



- PUBLIC
- INDEPENDENT

NEW PROGRAM PROPOSAL FOR ROUTINE REVIEW

When finished, please save and email to: he.academicprogramactions@dhe.mo.gov

Sponsoring Institution:

Program Title: Biomedical Engineering

Degree/Certificate:

If other, please list:

Options:

Delivery Site: Columbia Campus

CIP Classification: 14.0501

Implementation Date: Fall 2018

Is this a new off-site location? Yes No

If yes, is the new location within your institution's current CBHE-approved service region?

**If no, public institutions should consult the comprehensive review process*


Is this a collaborative program? Yes No

**If yes, please complete the collaborative programs form on last page.*

CERTIFICATIONS

- The program is within the institution's CBHE approved mission. *(public only)*
- The program will be offered within the institution's CBHE approved service region. *(public only)*
- The program builds upon existing programs and faculty expertise
- The program does not unnecessarily duplicate an existing program in the geographically-applicable area.
- The program can be launched with minimal expense and falls within the institution's current operating budget. *(public only)*

AUTHORIZATION

Steve Graham, Sr. Assoc. Vice President		12/15/2017
Name/Title of Institutional Officer	Signature	Date

PROGRAM CHARACTERISTICS AND PERFORMANCE GOALS

Although all of the following guidelines may not be applicable to the proposed program, please carefully consider the elements in each area and respond as completely as possible in the format below.

Quantification of performance goals should be included wherever possible.

1. Student Preparation

- Any special admissions procedures or student qualifications required for this program which exceed regular university admissions, standards, e.g., ACT score, completion of core curriculum, portfolio, personal interview, etc. Please note if no special preparation will be required.

For the BS in Biomedical Engineering (BS BME) program, we will follow the MU and MU College of Engineering (CoE) admission processes and requirements. The requirements for freshman admission into MU CoE are an ACT Math score of at least 24, and an ACT Composite of at least 24 or a high school class rank in the upper 25 percent. Students who have not taken a college calculus course must take the math placement test ALEKS (Assessment and Learning in Knowledge Spaces). Beginning in Fall 2014, students admitted enter MU CoE as undeclared and work to complete a foundational curriculum consisting of math, science, and engineering courses during their first year. At least 12 hours of stipulated classes must be completed at MU, and upon completion of requirements, students will be evaluated for admittance into available degree programs. Students accepted into the new BS BME program must complete Calculus I, Calculus II, General Chemistry, and University Physics I. It is recommended that Biological Sciences I be completed. Direct admission to the BS BME program is available to students that meet the minimum requirements of ACT of 32, cumulative and in math, and are in the 10% of the high school class.

- Characteristics of a specific population to be served, if applicable.

Based on our own and peers' experiences, the BS BME program will attract the highest percentage (40-50%) of women among all engineering majors. Increasing women in STEM disciplines, in engineering in particular, has been a long-time national and institutional goal.

2. Faculty Characteristics

- Any special requirements (degree status, training, etc.) for assignment of teaching for this degree/certificate.

The Dept. of Bioengineering at MU currently (August 2017) has 15 full-time and 2 half-time (Assistant Teaching Professors) faculty members with teaching appointments. All the core required courses are covered. Thirteen of the current faculty have expertise in teaching technical elective courses in BME. The current technical electives offered in Bioengineering and other engineering departments provide courses for four tracks (focused areas of interest) in BME. Five new faculty members are expected to join the department during Fall 2017. These are joint hires with the MU School of Medicine and other units. Three of these new hires will be able to add new BME courses. At least half a dozen additional new faculty hires are expected next year. All existing or new faculty members have a PhD in BME or a closely-related discipline. All are active professionally. The two part-time positions will be phased out within the coming year and thus 100% of the credit hours in the major will be taught by full-time faculty.

- Estimated percentage of credit hours that will be assigned to full time faculty. Please use the term "full time faculty" (and not FTE) in your descriptions here.

100%.

- Expectations for professional activities, special student contact, teaching/learning innovation.

All faculty are in tenured or tenure-track positions and they are expected to be professionally active nationally and internationally. Each faculty member belongs to one or more professional organizations, and they will be actively engaged in research grant and journal paper reviews, professional services on and off campus and in the community. Faculty serve as mentors that provide career and professional guidance to students, mentor undergraduates for research, and mentor student design teams in the Capstone Design class. All faculty are expected to be engaged in the scholarship of teaching and learning. Some recent examples of teaching innovations the faculty have experimented include: adapting a creative thinking module developed in Theater teaching to foster creativity in the Capstone Design course, problem-based learning, and vertical integration of engineering techniques in a sequence of courses.

3. Enrollment Projections

- Student FTE majoring in program by the end of five years.

295

- Percent of full time and part time enrollment by the end of five years.

Part-Time: 1.69% Full-Time: 98.31%

STUDENT ENROLLMENT PROJECTIONS

YEAR	1	2	3	4	5
Full Time	250	260	270	280	290
Part Time	5	5	5	5	5
Total	255	265	275	285	295

4. Student and Program Outcomes

- Number of graduates per annum at three and five years after implementation.

Year	1	2	3	4	5
Degrees Awarded	50	55	60	65	65

- Special skills specific to the program.

Accreditation of the program by ABET (the accreditation organization for engineering, computer science, and technology programs) requires that the BS BME curriculum provide both breadth and depth across the range of engineering and science topics. More specifically, the curriculum should prepare graduates with experience in:

- applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations), and statistics;
 - solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;
 - analyzing, modeling, designing and realizing bio/biomedical engineering devices, systems, components, or processes; and
 - making measurements on and interpreting data from living systems.
- Proportion of students who will achieve licensing, certification, or registration.

All students are encouraged to take the Fundamentals of Engineering (FE) exam, the first step towards Professional Engineer (PE) licensure. PE licensure, however, is uncommon in the BME field and thus few students are expected to obtain PE registration. The FE test is used as a nationally-normed exam for program assessment (see below).

- Performance on national and/or local assessments, e.g., percent of students scoring above the 50th percentile on normed tests; percent of students achieving minimal cut-scores on criterion-referenced tests. Include expected results on assessments of general education and on exit assessments in a particular discipline as well as the name of any nationally recognized assessments used.

Program performance will be assessed regularly through the ABET process. ABET accreditation requires that each program has defined *program educational objectives* (PEOs) and *student outcomes* (SOs). The SOs are to be regularly assessed and evaluated to assure attainment of the PEOs. The PEOs and the SOs for the program are as follows.

The PEOs are that graduates of the BS in biomedical engineering program will, within 3-5 years of graduation:

- 1) Show proficiency in quantitative analysis, engineering design and development.
- 2) Interact effectively with life science and other professionals.
- 3) Leverage principles of biological and engineering sciences for the design and development of innovative systems.
- 4) Demonstrate leadership and professionalism as they continually add value to their chosen field of endeavor.
- 5) Succeed in advanced study in engineering, medicine or other fields, if pursued.

To attain the PEOs, students will achieve the following SOs, by the time of graduation:

- a. an ability to apply knowledge of mathematics, science and engineering;
- b. an ability to design and conduct experiments, as well as to analyze and interpret data;
- c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
- d. an ability to function on multi-disciplinary teams;
- e. an ability to identify, formulate and solve engineering problems;
- f. an understanding of professional and ethical responsibility;
- g. an ability to communicate effectively;
- h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
- i. a recognition of the need for, and an ability to engage in, life-long learning;
- j. a knowledge of contemporary issues;

- k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice; and
- l. an ability to integrate engineering and biological sciences in developing systems and processes to fulfill unmet needs in medicine and human health.

The ABET process for continuous improvement entails that the SOs be regularly assessed and evaluated to ensure attainment of the long-term student performance goals defined by the PEOs. Each PEO is supported by one or more SOs and each SO may support one or more PEOs. The SO assessment/evaluation process involves three *yearly* steps: (1) data collection (assessment), (2) data analysis (evaluation), and (3) design of improvement actions (loop closing).

SO Data Collection

The following instruments are used to collect SO data on a yearly basis:

- *Course-based Assessment*: Each engineering course in the major is designed to address a number of SOs and is assigned to assess one or more SOs most closely related to the course. The instructor chooses a method (such as a specific exam, class project; or homework) most suitable to an SO and the course. All instructors use a commonly defined and understood numerical scale.
- *Exit Survey*: We conduct an exit survey of all the graduating seniors every semester. The survey consists of sixty-one wide-ranging questions, including those designed for students to assess their own attainment of the SOs.
- *Fundamentals of Engineering (FE) Exam*: The FE is a nationally-normed exam. We use the FE data as direct measures of a subset of SOs.

SO Data Analysis

The SO data are tabulated and analyzed every year. We use several statistical procedures to characterize the data, perform detailed comparisons, and discuss trends and changes. Data from different instruments may be analyzed separately or in a composite form. We have found that systematic and continuing graphical analysis of the SO data facilitates the discussions. In this context, we maintain Statistical Quality Control (SQC) charts for each outcome using historical data.

Continuous Improvement

From SO data analysis, we determine the level of attainment of each SO with respect to a minimum target score and spot trends and variations in the SO. The faculty then discuss the possible reasons for any lowered level of attainment, an undesirable trend, or an unexpected change; and design a set of actions, if necessary, in terms of course content modification, course restructuring, or enrichment activities. These actions are implemented for continuous improvement of the program (closing the loop).

Nationally-Normed Exam

Students are encouraged to take the Fundamentals of Engineering (FE) exam during the senior year as their first step towards licensure as a Professional Engineer (PE). As mentioned above, student performance in this nationally-normed exam is part of the SO data we collect and evaluate every year. Our assessment scale is defined such that the minimum acceptable passing rate for the first attempt is 60%. Our actual passing rate has been averaging at approximately 80%.

- Placement rates in related fields, in other fields, unemployed.

As a track in our Biological Engineering (BE) program, the BME student placement rate six months after graduation has been between 85-90%, including approximately 30% of the graduates going to medical school, graduate school, pharmacy school, or law school. Nearly all students are placed in fields related to their education. We expect similar rates or percentages to continue.

- Transfer rates, continuous study.

Since the College of Engineering has a common freshmen year, the transfer rates are expected to be generally low. As a track in the BE program, we have a few students transferring in, mostly from other engineering programs, but some from other majors at MU or other institutions. A few transfer out, usually into other engineering majors.

5. Program Accreditation

- Institutional plans for accreditation, if applicable, including accrediting agency and timeline. If there are no plans to seek specialized accreditation, please provide rationale.

Immediately upon approval of the proposed program, we will start the process to seek ABET accreditation of the BS BME program. ABET is the accreditation organization for engineering, computer science, and technology programs.

Our BS program in Biological Engineering has been successfully accredited for multiple cycles. Through the process, we have had the necessary knowledge and an established system for what is required for successful engineering program accreditation. All engineering programs follow the same process of continuous improvement to achieve accreditation. We anticipate no issues with obtaining expeditious accreditation of the BS BME program.

6. Program Structure

A. Total credits required for graduation: 126

B. Residency requirements, if any:

C. General education: Total credits:
21 credit hours of general education courses.

Courses (specific courses OR distribution area and credits)

Course Number	Credits	Course Title
	9	Behavioral and Social Science (Including Economics and American History or Government)
	3	English 1000 – Exposition and Argumentation
	9	Humanities and Fine Arts (from approved list)

D. Major requirements: Total credits: 102

Course Number	Credits	Course Title
	19	Math and Statistics
	28	Basic Sciences
	14	Basic Engineering
	18	Biomedical Engineering

	24	Technical Electives
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E. Free elective credits: 3
(sum of C, D, and E should equal A)

F. Requirements for thesis, internship or other capstone experience:

A major engineering design experience is required. Two required courses provide this experience. In BE 4980 (Capstone Design), students complete an engineering design project and each design team is mentored by a faculty member. In BE 4380 (Instrumentation), student teams design and implement a computerized system to meet certain specifications as a class project.

G. Any unique features such as interdepartmental cooperation:

[Click here to enter text](#)

7. Need/Demand

Student demand

Market demand

Societal demand

I hereby certify that the institution has conducted research on the feasibility of the proposal and it is likely the program will be successful.

On July 1, 2011, the Coordinating Board for Higher Education began provisionally approving all new programs with a subsequent review and consideration for full approval after five years.

COLLABORATIVE PROGRAMS

- **Sponsoring Institution One:**
- **Sponsoring Institution Two:**
- **Other Collaborative Institutions:**
- **Length of Agreement:**
- **Which institution(s) will have degree-granting authority?**
- **Which institution(s) will have the authority for faculty hiring, course assignment, evaluation and reappointment decisions?**
- **What agreements exist to ensure that faculty from all participating institutions will be involved in decisions about the curriculum, admissions standards, exit requirements?**
- **Which institution(s) will be responsible for academic and student-support services, e.g., registration, advising, library, academic assistance, financial aid, etc.?**
- **What agreements exist to ensure that the academic calendars of the participating institutions have been aligned as needed?**

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