BIOMECHANICAL ENGINEERING UNDERGRADUATE MAJOR

COVID-19-Related Degree Requirement Changes
Grading
The Biomechanical Engineering program counts all courses taken in academic year 2020-21 with a grade of 'CR' (credit) or 'S' (satisfactory) towards satisfaction of undergraduate degree requirements that normally require a letter grade.

Other Undergraduate Policies
The Biomechanical Engineering program encourages students to take courses for letter grades when possible in order to have complete records for use when seeking future opportunities, including employment in industry and students seeking to apply for graduate studies. Per University policy, students can change grading basis through the end of Week 8 in all four quarters in 2020-21. Students are encouraged to reach out directly to Biomechanical Engineering Program Director, Marc Elliott Levenston <levenston@stanford.edu>, for questions about petitions, especially in situations related to COVID-19 policies and grading basis.

Biomechanical Engineering (BME)
Completion of the undergraduate program in Biomechanical Engineering leads to the conferral of the Bachelor of Science in Engineering. The subplan “Biomechanical Engineering” appears on the transcript and on the diploma.

Mission of the Undergraduate Program in Biomechanical Engineering
The mission of the undergraduate program in Biomechanical Engineering is to help students address health science challenges by applying engineering mechanics and design to the fields of biology and medicine. The program is interdisciplinary in nature, integrating engineering course work with biology and clinical medicine. Research and teaching in this discipline focus primarily on neuromuscular, musculoskeletal, cardiovascular, and cell and tissue biomechanics. This major prepares students for graduate studies in bioengineering, biomechanics, medicine or related areas.

Requirements

Mathematics

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 units minimum; CME sequence is recommended, but MATH sequence is acceptable; see Basic Requirement 1</td>
<td>21</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
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<tbody>
<tr>
<td>CME 102/ENGR 155A</td>
<td>Ordinary Differential Equations for Engineers</td>
</tr>
<tr>
<td>or MATH 53</td>
<td>Ordinary Differential Equations with Linear Algebra</td>
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Option: CME 106/ENGR 155C

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
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<tbody>
<tr>
<td>Introduction to Probability and Statistics for Engineers</td>
<td>3</td>
</tr>
</tbody>
</table>

Statistics

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>STATS 110</td>
<td>Statistical Methods in Engineering and the Physical Sciences</td>
</tr>
<tr>
<td>STATS 116</td>
<td>Theory of Probability</td>
</tr>
<tr>
<td>STATS 141</td>
<td>Biostatistics</td>
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</table>

Science (22 units Minimum)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Units</th>
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<tbody>
<tr>
<td>CHEM 31M</td>
<td>Chemical Principles: From Molecules to Solids (or CHEM 31A &amp; CHEM 31B)</td>
</tr>
</tbody>
</table>

PHYSICS 41 Mechanics 4
Biology or Human Biology A/B core courses 2 8:10
BIO 45 Introduction to Laboratory Research in Cell and Molecular Biology 4
or BIOE 44 Fundamentals for Engineering Biology Lab

Technology in Society
One course required; BIOE 131 satisfies both TiS and WIM requirements. TiS course must be on School of Engineering Approved Courses list in the UGHB the year taken.

Engineering Topics (Engineering Science and Design)
Engineering Fundamentals (minimum two courses; see Basic Requirement 3):
ENGR 14 Intro to Solid Mechanics 3
Pick one of the following:
ENGR 80 Introduction to Bioengineering (Engineering Living Matter) 3
ENGR 50M Introduction to Materials Science, Biomaterials Emphasis 3

Engineering Depth
ENGR 15 Dynamics 3
ME 30 Engineering Thermodynamics 3
ME 70 Introductory Fluids Engineering 3
ME 80 Mechanics of Materials 3
ME 389 Biomechanical Research Symposium 4 1

Mechanical Engineering/ Biomechanical Engineering Depth
Students are encouraged to carefully select ME and BME depth courses that complement each other and form a cohesive plan of study.

Options to complete the ME depth sequence (3 courses, minimum 9 units): 5
ENGR 105 Feedback Control Design 3
ME 102 Foundations of Product Realization 3
ME 103 Product Realization: Design and Making 3
ME 104 Mechanical Systems Design 3
ME 131 Heat Transfer 3
ME 133 Intermediate Fluid Mechanics 3
ME 151 Introduction to Computational Mechanics 3
ME 152 Material Behaviors and Failure Prediction 3
ME 161 Dynamic Systems, Vibrations and Control 3

Options to complete the BME depth sequence (3 courses, minimum 9 units); (alternative courses may be allowed but only if petitioned for use in advance of being taken) 5
BIOE 285 Computational Modeling in the Cardiovascular System 3
ME 234 Introduction to Neuromechanics 3
ME 281 Biomechanics of Movement 3
ME 283 Introduction to Biomechanics and Mechanobiology 3
ME 287 Mechanics of Biological Tissues 3
ME 337 Mechanics of Growth 3

Total Units 79-83

1 Math: 21 units required and must include a course in differential equations (CME 102 or MATH 53; one of these required) and a course in calculus-based Statistics (CME 106 Introduction to Probability and Statistics for Engineers or STATS 110 Statistical Methods in Engineering and the Physical Sciences or STATS 116 Theory of Probability or STATS 141 Biostatistics).

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Students satisfy the Biology requirement by either:

- taking two of the following: BIO 82 Genetics, BIO 83 Biochemistry & Molecular Biology, BIO 84 Physiology or BIO 86 Cell Biology (requires BIO 83); or
- taking two of the following: HUMBIO 2A Genetics, Evolution, and Ecology, HUMBIO 3A Cell and Developmental Biology, or HUMBIO 4A The Human Organism

There are two options for fulfilling the WIM requirement. The first option is to complete BIOE 131 Ethics in Bioengineering, which also fulfills the TiS requirement. The second option is to perform engineering research over the summer or during the academic year and enroll in 3 units of ENGR 199W Writing of Original Research for Engineers, preferably during the time a student is performing research or the following quarter, to write a technical report on the research. This second option requires an agreement with the student's faculty research supervisor.

If ME 389 is not offered, other options include BIOE 393, ME 571, or course by petition.

Courses may only be listed once on the program sheet i.e no double counting. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

Honors Program

The School of Engineering offers a program leading to a Bachelor of Science in Engineering: Biomechanical Engineering with Honors. This program provides an opportunity for qualified BME majors to conduct independent study and research related to biomechanical engineering at an advanced level with a faculty mentor.

Honors Criteria:

- GPA of 3.5 or higher in the major
- Arrangement with an ME faculty member (or a faculty member from another department who is approved by the BME Undergraduate Program Director) who agrees to serve as the honors adviser, plus a second faculty member who reads and approves the thesis. The honors adviser must be a member of the Academic Council in the School of Engineering.
- Submit an application to the ME student services office no later than the second week of the term two quarters before anticipated conferral (e.g., Autumn for Spring conferral, Spring for Autumn conferral). An application consists of:
  - A one-page written statement describing the research topic, with signatures indicating approval of both the thesis adviser and thesis reader on a cover page
  - An unofficial Stanford transcript;
- Applications are subject to the review and final approval by the BME Undergraduate Program Director. Applicants and thesis advisers receive written notification when a decision has been made.
- In order to graduate with honors:
  - Declare ENGR-BSH (honors) program in Axess
  - Maintain 3.5 GPA
  - Submit a completed thesis draft to the adviser by the third week of the quarter in which they intend to confer. Further revisions and final endorsement by the adviser and reader are to be finished by week six, when two bound copies are to be submitted to the Mechanical Engineering student services office. A pdf of the thesis, including the signature page signed by both readers, should also be submitted to the student services officer. Students are sent email instructions on how to archive a permanent electronic copy in Terman Engineering library.
- Present the thesis at the Mechanical Engineering Poster Session held in mid-April. If the poster session is not offered or the student does not confer in the Spring, an alternative presentation will be approved on a case by case basis with advisor and BME Program Director approval.

Note: Students may not use work completed towards an honors degree to satisfy BME course requirements.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

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