The Department of Bioengineering offers a Bachelor of Science degree in Biomedical Engineering, as well as two programs for earning a combined BS/MS degree in Bioengineering. The Department also offers ME, MS, and PhD degrees (described elsewhere).

This handbook is intended to give information about policies and procedures for the undergraduate program in Biomedical Engineering. Please come to the Department office at 2480 Merrill Engineering Building, or email an advisor if you have questions not answered here. The information in this handbook as well as various downloadable forms are also available online at www.bioen.utah.edu.

The University of Utah is committed to policies of equal opportunity, affirmative action, and nondiscrimination. The University seeks to provide equal access to its programs, services and activities for people with disabilities.

Contact Information and Links

<table>
<thead>
<tr>
<th>Role</th>
<th>Name/Email</th>
<th>Location</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate Secretary:</td>
<td>Beth Swanson</td>
<td>2480 MEB</td>
<td>585-3651</td>
</tr>
<tr>
<td>Pre-Major and Honors Advisor:</td>
<td>Kelly Broadhead</td>
<td>2480 MEB</td>
<td>585-7605</td>
</tr>
<tr>
<td>Major Advisor/Director of Undergraduate Studies:</td>
<td>Rob MacLeod</td>
<td>3476 MEB</td>
<td>587-9511</td>
</tr>
<tr>
<td>Department Web Site:</td>
<td><a href="http://www.bioen.utah.edu">www.bioen.utah.edu</a></td>
<td></td>
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<tr>
<td>University of Utah Web Site:</td>
<td><a href="http://www.utah.edu">www.utah.edu</a></td>
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<tr>
<td>Biomedical Engineering Web Sites:</td>
<td><a href="http://www.bmes.org">www.bmes.org</a></td>
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</tbody>
</table>

See the site for links to:

- Course Descriptions
- Faculty Directory
- Undergraduate Studies

Page 1
## Contents

1. **Program description** 3
   - 1.1 Mission 3
   - 1.2 Educational objectives 3
   - 1.3 Program outcomes 3

2. **Status and admissions** 4
   - 2.1 Pre-Major status 4
   - 2.2 Admission to major status 4
   - 2.3 Scholarships 4

3. **Requirements for the B.S. Degree in BME** 5
   - 3.1 General education requirements 5
   - 3.2 Mathematics and Science 6
   - 3.3 Biomedical Engineering Core 6
   - 3.4 Tracks 6
   - 3.5 COOP/Internship Opportunities 7
   - 3.6 Continuing Performance 7
   - 3.7 Leave of Absence 7
   - 3.8 Probation 8
   - 3.9 Repeat and Withdrawal Policies 8
   - 3.10 Transfer Credit and Exceptions to Policy 8
   - 3.11 Exit Interviews and Graduation 8
   - 3.12 Undergraduate Advising 8

4. **Suggested Biomedical Engineering Plan of Study** 9

5. **Track Courses** 10
   - 5.1 Bioelectrical Engineering Track 10
   - 5.2 Biomaterials Engineering Track 11
   - 5.3 Biomechanical Engineering Track 11
   - 5.4 Biomolecular Engineering Track 12
   - 5.5 Computational Bioengineering Track 13
   - 5.6 Premedical Track 13
   - 5.7 Department of Bioengineering courses approved for inclusion in BME tracks 15
   - 5.8 Course NOT acceptable for inclusion as a track elective 16
1 Program description

1.1 Mission

The mission of the Department of Bioengineering is to advance human understanding, health, and the quality of life through:

- internationally recognized research, discovery, and invention in the area of biomedical engineering;
- education of world-class Ph.D. scientists and engineers for accomplishment in research, academics, medicine, and industry;
- education of nationally-recognized B.S. and M.S. graduates for success and leadership in industry and in preparation for future study in medicine, science and engineering;
- transfer of scientific discoveries and biomedical technology to the private sector nationwide;
- delivery of high-quality M.E. continuing education to enhance the economy by supporting biomedical industries;
- training of students throughout the College of Engineering in bio-based solutions to traditional engineering problems and in the application of their specialty to biological and biomedical science.

1.2 Educational objectives

The department’s educational objectives for the undergraduate BME program are:

- graduates will be successful in entering graduate programs, in gaining admission to professional schools including medical and law schools, or in obtaining employment in a biomedical engineering aligned industry;
- graduates will be able to solve problems at the interface of engineering and biology whether in a research environment, a clinical setting, or in industry;
- graduates will be motivated to pursue life-long learning efforts in order to fulfill their professional and ethical responsibility; and they will recognize their responsibility to understand contemporary questions at the interface of biomedical science, technology, and society;
- graduates will have noteworthy careers no matter what the direction or environment they chose because of their broad education founded in science and engineering.

1.3 Program outcomes

The department’s Program Outcomes are:

- an ability to apply mathematics, science and engineering principles;
- an ability to conduct experiments and analyze and interpret data;
- an ability to design an experiment, system, component, or process to meet desired needs;
- an ability to function on multi-disciplinary teams;
- an ability to identify, formulate, and solve engineering problems;
- an understanding of professional ethical responsibility;
- an ability to communicate effectively in an oral format;
- an ability to communicate effectively in a written format;
- an understanding of the impact of engineering solutions in a global and societal context;
- an understanding of the need for and the ability to engage in lifelong learning;
- an understanding of contemporary issues;
- an ability to apply the techniques, skills, and modern engineering tools necessary for engineering practice.
2 Status and admissions

2.1 Pre-Major status

Students beginning the undergraduate program, including transfer students, should choose the Pre-Biomedical Engineering category as their major for registration purposes. Pre-major students are eligible to register for all classes listed in the freshman and sophomore years of the Suggested Biomedical Engineering Plan of Study in Section 4. Pre-majors are strongly encouraged to meet early with the Pre-Major Advisor in the Department to outline a course of study that will prepare them to apply for major status in a timely manner. Junior- and senior-year courses in the Biomedical Engineering program are open only to students with major status.

2.2 Admission to major status

Admission to major status in the Biomedical Engineering program is limited by the availability of Department teaching and laboratory resources and based solely on academic achievement. Approximately 40 applicants will be admitted to major status each year. Admission to major status is based on a specific grade point average made up of selected courses. See Application Form at the end of this document and check with the Undergraduate Secretary in the Department office for details. In order to register for Department upper-division courses (3000-level or higher), a student must have major status (or receive permission from the Department and course instructor for exceptional circumstances).

To be considered for admission to major status, a student must have completed the following courses:

- BIOEN 1101 Fundamentals of Bioengineering I
- BIOEN 1102 Fundamentals of Bioengineering II
- BIOEN 2000 Careers in Biomedical Engineering
- BIOL 2020 Cell Biology (or equivalent)
- CHEM 2310 Organic Chemistry I
- CHEM 2315 Organic Chem Lab I
- MATH 2250 Diff Eq/Lin Alg
- PHYS 2210 Physics for Scientists I

with an overall grade point average (GPA) in these classes of 3.0 or better. In addition, the overall University GPA (including transfer credit) is combined with the GPA in these classes to arrive at a composite GPA. Note that the composite GPA required for admission (as calculated on the application form) must be 3.2 or higher for automatic admission. Students with a composite GPA below 3.2 but above 3.0 will join an admission waiting list.

2.3 Scholarships

The Department, in cooperation with the College of Engineering, provides a limited number of scholarships to highly qualified applicants. Applications for scholarships are usually due on March 1. Contact the Department Office or see the Department web site for details.
3 Requirements for the B.S. Degree in BME

The undergraduate degree (B.S.) in Biomedical Engineering is granted upon successful completion of a minimum of 122 semester hours of the following requirements:

1. University’s General Education Requirements,
2. Mathematics and Science,
3. the Biomedical Engineering Core, and
4. Track Electives.

These program requirements are described in detail below. Note that some of the requirements have changed from previous years and may continue to change.

Some of the General Education, mathematics and science courses may be waived for students who have AP credit from high school in those courses and who have achieved certain grades on the AP test. Details are in the [www.ugs.utah.edu/catalog/](http://www.ugs.utah.edu/catalog/) under the department offering the specific course.

3.1 General education requirements

See the website [www.ugs.utah.edu/student/gened/index.htm](http://www.ugs.utah.edu/student/gened/index.htm) for a description of the University’s General Education requirements. General Education includes Intellectual Explorations courses (including a Diversity requirement), and the Writing, American Institutions, and Quantitative Reasoning course requirements.

**Intellectual explorations** Students must take two courses in each of the areas of Fine Arts, Humanities, and Social and Behavioral Science. The requirement in the Physical and Life Science area is automatically met by the Biomedical Engineering curriculum. One of the Intellectual Explorations courses selected should also meet the Diversity requirement. See the website [www.ugs.utah.edu/student/gened/dv.htm](http://www.ugs.utah.edu/student/gened/dv.htm) for a description and list of Diversity courses. Note that not all of the classes that meet the Diversity criterion are also courses in the Intellectual Explorations lists. Students should try to take a Diversity course that will clear two requirements (Diversity and Intellectual Explorations) simultaneously.

**Lower division writing** Writing 2010 or the equivalent is required. The University’s upper-division communication/writing requirement will automatically be met by successful completion of BIOEN 4202 (Biomedical Engineering Project II) in the senior year.

**American institutions** See the website [http://www.ugs.utah.edu/student/gened/ai.htm](http://www.ugs.utah.edu/student/gened/ai.htm) for courses that meet the American Institutions requirement. The American Institutions requirement may also be cleared by AP credit or by examination at the Testing Center in the Student Services Building during regular testing room hours.

**Quantitative reasoning** The Quantitative Reasoning and Quantitative Intensive course requirements (QA, QB, and QI) are met by the Biomedical Engineering curriculum through the calculus requirements and through BIOEN 5001 and BIOEN 5201 (Biophysics and Biomechanics).
3.2 Mathematics and Science

The following courses are required from the areas of mathematics and science:

- MATH 1250 Calculus AP Students I
- MATH 1260 Calculus AP Students II (or equivalent)
- MATH 2250 Diff Eq/Lin Alg
- MATH 3070 Applied Statistics I
- PHYS 2210 Physics for Scientists I
- PHYS 2220 Physics for Scientists II
- CHEM 1210 Chemistry I
- CHEM 1215 General Chemistry Lab I
- CHEM 1220 General Chemistry II
- CHEM 1225 General Chemistry Lab II
- CHEM 2310 Organic Chemistry I
- CHEM 2315 Organic Chem Lab I
- CHEM 2320 Organic Chemistry II
- CHEM 2325 Organic Chem Lab II
- BIOL 2020 Cell Biology

3.3 Biomedical Engineering Core

The following 13 courses are required from the BME Core:

**Premajor**
- BIOEN 1101 Fundamentals of Bioengineering I
- BIOEN 1102 Fundamentals of Bioengineering II
- BIOEN 2000 Careers in Biomedical Engineering

**Major**
- BIOEN 3201 Bimolecular Engineering
- BIOEN 3202 Physiology for Engineers
- BIOEN 3801 Biomedical Engineering Design I
- BIOEN 4801 Biomedical Engineering Design II
- BIOEN 4201 Biomedical Engineering Project I
- BIOEN 4202 Biomedical Engineering Project II
- BIOEN 5001 Biophysics
- BIOEN 5101 Bioinstrumentation
- BIOEN 5201 Biomechanics
- BIOEN 5301 Biomaterials

3.4 Tracks

The Biomedical Engineering program offers students an opportunity for specialization in the following areas:

**Bioelectrical Engineering:** based on course material from electrical engineering typically with a focus on instrumentation, imaging, or electrically based diagnostcis and therapy.

**Biomaterials Engineering:** based on course material from materials science, material engineering, and mechanical engineering focused on the role of materials in biomedical applications.
Biomechanical Engineering: based on course material from physics or mechanical engineering focused on mechanical aspects of the body, mechanical characteristics of biomedical materials, fluids, use of heat and heat-inducing therapies, and prosthetics.

Biomolecular Engineering: based on course material from chemistry and chemical engineering and focused on the chemical characteristics of materials, biochemistry of living systems, and chemical based diagnostics and therapeutic drugs and materials.

Computational Bioengineering: based on courses in computer science and mathematics and focused on the application of numerical and computational approaches to all aspects of the analysis, interpretation, visualization, and simulation of living systems.

Premedical Preparation: includes the required courses for entry to most medical and dental programs with an emphasis on clinical perspectives of engineering.

Special: for students with unique goals in their engineering degree; draws on courses from many engineering disciplines and the basic or medical sciences.

A student chooses an area based on his or her career goals and a discussion with the undergraduate advising in order to meet one or more of the following needs:

- Deeper knowledge of a particular field because of a pre-existing interest or focused career goals.
- Broader knowledge of a field in order to be prepared for a diverse career that has not yet focused on a particular aspect.
- Exploration of a wide variety of directions and courses in order to identify the most compelling and fulfilling future career directions.

The student then selects a set of courses consistent with the nature of the chosen track, which must be approved by the Program Directory. A student with special interests may design a spatial or customized track in consultation with the Department’s Major Advisor.

Section 5 contains specific requirements and lists of approved track classes. Note that discussion and approval of the track electives must occur in discussion with the Major Advisory.

3.5 COOP/Internship Opportunities

Students interested in including industrial experience in their university education should consider participating in the Department’s COOP/Internship Program. Internships can also lead to credit through BIOEN 4990, which can also be used as a track course. Contact Dr. Brenda Mann for more details (see website for contact information).

3.6 Continuing Performance

A student admitted to major status must maintain a cumulative University of Utah GPA, as reported on his or her transcript, above 3.00. Each course taken to satisfy departmental requirements in mathematics, chemistry, physics, biology, biomedical engineering core, and the track electives must be taken for credit and passed with a grade of C or better. A student may repeat these technical courses only once, and the second grade received will be counted for the requirement.

3.7 Leave of Absence

Students are expected to complete all degree requirements within four years of acceptance to major status. Students accepted into major status who are planning to be absent from the program for more than one year should request a leave of absence by submitting a letter to the Undergraduate Secretary. (A copy
should also be sent to the University Admissions Office to avoid the necessity of reapplying for admission and repaying the admission fee upon return.

Students who move to a part time status and do not take the normal course load should apply to the Major Advisor and a variance (tab form) and to work out an acceptable plan for continuing progress in the program.

Otherwise, students accepted into major status who are not making satisfactory progress may be dropped from the program and declared inactive. To be reinstated to active status, students must submit a written petition to the Director of Undergraduate Studies. Reinstated students matriculate under the latest graduation requirements.

3.8 Probation

A student admitted to major status whose cumulative GPA falls below 3.00 is placed on departmental academic probation and given written instructions for a return to good standing. Normally, these conditions must be met during the ensuing semester. Students who fail to meet probationary conditions are dropped from the program. Reinstatement requires a written petition to the Director of Undergraduate Studies. Reinstated students matriculate under the latest graduation requirements.

3.9 Repeat and Withdrawal Policies

The Biomedical Engineering program adheres to the College of Engineering policies for a course that is repeated and for withdrawals. In particular, a technical course required for the degree may be repeated only once, and the second grade received will be counted toward application for admission to major status and to the continuing performance requirement. Grades of W, I or V on the student’s record count as having taken the class. This policy does not apply to courses taken to satisfy Intellectual Exploration and lower division Writing requirements.

3.10 Transfer Credit and Exceptions to Policy

Students wishing to apply credit from another school for any technical class which is not included in the College of Engineering Articulation Agreement (available on the University of Utah web site and in the Department of Bioengineering Office) must submit a Petition for Transfer Credit or Variance (the “tan sheet”) along with thorough supporting documentation. Only after the petition has been approved by the Department will transfer technical credit by allowed toward completion of the BS degree in Biomedical Engineering. This applies even to classes that have been accepted by the University for general transfer credit; the classes must still be submitted for Departmental acceptance for transfer credit toward the degree by petition (unless they appear on the Articulation Agreement, in which case approval is automatic). Note that any exception to the Department’s academic policies must be requested by submission of this same form, and that such an exception is allowed only after the petition has been approved by the Department.

3.11 Exit Interviews and Graduation

In order to be cleared to graduate, a student must meet with the Major Advisor to review the DARS audit report and to verify that all graduation requirements will be completed by the time of graduation. This must be done one semester prior to graduation. Immediately prior to graduation, the student attends an exit interview with a faculty member during a time announced in the senior classes. This exit interview provides important feedback to the Department to help improve the Biomedical Engineering program.

3.12 Undergraduate Advising

Please visit the Department of Bioengineering undergraduate office, 2480 Merrill Engineering Building, for academic advice and information about the undergraduate program or call 801-585-3651.
## 4 Suggested Biomedical Engineering Plan of Study

<table>
<thead>
<tr>
<th>Course #</th>
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<th>Hrs</th>
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<td>Funds of Bioeng II</td>
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<tr>
<td>CHEM 1215</td>
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<td>CHEM 1225</td>
<td>General Chemistry Lab II</td>
<td>1</td>
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<td>MATH 1250</td>
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<td>MATH 1260</td>
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<td>Total</td>
<td></td>
<td>15</td>
<td>Total</td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

| **Sophomore Year** |                             |     | **Junior Year** |                             |     |
| BIOEN 2000 | Careers in Biomed Eng        | 1   | BIOEN 3201 | Biomolecular Engineering     | 4   |
| BIOL 2020  | Cell Biology**               | 3   | CHEM 2320 | Organic Chemistry II         | 4   |
| CHEM 2310 | Organic Chemistry I          | 4   | CHEM 2325 | Organic Chem Lab II          | 1   |
| CHEM 2315 | Organic Chem Lab I           | 1   | PHYCS 2220 | Physics for Scientists II    | 4   |
| MATH 2250 | Diff Eq/Lin Alg              | 3   | Phy Ed Elective |                   | 3   |
| PHYCS 2210 | Physics for Scientists I     | 4   | Total     |                              | 16  |

| **Senior Year** |                             |     |              |                             |     |
| BIOEN 4801 | BME Design II                | 3   | BIOEN 4202 | BME Project II              | 3   |
| BIOEN 4201 | BME Project I                | 2   | BIOEN 5001 | Biophysics                  | 4   |
| BIOEN 5201 | Biomechanics                 | 4   | BIOEN 5301 | Biomaterials                | 4   |
|             | Engineering Track            | 3   |             | Engineering Track           | 4   |
|             | Gen Ed Elective              | 3   |             | Gen Ed Elective             | 3   |
| Total       |                              | 15  | Grand total |                              | 122 |

* As an alternative to this math sequence, students may take MATH 1270 and 1280 or the three-semester calculus series MATH 1210, 1220, and 2210.

** Students who have not had AP Biology in high school (with a score of 4 or 5) should take BIOL 1210 as a prerequisite to BIOL 2020.

*** Students participating in the COOP/Intern program would have an additional 3 hours of credit.

Descriptions of Bioengineering Department courses can be found at [www.bioen.utah.edu/](http://www.bioen.utah.edu/)
5 Track Courses

All accepted track course sequences must consist of the following:

1. a minimum of 13 credit hours of course work, of which
2. at least 10 hours must be from the College of Engineering and/or the College of Mines & Earth Sciences (ensures meeting College course requirements), and
3. at least 8 of the hours must be at the upper division level.

A student’s track plan must be approved by the Department’s Major Advisor by submitting a Track Coursework Plan (the “green sheet”) available from the BE office, the Major Advisor or [this link]. Seeking approval for the track plan should occur in the first semester after admission to major status and before starting the track sequence. Students who have not submitted a track sheet by the middle of the semester immediately following their admission will not be allowed to register for Spring semester junior-year Bioengineering courses. When planning a track, students must pay particular attention to prerequisites to be sure the courses are taken in the correct order. A list of Bioengineering Department courses suitable for inclusion in a track appears at the end of this section. Each student must check with the appropriate departments to determine if and when individual courses will be offered in the future and to identify the associated prerequisites.

Below are some samples of course selections organized by track

5.1 Bioelectrical Engineering Track

Prerequisites Note that there are prerequisites for many of these courses and that to have the most choice of courses, it is important to take these prerequisites as early as possible. Especially ECE 1270 and ECE 2270 are valuable prerequisites. For a map of the (rather complex) prerequisite pathway in ECE, see the ECE website.

BIOEN 6421 Fundamentals of Micromachining Processes
BIOEN 5480 Ultrasound
ECE 1270 Introduction to Electrical and Computer Engineering
ECE 2260 Fundamentals of Electric Circuits
ECE 2280 Fundamentals of Engineering Electronics
ECE 3101 Engineering Electronics II
ECE 3300 Fundamentals of Electromagnetics and Transmission Lines
ECE 3500 Fundamentals of Signals and Systems
ECE 3510 Introduction to Feedback Systems
ECE 5325 Wireless Communication Systems
ECE 5340 Numerical Techniques in Electromagnetics
ECE 5410 Lasers and Their Applications
ECE 5530 Digital Signal Processing
5.2 Biomaterials Engineering Track

MSE 2010 Introduction to Materials Science & Engineering
MSE 3010 Materials Processing Laboratory
MSE 3310 Introduction to Ceramics
MSE 3011 Structural Analysis of Materials
MSE 3210 Electronic Properties of Solids
MSE 3310 Introduction to Ceramics
MSE 3410 Introduction to Polymers
MSE 3510 Introduction to Metallic Materials
MSE 5010 X-ray Diffraction Techniques
MSE 5035 Electron Microscopy Techniques
MSE 5061 Transport Phenomena in Materials Science and Engineering
MSE 5201 Semiconductor Device Physics I
MSE 5202 Semiconductor Device Physics II
MSE 5211 Semiconductor Device Fabrication Laboratory I
MSE 5212 Semiconductor Device Fabrication Laboratory II
MSE 5240 Principles and Practice of Transmission Electron Microscopy
MSE 5353 Physical Ceramics
MSE 5354 Processing of Advanced Ceramics
MSE 5471 Polymer Processing
MSE 5473 Polymer Synthesis and Characterization
MSE 5475 Introduction to Composites
ME EN 1300 Statics and Strength of Materials
MET E 1620 Introduction to Physical Metallurgy
MET E 3530 Experimental Techniques in Metallurgy
MET E 5260 Physical Metallurgy I
MET E 5450 Mechanical Metallurgy
MET E 5600 Corrosion Engineering

5.3 Biomechanical Engineering Track

ME EN 1300 Statics and Strength
ME EN 2080 Dynamics
ME EN 2300 Thermodynamics I
ME EN 2450 Numerical Techniques in Engineering
ME EN 3300 Strength of Materials
ME EN 3650 Heat Transfer
ME EN 3700 Fluid Mechanics
ME EN 5300 Advanced Strength of Materials
ME EN 5500 Engineering Elasticity
ME EN 5510 Introduction to Finite Elements
ME EN 5520 Composites
ME EN 5720 Comp. Fluid Mechanics
5.4 **Biomolecular Engineering Track**

BIOEN 5090  Biophysical Chemistry  
BIOEN 6140  Fundamentals of Tissue Engineering  
BIOEN 6421  Fundamentals of Micromachining Processes  
BIOL 2030  Genetics  
BIOL 3215  Cell Biology Laboratory  
BIOL 3230  Developmental Biology  
CH EN 5103  Biochemical Engineering  
CH EN 5104  Biochemical Engineering Laboratory  
CHEM 3510  Biological Chemistry I  
CHEM 3515  Biological Chemistry Laboratory  
CHEM 3520  Biological Chemistry II  
CHEM 3525  Molecular Biology of DNA Lab  
CHEM 5810  Nanoscience: Where Biology, Chemistry and Physics Intersect  
MSE 2010  Introduction to Materials Science & Engineering  
MSE 3410  Introduction to Polymers  
MSE 5010  X-ray Diffraction Techniques  
MSE 5035  Electron Microscopy Techniques  
MSE 5061  Transport Phenomena in Materials Science and Engineering  
PATH 5030  Basic Immunology
5.5 Computational Bioengineering Track

CS 1010 Introduction to Unix
CS 1410 Introduction to Computer Science I
CS 2420 Introduction to Computer Science II
CS 2010 Discrete Structures
CS 3200 Scientific Computation
CS 3500 Software Practice I
CS 3505 Software Practice II
CS 3700 Fundamentals of Digital System Design
CS 5300 Artificial Intelligence
CS 5310 Robotics
CS 5320 Computer Vision
CS 5530 Database Systems
CS 5540 Human/Computer Interaction
CS 5600 Introduction to Computer Graphics
CS 5610 Interactive Computer Graphics
CS 5630 Scientific Visualization
CS 6210 Advanced Scientific Computing I
CS 6220 Advanced Scientific Computing II
CS 6760 Modeling and Analysis of Biological Networks
ECE 3700 Fundamentals of Digital System Design
ECE 5340 Numerical Techniques in Electromagnetics
CH EN 3510 Introduction to Metallic Materials
CH EN 5353 Computational Fluid Dynamics
CH EN 6703 Applied Numerical Methods
MATH 5110 Mathematical Biology I
MATH 5120 Mathematical Biology II
MATH 5600 Survey Numerical Analysis
MATH 5610 Intr. Numerical Analysis I
MATH 5740 Mathematical Modeling

5.6 Premedical Track

Students planning on applying to medical school may wish to design a track that supports this goal. The track courses selected should meet, to the extent possible, three criteria:

1. They complete course requirements set by the medical schools for admission;
2. They are from a subject area in which the student does well;
3. They provide the student a sound foundation for an alternative career choice should the medical schools not respond favorably.

BS in Biomedical Engineering generally meets all the course requirements for medical school with the possible exception of laboratories in introductory courses in Biology and Physics. However, the Biomedical Engineering core courses taken in the junior and senior years supply laboratory course hours which may be accepted in lieu of these explicit laboratory courses. Because there is considerable variability in what is both recommended and required among different medical schools, students should review the entrance requirements of the medical schools to which they are considering applying and determine which of the following courses to include in their tracks.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOEN 5460</td>
<td>Engineering Aspects of Clinical Medicine</td>
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<tr>
<td>BIOEN 6000</td>
<td>Systems Physiology I: Cardiovascular System</td>
</tr>
<tr>
<td>BIOEN 6010</td>
<td>Systems Physiology II: Nervous/Endocrine Systems</td>
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<tr>
<td>BIOEN 6140</td>
<td>Fundamentals of Tissue Engineering</td>
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<tr>
<td>BIOEN 6230</td>
<td>Functional Anatomy for Engineers</td>
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<td>BIOEN 5480</td>
<td>Ultrasound</td>
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<td>BIOL 2030</td>
<td>Genetics</td>
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<td>PATH 5030</td>
<td>Basic Immunology</td>
</tr>
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</table>
5.7 Department of Bioengineering courses approved for inclusion in BME tracks

The following courses are all approved for inclusion in the track plan for Biomedical Engineering. This course list is changing constantly and course offerings change in other departments so please consult with the Major Advisor whenever making a decision on the track plan. **It is up to the individual student to ensure that the courses in the track exist and are offered at the time the student wishes to take them. Note that many courses are taught only every second year.**

BIOEN 5090 Biophysical Chemistry
BIOEN 5401 Medical Imaging Systems
BIOEN 5460 Engineering Aspects of Clinical Medicine
BIOEN 5480 Ultrasound
BIOEN 4990 Internships and Cooperative Education
BIOEN 6000 Systems Physiology I: Cardiovascular System
BIOEN 6010 Systems Physiology II: Nervous/Endocrine Systems
BIOEN 6002 Molecular Biophysics
BIOEN 6003 Cellular Electrophysiology and Biophysics
BIOEN 6050 Cellular Physiology for Engineers
BIOEN 6080 Ideas Into Dollars: Writing Grant Proposals
BIOEN 6140 Fundamentals of Tissue Engineering
BIOEN 6230 Functional Anatomy for Engineers
BIOEN 6310 Physics of MEG, X-Ray and Ultrasound
BIOEN 6320 Physics of Nuclear Medicine and MRI
BIOEN 6410 Bioinstrumentation
BIOEN 6421 Fundamentals of Micromachining Processes
BIOEN 6422 Biomedical Applications of Micromachining
BIOEN 6430 Systems Neuroscience
BIOEN 6433 Biological Statistical Signal Processing
BIOEN 6440 Neural Engineering
BIOEN 6450 Bioengineering Control Systems
BIOEN 6460 Electrophysiology and Bioelectricity
BIOEN 7111 Physicochemical Approach to Proteins and Nucleic Acids
BIOEN 7120 Biocompatibility
BIOEN 7130 Pharmaceutical Applications of Colloid and Interfacial Science
BIOEN 7140 Advanced Topics in Tissue Engineering
BIOEN 7150 Introduction to Biomimetic Engineering
BIOEN 7155 Neural Interfaces Laboratory
BIOEN 7160 Physical Nature of Surfaces
BIOEN 7168 Proteins at Interfaces and in Membranes
BIOEN 7210 Biosolid Mechanics
BIOEN 7220 Biofluid Mechanics
BIOEN 7310 Advanced Topics in Magnetic Resonance Imaging
BIOEN 7320 3D Reconstruction Techniques in Medical Imaging
BIOEN 7410 Advanced Bioinstrumentation
BIOEN 7420 Modeling of Physiological Systems
5.8 Course NOT acceptable for inclusion as a track elective

The following courses are not acceptable as a track elective for the Biomedical Engineering program. The reasons for excluding courses include:

- course does not include adequate engineering or biomedical content;
- course overlaps too much with a course already in the core curriculum of the BME program;
- course level, requirements, or evaluation are not equivalent to the rest of the BME program;
- course does not require active participation of the student

BE 4990 Internship and Co-op
BE 4999 Honors Thesis/Project
BE 5020 Interactive Science Exhibits
BE 5950/6910 Independent Study
BE 6062 Biomedical Engineering Literature Survey
BE 6480 Biomechanics Seminar*
BE 6464 Cardiac Electrophysiology and Biophysics Seminar*
BE 6900 Special Topics
BE 6930 Special Project
MSE 2160 Elements of Materials Science and Engineering
    Take MSE 2010 instead
MSE 2170 Elements of Materials Science and Engineering
    Take MSE 2010 instead
PHYS 3110 Physics of the Human Body I
PHYS 3111 Physics of the Human Body II

* students may take these courses for track credit only if they otherwise have adequate numbers of hours but need to achieve the required number of college hours.