This program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

**Undergraduate Program Mission Statement**

To provide education that prepares students to lead, innovate, and self-educate through their careers in bioengineering and biomedical professions and industries.

**Program Objectives**

**Career Achievements** – Using a knowledge base with a core foundation in engineering and biology, our students will be able to apply their skills to a variety of challenges in their chosen field. Our graduates will demonstrate skills such as innovation, creativity, adaptability, and critical thinking to solve problems in biomedical industry, medicine, academia, and consulting.

**Professionalism** – Our graduates will demonstrate leadership in their chosen fields, and make decisions that are socially and ethically responsible. Graduates will function effectively in multidisciplinary team environments and communicate effectively to a variety of audiences.

**Life-long Learning** – Our graduates will build and expand upon their undergraduate foundations by engaging in learning opportunities throughout their careers.
To obtain the B.S. in Biomedical Engineering, a student must obtain 18 course credits in engineering topics.

I. **MATHEMATICS** (4 courses)
   - MATH 220, 224, 230  Calculus
   - MATH 234  Multiple Integration and Vector Calculus

II. **BASIC SCIENCES** (4 courses)
   - PHYSICS 135-2,3  General Physics
   - CHEM* 102, 103  General Chemistry
   - CHEM* 171, 172  Accelerated Chemistry
   *Chem 101 may be used as a technical elective.

III. **ENGINEERING ANALYSIS** (4 courses)
   - GEN ENG 205-1  Computational Methods and Linear Algebra
   - GEN ENG 205-2  Linear Algebra and Mechanics
   - GEN ENG 205-3  Dynamic System Modeling
   - GEN ENG 205-4  Differential Equations

IV. **ENGINEERING DESIGN AND COMMUNICATION** (3 courses)
   - IDEA 106-1, 2  Engineering Design and Communication (0.5 each) plus English 106-1,2 (0.5 each)
   - BMD_ENG 390-2  Biomedical Engineering Design
   - Another capstone design course (including BME 391-SA) may be substituted for this course by petition.

V. **BASIC ENGINEERING*** (5 courses)
   A. **Thermodynamics** - 1 course listed from those below
      - BMD_ENG 250  Thermodynamics
      - CHEM 342-1  Thermodynamics
      - MECH ENG 220  Thermodynamics I
   B. **Fluids and Solids** - 2 courses as specified below
      - BMD_ENG 271  Introduction to Biomechanics
      - BMD_ENG 270  Fluid Mechanics
      - MECH ENG 241  Fluid Mechanics I
   C. **Material Science** - 1 course
      - MAT SCI 201  Principles of the Properties of Materials
   D. **Probability, Statistics, and Quality Control** - 1 course listed from those below
      - BMD_ENG 220  Introduction to Biostatistics
      - IEMS 201  Introduction to Statistics
VI. **SOCIAL SCIENCES/HUMANITIES THEME** (7 courses)

VII. **UNRESTRICTED ELECTIVES** (5 courses)

VIII. **BIOMEDICAL ENGINEERING PROGRAM** (16 courses, none of which may be taken P/N*)

Students seeking admission to dental or medical schools should familiarize themselves with the specific entrance requirements of those schools to which they intend to apply. In addition to the specifically required courses of the BME program, many professional schools also require additional courses in physics, organic and/or physical chemistry, biochemistry, and laboratory biology. These requirements can be satisfied through the BME curriculum and by judicious use of electives.

**A. Core** – 9 courses + 1 zero credit seminar

- **BMD_ENG 101** Introduction to Biomedical Engineering (zero credit seminar)
- **CHEM 210-1** Organic Chemistry
- **BIOLSCI 215-0** Genetics and Molecular Biology
  
  **Or**
  - **BIOLSCI 216-0** Cell Biology

- **BMD_ENG 301** Systems Physiology I
- **BMD_ENG 302** Systems Physiology II
- **BMD_ENG 303** Systems Physiology III
- **BMD_ENG 305** Biomedical Signals Analysis
- **BMD_ENG 306** Biomedical Systems Analysis
- **BMD_ENG 307** Quantitative Experimentation and Design

- **BMD_ENG 390-1** Biomedical Engineering Design

**B. Tracks** - 7 courses

Each student in the Biomedical Engineering Program completes his/her course of study either by selecting one of the following tracks or by an alternate set of courses developed with his/her advisor and submitted by petition to and approved by the BME Undergraduate Committee. Students should also be aware that 395 Special Topics courses are offered each year in BME and other departments. Not all of these courses are accepted as technical electives; they must be approved by petition.

*Technical electives in Biomedical Engineering may include: CHEM 101, BIOLSCI 215 or BIOLSCI 216 (the one not used to satisfy core requirement), BIOLSCI 218, CHEM 210-2 and 3, EECS 230, DSGN 245-1,2, and 300-level or higher courses in engineering*, science or mathematics. Students are urged to choose technical electives that emphasize engineering design.

*395 courses must be approved; not all are acceptable. BME 399 Independent Study is only graded P/N and may not be used as a technical elective. BME 499 is graded and may be used as a technical elective.*
1. Biomechanics and Rehabilitation (Professors Ameer, Dhaher, Glucksberg, Hartmann, Johnson, Liu, MacIver, Murray, Perreault)

Take both of the following courses:
- BMD_ENG 366 Biomechanics of Movement
- BMD_ENG 371 Mechanics of Biological Tissue

Take one of the following courses:
- BMD_ENG 346 Tissue Engineering
- BMD_ENG 349 Bioregenerative Engineering

Take two of the following courses:
- BMD_ENG 344 Biological Performance of Materials
- BMD_ENG 365 Human Limbs and their Artificial Replacements
- BMD_ENG 377 Intermediate Fluid Mechanics in Engineering and Biology
- CIV ENG 327 Finite Element Methods in Mechanics
- MECH ENG 315 Theory of Machines-Design
- MECH ENG 362 Stress Analysis
- MECH ENG 389 Molecular Machines in Biology
- MECH ENG 391 Fundamentals of Control Systems
- EECS 360 Introduction to Feedback Systems

Two technical electives

2. Transport Processes and Tissue Engineering (Professors Ameer, Ho, Johnson, Linsenmeier, Liu)

BMD_ENG 350 Transport Fundamentals
BMD_ENG 377 Intermediate Fluid Mechanics in Engineering and Biology

Take one of the following courses
- BMD_ENG 346 Tissue Engineering
- BMD_ENG 349 Bioregenerative Engineering

Take two of the following courses:
- BMD_ENG 359 Regenerative Engineering Laboratory
- BMD_ENG 315 Application of Genetic Engineering to Immunochemistry
- BMD_ENG 317 Biochemical Sensors
- BMD_ENG 343+ Biomaterials and Medical Devices
- MAT SCI 370+ Biomaterials
- BMD_ENG 344 Biological Performance of Materials
- BMD_ENG 371 Mechanics of Biological Tissue
- BIOL SCI 315* Cell Biology
- BIOL SCI 390* Molecular Biology

*Only 1 of these courses may be counted toward the track
+ Only 1 of these courses may be counted toward the track

Two technical electives

3. Biological Materials and Molecular Engineering (Professors Ameer, Ho, Kelso, Liu, Messersmith, Szleifer, Wu)

BMD_ENG 314 Models in Biochemistry and Molecular Biology
BMD_ENG 317 Biochemical Sensors

Take one of the following courses:
BMD_ENG 343 Biomaterials and Medical Devices
MAT SCI 370 Biomaterials

Take one of the following courses:
BMD_ENG 344 Biological Performance of Materials
MAT SCI 331 Physical Properties of Polymers

Take one of the following courses:
BMD_ENG 359 Regenerative Engineering Laboratory
BMD_ENG 315 Application of Genetic Engineering to Immunochemistry
BMD_ENG 333 Modern Optical Microscopy and Imaging
BMD_ENG 346 Tissue Engineering
BMD_ENG 349 Bioregenerative Engineering
BMD_ENG 350 Transport Fundamentals
BMD_ENG 377 Intermediate Fluid Mechanics in Engineering and Biology
MECH ENG 385 Nanotechnology
CHEM ENG 379 Introduction to Computational engineering
BIOL SCI 301 Biochemistry
BIOL SCI 315 Cell Biology
BIOL SCI 390 Molecular Biology

Two technical electives

4. Biomedical Signals and Images (Professors Backman, Carroll, D. Li, X. Li, Perreault, Troy, Walsh)

BMD_ENG 325 Introduction to Medical Imaging
EECS 302 Probabilistic Systems and Random Signals

Take one of the following:
BMD_ENG 327* Magnetic Resonance Imaging
BMD_ENG 333* Modern Optical Microscopy and Imaging

Take two of the following courses:
BMD_ENG 323 Visual Science – not offered in 2010-11
BMD_ENG 327* Magnetic Resonance Imaging
BMD_ENG 333* Modern Optical Microscopy and Imaging
EECS 395 Cardiovascular Instrumentation (by petition)
BMD_ENG 495 Biomedical Imaging Principles and Applications
EECS 328 Numerical Methods for Engineers
EECS 360 Introduction to Feedback Systems
PHY 357 Bio-Photonics Laboratory

*BME 327 and BME 333 are listed in 2 places in this track because both courses can count toward this track. Neither course may not be double-counted, however.

Two technical electives
The following 2 tracks allow alternate courses to be used for the basic engineering requirement to better prepare students for upper level courses within the track. These courses are listed below but must be approved by petition.

5. Computer Engineering (Professors Sahakian, X. Li)

V. Basic Engineering Courses:

EECS 202 Introduction to Electrical Engineering
EECS 203 Introduction to Computer Engineering
EECS 205 Fundamentals of Computer System Software
1 course from area VD - Probability, Statistics, and Quality Control
BME 250, BME 270, MECH ENG 241, or BMD_ENG 271

VIIIA. Core Courses – as listed

VIIIB. Track courses:

EECS 211 Programming for Computer Engineers (C++ programming)
EECS 303 Advanced Digital Logic Design
BMD_ENG 383 Cardiovascular Instrumentation

Take one of the following pair of classes

EECS 346 Microprocessor System Design
EECS 347 Microprocessor System Projects (design, build, and embed a microprocessor)
EECS 361 Computer Architecture
EECS 362 Computer Architecture Project
EECS 391 VLSI Systems Design
EECS 392 VLSI Systems Design Projects (design an integrated circuit)

Two technical electives

6. Electrical Engineering (Professors Sahakian, X. Li)

V. Basic Engineering Courses

EECS 202 Introduction to Electrical Engineering
EECS 203 Introduction to Computer Engineering – this is a prereq for EECS 303
1 course from area VB – Fluids and Solids
1 course from area VC – Materials Science
1 course from area VD – Probability, Statistics, and Quality Control

VIIIA. Core Courses – as listed

VIIIB. Track courses

Take all of the following courses:

EECS 223 Fundamentals of Solid State Engineering
EECS 225 Fundamentals of Electronics
EECS 230 Programming for Computer Engineers
EECS 303 Advanced Digital Logic Design
EECS 395 Cardiovascular Instrumentation (by petition)

Two technical electives
### Biomedical Engineering Courses

*Offered in the McCormick School of Engineering and Applied Sciences*

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMD_ENG 101</td>
<td>Introduction to Biomedical Engineering</td>
</tr>
<tr>
<td>BMD_ENG 220</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>BMD_ENG 250</td>
<td>Thermodynamics</td>
</tr>
<tr>
<td>BMD_ENG 270</td>
<td>Fluid Mechanics (with labs)</td>
</tr>
<tr>
<td>BMD_ENG 301</td>
<td>Systems Physiology I (with design)</td>
</tr>
<tr>
<td>BMD_ENG 302</td>
<td>Systems Physiology II</td>
</tr>
<tr>
<td>BMD_ENG 303</td>
<td>Systems Physiology III</td>
</tr>
<tr>
<td>BMD_ENG 305</td>
<td>Biomedical Signals Analysis</td>
</tr>
<tr>
<td>BMD_ENG 306</td>
<td>Biomedical Systems Analysis</td>
</tr>
<tr>
<td>BMD_ENG 307</td>
<td>Quantitative Experimentation and Design</td>
</tr>
<tr>
<td>BMD_ENG 314</td>
<td>Models in Biochemistry and Molecular Biology</td>
</tr>
<tr>
<td>BMD_ENG 315</td>
<td>Applications of Genetic Engineering to Immunochemistry</td>
</tr>
<tr>
<td>BMD_ENG 317</td>
<td>Biochemical Sensors (not offered every year)</td>
</tr>
<tr>
<td>BMD_ENG 323</td>
<td>Visual Science (with design; not offered every year)</td>
</tr>
<tr>
<td>BMD_ENG 325</td>
<td>Introduction to Medical Imaging</td>
</tr>
<tr>
<td>BMD_ENG 327</td>
<td>Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>BMD_ENG 333</td>
<td>Modern Optical Microscopy and Imaging (with design)</td>
</tr>
<tr>
<td>BMD_ENG 343</td>
<td>Biomaterials and Medical Devices</td>
</tr>
<tr>
<td>BMD_ENG 344</td>
<td>Biological Performance of Materials</td>
</tr>
<tr>
<td>BMD_ENG 346</td>
<td>Tissue Engineering (with labs and design)</td>
</tr>
<tr>
<td>BMD_ENG 349</td>
<td>Bioregenerative Engineering (with labs and design)</td>
</tr>
<tr>
<td>BMD_ENG 350</td>
<td>Mass and Heat Transport</td>
</tr>
<tr>
<td>BMD_ENG 359</td>
<td>Regenerative Engineering Laboratory</td>
</tr>
<tr>
<td>BMD_ENG 365</td>
<td>Human Limbs and Their Artificial Replacements</td>
</tr>
<tr>
<td>BMD_ENG 366</td>
<td>Biomechanics of Movement</td>
</tr>
<tr>
<td>BMD_ENG 371</td>
<td>Mechanics of Biological Tissues</td>
</tr>
<tr>
<td>BMD_ENG 377</td>
<td>Intermediate Fluid Mechanics in Engineering and Biology</td>
</tr>
<tr>
<td>BMD_ENG 383</td>
<td>Cardiovascular Instrumentation (now offered as EECS 395)</td>
</tr>
<tr>
<td>BMD_ENG 390-1</td>
<td>Biomedical Engineering Design (with design)</td>
</tr>
<tr>
<td>BMD_ENG 390-2</td>
<td>Biomedical Engineering Design (with design)</td>
</tr>
<tr>
<td>BMD_ENG 395</td>
<td>Special Topics in Biomedical Engineering (see list below)</td>
</tr>
<tr>
<td>BMD_ENG 401</td>
<td>Advanced Systems Physiology I (with design)</td>
</tr>
<tr>
<td>BMD_ENG 402</td>
<td>Advanced Systems Physiology II (with design)</td>
</tr>
<tr>
<td>BMD_ENG 403</td>
<td>Advanced Systems Physiology III</td>
</tr>
<tr>
<td>BMD_ENG 427</td>
<td>Advanced MR Imaging</td>
</tr>
<tr>
<td>BMD_ENG 441</td>
<td>Biointerface Science</td>
</tr>
<tr>
<td>BMD_ENG 442</td>
<td>Thermodynamics and Interactions at Biointerfaces</td>
</tr>
<tr>
<td>BMD_ENG 444</td>
<td>Nanomedicine</td>
</tr>
<tr>
<td>BMD_ENG 445</td>
<td>Macromolecular Biomaterials</td>
</tr>
<tr>
<td>BMD_ENG 460</td>
<td>Neural Engineering: Fundamentals</td>
</tr>
<tr>
<td>BMD_ENG 461</td>
<td>Neural Engineering: Computational Neuromechanics and Neuroethology</td>
</tr>
<tr>
<td>BMD_ENG 462</td>
<td>Neural Engineering: Sensory Acquisition through Movement</td>
</tr>
<tr>
<td>BMD_ENG 463</td>
<td>Systems Neuropathophysiology</td>
</tr>
<tr>
<td>BMD_ENG 464</td>
<td>Neuromechatronics</td>
</tr>
<tr>
<td>BMD_ENG 465</td>
<td>Biomechanical Modeling and Simulation of Human Movement</td>
</tr>
<tr>
<td>BMD_ENG 467</td>
<td>Biomedical Robotics</td>
</tr>
<tr>
<td>BMD_ENG 469</td>
<td>Neural Control and Mechanics of Movement</td>
</tr>
<tr>
<td>BMD_ENG 475</td>
<td>Cardiovascular Biology and Engineering</td>
</tr>
<tr>
<td>BMD_ENG 495</td>
<td>Advanced Special Topics in Biomedical Engineering (see list below)</td>
</tr>
</tbody>
</table>

**Special Topics in BME:**
- BMD_ENG 395 Engineering Design of Therapeutic Antibodies
- BMD_ENG 395 Medical Devices, Disease, and Global Health
- BMD_ENG 495 Functional MRI
BMD_ENG  495 Advanced Optics
BMD_ENG  495 Advanced Tissue Engineering