BIOMECHANICAL ENGINEERING UNDERGRADUATE MAJOR

Biomechanical Engineering (BME)

Completion of the undergraduate program in Biomechanical Engineering leads to the conferment 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**
  - 21 units minimum; CME sequence is recommended, but MATH sequence is acceptable; see Basic Requirement
  - CME 102/ ENGR 155A or MATH 53: Ordinary Differential Equations for Engineers
  - Ordinary Differential Equations with Linear Algebra
  - Select one of the following:
    - CME 106/ ENGR 155C: Introduction to Probability and Statistics for Engineers
    - STATS 110: Statistical Methods in Engineering and the Physical Sciences
    - STATS 116: Theory of Probability
    - STATS 141: Biostatistics

- **Science (22 units Minimum)**
  - CHEM 31M: Chemical Principles: From Molecules to Solids (or CHEM 31A & CHEM 31B)
  - PHYSICS 41: Mechanics
    - PHYSICS 41E: Mechanics, Concepts, Calculations, and Context
  - Biology or Human Biology A/B core courses
  - BIO 45: Introduction to Laboratory Research in Cell and Molecular Biology
  - or BIO 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
  - Pick one of the following:
    - ENGR 25B: Biotechnology
    - ENGR 80: Introduction to Bioengineering (Engineering Living Matter)

**Engineering Depth**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 15</td>
<td>Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 30</td>
<td>Engineering Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 70</td>
<td>Introductory Fluids Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ME 80</td>
<td>Mechanics of Materials</td>
<td>3</td>
</tr>
<tr>
<td>ME 104</td>
<td>Mechanical Systems Design</td>
<td>4</td>
</tr>
<tr>
<td>ME 389</td>
<td>Biomechanical Research Symposium</td>
<td>1</td>
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**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):
  - ENGR 105: Feedback Control Design
  - ME 102: Foundations of Product Realization
  - ME 131: Heat Transfer
  - ME 133: Intermediate Fluid Mechanics
  - ME 151: Introduction to Computational Mechanics
  - ME 152: Material Behaviors and Failure Prediction
  - ME 161: Dynamic Systems, Vibrations and Control

- Options to complete the BME depth sequence (3 courses, minimum 9 units): 5
  - BIOE 260: Tissue Engineering
  - BIOE/ME 285: Computational Modeling in the Cardiovascular System
  - ME 234: Introduction to Neuromechanics
  - ME 281: Biomechanics of Movement
  - ME 283: Introduction to Biomechanics and Mechanobiology
  - ME 287: Mechanics of Biological Tissues
  - ME 328: Medical Robotics (with permission of instructor)
  - ME 337: Mechanics of Growth

**Total Units**: 83-87

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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).
2. Students satisfy the Biology requirement by either:
   - taking two of the following: BIO 82 Genetics, BIO 83 Biotechnology & 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).