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 2750 Warnock 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.

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Department Web Site:
www.bioen.utah.edu

See the site for links to:
Course Descriptions
Faculty Directory
Undergraduate Studies

University of Utah Web Site:
www.utah.edu

Biomedical Engineering Web Sites:
www.bmes.org
www.embs.org
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# Program description

## 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.

## 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.

## 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 50 applicants will be admitted to major status each year.

2.2.1 Regular admission

Normal 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 Advisory 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
- PHYCS 2210 Physics for Scientists I

with an overall grade point average (GPA) in these classes of 3.0 or better. Combining this score with the overall University GPA (including transfer credit) leads to a composite GPA (as calculated on the application form) which must be 3.25 or higher for automatic admission. Students with a composite GPA below 3.25 but above 3.0 will join an admission waiting list.
2.2.2 Freshman admission

Starting in 2008, the program will also grant admission to a limited number of a freshman who show outstanding academic standing. Identification of these students will be based on entrance applications to the University and will occur automatically once students submit their applications. There is no additional application required to the Department or the program.

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 (Bioengineering 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
PHYS 2210 Physics for Scientists I
PHYS 2220 Physics for Scientists II
CHEM 1210 General 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
BIOL 2020 Cell Biology

All mathematics, science, and bioengineering core and technical elective courses should be taken for letter grade whenever this option is available.

3.3 Biomedical Engineering Core

The following 16 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 3070 Statistics for Bioengineering*
BIOEN 3201 Bimolecular Engineering
BIOEN 3202 Physiology for Engineers
BIOEN 3301 Computation Methods for Bioengineers
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 5091 Current Research in Bioengineering
BIOEN 5001 Biophysics
BIOEN 5101 Bioinstrumentation
BIOEN 5201 Biomechanics
BIOEN 5301 Biomaterials

* It is possible to substitute another statistics class e.g., Math 3070, for this requirement.

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 diagnostics 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 CO-OP/Internship Opportunities

Students interested in including industrial experience in their university education should consider participating in the Department’s CO-OP/Internship Program. Internships can also lead to credit through BIOEN 4990, which can also be used as a track course (for 1 hour of credit). Contact Dr. Brenda Mann for more details (see website for contact information).

Note: BIOEN 4990 carried up to 3 hours of credit towards the degree but only 1 hour of track course credit!!!
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 Advisor. (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 (tan colored 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 must attend 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, 2750 Warnock Engineering Building, or call (801) 585-3651 for academic advice and information about the undergraduate program.
# 4 Suggested Biomedical Engineering Plan of Study

Below is a suggested plan of study. Items in italics indicate changes made for the 2008/09 entry (catalog) year.

<table>
<thead>
<tr>
<th>Course #</th>
<th>Title</th>
<th>Hrs</th>
<th>Course #</th>
<th>Title</th>
<th>Hrs</th>
</tr>
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<tbody>
<tr>
<td><strong>Fall Semester</strong></td>
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<td><strong>Spring Semester</strong></td>
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<tr>
<td>BIOEN 1101</td>
<td>Funds of Bioeng I</td>
<td>3</td>
<td>BIOEN 1102</td>
<td>Funds of Bioeng II</td>
<td>3</td>
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<tr>
<td>CHEM 1210</td>
<td>General Chemistry I</td>
<td>4</td>
<td>CHEM 1220</td>
<td>General Chemistry II</td>
<td>4</td>
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<tr>
<td>CHEM 1215</td>
<td>General Chemistry Lab I</td>
<td>1</td>
<td>CHEM 1225</td>
<td>General Chemistry Lab II</td>
<td>1</td>
</tr>
<tr>
<td>MATH 1250</td>
<td>Calculus AP Students I*</td>
<td>4</td>
<td>MATH 1260</td>
<td>Calculus AP Students II*</td>
<td>4</td>
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<tr>
<td>WRTG 2010</td>
<td>College Writing</td>
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<td>Gen Ed Elective</td>
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<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   | BIOEN 3301     | Computational Methods          | 3   |
| CHEM 2310        | Organic Chemistry I            | 4   | PHYCS 2220     | Physics for Scientists II      | 4   |
| PHYCS 2210       | Physics for Scientists I       | 4   |                |                                |     |
| MATH 2250        | Diff Eq/Lin Alg                | 3   | Gen Ed Elective |                           | 3   |
| CHEM 2315        | Org. Chem I Lab                | 1   | Gen Ed Elective |                           | 3   |
| Total            |                                | 16  | Total          |                                | 17  |

| **Junior Year** |                               |     | **Senior Year** |                               |     |
| BIOEN 3202       | Physiology for Engineers       | 4   | BIOEN 3801     | BME Design I                   | 3   |
| BIOEN 5101       | Bioinstrumentation             | 4   | BIOEN 5001     | Biophysics                     | 4   |
| **BIOEN 3070***  | Statistics for Eng             | 3   | BIOEN 4201     | BME Project II                 | 3   |
|                   | Engineering Track              | 3   | BIOEN 5301     | Biomaterials                   | 4   |
| **BIOEN 5091**   | Current Research in BME        | 1   | Gen Ed Elective |                           | 3   |
| Total            |                                | 15  | Total          |                                | 16  |

| **Senior Year** |                               |     | **Grand total** |                               |     |
| BIOEN 4801       | BME Design II                  | 3   | Total          |                                | 122 |
| BIOEN 4201       | BME Project I                  | 2   |               |                                |     |
| BIOEN 5201       | Biomechanics                   | 4   |               |                                |     |
| Engineering Track|                               | 3   |               |                                |     |
| Gen Ed Elective  |                               | 3   |               |                                |     |
| Total            |                                | 15  |               |                                | 13  |

* 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.

*** MATH 3070 is accepted as a replacement for BIOEN 3070.

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

Note: the number and criteria for track class have changed for the 2008/09 catalog year. Please note these changes if you have entered the program after September 1, 2007. The new requirements are as follows:

1. a minimum of **15** credit hours of course work, of which

2. at least **5** hours must be from courses taught in the College of Engineering and/or the College of Mines & Earth Sciences (ensures meeting ABET course requirements), and

3. at least **9** must be at the upper division level (3000 or above).

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 the following semester junior-year Bioengineering courses.**

5.1  Tips for planning track classes

- A list of Bioengineering Department courses suitable for inclusion in a track appears at the end of this section.

- Pay attention to prerequisites to be sure the courses are taken in the correct order.

- However, entry into upper division courses in other departments is often possible without the standard prerequisites for that department as long as the associated BME core course is completed. For example, to enter upper division classes in Mechanical Engineering, ensure that the BIOEN 5201, Biomechanics, is completed first (or concurrently). When in doubt, contact the Program Director for clarification or assistance.

- Organic Chemistry II and the Physics lab course required for entry to medical school are acceptable track classes.

- BIOEN 4990, Internship, will receive only 1 hour of track credit, even when it contributes additional hours to the program of study.

- Directed reading, independent study, literature surveys, and special project classes do not generally qualify as track classes. Exceptions are possible but the Program Director must approve these **beforehand**.

- Some seminar classes (e.g., BIOEN 6480, BIOEN 6464) may be acceptable for 1 hour of track credit, but only when they are used only to ensure adequate college credit hours, *i.e.*, they are not counted as part of the minimum 15 hours.

Below are some samples of course selections organized by track. Note that in many cases, Bioengineering students can progress directly to the upper division classes offered by other departments **without completing the usual requirements** for those classes. When in doubt, the Major Advisor or the instructor of the course can provide guidance.

**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. Direct entry into most upper division classes is permitted as long as the associated BME core class is complete, *e.g.*, Biomechanics for upper division classes in Mechanical Engineering.
5.2 Bioelectrical Engineering Track

BIOEN 5401 Medical Imaging Systems
BIOEN 5460 Engineering Aspects of Clinical Medicine
BIOEN 5480 Ultrasound
BIOEN 6330 Principles of Magnetic Resonance Imaging
BIOEN 6410 Bioinstrumentation: Biosignals and Biosensors
BIOEN 6421 Fundamentals of Micromachining Processes
BIOEN 6500 Mathematics of Imaging
BIOEN 6640 Introduction to Image Processing
ECE 2260 Fundamentals of Electric Circuits
ECE 2280 Fundamentals of Engineering Electronics
ECE 3110 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

5.3 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
### 5.4 Biomechanical Engineering Track

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOEN 6230</td>
<td>Functional Anatomy for Engineers</td>
</tr>
<tr>
<td>BIOEN 6421</td>
<td>Fundamentals of Micromachining</td>
</tr>
<tr>
<td>BIOEN 7210</td>
<td>Biosolid Mechanics</td>
</tr>
<tr>
<td>BIOEN 7220</td>
<td>Biofluid Mechanics</td>
</tr>
<tr>
<td>ME EN 1300</td>
<td>Statics and Strength</td>
</tr>
<tr>
<td>ME EN 2080</td>
<td>Dynamics</td>
</tr>
<tr>
<td>ME EN 2300</td>
<td>Thermodynamics I</td>
</tr>
<tr>
<td>ME EN 2450</td>
<td>Numerical Techniques in Engineering</td>
</tr>
<tr>
<td>ME EN 3300</td>
<td>Strength of Materials</td>
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<tr>
<td>ME EN 3650</td>
<td>Heat Transfer</td>
</tr>
<tr>
<td>ME EN 3700</td>
<td>Fluid Mechanics</td>
</tr>
<tr>
<td>ME EN 5300</td>
<td>Advanced Strength of Materials</td>
</tr>
<tr>
<td>ME EN 5500</td>
<td>Engineering Elasticity</td>
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<tr>
<td>ME EN 5510</td>
<td>Introduction to Finite Elements</td>
</tr>
<tr>
<td>ME EN 5520</td>
<td>Composites</td>
</tr>
<tr>
<td>ME EN 5720</td>
<td>Comp. Fluid Mechanics</td>
</tr>
</tbody>
</table>

### 5.5 Biomolecular Engineering Track

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOEN 5090</td>
<td>Biophysical Chemistry</td>
</tr>
<tr>
<td>BIOEN 6002</td>
<td>Molecular Biophysics</td>
</tr>
<tr>
<td>BIOEN 6140</td>
<td>Fundamentals of Tissue Engineering</td>
</tr>
<tr>
<td>BIOEN 6421</td>
<td>Fundamentals of Micromachining Processes</td>
</tr>
<tr>
<td>BIOEN 6505</td>
<td>Biotransport Phenomena</td>
</tr>
<tr>
<td>BIOEN 7111</td>
<td>Physicochemical Approach to Proteins and Nucleic Acids</td>
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<tr>
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<td>Developmental Biology</td>
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<td>Biochemical Engineering</td>
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<td>Biological Chemistry Laboratory</td>
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<td>CHEM 3520</td>
<td>Biological Chemistry II</td>
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<td>CHEM 3525</td>
<td>Molecular Biology of DNA Lab</td>
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<tr>
<td>CHEM 5810</td>
<td>Nanoscience: Where Biology, Chemistry and Physics Intersect</td>
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<td>MSE 2010</td>
<td>Introduction to Materials Science &amp; Engineering</td>
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<tr>
<td>MSE 3410</td>
<td>Introduction to Polymers</td>
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<tr>
<td>MSE 5010</td>
<td>X-ray Diffraction Techniques</td>
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<tr>
<td>MSE 5035</td>
<td>Electron Microscopy Techniques</td>
</tr>
<tr>
<td>MSE 5061</td>
<td>Transport Phenomena in Materials Science and Engineering</td>
</tr>
<tr>
<td>PATH 5030</td>
<td>Basic Immunology</td>
</tr>
</tbody>
</table>
5.6 Computational Bioengineering Track

- BIOEN 6500 Mathematics of Imaging
- BIOEN 6640 Introduction to Image Processing
- BIOEN 6760 Modeling and Analysis of Biological Network
- BIOEN 7320 3-D Reconstruction Techniques in Medical Imaging
- CS 1010 Introduction to Unix
- CS 2000 Introduction to Programming in C
- 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 4100 Advanced Algorithms and Data Structures
- 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
- 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
- ME EN 5510 Introduction to Finite Elements

5.7 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.

The BS program in Biomedical Engineering generally meets all the course requirements for medical school with the possible exception of Organic Chemistry II (lecture and laboratory) and 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. Some medical schools also require an upper division writing course, i.e., they do not accept the Senior Project classes as equivalent.

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.

- BIOEN 5090 Biophysical Chemistry
- BIOEN 5401 Medical Imaging Systems
- BIOEN 5460 Engineering Aspects of Clinical Medicine
- BIOEN 5480 Ultrasound
- BIOEN 6000 Systems Physiology I: Cardiovascular System
- BIOEN 6010 Systems Physiology II: Nervous/Endocrine Systems
- BIOEN 6140 Fundamentals of Tissue Engineering
- BIOEN 6230 Functional Anatomy for Engineers
- BIOL 2030 Genetics
- BIOL 3215 Cell Biology Lab
- BIOL 3230 Developmental Biology
- BIOL 3510 Biological Chemistry I
- BIOL 3515 Biological Chemistry Lab
- BIOL 3520 Biological Chemistry II
- PATH 5030 Basic Immunology
5.8 Department of Bioengineering courses approved for inclusion in BME tracks

The following courses are all recommended and 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 (1 Credit Hour)
- 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 6330 Principles of Magnetic Resonance Imaging
- 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
5.9 Courses 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 4999 Honors Thesis/Project
BE 5020 Interactive Science Exhibits
BE 5950/6910 Independent Study
BE 6090/1 Department Seminar
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
MSE 2170 Elements of Materials Science and Engineering
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.

** Special topics class may count for track electives depending on the type and structure of the course. Please see the Major Advisor before taking a special topics class to determine its status.

6 Senior Project

A major component of the undergraduate program is the senior project, which involves two components:

1. A substantial involvement (approximately 200 hours) in one of three activities:
   - A scientific research project supervised by a faculty member either in or affiliated with the Bioengineering Department.
   - A design project that extends above and beyond the scope of the Bioengineering Design Course, mentored by a Bioengineering faculty member.
   - A substantial design or research project undertaken as part of an industrial or academic internship.

2. Completing the Senior Project class (BE 4201 and BE 4202).

The goals of the senior project are to develop specific experience and skills in scientific research and/or engineering design and development and to learn to present the results of such a study in all forms: written, oral, and visual. For most students, the senior project should be the culminating activity of their program in
which they use skills acquired from numerous courses and previous laboratories and develop a whole new set of abilities in the science (and art) of organizing and presenting ideas.

Success in the senior project requires taking the following steps:

1. As the very latest in the spring of the Junior year, obtain a placement in a research lab, with a biomedical engineering form, or in a lab related to the design class project.

2. Discuss with a mentor the specific needs of the senior project and develop a plan to carry out a project of adequate scope to generate the results for the senior project.

3. Make sure that by the beginning of the fall semester in the Senior year, there are enough results/data to write and talk about in the Senior Project class BE 4201.

If there are questions or uncertainty at any step in the process, the Major Advisor will be available to help.

7 B.S./M.S. Program

The Department offers for students interested in rapidly advancing to the Master’s level a combined B.S./M.S. program. The program is described in a separate document on the Department website and students interested in the program should read this description carefully to ensure that their course of study complies with the requirements.

Note that international students on visas are not eligible to participate in the combined BS/MS programs, per SEVIS regulations according to the U.S. Immigration and Customs Enforcement (URL: www.ice.gov/sevis).
Department of Bioengineering
Application for Admission to Major Status in Biomedical Engineering

Instructions: In order to earn a Bachelor of Science degree in Biomedical Engineering, you must be admitted to major status before registering for any upper level Biomedical Engineering classes. To be considered for admission to major status requires, as a minimum, completion of the courses listed below with a grade point average of 3.00 or better. You may repeat technical courses only once, and the second grade received will be counted for the requirement. Actual admission is based on the composite GPA as calculated on this form. Students with composite GPAs of 3.25 or higher will be automatically admitted to major status; students with composite GPAs below 3.25 but above 3.0 will be placed on a wait list and admitted as space permits at the end of the next summer session. Target enrollment is 50 students.

To apply for admission to major status, submit this application form, an official copy of your University of Utah transcript and a summary of transfer credits (if applicable) to the Undergraduate Secretary any time during the academic year but no later than one day after the posting of grades for the previous summer session. Applications for admission will be considered as they are received. Students admitted to major status before the beginning of spring semester may start taking major classes that semester.

Name: _______________________________ Student No. __________________
Address: _____________________________________________________________ Phone: ________________
___________________________________________________________ Email: __________________

<table>
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<tr>
<th>Course</th>
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<td><strong>Total</strong></td>
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* Grade Values: A = 4.00, A- = 3.70, B+ = 3.30, B = 3.00, B- = 2.70, C+ = 2.30, C = 2.00

A GPA from courses above (Total Points / Total Credit Hours):

B U of U Cumulative GPA reported on transcript (adjusted to include transfer grades weighted by hrs.):

C Composite GPA: (0.50 x A + 0.50 x B):

Student Signature: _______________________________ Date: ________________

Office use
Confirmed:

Action date(s): _______ Admit _______ Wait list _______ Decline _______
Department of Bioengineering  
Track Coursework Plan (2008)

Name: ___________________________________________________________ Student No: ____________

Address: ______________________________________________________________________________________

Phone number: __________________________ email address: _______________________________________

Indicate one of these areas that best describes your track:

- Bioelectrical Engineering
- Biomaterials Engineering
- Biomechanical Engineering
- Biomolecular Engineering
- Computational Bioengineering
- Premed
- Special

List below a set of courses that is consistent with meeting your career goals. The plan must be well-thought out and coherent in terms of these goals. Examples of possible track courses are given in the Undergraduate Handbook.

Each of the courses listed below must be in the area of science or engineering. They must total 15 or more credit hours. At least 5 of the hours must be from the College of Engineering and/or the College of Mines & Earth Sciences. At least 9 of the hours must be at the 3000 level or above.

Consult with the Bioengineering Department’s Major Advisor in planning your track. Submit this completed form to the Department's Major Advisor for approval before taking courses toward the track requirements. Any subsequent changes to your plan must also be approved using this form.

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Student Signature: ____________________________________________

Department Approval: __________________________________________ Date: __________________________