

## **The Development of an Undergraduate Curriculum in Biomedical Engineering**

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### Abstract

This paper describes the development of an undergraduate curriculum in Biomedical Engineering that will prepare students to enter industry, graduate school or medical school. The program focuses first on engineering fundamentals, followed by more specific applications within the field of Biomedical Engineering, either in the Biomechanics track or in the Instrumentation, Signals and Imaging track. Students are highly recommended to participate in the co-operative education program at The University of Akron to gain practical experience in the area they choose to study. Students planning on attending medical or graduate school are encouraged to participate in hospital or research internships instead of the co-op program to allow them to gain valuable experience which will assist in their admission to the school of their choice.

### I. Introduction

Biomedical Engineering is a union between the scientific principles developed through engineering practices and the less exact nature of the human body and the devices used to interact with it. Biomedical Engineers must be prepared to deal with the challenges of the human body and its functions through use of their understanding of biology, chemistry, engineering and physics. Biomedical Engineers must also be able to interact with physicians and other medical personnel, as well as with engineers from other disciplines. The goal of the Bachelor of Science degree in Biomedical Engineering at The University of Akron is to prepare its graduates to succeed in this challenging field, whether in industry, hospitals, graduate school or other professional schools.

### II. The Undergraduate Program

The undergraduate program in Biomedical Engineering was designed to provide an in-depth understanding of the fundamentals of engineering and therefore, the Bachelors degree in Biomedical Engineering at The University of Akron focuses first on core engineering course work, followed by advanced applications specific to the field of Biomedical Engineering. To assure a fundamental understanding in engineering, the program is divided into two tracks: (1) Biomechanics and (2) Instrumentation, Signals and Imaging. The Biomechanics track (See Table 1) is designed for those students who would pursue a Mechanical Engineering background with specialization in the areas of cardiovascular, orthopaedic, rehabilitation engineering, biomaterials and system simulations. The Instrumentation, Signals and Imaging track (See Table 2) is designed for those students who wish to pursue an Electrical Engineering background with specialization in biomedical instrumentation, signal and image processing, imaging devices and

detectors and system simulations. Students are required to choose one of these two tracks by the end of their freshman year. To ensure early contact with all students, freshmen are required to take two classes from the Department of Biomedical Engineering, Tools for Biomedical Engineering and Introduction to Biomedical Engineering Design. This also allows the Department to assign each student an advisor to allow for close contact with each and every student.

Fifteen new courses will be developed by the faculty in the Department of Biomedical Engineering to provide students with instruction in a variety of areas of application, in addition to traditional electrical and mechanical engineering courses currently available at The University of Akron. The majority of these courses serve as required courses for either one or both tracks, or serve as electives during the senior year. A heavy emphasis is placed on design, from the freshman level (Introduction to Biomedical Engineering Design) through the senior year, culminating in two capstone senior Design classes. BME Design I requires a team of students to complete a design project specific to their chosen track. BME Design II requires that the projects entail a joint venture between students in the two tracks.

Furthermore, it is anticipated that the majority of the students will choose to participate in the cooperative education program in the College of Engineering at The University of Akron. The Co-op program at the University of Akron is one of the oldest in the country and has provided students with three semesters of hands-on experience and practical training in industry for many years. Students will be paired with industrial partners by area of interest and track. Those students planning on continuing their education in graduate school or medical school will also have the opportunity to choose hospital or research laboratory internships to prepare them for their future endeavors.

#### MARY C. VERSTRAETE

Mary C. Verstraete is an Associate Professor and Chair of the Department of Biomedical Engineering. Dr. Verstraete received her BS, MS and Ph.D. in Engineering Mechanics/Biomechanics from Michigan State University in 1982, 1984, and 1988, respectively. She is active in teaching at both the undergraduate and graduate levels and performs research in the area of human movement and gait analysis.

#### DANIEL B. SHEFFER

Daniel B. Sheffer is an Associate Professor of Biomedical Engineering. Dr. Sheffer received his BS and M.Ed. in Physical Education from Northwestern State University in Louisiana in 1971 and 1972, respectively and his Ph.D. in Physical Education (Work Physiology) from Texas A&M University in 1976. Dr. Sheffer teaches the Freshman Design course in Biomedical Engineering and graduate level Biomedical Engineering courses. His research interests include the application of Biostereometrics for the detection of breast cancer.

#### BRUCE C. TAYLOR

Bruce C. Taylor is an Associate Professor of Biomedical Engineering and Electrical Engineering at The University of Akron. Dr. Taylor received his BS in Biology from Hiram College in 1964, MA and Ph.D. in Physiology from Kent State University in 1967 and 1971, respectively. Dr. Taylor teaches undergraduate classes in both Biomedical and Electrical Engine and graduate courses in Biomedical Engineering and his research is directed towards all aspect of Biomedical Instrumentation.

**TABLE 1 : BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING  
Biomechanics OPTION**

<b>Course #</b>	<b>Course Name</b>	<b>CR</b>	<b>Course #</b>	<b>Course Name</b>	<b>CR</b>
	<b><u>English Composition : 7 Cr</u></b>		3100:200	Human Anatomy & Physiology I	3
3300:111	English Composition I	4	3100:201	Human Anatomy & Physiology I Lab	1
3300:112	English Composition II	3	3100:202	Human Anatomy & Physiology II	3
	<b><u>Oral Communication : 3 Cr</u></b>		3100:203	Human Anatomy & Physiology II Lab	1
7600:105	Intro to Public Speaking <b>OR</b>	3		<b><u>Engineering Core : 31 Cr</u></b>	
7600:106	Effective Public Speaking	3	4300:201	Statics	3
	<b><u>Social Science : 6 Cr</u></b>		4600:203	Dynamics	3
3250:244	Intro Economic Analysis	3	4300:202	Intro to Mechanics of Solids	3
	Elective : See Bulletin		4600:300	Thermodynamics	4
	<b><u>Humanities : 10 Cr</u></b>		4600:321	Kinematics of Machines	3
3400:210	Humanities Western Tradition	4	4200:305	Materials Science	2
3600:120	Introduction to Ethics	3	4600:360	Engineering Analysis	3
	Elective : See Bulletin		4600:315	Heat Transfer Process	3
	<b><u>Area Studies : 2 Cr</u></b>		4400:320	Basic Electrical Engineering	4
	Elective : See Bulletin		4600:420	Intro to the FEM	3
	<b><u>Physical Education : 1 Cr</u></b>			<b><u>Biomedical Engineering : 27 Cr</u></b>	
	Elective : See Bulletin		4800:101	Tools for Biomedical Engineering	3
	<b><u>Math &amp; Natural Sciences : 42 Cr</u></b>		4800:111	Intro to BME Design	2
3450:221	Analytical Geometry & Calculus I	4	4800:360	Biofluid Mechanics	3
3450:221	Analytical Geometry & Calculus II	4	4800:365	Mechanics of Biological Tissues	3
3450:221	Analytical Geometry & Calculus III	4	4800:310	Modeling & Sim of Biomed Sys	3
3450:235	Differential Equations	3	4800:400	Biomaterials	3
3470:461	Applied Statistics	4	4800:305	Intro to Biophysical Measurements	3
3150:151	Principals of Chemistry I	3	4800:460	Experimental Tech in Biomechanics	3
3150:152	Principals of Chemistry I Lab	1	4800:491	BME Design I	2
3150:153	Principals of Chemistry II	3	4800:492	BME Design II	2
3650:291	Elementary Classical Physics I	4		<b><u>BME Electives : 9 Cr</u></b>	
3650:292	Elementary Classical Physics II	4			

**TABLE 2 : BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING  
Instrumentation, Signals and Imaging OPTION**

Course #	Course Name	CR	Course #	Course Name	CR
	<b><u>English Composition : 7 Cr</u></b>		3100:200	Human Anatomy & Physiology I	3
3300:111	English Composition I	4	3100:201	Human Anatomy & Physiology I Lab	1
3300:112	English Composition II	3	3100:202	Human Anatomy & Physiology II	3
	<b><u>Oral Communication : 3 Cr</u></b>		3100:203	Human Anatomy & Physiology II Lab	1
7600:105	Intro to Public Speaking OR	3		<b><u>Engineering Core : 33 Cr</u></b>	
7600:106	Effective Public Speaking	3	4300:201	Statics	3
	<b><u>Social Science : 6 Cr</u></b>		4600:203	Dynamics	3
3250:244	Intro Economic Analysis	3	4400:230	Circuits I	3
	Elective : See Bulletin		4400:231	Circuits II	3
	<b><u>Humanities : 10 Cr</u></b>		4400:340	Circuits Lab	1
3400:210	Humanities Western Tradition	4	4400:243	Signal Analysis	3
3600:120	Introduction to Ethics	3	4450:208	Programming for Engineers	3
	Elective : See Bulletin		4400:363	Switching & Logic	4
	<b><u>Area Studies : 2 Cr</u></b>		4400:353	Electromagnetics I	3
	Elective : See Bulletin		4400:360	Physical Electronics	3
	<b><u>Physical Education : 1 Cr</u></b>		4600:305	Thermal Science	2
	Elective : See Bulletin		4200:305	Materials Science	2
	<b><u>Math &amp; Natural Sciences : 42 Cr</u></b>			<b><u>Biomedical Engineering : 27 Cr</u></b>	
3450:221	Analytical Geometry & Calculus I	4	4800:101	Tools for Biomedical Engineering	3
3450:221	Analytical Geometry & Calculus II	4	4800:111	Intro to BME Design	2
3450:221	Analytical Geometry & Calculus III	4	4800:305	Intro to Biophysical Measurements	3
3450:235	Differential Equations	3	4800:310	Modeling & Sim of Biomed Sys	3
3470:461	Applied Statistics	4	4800:420	Biomedical Signals & Image Proc	3
3150:151	Principals of Chemistry I	3	4800:325	Design of Medical Devices	3
3150:152	Principals of Chemistry I Lab	1	4800:430	Design of Medical Imaging Systems	3
3150:153	Principals of Chemistry II	3	4800:400	Biomaterials	3
3650:291	Elementary Classical Physics I	4	4800:491	BME Design I	2
3650:292	Elementary Classical Physics II	4	4800:492	BME Design II	2
				<b><u>BME Electives : 9 Credits</u></b>	