BIOMEDICAL ENGINEERING TECHNOLOGY AS AN OPTION IN EET

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Abstract

The ECET department at Southern Polytechnic State University (SPSU) is considering the introduction of Biomedical Engineering Technology (BMET) as an option under its Electrical Engineering Technology (EET) program. 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 economy. Though there are currently many Biomedical Engineering programs, few Biomedical Engineering Technology programs have been developed to address the need for qualified technologists in this filed. With a solid track record of producing highly qualified graduates for the electrical/electronics industry, EET program graduates receive a broad-based hands-on experience that encompasses circuit analysis and design, digital electronics, electronic devices and systems, telecommunication circuits and systems, data communications, signals and systems, controls, and electrical machines. The program provides an excellent framework for the introduction of the BMET option. The primary objective for the BMET option would be to produce graduates that will have the requisite skills for a successful career in the biomedical engineering/technology field. This paper examines some of the issues and considerations for the proposed development of the BMET option.

Keywords: BMET, Biomedical Engineering, Technology, EET

I. Introduction

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. The rapid growth in the field of Biomedical Engineering has been spurred by developments in the health care industry, which is expected to continue to form a major segment of the U.S. economy into the next decade. The advent of computers and electronics technology has led to tremendous advances in the fields of biomedical sciences and medicine. According to the United States

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Department of Labor "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 [1]. Biomedical devices and equipment represent one of the fastest growing segments of the health care technology economy. Even though the U.S. Department of Labor reports that in 2004, engineers held 1.4 million jobs of which only 9,700 were in Biomedical Engineering[2], many Biomedical Engineering graduates end up in related fields such as medicine, clinical engineering, health and safety engineering, medical imaging, environmental engineering, agricultural engineering, food science, etc. Many of these engineers end up with job titles other than Biomedical Engineers.

As stated in Enderle et. al.[3]; "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
- Biosensors
- Medical and Bioinformatics
- Rehabilitation Engineering
- Prosthetic Devices and Artificial Organs
- Biomaterials
- Neural Engineering
- Biomedical Instrumentation
- Medical and Biological Analysis
- Clinical Engineering
- Tissue Engineering
- Physiological Modeling
- Medical Imaging
- Biotechnology
- Bio-nanotechnology

Although many Biomedical Engineering programs have been developed within the last decade, few Biomedical Engineering Technology programs have been developed to address the need for qualified technologists in the field.. Only five Biomedical Engineering Technology programs have so far received ABET accreditation and all are at the associate (A.S.) degree level [1,4]. Given this reality, the ECET faculty at SPSU set about examining the possibility of developing a new B.S. degree program in Biomedical Engineering Technology (BSBMET).

II. Background

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). As an expedient alternative, It was decided that as an initial step, the department would look at its current, ABET accredited, program offerings to determine the possibility of developing

the Biomedical Engineering Technology program as an option under one of them. The Electrical Engineering Technology [5] (EET) program offered by the ECET department appeared to be the most suitable. Students would benefit by taking a few specialty courses in the Biomedical Engineering area while graduating from an already ABET accredited degree program. 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.

Since the EET program is accredited by ABET [4], it was essential to ensure that the new program option would satisfy all the requirements for obtaining accreditation from ABET.

III. BMET Option Development

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 [6] (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 proposed curriculum 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.

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

The main differences between the EET curriculum and the proposed BMET option are indicated in 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 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

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.

A special topics course in Biomedical Instrumentation Technology is currently being offered by the ECET department in order to judge the level of interest for the proposed option. Fourteen (14) students are registered for the course.

Recruitment for the program will initially be conducted at a local Technical college, and later on 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

The proposed BMET option is a much needed, and timely, program that promises to develop well trained technologist to serve in the growing health care industry. The EET program, at SPSU provides a suitable framework for this 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. The good sized enrollment in the current special topics course in Biomedical Instrumentation Technology suggests that there is enough interest within the ECET student population to justify a full degree program in the future. Employment opportunities in Biomedical Engineering Technology and related fields are expected to 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] URL: http://stats.bls.gov/oco/cg/cgs020.htm

[3] John Enderle, Susan Blanchard and Joseph Bronzino, *Introduction to Biomedical Engineering*, Prentice-Hall, 2nd ed., 2005.

[4] ABET Inc. Web Page: http://www.abet.org

[5] URL: http://ecet.spsu.edu/home/Programs/Programs.php

[6] URL: http://ecet.spsu.edu/home/Advisory-Board/Advisory-Board.php

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