

**Program Request for Minor in Biomedical Engineering**

Department of Bioengineering  
College of Engineering  
March 10, 2006

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## **SECTION I: The Request**

### **The Request**

This proposal requests the establishment of an undergraduate Minor in Biomedical Engineering. The proposed minor will give students enrolled in other majors the opportunity to study topics in modern biomedical engineering that will enhance their educational horizons and broaden their potential employment opportunities. It will meet a recognized need within the College of Engineering to give students from several departments exposure to biological concepts and applications. It will also strengthen interdisciplinary ties between the respective departments.

### **Complete Program Description**

The proposed Minor in Biomedical Engineering has the following coursework requirements:

- Completion of both Biol 2020 – Cell Biology (3)  
and Math 2250 – Ordinary Differential Equations (3)
- Six (6) credit hours of courses from the Bioengineering Department in Category I (see Appendix A). These courses have an emphasis on a life-sciences component. (6)
- Seven (7) credit hours of courses from the Bioengineering Department in Category II (see Appendix B). These courses have an emphasis on an engineering component. (7)

***Total number of credit hours to complete the minor - 19***

Notes: All courses applied toward completion of the minor must be passed with a letter grade of C or better. Students are responsible for meeting the prerequisites for each class taken. Courses that are cross-listed between the Bioengineering Department and another department may be taken from either department to count toward the minor.

### **Purpose of the Degree**

Modern biomedical engineering is an excellent example of interdisciplinary study. By its nature, it relies upon interactions with many disciplines, such as electrical, mechanical and chemical engineering, materials science, chemistry, physics, math and biology. This minor will allow students in other majors the opportunity to learn selected bioengineering principles and applications to supplement their major field of study while remaining in their traditional fields. At graduation, it will give official transcript recognition of completion of the requirements for the minor.

## **Admission Requirements**

Students admitted to the minor program must be in good standing with their home department and with the University, as evidenced by a current DARS report. They must have a cumulative University of Utah earned grade point average (as listed on the DARS report) at least as high as the admissions GPA being applied to students admitted to major status in the Biomedical Engineering program during the year of application; this major admission GPA is posted on the Bioengineering Department website each year. Students apply for admission to the minor by submitting an application form (name, student ID, home and email address, current major, intended graduation date, and a preliminary list of proposed minor coursework) to the Bioengineering Department office.

## **Student Advising**

Upon admission, each student will be required to meet with the Department's minor program advisor to confirm the practicality and appropriateness of their preliminary program of study for the minor, including meeting the proper prerequisites for each class. Additional meetings with the advisor are encouraged when questions, problems or changes in the proposed coursework are encountered. One semester before graduation, the Department's designated graduation clearance official will confirm completion of the minor requirements.

## **Justification for Number of Credits**

The minimum number of credit hours required for this minor is 19, of which 13 are at the upper-division level. This meets the University's requirement for a minor as well as satisfying the criterion for a sufficient number of hours to justify official recognition of supplemental training in biomedical engineering topics.

## **External Review and Accreditation**

The program structure was developed internally and endorsed by the faculty of the Bioengineering Department since it was felt that this input provided appropriate perspective on the need and requirements for the minor. This minor is not intended to prepare students fully for practice as a biomedical engineer; students desiring such complete preparation must pursue the BS degree offered by the Department.

## **SECTION II: Program Need**

### **Program Necessity**

The undergraduate BS degree in Biomedical Engineering was instituted at Utah in fall 1999. It has been very popular, with between 93 and 113 students enrolling in the open-enrollment freshman Bioen 1101: Fundamentals of Bioengineering I course each year. Due to space limitations in the upper-division labs, upper-division Bioengineering courses are normally open only to students who have been admitted to major status leading to the BS degree based upon grade point average, currently about 40 students per year.

However, a number of other students in allied fields (electrical, mechanical, chemical and civil engineering, materials science, physics, math and biology) wish to

stay in their traditional fields but are interested in biological and medical applications of their disciplines. At present, they take courses *ad hoc*, with perhaps some direction from their respective departments but often in an uncoordinated manner. This minor will formalize the coursework guidelines for their supplemental study in biomedical engineering while still allowing some flexibility according to the particular background and interests of the students from these various majors.

Of particular importance in the minor's program is the introductory training in biology and physiology though the inclusion of the Cell Biology and courses with a life-sciences emphasis. Students from different disciplines often lack this exposure, especially those in engineering majors, yet this training is what sets bioengineering apart from traditional engineering fields. Also important is the training in mathematics through Ordinary Differential Equations, since such math is an important tool used by in the biomedical engineering field. The additional required classes give breadth and depth while also allowing some flexibility to meet the individual needs of the students.

### **Similar Programs**

There are approximately 118 institutions in the United States granting BS degrees in Biomedical Engineering or Bioengineering (as of 2006). Of these, the Whitaker Foundation listed 20 as offering minor programs. The average number of credit hours required in these minor programs is 21. Our proposed minor is in line with these programs both in the number of required hours and in the curriculum content, including the life-science component.

### **Benefits**

Students pursuing this option as well as the University as a whole will benefit from the minor program. Students will be able to pursue their interests in biomedical applications of engineering, and the College and University will experience increased interdisciplinary training that crosses departmental boundaries.

### **Consistency with Institutional Mission**

The proposed minor is consistent with the University's stated mission. In particular, this program "*encourages interdisciplinary work*" and facilitates "*the broad and liberal education of all its students and their familiarity with a changing world.*" It will be maintained at the high standard of academic and professional quality that is now present in the Biomedical Engineering BS program.

### **Coordination with Other Departments' Major Requirements**

Several departments within the College of Engineering already recognize specialization by their major students into bioengineering-related tracks. For example, the Mechanical Engineering Department offers a technical-elective option in Biomechanical Engineering that gives credit for some Bioengineering Department courses. In addition, several courses in the Bioengineering Department are cross-listed with participating departments, and can be counted toward the minor. Therefore, many students pursuing the proposed minor will likely receive partial credit toward this minor for some of the courses taken as part of their major. *The proposed minor program will*

*focus, codify and recognize the specialization in biomedical engineering topics without adding extensively to the time required to obtain the BS degree for many students. Appendix C gives details about the interaction of the minor requirements with the BS requirements for two example departments: the Electrical and Computer Engineering Department, and the Mechanical Engineering Department.*

### **SECTION III: Institutional Impact**

#### **Projected Enrollment**

The anticipated enrollment will be about 8-10 students/year, mostly from other departments (such as electrical, mechanical and chemical) in the College of Engineering. If the demand is extensive, exceeding the Department's ability to accommodate all minor students due to limited space in labs and classrooms, enrollment limitations may be instituted based upon grade point average.

#### **Expansion of Existing Program**

The Minor in Biomedical Engineering is not an expansion of existing programs and will not require any additional courses.

#### **Faculty**

No additional faculty will be required; current faculty and facilities can absorb the anticipated additional student load.

#### **Staff**

No additional staff will be required; current staff can meet the needs of the additional student load.

#### **Library**

Existing library materials and resources are adequate to meet the needs of this program.

#### **Other Learning Resources**

No additional learning resources are required to support this program.

### **SECTION IV: Finances**

#### **Budget**

No additional resources are required, either as new funding or reallocation of existing budgets.

**Appendix A – Category I Courses with Life-Sciences Emphasis  
Qualified for Inclusion in the Minor Program of Study**

BIOEN 3201	Biomolecular Engineering (4)
BIOEN 3202	Physiology for Engineers (4)
BIOEN 6000	Systemic Physiology I (3)
BIOEN 6010	Systemic Physiology II (3) (Cross-listed as PHYSL 6010)
BIOEN 6050	Cellular Physiology (3)
BIOEN 6140	Fundamentals of Tissue Engineering (2)
BIOEN 6230	Functional Anatomy for Engineers (3) (Meets with ME EN 7120)
BIOEN 6430	Systems Neuroscience (4) (Cross-listed as NEUSC 6050)
BIOEN 6440	Applied Neurophysiology (2)
BIOEN 6460	Electrophysiology and Bioelectricity (3)

**Appendix B – Category II Courses with Engineering Emphasis  
Qualified for Inclusion in the Minor Program of Study**

BIOEN 1101	Fund of Bioeng I (3)	-OR-	BIOEN 1102	Fund of Bioeng II (3)
BIOEN 5001	Biophysics (4)			
BIOEN 5090	Biophysical Chemistry (3) (Cross-listed as CHEM 3090)			
BIOEN 5101	Bioinstrumentation Signals and Systems (4)			
BIOEN 5201	Biomechanics (4)			
BIOEN 5301	Biomaterials (4) (Cross-listed as MSE 5040 and PHCEU 6020)			
BIOEN 5401	Medical Imaging Systems (3)			
BIOEN 5480	Ultrasound (3) (Cross-listed as ECE 5480)			
BIOEN 6422	Biomedical Applications of Micromachining (2) (Cross-listed as ECE 5222)			

## **Appendix C – Examples of Coordination with Other Departments' BS Requirements**

### **Electrical and Computer Engineering Department –**

To complete the requirements for the BS degree, students in the ECE Department must take 27 credit hours of technical electives, of which 21 must be ECE classes. Thus there are 6 technical-elective credit hours from outside the ECE Department that can be applied toward the minor requirements as well as the major requirements. The ECE Department automatically allows technical-elective credit for Biology 2020, which would account for 3 of these 6 hours. The other 3 hours might be taken from the Category I list. That leaves 3 hours required from the Category I list that would not apply toward the ECE major. Moreover, there are 2 courses that are cross-listed between the ECE Department and the Bioengineering Department that appear on the Category II list, so if these courses are taken, 5 hours of the Category II requirement would be satisfied by technical electives that also apply to the major requirements. In addition, the ECE Department requires Math 2250 of all students. Therefore, with careful planning an ECE undergraduate could obtain a Minor in Biomedical Engineering with two additional courses beyond what is required for the BS degree alone.

### **Mechanical Engineering Department –**

The ME Department requires that a student seeking the BS degree take 12 credit hours of technical electives, of which 6 must be completed within the Department. Thus there are 6 technical-elective credit hours from outside the ME Department that can be applied toward the minor requirements—for example toward the Category I or II requirements or the Biology 2020 requirement—as well as the major requirements, assuming that these 6 hours are allowed for ME technical-elective credit by petition. The ME Department requires Math 2250 of all students. There is one course that is cross-listed between the ME Department and the Bioengineering Department that appears on the Category I list. If this course is taken and assuming that all 6 technical-elective credits are allowed by petition, the requirements for the minor can be met by taking only two additional classes beyond what is required for the BS degree alone.

## Signature Page

Institution Submitting Proposal: University of Utah

College, School of Division affected: College of Engineering

Department(s) or Areas(s) affected: Department of Bioengineering

Change Description: Creation of an Undergraduate Minor in Biomedical Engineering

Proposed Beginning Date: Spring 2007

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Institutional Signatures (as appropriate):

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Richard Rabbitt, Department Chair

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Richard B. Brown, Dean

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Chief Academic Officer

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President

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Date