

## **2006-2086: CURRICULUM DEVELOPMENT FOR AN EET DEGREE OPTION IN BIOMEDICAL ENGINEERING TECHNOLOGY**

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# CURRICULUM DEVELOPMENT FOR AN EET DEGREE OPTION IN BIOMEDICAL ENGINEERING TECHNOLOGY

## ***Abstract***

*Biomedical Engineering is a rapidly growing field of engineering and in recent years, its growth rate has outpaced other traditional engineering disciplines. The health care industry forms a major segment of the U.S. economy with spending expected to surpass \$2 trillion in the next decade. Biomedical devices represent one of the fastest growing segments of the health care technology economy. To meet this growing trend, it is imperative for academic institutions to provide high-quality educational programs with training in biomedical engineering and technology. Many Biomedical Engineering programs have been developed within the last decade to address this trend. However, few Biomedical Engineering Technology programs have been developed to address the need for qualified technologists in this field.*

*The Electrical Engineering Technology (EET) program at Southern Polytechnic State University (SPSU) is the largest of three programs offered by the Electrical and Computer Engineering Technology (ECET) department. It has a solid track record of producing highly qualified graduates for the electrical/electronics industry. EET graduates receive a broad-based hands-on experience encompassing circuit analysis and design, digital electronics, electronic devices and systems, telecommunication circuits and systems, data communications, signals and systems, controls, and electrical machines. An examination of the curriculum in EET revealed that it was an excellent candidate for the introduction of an option in Biomedical Engineering Technology (BMET). The primary objective for the development of the BMET option has been to produce graduates that will have the requisite skills for a successful career in the biomedical engineering/technology field. This paper discusses the rationale and considerations for the development of the BMET option.*

## **I. Introduction**

The field of Biomedical Engineering has experienced tremendous growth in recent years. The growth rate in Biomedical Engineering has outpaced traditional engineering disciplines such as electrical and mechanical engineering. The health care industry is expected to continue to form a major segment of the U.S. economy in the next decade. The fields of biomedical sciences and medicine have undergone tremendous advances due to the advent of computers and electronics technology. Biomedical devices and equipment represent one of the fastest growing segments of the health care technology economy. The United States Department of Labor reports that “the number of biomedical engineering jobs will increase by 31.4 percent through 2010---double the rate for all other jobs combined.” Overall job growth in this field will average 15.2% through the end of the decade <sup>1</sup>. Many of the recent advances in medicine have come about as a result of collaborations between medical personnel and engineers. Biomedical Engineering is an integration of medicine and engineering and assists in the struggle against illness and disease by providing tools that can be utilized for research, diagnosis, and treatment by health care professionals.

As stated in Enderle et. al.<sup>2</sup>; “Biomedical Engineers apply electrical, chemical, optical, mechanical, and other engineering principles to understand, modify, or control biological systems, as well as design and manufacture products that can monitor physiologic functions and assist in the diagnosis and treatment of patients.” Clearly, this implies that Biomedical Engineering is a cross-disciplinary field of engineering, encompassing many braches of traditional engineering fields. Computers are also playing an increasingly major role in the field. The Biomedical Engineering field currently encompasses the following:

Biomechanics	Medical and Biological Analysis
Biosensors	Clinical Engineering
Medical and Bioinformatics	Tissue Engineering
Rehabilitation Engineering	Physiological Modeling
Prosthetic Devices and Artificial Organs	Medical Imaging
Biomaterials	Biotechnology
Neural Engineering	Bio-nanotechnology
Biomedical Instrumentation	

To meet the growing demand for trained professionals in the Biomedical Engineering field many institutions have developed high-quality educational programs with training in Biomedical Engineering and Technology. Within the last decade, many Biomedical Engineering programs have been developed. However, few Biomedical Engineering Technology programs have been developed to address the need for qualified technologists in the field. Of the many Biomedical Engineering programs that have been developed, only thirty-seven have received accreditation from the Accreditation Board for Engineering and Technology (ABET). Only five of the Biomedical Engineering Technology programs have so far received ABET accreditation and all are at the associate (A.S.) degree level<sup>1,3</sup>. Clearly, there is a real need for more Biomedical Engineering Technology programs, particularly at the B.S. degree level. With this in mind, the ECET faculty at SPSU set about examining the possibility of developing a new B.S. degree program in Biomedical Engineering Technology (BSBMET).

## II. Motivation and Background

The main motivation for developing the program came from solicitations from incoming and transfer students who were interested in getting a degree in the Biomedical Engineering area. Many of these students had been made aware of the potential opportunities in the Biomedical Engineering field prior to attending SPSU. Another source of motivation was the approach made to the ECET department by a local two-year Technical college which offers an A.S. degree in Biomedical Engineering Technology. This college was interested in the possibility of developing a two-plus-two articulation agreement for their Biomedical Engineering Technology program.

The initial consideration was to develop a full-fledged four-year B.S. degree program in Biomedical Engineering Technology. However, after consultations within the ECET faculty, with faculty from collaborating departments, and with upper administration, it was concluded that it would take two years at a minimum to develop a degree program proposal and to get it approved by the Georgia Board of Regents (BOR). It was therefore decided that as an initial

step, the department would develop the Biomedical Engineering Technology program as an option under the Electrical Engineering Technology<sup>4</sup> (EET) program already offered by the ECET department. In this way the students would benefit by taking a few specialty courses in the Biomedical Engineering area while graduating from an already ABET accredited degree program. It was decided that once the option became viable with a large enough core of students, a proposal would then be forwarded for the full stand alone B.S. degree in Biomedical Engineering Technology program.

In developing the new EET program option, one of the key factors was to have a program that would match the unique capabilities and strengths of engineering technology students. In general, these types of students respond well to course content that is practically oriented and less abstract. The ECET engineering technology programs offer hands-on laboratory experiences that contribute significantly to students' abilities and confidence. Since the EET program is accredited by ABET<sup>3</sup>, it was essential to ensure that the new program option would satisfy all the requirements for obtaining accreditation from ABET. Approval for the development of the option has been obtained and the department plans to begin offering the first set of courses in the fall semester 2006.

### **III. Program Development**

The curriculum for the proposed EET option in Biomedical Engineering Technology (BMET) will add five new technical courses to a core of ECET, mathematics, English, science, and social science courses. The program will be structured within the 130 credit-hour limit set by the Board of Regents. Eighteen (18) hours will be allocated to Biomedical Engineering Technology specific courses created for the program; Fifty-two (52) hours constitute a core of ECET technical courses; Sixty (60) hours are for the mathematics, science, English, and social science core.

Table 1 lists the ECET courses that will be part of the EET-BSBMET degree option. The Biomedical Engineering Technology courses are identified. Weekly lecture hours, laboratory hours, and total credit hours are also provided. Laboratory exercises will be conducted for 12 out of the 15 weeks in each semester.

The proposed BMET option has been structured so as to retain the main core of the EET program. The EET curriculum was recently revised with input from the Industrial Advisory Board<sup>5</sup> (IAB) to allow the ECET students more flexibility in designing their curriculum. This has allowed for the proposed BMET option to be easily accommodated within the EET program. The main differences between the EET curriculum and the proposed BMET option are indicated Table 2. It was reasoned that a Differential Equations course was not needed for the BMET option, and that course will be replaced by a Probability and Statistics course. To accommodate the Introduction to Biomedical Engineering Technology course, the course in Survey of Electric Machines will be replaced. The Signals and Systems course will be replaced by the Health Care Safety course. Additionally, the course in Control Systems will be replaced by C++, JAVA, and HTML course. It has been determined that this course is more appropriate for some aspects of Biomedical Engineering such as Bioinformatics and Telemedicine. Students will still be able to

take either the Signals and Systems course or the Control Systems course as an ECET elective under the option program.

Table 1. ECET courses in the proposed BSBMET degree program option.

Course Name	Semester Number	Weekly Lecture Hrs	Weekly Lab Hrs	Credit Hours
Orientation	1	2	0	2
Fundamentals	1	2	3	3
Circuits I	2	3	3	4
Digital I	2	3	3	4
Circuits II	3	3	3	4
Electronics I	3	3	3	4
Introduction to Biomedical ET*	4	3	0	3
Digital II	4	3	3	4
Electronics II	4	3	3	4
Data Communications	5	3	3	4
Test Engineering	5	3	3	4
Applications of C++, JAVA and HTML	5	2	3	3
Health Care Safety*	5	3	0	3
High Frequency Systems	6	3	3	4
Embedded PCs	6	3	3	4
Biomedical Instrumentation*	7	3	3	4
BMET Elective (ECET)	7	3	3	4
BMET Elective*	8	3	3	4
BMET Capstone Project/Internship*	8	3	3	4

\*Indicates added Biomedical ET course

Table 2. EET courses vs. proposed BMET courses.

EET	BMET
Biological Principles I (3)	Principles of Chemistry I (3)
Introduction to Biomedical ET (3)	Survey of Electric Machines (3)
*Health Care Safety (3)	Signal and Systems Analysis (4)
Probability and Statistics I (3)	Differential Equations (3)
*C++, JAVA, and HTML (3)	Control Systems (4)

\*Difference made up in Elective hours

Other ECET electives that have been proposed for the option include the following:

- Communication Networks and the Internet
- Network Programming and Interfacing

These courses would be useful for those students who wish to specialize in the Bioinformatics and Telemedicine area. Both are currently offered by the ECET department. Proposed Biomedical Engineering electives for the program include the following:

- Biomechanics
- Bioinformatics and Telemedicine
- Virtual Biomedical Instrumentation
- Medical Imaging
- Biometrics

Students must select at least one course from this list of electives. The capstone course is envisioned as either a capstone project in an area of Biomedical Engineering Technology or as a supervised industrial Internship during which the student will gain a broad experience of some area(s) of Biomedical Engineering Technology. Students will be required to write a report of their Internship experiences, and will also be provided with a grade by their industrial supervisor.

The ECET faculty is already working in consultation with the Biology department to develop a course in Anatomy and Physiology which will be used to replace the Biological Principles I course. This course will provide an overview of all the major body systems and their inter-relatedness. The Biological Systems course only covers some of the human anatomical systems in greater detail than is required for a Biomedical Engineering Technology program.

#### **IV. Current Status**

In order to take advantage of industrial expertise for the program, a Biomedical Engineering Technology IAB has been established consisting of members currently working in the field and well as some educators. The BMET IAB met in November, 2005 and the members have provided valuable additional input on the proposed curriculum. They provided support for the approach proposed by the department and offered suggestions for some course material.

The department is in the process of submitting new course numbering requests to the campus undergraduate curriculum committee for approval. Once this is achieved, the new courses can then be offered as part of the BMET option in EET. It is anticipated that the first such course offering will be in the fall semester, 2006.

A proposal has been developed for preliminary equipment for the BMET option. It is anticipated that this will receive priority for funding within the current fiscal year. The department has also

received some offers from the new BMET advisory board for help with procuring equipment for the program.

In order to judge the level of interest in the proposed option, a special topics course in Biomedical Instrumentation Technology is currently being offered by the ECET department. Fourteen (14) students are registered for the course. This provides a good indication of the level of interest in the proposed program.

It is anticipated that recruitment for the program will initially be conducted at the local Technical college, and later expanded to include other colleges in the greater Atlanta metro area. Once it is determined that a critical mass of students have joined the program, a proposal for a stand-alone BMET program will be developed and submitted to the BOR.

## V. Conclusion

Given the tremendous growth in the health care industry along with the subsequent increase in Biomedical Engineering and Biomedical Engineering Technology type programs, the proposed BMET option to be offered at SPSU is a much needed, and timely, program. The good size enrollment in the current special topics course in Biomedical Instrumentation Technology suggests that there is enough interest within the ECET student population to justify the program. The EET program, at SPSU provides a suitable framework for the BMET option. The EET program offers a broad-based hands-on experience in Electrical Engineering Technology, and the BMET option will allow the graduates to utilize their broad education and specialize in the area of Biomedical Engineering Technology. It is anticipated that employment opportunities in the field will continue to grow with further advances in medical technology. This will fuel a continuing demand for graduates with BMET expertise.

## References

- [1] Biomedical Engineering Society Web Page: <http://www.bmes.org>
- [2] John Enderle, Susan Blanchard and Joseph Bronzino, *Introduction to Biomedical Engineering*, Prentice-Hall, 2<sup>nd</sup> ed., 2005.
- [3] ABET Inc. Web Page: <http://www.abet.org>
- [4] URL: <http://ecet.spsu.edu/home/Programs/Programs.php>
- [5] URL: <http://ecet.spsu.edu/home/Advisory-Board/Advisory-Board.php>