

**University of South Carolina
Columbia Campus**

PROGRAM PLANNING SUMMARY

**Master of Engineering in Biomedical
Engineering**

02/18/2013

Date of Submission

Harris Pastides, President

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I. CLASSIFICATION

A. Program Title:	Master of Engineering in Biomedical Engineering
B. Concentrations	None
C. Designation, Type, Level of Degree:	Master of Engineering (M.E.)
D. Proposed Date of Implementation:	Fall 2014
E. Qualifies for supplemental Palmetto/LIFE Scholarship?	No
F. Delivery Mode	On Campus
G. Proposed CIP Code:	140501

JUSTIFICATION:

Need for Program in the State

The multidisciplinary field of Biomedical Engineering incorporates: life sciences, engineering sciences, design, manufacturing and operation of biomedical processes and devices. Biomedical engineering is one of the fastest growing engineering areas in terms of enrollment of students, employment of graduates and research funding. The proposed Master of Engineering in Biomedical Engineering (M.E. in BME) will:

1. Prepare graduates of the program to meet the growing demands for continued development of and entrepreneurship in the biomedical industry
2. Respond to the rapidly growing national demand for new biomedical technologies and provide opportunities for economic development and entrepreneurial growth for the State of South Carolina
3. Meet the goals of the University of South Carolina in its emphasis area of biomedical sciences

The proposed Master of Engineering degree program will offer intensive, focused training in the professional practice of biomedical engineering. It is targeted toward students planning to pursue industrial careers in Biomedical Engineering professions. Industry demand for post-baccalaureate training remains high, while reductions in federal research support have reduced the availability of assistantships for traditional M.S.-seeking students. Such programs have recently been introduced at top Universities both nationwide and at our peer institutions within the Southeast. In addition, this degree program is designed to support economic development in

the healthcare field, contributing to the advancement of a knowledge-based economy in South Carolina. We have recently observed strong growth in the relocation or opening of new facilities by healthcare companies in the State, as well as the formation of new start-up businesses. According to the Bureau of Labor Statistics, employment of biomedical engineers is projected to grow by 62 percent from 2010 to 2020, much faster than the average for all occupations - The Whitaker Foundation; <http://www.whitaker.org/glance/outlook2012.html>. The aging baby-boom generation is expected to increase demand for biomedical devices and procedures, as it seeks to maintain healthy and active lifestyles. Additionally, as the public has become aware of recent medical advances and procedures, increasing numbers of people are seeking these new treatments from their physicians. Professional biomedical engineers will likely experience more demand for their services because of the breadth of activities they are prepared to engage in, made possible by the diverse nature of their training.

Relationship of the Proposed Program to Existing Programs at the Proposing Institution:

The 30 credit hour M.E. in Biomedical Engineering degree program has been developed by the Biomedical Engineering Program at USC to meet the needs of students who desire to embrace a biomedical engineering industrial career in product and technology development or other related fields. Based on industrial career interest, students will be advised to select courses from an approved list of existing graduate level courses with the majority offered by the Biomedical Engineering Program at USC. Currently, the Biomedical Engineering Interdisciplinary program at USC offers a total of 36 graduate level courses in four colleges (Engineering and Computing, Arts and Sciences and the School of Medicine). Advising will be managed by the Biomedical Engineering Graduate Committee along with the graduate student's advisor.

Assessment of Extent to Which the Proposed Program Duplicates Existing Programs in the State:

There is no similar program at a public or private university in South Carolina. Both Clemson University and the University of South Carolina offer Master of Science (M.S.) degrees in Bioengineering/Biomedical Engineering, but neither offers a professional degree for the practice of biomedical engineering at the advanced level. The M.S. degree is a research-focused advanced degree intended to prepare students for a career in biomedical research. The new M.E. program will integrate graduate-level course work with opportunities for internship experience to prepare students for product and technology development. It is considered a professional terminal degree. Both the University of South Carolina and Clemson University are currently developing the degree Master of Engineering in Biomedical Engineering. The employment projections and other needs described in the Justification section above provide substantial arguments to justify both schools offering this degree to meet biomedical economic development needs in South Carolina.

PROGRAM DEMAND AND PRODUCTIVITY

We anticipate about 10 students will enroll in the M.E. degree in biomedical engineering the first semester it is offered. The Biomedical Engineering Program is working closely with the South Carolina's Life Sciences Industry Organization (SCBIO) and its members to assure that the curriculum that will be delivered through this professional degree will meet the needs of the biomedical manufacturing community. Therefore, we anticipate in year one, 10 students will enroll, followed by 30% increase annually for a cap of 30 students enrolled annually and a graduation rate of 25 annually.

ARTICULATION AND INTER-INSTITUTIONAL COOPERATION

This program will offer a University of South Carolina degree. As mentioned above, both the University of South Carolina and Clemson University are currently developing the degree Master of Engineering in Biomedical Engineering. There have been discussions regarding the sharing of courses in the future. While we have not examined other possibilities of collaboration, we would certainly welcome collaboration with other schools.

Assessment Plan

The assessment plan for this new degree program will include reporting using WEAVE-online, a web-based tool that supports continuous improvement processes for academic programs within institutions of higher education. All students will also be required to submit an e-portfolio containing artifacts demonstrating competency in biomedical engineering design, oral/written communication, industrial practices, and mentoring/leadership. This e-portfolio will be evaluated by the assessment committee following a review by a sub-committee of the departmental industrial advisory board, whose members are practicing bioengineers in the biomedical industry. The M.E. Program in Biomedical Engineering is a professional degree program for students who are focused on a career in the healthcare, medical device, or bioinstrumentation industries. The curriculum ensures that students preparing for a career in the health care sector gain fundamental technology leadership skills important to biomedical engineers. Students in the M.E. degree program receive exposure to issues related to product development, project management, innovation, and commercialization. Students are also required to focus their technical training by completing advanced biomedical engineering coursework.

CURRICULUM

The proposed curriculum consists of 30 total credit hours including:

Mandatory Courses (12 Credit Hours – all courses):

- BMEN 710: Modeling and Simulation of Biomedical Systems. (3)
- BMEN 713: Human Cell and Molecular Biology for Biomedical Engineers. (3)
- BMEN 720: Transport Phenomena in Biomedical Systems. (3)
- BMEN 723: Anatomy and Physiology for Biomedical Engineers (3)

Recommended Core Courses (6 Credit Hours – two courses):

- BMEN 546: Delivery of Bioactive Agents
- ECHE 572: Tissue Engineering
- BMEN 589W: BioMEMS (Bio-Micro-Electro-Mechanical Systems)
- BMEN 589W: Micro/Nanofluidics and Lab-on-a-Chip

Choice of BMEN Electives (12 Credit Hours – three courses):

College of Engineering and Computing:

BMEN 795: Biomedical Engineering Literature (1 credit)

BMEN 797: Biomedical Engineering Development (1 credit)

BMEN 798: Graduate Seminar in Biomedical Engineering (1 credit)

ECHE 710 Advanced Chemical Engineering Thermodynamics
ECHE 720 Advanced Fluid Flow Analysis
ECHE 721 Advanced Heat Flow Analysis
ECHE 722 Advanced Mass Transfer
ECHE 725 Rheology
ECHE 730 Chemical Reactor Design
ECHE 750 Process Dynamics and Control
ECHE 770 Electrochemical Engineering
ECHE 772 Principles of Polymer Systems
EMCH 717 Advanced Finite Element Methods
EMCH 722 Plasticity
EMCH 741 Viscous and Turbulent Flow
EMCH 751 Advanced Heat Transfer
EMCH 771 Design Properties of Plastics
EMCH 794 Thermodynamics
CSCE 555 Algorithms in Bioinformatics.
CSCE 561 Numerical Analysis.
CSCE 563 Systems Simulation.
CSCE 564 Computational Science.
CSCE 580 Artificial Intelligence.
CSCE 758 Probabilistic System Analysis
CSCE 763 Digital Image Processing.
CSCE 768 Pattern Recog.n.and Classification.
CSCE 769 Computational Structural Biology.
CSCE 784 Neural Information Processing.
CSCE 822 Data Mining and Warehousing

College of Arts and Sciences:

CHEM 751 Biosynthesis of Macromolecules
CHEM 752 Regulation and Integration of Metabolism
CHEM 753 Enzymology and Protein Chemistry
CHEM 754 Biomedical Biochemistry I

CHEM 755 Biomedical Biochemistry II
BIOL 714 Advanced Cell Biology
BIOL 736 Advanced Developmental Biology

School of Medicine:

ANAT 700 Principles of Electron Microscopy
ANAT 701 Human Embryology and Gross Anatomy
ANAT 720 Special Topics in Microscopic Anatomy
BMSC 700 Biomedical Science Interdisciplinary Laboratory I
BMSC 701 Biomedical Science Interdisciplinary Laboratory II
BMSC 720 Signal Transduction
BMSC 730 Cardiovascular Science
CBNS 702 Human Microscopic Anatomy
MBIM 710 Advanced Immunobiology
MBIM 720 Comprehensive Microbiology
MBIM 739 Medical Bacteriology
MBIM 740 Virology
MCBA740 Biological Microscopic Imaging
MCBA741 Molecular Imag/Biomed Res
PATH 710 Neoplasia
PATH 741 Pathology I
PATH 742 Pathology II
PATH 760 Topics in Pathobiology
PHPH 705 Biomedical Pharmacology
PHPH 735 Cardiovascular Pharmacology
PHPH 740 Neuroscience
PHPH 745 Neurophysiology
PHPH 750 Fundamental Neuroscience I
PHPH 751 Fundamental Neuroscience II

ESTIMATE OF COSTS

The cost of implementation of the ME in BME is \$40,000 per semester. This includes \$15,000 for administrative oversight and advising students, and \$25,000 for supplies, consumables, marketing, publications, printing and other commercialization costs each semester. Student tuition will cover these implementation costs. No new faculty costs are anticipated. All courses for the degree are already taught as part of the Master of Science in Biomedical Engineering program.