechnology industries upon graduation. This requirement is a manifestation of the demand for B.S. Chemical Engineers from a wide range of industries. No longer do petrochemical companies hire 70-80% of our undergraduates. Rather, graduates are pursuing careers as chemical engineers within pharmaceutical, biotechnology and consumer products companies that expect their new employees to apply Chemical Engineering core competencies to a range of applications with biological, chemical and life sciences implications. In addition, Chemical Engineering is nationally viewed as a rigorous, professional, preparatory degree for undergraduates matriculating to pharmacy and medical schools.

The continually evolving face of Chemical Engineering has led to changes in (1) the public profile of the discipline; (2) the demands of companies that recruit our students; (3) the career goals and aspirations of B.S. graduates; and (4) the research activities of the faculty in response to the interests of funding agencies and corporate partners. To better serve all of these constituents, the department proposes adding a concentration to the B.S. degree in Chemical Engineering. By definition, this concentration will *only* be available to those students within the Chemical and Biomolecular Engineering Department, and must be viewed as an academic concentration within the greater Chemical Engineering discipline. This concentration is not a complete university Major (course of study), but provides a focused learning experience beyond the core Chemical Engineering courses to (1) enhance the academic experience of chemical engineering students and (2) allow Clemson Chemical Engineering students to compete nationally with other B.S. Chemical Engineering graduates. Given this specific context within the existing Chemical Engineering discipline, this concentration does not duplicate any other majors that are available on campus or across the state. The proposed concentration is in Biomolecular Engineering. We believe that this concentration is evolutionary, as it

builds upon the traditional foundation of the Chemical Engineering curriculum, and represents one of the primary directions in which the discipline is moving at the national level.

In developing the concentration in Biomolecular Engineering, the faculty members have solicited and incorporated input and justification from a wide range of sources as detailed below.

- In early 2005, the Board of Trustees approved, and the Commission on Higher Education (CHE) was notified of, a name change for the Department of Chemical Engineering to the Department of Chemical and Biomolecular Engineering. This name change is consistent with many other institutions nationwide (and worldwide), and reflects the fact that the skills traditionally taught and applied to Chemical Engineering problems increasingly require a knowledge of biological processes on a molecular scale. The current proposal codifies and gives substance to this approved name change.
- A Curriculum Workshop, hosted by the department in 2004, noted that the companies that hire chemical engineers increasingly have a biological/life sciences focus, and recommended developing formal ways to incorporate these needs into the curriculum.
- At the Fall 2005 Advisory Board meeting, the board members encouraged the department to develop biology-based curriculum concentrations relevant to the Biotechnology industry.
- A series of workshops sponsored by the National Science Foundation and the Council for Chemical Research (CCR), and organized by Professor Bob Armstrong (Chair of Chemical Engineering at MIT), brought together both academics and industrial representatives to work on a revitalization of the Chemical Engineering curriculum. Two key outcomes of this meeting were the recognition of biology as a necessary and enabling science for Chemical Engineering, and the observation that the discipline must respond to the industries (e.g. pharmaceutical, consumer products/personal care, and biotechnology) that are increasingly seeking our graduates at the B.S. level.
- In a survey of our current undergraduate students, over 50% list working in a bio-related field among their career goals.
- Approximately 5% of our graduates have gone on to Medical School over the past fifteen years.
- Clemson faculty members in the Department of Chemical and Biomolecular Engineering have developed strong, competitively funded research programs in the bio area of Chemical Engineering. These research programs include: biodiesel, biopolymers, bioseparations, biosensors, and biomaterials. To enhance the undergraduate academic experience, these topics are increasingly being incorporated into core and elective courses within the department.
- The Department of Chemical and Biomolecular Engineering is the home department for research in bioelectronics, biosensors and biochips. This research, led by Professor Anthony (Tony) Guiseppi-Elie, has annual research expenditures of ~\$1.2MM and 7 biotech industry partners.

Anticipated program demand and productivity

It is anticipated that 5-10 students annually (i.e., a program size of 25-40 students) will choose to pursue the B.S. degree in Chemical Engineering with a Concentration in

Biomolecular Engineering. This number could reach 20% of the B.S. in Chemical Engineering degrees awarded annually. This number is based upon the interests of the current B.S. Chemical Engineering students, employment opportunities for Chemical Engineers within the biotech, pharmaceutical and life sciences related chemical industries.

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

The Biomolecular Engineering concentration is designed to enhance the academic experience and career opportunities of students selecting the existing Chemical Engineering major and degree at Clemson. There is no other program in the state which results in a B.S. degree in Chemical Engineering that incorporates a focused set of courses leading to a Biomolecular Engineering Concentration. The concentration will be offered under the broader Chemical Engineering discipline, will be based upon and be derived from the core chemical engineering curriculum and will therefore be subject to accreditation as a Chemical Engineering degree by ABET.

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

The Biomolecular Engineering concentration will incorporate a well-defined set of courses that enhance the Chemical Engineering curriculum in keeping with the nationally and internationally evolving trends in the discipline and historic placement of our students. There is no other program at the University that incorporates a focused set of courses leading to a Biomolecular Engineering Concentration coupled with the historical value and educational breadth of a chemical engineering degree.

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

As noted above, the department consistently sends several students each year to medical school. The vast majority of these students attend either MUSC or USC. Additionally students graduating from this program will be eligible to enroll in the graduate and bioengineering program at USC. This program has a chemical and mechanical focus which would augment study in the biomolecular field.

Total new costs associated with implementing the proposed program

Because of two recent faculty hires with scholarly and teaching interests in biomolecular engineering and chemical engineering, the additional concentration within the department will require, pending the appropriate enrollment growth, the addition of one new faculty member whose scholarly and teaching interests and research expertise focuses on biomolecular engineering. The recurring budget items would include

- Faculty salary \$74,000 (on-going search)
- Teaching Assistant Support \$45,000 (grant-based)
- Operating Funds \$10,000

The nonrecurring budget items would include \$200,000 towards a startup package of \$400,000 for a new faculty member, and \$50,000 towards new undergraduate laboratory equipment focused on biomolecular engineering for the Senior Lab course.