

# UNIVERSITY FACULTY SENATE FORMS

## Academic Program Approval

This form is a routing document for the approval of new and revised academic programs. Proposing department should complete this form. Detailed instructions for the proposal should be followed. A [checklist](#) is available to assist in the preparation of a proposal. For more information, call the Faculty Senate Office at 831-2921.

**Submitted by:** Jeannie Stephens phone number 302-831-6774

**Department:** Biomedical Engineering email address jss@udel.edu

**Date:** November 17, 2014

**Action:** Modify Bachelor of Biomedical Engineering degree program  
(Example: add major/minor/concentration, delete major/minor/concentration, revise major/minor/concentration, academic unit name change, request for permanent status, policy change, etc.)

**Effective term** 15F  
(use format 04F, 05W)

**Current degree** BBE  
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

**Proposed change leads to the degree of:** BBE  
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

**Proposed name:** N/A  
Proposed new name for revised or new major / minor / concentration / academic unit  
(if applicable)

### Revising or Deleting:

**Undergraduate major / Concentration:** Biomedical Engineering  
(Example: Applied Music – Instrumental degree BMAS)

**Undergraduate minor:** \_\_\_\_\_  
(Example: African Studies, Business Administration, English, Leadership, etc.)

**Graduate Program Policy statement change:** \_\_\_\_\_  
(**Must attach** your Graduate Program Policy Statement)

**Graduate Program of Study:** \_\_\_\_\_  
(Example: Animal Science: MS Animal Science: PHD Economics: MA Economics: PHD)

**Graduate minor / concentration:** \_\_\_\_\_

**Note: all graduate studies proposals must include an electronic copy of the Graduate Program Policy Document, either describing the new program or highlighting the changes made to the original policy document.**

**List new courses required for the new or revised curriculum. How do they support the overall program objectives of the major/minor/concentrations)?**  
(Be aware that approval of the curriculum is dependent upon these courses successfully passing through

the [Course Challenge](#) list. If there are no new courses enter “None”)

We propose the changes that are outlined below, followed by a more detailed description with the context for how they support the overall program objectives.

1. **Remove** as required courses: BISC208, CHEM322, CHEM527, MSEG460, BMEG479, CHG404
2. **Add new** required courses:
  - a. BMEG211 Cell & Tissue Laboratory (2-cr)
  - b. BMEG340 Biomedical Modeling and Simulations (3-cr)
  - c. **BMEG341 Research Methods for Biomedical Engineering (3-cr)**
  - d. BMEG360 Biomedical Engineering Junior Design (2-cr)
3. **Revise** required courses:
  - a. BMEG320 Biological Transport Phenomena (3-cr) to BMEG420 (4-cr) including a discussion section
  - b. BMEG401 Systems Physiology I to BMEG301 Quantitative Cellular Physiology
  - c. BMEG402 Systems Physiology II to BMEG302 Quantitative Systems Physiology
  - d. BMEG101 to add a discussion section
4. **Align timing** of CHEM103 General Chemistry I and BISC207 Introduction to Biology I for the integrated CHEM103/BISC207 sequence.
5. **Update** the list of technical electives

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1. **Remove** as required courses: BISC208, CHEM322, CHEM527, MSEG460, BMEG479, CHEG404

After a comprehensive review of the Biomedical Engineering curriculum across 25 departments nationwide, we noted that our students are taking twice as many biology and chemistry course as compared to other BME programs. In order to effectively train BME students as engineers we will offer more core BME courses and start them during sophomore year. The limited engineering content in the current curriculum was also a concern that ABET recognized **and which is addressed in this curriculum revision**. Of the courses being removed as required courses, most will be allowed as elective courses.

BMEG479 (Introduction to Medical Imaging) and MSEG460 (Biomaterials & Tissue Engineering) are currently required core BME courses. **The BME faculty agreed these are excellent courses, yet not essential for all graduates with a BME degree, thus these will be removed as required core courses**. Both will be allowed as BME-technical electives. A BME student will be encouraged to take these courses if they are in her/his interest area. The current curriculum requires CHEG404, which has limited coverage of practical applications for biomedical engineers, so it will be removed. BISC208 (Introductory Biology II), CHEM322 (Organic Chemistry II), and CHEM527 (Introduction to Biochemistry) are currently required foundational science courses. **The BME faculty agreed that BISC208, CHEM322, and CHEM527 are excellent courses, yet these are also not essential for all graduates with a BME degree, thus they were removed as required courses and allowed as STEM-technical electives**. For example the syllabus for BISC208 focuses largely on plant biology, not essential for biomedical engineers. Two semesters of organic chemistry plus a semester of biochemistry is not required by any of the top 25 biomedical engineering departments. Thus after the faculty reviewed the syllabi they decided that these courses are not essential for all graduates with a BME degree. A student will be encouraged to take these courses if they are within the student’s interest area or if the student is planning to apply to medical school. The technical elective choices will make this possible without increasing the number of credits to graduate.

2. **Add new** required courses:
  - a. **BMEG211 Cell & Tissue Laboratory (2-cr Fall-Sopho)**: This laboratory course will teach BME students the fundamentals of cell culture for use in Biomedical Engineering investigations. Students will acquire skills in aseptic cell culture techniques, standard test methods, quantitative analysis, notebook keeping, report writing and oral presentation.
  - b. **BMEG340 Biomedical Modeling and Simulations (3-cr Fall-Jr)**: This course is the first in a two-part sequence with BMEG341. This course will cover mathematical models of biomedical processes and experiments. The topics include unit analysis, exponential growth and decay, half-life, exponential vs. age-structured death models, sigmoidal growth models,

sigmoidal effect models including Michaelis-Menten and Hill Curves, and MATLAB will be used to run simulations of all of the above.

- c. **BMEG341 Research Methods for Biomedical Engineering (3-cr Spring-Jr):** This course is the second in a two-part sequence with BMEG340. This course introduces biomedical engineering undergraduate students to the fundamental principles and techniques involved in the design, execution, and interpretation of biomedical research experiments. In addition to introducing students to analytical techniques used for biomedical data and training them how to properly communicate experimental results, this course provides students with an understanding of their professional and ethical responsibilities as biomedical engineers.
  - d. **BMEG360 Biomedical Engineering Junior Design (2-cr Spring-Jr):** In this course biomedical engineering students work on team-oriented design project to solve real-world biomedical engineering problems from industrial and clinical settings. The students will incorporate engineering standards and realistic design constraints, including relevant regulatory, intellectual property, and business management topics.
3. **Revise** required courses:
- a. **BMEG320 Biological Transport Phenomena (3-cr) to BMEG420 (4-cr), including a discussion section:** We currently require BMEG320 Biological Transport Phenomena as a BME required course (3-cr, Spring-Jr). The content of this course and the extent that engineering problem solving that is performed resulted in the faculty suggesting the number of credits increased to 4 (3 hours of lecture and 1 hour of discussion) and the course be renumbered to BMEG420 to reflect the technical rigor of the course.
  - b. **BMEG401 Systems Physiology I (3-cr, Fall-Jr) to BMEG301 Quantitative Cellular Physiology (3-cr, Fall-Sopho):** We currently require BMEG401 as a BME required course in Junior year. Quantitative physiology is central to the education of Biomedical Engineers. To best educate our students, we will re-number and re-name this course and offer it during Sophomore year.
  - c. **BMEG402 Systems Physiology II (3-cr, Spring-Jr) to become BMEG302 Quantitative Systems Physiology (3-cr, Spring-Sopho):** We currently require BMEG402 as a BME required course in Junior year. Quantitative physiology is a central to the education of Biomedical Engineers. To best educate our students, we will re-number and re-name this course and offer it during Sophomore year.
  - d. **BMEG101 Introduction to Biomedical Engineering to add a discussion section (2-cr, Fall-Fresh).** BMEG101 is a two-credit course that serves as the FYE course. This course is delivered as 1-hour lecture and 1-hour discussion, however, the catalog lists it as 2 lectures. This change is to reflect this delivery method (1-hour lecture, 1-hour discussion) within the course catalog.
4. **Align timing** of CHEM103 General Chemistry I and BISC207 Introduction to Biology I for the integrated CHEM103/BISC207 sequence.

BME students will take the integrated CHEM103/BISC207 course instead of the separate CHEM103 and BISC207 courses. The interdisciplinary nature of BME and the integrated CHEM/BISC delivery will provide a strong foundation for the BME students. Additionally there is positive student feedback regarding the integrated courses and the strong commitment from both CHEM & BISC encouraging the addition of BME to this curriculum.

5. **Update** the list of technical electives

In the proposed Biomedical Engineering curriculum the number of technical electives will increase from 3 technical electives (9-credits) to 6 technical electives (18-credits). The technical electives will be distributed in the following manner:

- 2 BME-technical electives will be required from the BME-technical elective lists (upper level BME course)
- 1 Engineering (ENG)-technical electives will be required from the ENG-technical electives list (which can include BME-technical electives & one BME independent study)
- 3 STEM-technical electives from the STEM-technical elective list (which can include BME, one BME independent study, & ENG tech electives).

**Supply support letter from the Library, Dean, and/or Department Chair if needed**

(all new majors/minors will need a support letter from the appropriate administrator.)

- Chemistry and Biochemistry: Integrated CHEM/BIO
- Biological Sciences: Integrated CHEM/BIO course and associated move of BISC207 to fall
- Computer and Information Science: CISC for moving from Fall-Fresh to Spring-Fresh
- Chemical and Biomolecular Engineering: for removal of CHEG404
- Materials Science and Engineering: for switch MSEG460 from required to tech elective

**Supply support letter from the Library, Dean, and/or Department Chair if needed**

(all new majors/minors will need a support letter from the appropriate administrator.)

**Supply a resolution for all new majors/programs; name changes of colleges, departments, degrees; transfer of departments from one college to another; creation of new departments; requests for permanent status. [See example of resolutions.](#)**

**Explain, when appropriate, how this new/revised curriculum supports the 10 goals of undergraduate education: <http://www.ugs.udel.edu/gened/>**

The BME BBE curriculum addresses the 10 general education goals of the University. Specifically, students are required to learn how to write reports effectively (GOAL 1), think critically and solve problems (GOAL 2), as that is an important part of engineering, and work independently and work in teams (GOAL 3). They are taught ethical behavior as part of BMEG101 and PHIL444 (GOAL 4), understand diverse thinking throughout their breadth requirements (GOAL 5), and are encouraged to expand their intellectual curiosity to other fields through open-ended projects (GOAL 6). The senior design capstone experience integrates the student knowledge with experiences that extend the boundaries of the classroom and expands understanding and appreciation for human creativity (GOAL 7 and 8). The field of biomedical engineering and our educational approach, which applies engineering principles to the study of biology, medicine, and health, requires an understanding of the US society and the global society, as it is within these diverse cultures and societies that different health issues arise (GOAL 9 and 10).

**Identify other units affected by the proposed changes:**

(This would include other departments/units whose courses are a required part of the proposed curriculum. Attach permission from the affected units. If no other unit is affected, enter “None”)

- Chemistry and Biochemistry: Integrated CHEM/BIO course in the fall; Students will no longer be required to take CHEM322 or CHEM527. We expect that approximately 15% of our students planning to attend medical school will still take these courses, reducing the annual BME enrollment from 55 to 15.
- Biological Sciences: Integrated CHEM/BIO course and associated move of BISC207 to fall; Students will no longer be required to take BISC208. We expect that approximately 15% of our students planning to attend medical school will still take these courses, reducing the annual BME enrollment from 55 to 15.
- Computer and Information Science: CISC106 will move from Fall-Fresh to Spring-Fresh
- Chemical and Biomolecular Engineering: Students will no longer be required to take CHEG404, which will reduce the class size by 55 students.
- Materials Science and Engineering: Students will no longer be required to take MSEG460 and it will remain as a technical elective. This should reduce the class size by about 25 students

**Describe the rationale for the proposed program change(s):**

(Explain your reasons for creating, revising, or deleting the curriculum or program.)

Following the first graduating class with a Bachelor's degree in Biomedical Engineering (BBE) in May 2014, the BME faculty conducted a curriculum retreat that included a comprehensive review of our program educational outcomes, student outcomes, and assessment data. Simultaneously, the BBE degree underwent review for ABET accreditation. Internal observations during the self-study preparation and external feedback during the on-site evaluation visit informed the curriculum review. The results of the faculty retreat, ABET review, and follow-up committee and faculty meetings resulted in this curriculum change.

These curriculum changes allow Biomedical Engineering the opportunity to effectively educate the BME students to address the needs of the biomedical engineering industry and research communities. Additionally these changes increase the minimum number of engineering credits that BME offers from 52, which is the close to the ABET minimum, to 57. The other departments within the College of Engineering offer an average of 61 engineering credits.

In an effort to offer more BME engineering content earlier in the curriculum, several courses have been moved to the technical elective list in order to teach foundation courses in Biomedical Engineering. Three BME-core courses will be offered sophomore year.

The added required courses were deemed critical core content for all students receiving a biomedical engineering education. Biomedical engineers need the fundamentals of experimental design and analysis for careers in research, medicine or industry. These courses are part of the core BMEG curriculum and will be taught with a series of applied problems in biomedical engineering.

### **Program Requirements:**

(Show the new or revised curriculum as it should appear in the Course Catalog. If this is a revision, be sure to indicate the changes being made to the current curriculum and **include a side-by-side comparison** of the credit distribution before and after the proposed change.) [See example of side by side.](#)

**DEGREE: BACHELOR OF BIOMEDICAL ENGINEERING**  
**MAJOR: BIOMEDICAL ENGINEERING**

**CURRICULUM** **CREDITS**

Parenthesized figures indicate year (1 = freshman, 2 = sophomore, 3 = junior, 4 = senior) and semester (F = fall, S = spring).

**UNIVERSITY REQUIREMENTS**

|   |     |
|---|-----|
| <a href="#">ENGL 110</a> Critical Reading and Writing (minimum grade C-) 3 (1S) |     |
| <a href="#">First Year Experience</a> (FYE)                                     | 0-4 |
| <a href="#">Breadth Requirements</a>  | 12  |
| <a href="#">Discovery Learning Experience</a> (DLE)                             | 3   |
| <a href="#">Multicultural Course(s)</a>   | 3   |

**MAJOR REQUIREMENTS**

College of Engineering Breadth Requirements 21  
 The College of Engineering requires 21 total Breadth Requirement credits (essentially 9 credits in addition to the University Breadth requirement.)

- If chosen carefully, up to 3 credits from each of the University Breadth Requirement categories may be used to simultaneously satisfy the College of Engineering Breadth Requirements for this major.
- Of the 21 credits, 6 credits must be at the Upper Level (usually 300-level or higher) as designated on the College of Engineering Breadth Requirement list.
- Of the 21 credits, 3 credits may be used to satisfy the University Multicultural Requirement (recommended for timely progress toward degree completion.)
- All Breadth Requirement coursework must be passed with a minimum grade of C-.

**Core Courses**

|   |        |
|---|--------|
| <a href="#">BISC 207</a> Introductory Biology I                       | 4 (1S) |
| <a href="#">BISC 208</a> Introductory Biology II                      | 4 (2F) |
| <a href="#">BMEG 101</a> Introduction to Biomedical Engineering (FYE) | 2 (1F) |
| <a href="#">BMEG 310</a> Bioengineering Mechanics                     | 4 (3F) |
| <a href="#">BMEG 311</a> Bioengineering Mechanics II                  | 3 (3S) |
| <a href="#">BMEG 320</a> Biological Transport Phenomena               | 3 (3S) |
| <a href="#">BMEG 330</a> Biomedical Instrumentation                   | 4 (3S) |
| <a href="#">BMEG 401</a> Systems Physiology I                         | 3 (3F) |
| <a href="#">BMEG 402</a> Systems Physiology II                        | 3 (3S) |
| <a href="#">BMEG 450</a> Biomedical Engineering Design (DLE)          | 6 (4F) |
| <a href="#">BMEG 479</a> Intro to Medical Imaging Systems             | 3 (4S) |
| <a href="#">CHEG 404</a> Probability and Statistics for Engineers     | 3 (3S) |
| <a href="#">CHEM 103</a> General Chemistry I                          | 4 (1F) |
| <a href="#">CHEM 104</a> General Chemistry II                         | 4 (1S) |
| <a href="#">CHEM 321</a> Organic Chemistry I                          | 4 (2F) |
| <a href="#">CHEM 322</a> Organic Chemistry II                         | 4 (2S) |
| <a href="#">CHEM 527</a> Introduction to Biochemistry                 | 3 (3F) |
| <a href="#">CISC 106</a> General Computer Science for Engineers       | 3 (1F) |
| <a href="#">ELEG 305</a> Signals and Systems                          | 3 (2S) |
| <a href="#">MATH 241</a> Analytic Geometry and Calculus A             | 4 (1F) |
| <a href="#">MATH 242</a> Analytic Geometry and Calculus B             | 4 (1S) |
| <a href="#">MATH 243</a> Analytic Geometry and Calculus C             | 4 (2F) |
| <a href="#">MATH 305</a> Applied Mathematics for Chemical Engineers   | 3 (2S) |
| <a href="#">MSEG 302</a> Materials Science for Engineers              | 3 (3F) |
| <a href="#">MSEG 460</a> Biomaterials and Tissue Engineering          | 3 (4F) |
| <a href="#">PHIL 444</a> Medical Ethics                               | 3 (4S) |
| <a href="#">PHYS 207</a> Fundamentals of Physics I                    | 4 (2F) |
| <a href="#">PHYS 208</a> Fundamentals of Physics II                   | 4 (2S) |

**TECHNICAL ELECTIVES**

Students must take 9 credits (usually 3 courses) of Technical Electives. Technical electives in the Bachelor of Biomedical Engineering curriculum provide the students with an opportunity to pursue areas of particular interest. Because of the breadth of technical areas in which biomedical engineers work, the approved list of technical electives include upper level courses across departments:

At least two courses must be selected from the College of Engineering: Biomedical Engineering: BMEG 350, 400-699

**DEGREE: BACHELOR OF BIOMEDICAL ENGINEERING**  
**MAJOR: BIOMEDICAL ENGINEERING**

**CURRICULUM** **CREDITS**

Parenthesized figures indicate year (1 = freshman, 2 = sophomore, 3 = junior, 4 = senior) and semester (F = fall, S = spring).

**UNIVERSITY REQUIREMENTS**

|   |     |
|---|-----|
| <a href="#">ENGL 110</a> Critical Reading and Writing (minimum grade C-) 3 (1S) |     |
| <a href="#">First Year Experience</a> (FYE)                                     | 0-4 |
| <a href="#">Breadth Requirements</a>  | 12  |
| <a href="#">Discovery Learning Experience</a> (DLE)                             | 3   |
| <a href="#">Multicultural Course(s)</a>   | 3   |

**MAJOR REQUIREMENTS**

College of Engineering Breadth Requirements 21  
 The College of Engineering requires 21 total Breadth Requirement credits (essentially 9 credits in addition to the University Breadth requirement.)

- If chosen carefully, up to 3 credits from each of the University Breadth Requirement categories may be used to simultaneously satisfy the College of Engineering Breadth Requirements for this major.
- Of the 21 credits, 6 credits must be at the Upper Level (usually 300-level or higher) as designated on the College of Engineering Breadth Requirement list.
- Of the 21 credits, 3 credits may be used to satisfy the University Multicultural Requirement (recommended for timely progress toward degree completion.)
- All Breadth Requirement coursework must be passed with a minimum grade of C-.

**Core Courses**

|  |                   |
|--|-------------------|
| <a href="#">BISC 207</a> Introductory Biology I                              | 4 (1F)            |
| <del><a href="#">BISC 208</a> Introductory Biology II</del>                  | <del>4 (2F)</del> |
| <a href="#">BMEG 101</a> Introduction to Biomedical Engineering (FYE)        | 2 (1F)            |
| <a href="#">BMEG 211</a> Cell and Tissue Laboratory                          | 2 (2F)            |
| <a href="#">BMEG 301</a> Quantitative Cellular Physiology                    | 3 (2F)            |
| <a href="#">BMEG 302</a> Quantitative Systems Physiology                     | 3 (2S)            |
| <a href="#">BMEG 310</a> Bioengineering Mechanics                            | 4 (3F)            |
| <a href="#">BMEG 311</a> Bioengineering Mechanics II                         | 3 (3S)            |
| <del><a href="#">BMEG 320</a> Biological Transport Phenomena</del>           | <del>3 (3S)</del> |
| <a href="#">BMEG 330</a> Biomedical Instrumentation                          | 4 (3F)            |
| <a href="#">BMEG 340</a> Biomedical Modeling & Simulation                    | 3 (3F)            |
| <a href="#">BMEG 341</a> Research Methods for Biomedical Engineering         | 3 (3S)            |
| <a href="#">BMEG 360</a> Biomedical Engineering Junior Design                | 2 (3S)            |
| <del><a href="#">BMEG 401</a> Systems Physiology I</del>                     | <del>3 (3F)</del> |
| <del><a href="#">BMEG 402</a> Systems Physiology II</del>                    | <del>3 (3S)</del> |
| <a href="#">BMEG 420</a> Biological Transport Phenomena                      | 4 (3S)            |
| <a href="#">BMEG 450</a> Biomedical Engineering Design (DLE)                 | 6 (4F)            |
| <del><a href="#">BMEG 479</a> Intro to Medical Imaging Systems</del>         | <del>3 (4S)</del> |
| <del><a href="#">CHEG 404</a> Probability and Statistics for Engineers</del> | <del>3 (3S)</del> |
| <a href="#">CHEM 103</a> General Chemistry I                                 | 4 (1F)            |
| <a href="#">CHEM 104</a> General Chemistry II                                | 4 (1S)            |
| <a href="#">CHEM 321</a> Organic Chemistry I                                 | 4 (2F)            |
| <del><a href="#">CHEM 322</a> Organic Chemistry II</del>                     | <del>4 (2S)</del> |
| <del><a href="#">CHEM 527</a> Introduction to Biochemistry</del>             | <del>3 (3F)</del> |
| <a href="#">CISC 106</a> General Computer Science for Engineers              | 3 (1S)            |
| <a href="#">ELEG 305</a> Signals and Systems                                 | 3 (2S)            |
| <a href="#">MATH 241</a> Analytic Geometry and Calculus A                    | 4 (1F)            |
| <a href="#">MATH 242</a> Analytic Geometry and Calculus B                    | 4 (1S)            |
| <a href="#">MATH 243</a> Analytic Geometry and Calculus C                    | 4 (2F)            |
| <a href="#">MATH 305</a> Applied Mathematics for Biomed, Chem Engg           | 3 (2S)            |
| <a href="#">MSEG 302</a> Materials Science for Engineers                     | 3 (3F)            |
| <del><a href="#">MSEG 460</a> Biomaterials and Tissue Engineering</del>      | <del>3 (4F)</del> |
| <a href="#">PHIL 444</a> Medical Ethics                                      | 3 (4S)            |
| <a href="#">PHYS 207</a> Fundamentals of Physics I                           | 4 (2F)            |
| <a href="#">PHYS 208</a> Fundamentals of Physics II                          | 4 (2S)            |

**TECHNICAL ELECTIVES**

Students must take 18 credits (usually 6 courses) of Technical Electives. Technical electives in the Bachelor of Biomedical Engineering curriculum provide the students with an opportunity to pursue areas of particular interest.

Chemical Engineering: CHEG 325, 326, 400-699 (except 404, 595)  
Civil and Environmental Eng: CIEG 301, 302, 305, 311, 331, 351, 400-699  
Computer and Information Sciences: 181, 220, 260, 275, 280, 303, 304, 310, 320, 360, 361, 400-699  
Computer Engineering: CPEG 202, 222, 400-699  
Electrical Engineering: ELEG 306, 320, 400-699  
Materials Science and Engineering: MSEG 400-699 (except 420, 425, 443)  
Mechanical Eng: MEEG 300-699 (except 483)

Additional courses **may** be selected from other departments:

Biology: BISC 400-699  
Chemistry: CHEM 322, 400-699 (except 527)  
Kinesiology and Applied Physiology: KAAP 220, 309, 428, 430  
Mathematics: MATH 315, 352 or 353, 389, 400-699  
Medical Laboratory Sciences: MEDT 360, 390, 401, 403, 406  
Neuroscience: NSCI 320  
Physics: PHYS 309, 310, 313, 400-699  
Statistics: STAT 400-699  
Thesis: UNIV 401, 402 (topic must be approved by academic advisor)

Additional upper-level and graduate-level courses may also be approved by the academic advisor. An independent study project approved by the academic advisor (3 credits) can also count as a technical elective.

**CREDITS TO TOTAL A MINIMUM OF 126**

Technical electives must meet the following criteria: (1) primarily technical, (2) have a skill or theory component, and (3) be above the introductory level or have a high technical rigor. Because of the breadth of technical areas in which biomedical engineers work, the approved list of technical electives include upper level courses across departments:

**At least two courses (6 credits) must be selected from Biomedical Biomedical Engineering Technical Elective List:**

BMEG350 Clinical Immersion for Engineers  
BMEG411 Advanced Techniques in Cell & Tissue  
BMEG461/661 Cell Engineering  
BMEG462/662 Engineering Biomedical Nanostructures  
BMEG463/663 Mechanotransduction  
BMEG464 Medical Device Development, Bench to Bedside  
BMEG479 Introduction to Medical Imaging Systems  
BMEG665 Tissue Biomechanics and Modeling  
MSEG460/660 Biomaterials and Tissue Engineering  
ELEG471/671 Mathematical Physiology (cross listed w/ BMEG) (excluding BMEG366/466)

**At least one course (3 credits) must be selected from Engineering (or BME list above):**

Biomedical Engineering: BMEG366/466  
Chemical Engineering: CHEG 325, 400-699 (except 473, 474, 595)  
Civil and Environmental Eng: CIEG 301, 302, 305, 311, 331, 351, 400-699 (exclude CIEG 466)  
Computer and Information Sciences: 181, 220, 260, 275, 280, 303, 304, 310, 320, 360, 361, 400-699  
Computer Engineering: CPEG 202, 222, 323, 400-699  
Electrical Engineering: ELEG 205, 302, 303, 305, 306, 309, 310, 312, 320, 340 400-699 (except 491)  
Materials Science and Engineering: MSEG 400-699 (except 420, 425, 443, 466, 615)  
Mechanical Engineering: MEEG 202, 300-699 (except 401, 432, 435, 442, 483)

**Additional technical elective courses (3 course, 9 credits) may be selected from the STEM (Science, Technology, Engineering and Math) courses below (or any engineering courses from lists above):**

Biomedical Engineering: BMEG366/466  
Biology: BISC 208, 300, 302, 312 BISC 400-699 (exclude 402, 422, 451, 452, 468, 510, 530, 603, 631)  
Chemistry: CHEM 322, 400-699 (exclude 402, 410, 465, 466, 467, 468, 566, 608, 666)  
Kinesiology and Applied Physiology: KAAP 220, 309, 428, 430  
Mathematics: MATH 315, 352 or 353, 389, 400-699 (exclude 580-591)  
Medical Laboratory Sciences: MEDT 360, 390, 401, 403, 406, 440  
Neuroscience: NSCI 320  
Physics: PHYS 309, 310, 313, 400-699  
Statistics: STAT 400-699  
Thesis: UNIV 401, 402 (topic must be approved by faculty advisor)

Students may take up to 6-credits of Independent Study (BMEG366/466) as ENG and STEM technical electives. The independent study project must be approved and formally submitted by Undergraduate Director to count as a technical elective. Additional upper-level and graduate-level courses may also be approved by the Undergraduate Director.

**CREDITS TO TOTAL A MINIMUM OF 126**

**ROUTING AND AUTHORIZATION:** (Please do not remove supporting documentation.)

Department Chairperson \_\_\_\_\_ Date \_\_\_\_\_

Dean of College \_\_\_\_\_ Date \_\_\_\_\_

(By signing above, the Dean confirms that their college policies and bylaws have been followed correctly during consideration of the request described in this form.

The approval actions that were taken at the college level were (check all that apply) :

\_\_\_\_\_ college faculty vote; \_\_\_\_\_ college curriculum approval \_\_\_\_\_ college senate approval

Chairperson, College Curriculum Committee \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, Senate Com. on UG or GR Studies \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, Senate Coordinating Com. \_\_\_\_\_ Date \_\_\_\_\_

Secretary, Faculty Senate \_\_\_\_\_ Date \_\_\_\_\_

Date of Senate Resolution \_\_\_\_\_ Date to be Effective \_\_\_\_\_

Registrar \_\_\_\_\_ Program Code \_\_\_\_\_ Date \_\_\_\_\_

Vice Provost for Academic Affairs & International Programs \_\_\_\_\_ Date \_\_\_\_\_

Board of Trustee Notification \_\_\_\_\_ Date \_\_\_\_\_

Revised 10/27/2014/khs