

Art. V

**New Program Proposal
M.S. and Ph.D. in Biomedical Engineering
USC-Columbia**

Summary

The University of South Carolina requests approval to offer programs leading to the Master of Science degree and the Doctor of Philosophy degree in Biomedical Engineering, to be implemented in Fall 2006.

The proposal was approved by the USC Board of Trustees on October 27, 2005, and submitted for Commission review on November 15, 2005. The proposal was reviewed with substantive discussion and voted upon favorably by the Advisory Committee on Academic Programs at its meeting on January 18, 2006.

The purpose of the program is to prepare graduates to meet the growing demand for advanced-level research and development, and to take advantage of entrepreneurial opportunities, in the biomedical industry. The proposed programs reflect the recent emergence of a theoretical understanding and conceptual framework among researchers that biology must be considered a "core science" in the education of future generations of engineers, physicists, mathematicians, and chemists.

USC is uniquely qualified to offer these programs because it is the only institution in South Carolina with both a medical school and an engineering school. The proposed programs distinguish themselves from USC School of Medicine's Ph.D. degree in Biomedical Sciences (established in 1981) in their interdisciplinary emphasis on Mechanical and Chemical Engineering (in addition to the biological sciences), and a focus on the development of biomedical devices such as heart pacemakers, bone and joint replacements, and kidney dialysis machines. The proposed programs are also distinct from Clemson's nationally ranked Department of Bioengineering, which focuses on biomaterials.

The proposed programs have the full endorsement of Clemson and MUSC, and represent yet another dimension of biomedical research collaboration between Clemson, MUSC, and USC that has evolved and matured over the last 22 years. In 1984 the three institutions entered into the South Carolina Bioengineering Alliance, an effort to forward inter-institutional research while ensuring that programs and research projects are synergistic and not duplicative. The Alliance

is recognized by both CHE and the South Carolina General Assembly. The three institutions are also part of the NIII-funded Biomedical Research Infrastructure Network, a national program designed to enhance research capacity through inter-institutional cooperation and information sharing. Finally, the proposed programs are aligned with research foci in South Carolina's Research Centers of Economic Excellence ("Endowed Chairs"), a state-funded effort to encourage economic growth through the recruitment of nationally recognized scientists and researchers.

In September, 2005, the proposed programs were reviewed by Konstantinos Konstantopoulos, an Associate Professor in the Department of Chemical and Biomolecular Engineering at Johns Hopkins University. The external review lauded the programs' commitment of existing faculty to the development of new elective courses, characterized existing resources and facilities as adequate, and offered an "enthusiastic endorsement" of the program and its "potential to contribute to the technology-based economic development of South Carolina and the nation."

Students may be admitted directly into either the M.S. program or the Ph.D. program, depending on the quality and depth of undergraduate preparation. Projected enrollment for the M.S. degree is two students in the first year, adding an additional five students in the second year, and adding an additional three students in year three. At its full operational capacity, enrollment is projected at ten FTE students per year, with five students graduating each year. If enrollment and program completion projections are met, the program will meet the Commission's productivity standards.

Projected enrollment for the Ph.D. degree is three students in the first year, adding an additional seven students in year two, ten students in year three, and ten more students in year four. At its full operational capacity, enrollment is projected at 30 FTE students per year, with ten students graduating each year. If enrollment and program completion projections are met, the program will meet the Commission's productivity standards.

The proposed M.S. program will consist of 30 semester hours, including: 12 semester hours in core Biomedical Engineering (BMEN) courses; six semester hours in BMEN electives; three semester hours in BMEN or other approved electives; three semester hours in the BMEN 798 seminar, and six semester hours of these preparation.

The proposed Ph.D. program will consist of 60 semester hours, including: 12 semester hours in core BMEN courses; nine semester hours in BMEN electives; six semester hours in BMEN or other approved electives; three semester

hours in the BMEN 798 seminar; 18 semester hours in research; and 12 semester hours in dissertation preparation.

Five new courses associated with the proposed programs include: BMEN 710 Modeling and Simulation of Biomedical Systems; BMEN 713 Human Cell and Molecular Biology for Biomedical Engineers; BMEN 720 Transport Phenomena in Biomedical Systems; BMEN 723 Anatomy and Physiology for Biomedical Engineers; and BMEN 798 Graduate Seminar in Biomedical Engineering. In addition, it is anticipated that several additional courses will be developed as new faculty are hired, including: BMEN xxx (catalog number not yet assigned) Tissue Implant Interfaces; BMEN xxx Tissue Engineering; BMEN xxx Biothermodynamics; and BMEN xxx Bioreactor Design.

Faculty for the proposed programs will be drawn from the College of Engineering and Information Technology (Departments of Mechanical and Chemical Engineering), as well as from the College of Arts and Sciences (Biochemistry and Biological Sciences) and the School of Medicine. Five existing faculty (2.0 FTE) will be supported by the hiring of six new faculty over the next five years. The proposed programs anticipate hiring two new faculty members in the first year, and one new faculty in each subsequent year, totaling eleven faculty (5.0 FTE) in year five. One administrator (0.25 FTE) is dedicated to the proposed programs, as well as two staff members (1.0 FTE).

There are no new physical plant requirements associated with the proposed programs, though existing space may be reallocated along with the dedication of new space in the USC Research Campus which is currently under development. There will be new equipment needs required to support the proposed programs, and the proposal notes that these are typically budgeted as part of start-up expenses for new faculty recruits. Funds for equipment will be provided by an existing National Science Foundation Research Infrastructure Improvement grant and by matching funds from the EPSCoR program.

The proposal also notes that current library holdings to meet program needs are supported by an existing annual allocation of about \$8,000 from the current library budget. These include access to NIH, PubMed, and Science Direct information resources, as well as 522 books and 31 periodicals in biomedical engineering and related fields. The proposal's budget includes an annual allocation of \$2,500 to add books and periodicals explicitly devoted to biomedical engineering.

New costs for the program are estimated to begin at \$1,357,500 in the first year, decreasing to \$600,000 in the second year, increasing to \$642,500 in the third year, increasing to \$685,000 in the fourth year, and increasing to \$727,500 in

the fifth year. Categories of costs over the first five years of the program's implementation include faculty salaries (\$850,000); program administrator (\$150,000); clerical and support personnel (\$100,000); library resources (\$12,500); equipment (\$2,800,000); and other operating expenses (\$100,000). Total estimated new costs for the program during the first five years will be \$4,012,500.

Shown below are the estimated Mission Resource Requirement (MRR) costs to the state and new costs not funded by the MRR associated with implementation of the proposed programs during their first five years. Also shown are the estimated revenues projected under the MRR and the Resource Allocation Plan as well as student tuition.

Year	Estimated MRR Cost for Proposed Program	Extraordinary (Non-MRR) Costs for Proposed Program	Total Costs	State Appropriation	Tuition	Total Revenue
2004-05	\$56,998	\$0	\$56,998	\$0	\$21,687	\$21,687
2005-06	\$199,493	\$0	\$199,493	27,480	\$76,806	\$104,286
2006-07	\$225,617	\$0	\$225,617	95,251	\$86,835	\$182,086
2007-08	\$225,617	\$0	\$225,617	107,338	\$86,835	\$194,173
2008-09	\$225,617	\$0	\$225,617	107,338	\$86,835	\$194,173

These data demonstrate that if the institution meets the projected student enrollments and contains costs as they are shown in the proposal, the M.S. degree program will not be able to cover costs during each of its first five years.

Year	Estimated MRR Cost for Proposed Program	Extraordinary (Non-MRR) Costs for Proposed Program	Total Costs	State Appropriation	Tuition	Total Revenue
2004-05	\$283,800	\$0	\$283,800	\$0	\$44,275	\$44,275
2005-06	\$946,000	\$0	\$946,000	134,512	\$146,111	\$280,623
2006-07	\$1,892,000	\$0	\$1,892,000	450,089	\$293,036	\$743,125
2007-08	\$2,838,000	\$0	\$2,838,000	904,293	\$439,147	\$1,343,440
2008-09	\$3,334,650	\$0	\$3,334,650	1,354,382	\$515,952	\$1,870,335

These data demonstrate that if the institution meets the projected student enrollments and contains costs as they are shown in the proposal, the Ph.D. degree program will not be able to cover costs during each of its first five years.

In summary, USC-Columbia will offer programs leading to the Master of Science and Doctor of Philosophy degrees in Biomedical Engineering. The proposed programs represent the coordinated inter-institutional efforts of USC, Clemson University, and MUSC to deliver, without unnecessary program duplication, graduate study designed to prepare researchers to meet the growing need for medical devices and related biomedical technologies.

Recommendation

The Committee on Academic Affairs and Licensing recommends that the Commission approve USC-Columbia's proposed programs leading to the M.S. and Ph.D. degrees in Biomedical Engineering to be implemented in Fall 2006, provided that no additional "unique cost" or other special state funding be required or requested.