# BIOMEDICAL ENGINEERING - BS

## Program Requirements

The freshman year is identical for degrees in aerospace engineering, architectural engineering, civil engineering, computer engineering, computer science, electrical engineering, electronic engineering, systems engineering technology, environmental engineering, industrial distribution, industrial engineering, interdisciplinary engineering, manufacturing and mechanical engineering technology, mechanical engineering, multidisciplinary engineering technology, nuclear engineering, ocean engineering, and petroleum engineering (Note: not all programs listed are offered in Qatar). The freshman year is slightly different for chemical engineering, biomedical engineering and materials science and engineering degrees in that students take CHEM 119 or CHEM 107/CHEN 107 and CHEM 120. Students pursuing degrees in biological and agricultural engineering should refer to the specific curriculum for this major. It is recognized that many students will change the sequence and number of courses taken in any semester. Deviations from the prescribed course sequence, however, should be made with care to ensure that prerequisites for all courses are met.

<table>
<thead>
<tr>
<th>First Year</th>
<th>Semester Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fall</strong></td>
<td></td>
</tr>
<tr>
<td>CHEM 107</td>
<td>General Chemistry for Engineering Students 1,4</td>
</tr>
<tr>
<td>CHEM 117</td>
<td>General Chemistry for Engineering Students Laboratory 1,4</td>
</tr>
<tr>
<td>ENGL 103</td>
<td>Introduction to Rhetoric and Composition 1 or Composition and Rhetoric</td>
</tr>
<tr>
<td>ENGR 102</td>
<td>Engineering Lab I - Computation 1</td>
</tr>
<tr>
<td>MATH 151</td>
<td>Engineering Mathematics I 1,2</td>
</tr>
<tr>
<td>University Core Curriculum (<a href="http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/">http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/</a>) 1,3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Spring</strong></td>
<td>Semester Credit Hours 16</td>
</tr>
<tr>
<td>ENGR 216/</td>
<td>Experimental Physics and Engineering Lab II - Mechanics 1</td>
</tr>
<tr>
<td>PHYS 216</td>
<td>Engineering Mathematics II 1</td>
</tr>
<tr>
<td>MATH 206</td>
<td>Newtonian Mechanics for Engineering and Science 1</td>
</tr>
<tr>
<td>University Core Curriculum (<a href="http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/">http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/</a>) 1,3</td>
<td>3</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>3-4</td>
</tr>
<tr>
<td>CHEM 120</td>
<td>Fundamentals of Chemistry II 1,4</td>
</tr>
<tr>
<td>University Core Curriculum (<a href="http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/">http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/</a>) 1,4</td>
<td>3,5</td>
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</table>

<table>
<thead>
<tr>
<th>Second Year</th>
<th>Semester Credit Hours 16</th>
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<tbody>
<tr>
<td><strong>Fall</strong></td>
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</tr>
<tr>
<td>BMEN 253</td>
<td>Discovering Biomedical Engineering Design Thinking 1</td>
</tr>
<tr>
<td>ENGR 217/</td>
<td>Experimental Physics and Engineering Lab III - Electricity and Magnetism 1</td>
</tr>
<tr>
<td>PHYS 217</td>
<td>Engineering Mathematics III 1 or Engineering Mathematics III 1</td>
</tr>
<tr>
<td>MATH 251/MATH 253</td>
<td>Electricity and Magnetism for Engineering and Science 1</td>
</tr>
<tr>
<td>VTPP 434</td>
<td>Physiology for Bioengineers I 1</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>3</td>
</tr>
<tr>
<td>COMM 203</td>
<td>Public Speaking</td>
</tr>
<tr>
<td>COMM 205</td>
<td>Communication for Technical Professions</td>
</tr>
<tr>
<td>ENGL 203</td>
<td>Writing about Literature</td>
</tr>
<tr>
<td>ENGL 210</td>
<td>Technical and Professional Writing</td>
</tr>
<tr>
<td><strong>Spring</strong></td>
<td>Semester Credit Hours 17</td>
</tr>
<tr>
<td>BMEN 201</td>
<td>Professional Development Essentials 1,6</td>
</tr>
<tr>
<td>BMEN 207</td>
<td>Computing for Biomedical Engineering 1</td>
</tr>
<tr>
<td>BMEN 250</td>
<td>Biostatistics and Data Visualization 1 or Statistics for Biology</td>
</tr>
<tr>
<td>BMEN 254</td>
<td>Biomedical Engineering Design I 1</td>
</tr>
<tr>
<td>MATH 308</td>
<td>Differential Equations 1</td>
</tr>
<tr>
<td>VTPP 435</td>
<td>Physiology for Bioengineers II 1</td>
</tr>
</tbody>
</table>

1 A grade of C or better is required.

2 Entering students will be given a math placement exam. Test results will be used in selecting the appropriate starting course which may be at a higher or lower level.

3 Of the 21 hours shown as University Core Curriculum electives, 3 must be from creative arts (see AREN curriculum for more information), 3 from social and behavioral sciences (see IDIS curriculum for more information), 3 from language, philosophy and culture (see CVEN, EVEN and PETE curriculum for more information), 6 from American history and 6 from government/political science. The required 3 hours of international and cultural diversity and 3 hours of cultural discourse may be met by courses satisfying the creative arts, social and behavioral sciences, language, philosophy and culture, and American history requirements if they are also on the approved list of international and cultural diversity (http://catalog.tamu.edu/undergraduate/general-information/degree-information/international-cultural-diversity-requirements/) courses and cultural discourse (http://catalog.tamu.edu/undergraduate/general-information/degree-information/cultural-discourse-requirements/) courses.

4 BMEN, CHEN and MSEN require 8 hours of fundamentals of chemistry which are satisfied with CHEM 119 or CHEM 107/CHEN 117 and CHEM 120; Students with an interest in BMEN, CHEN and MSEN can take CHEM 120 second semester freshman year. CHEM 120 will substitute for CHEM 107/CHEN 117.

5 For BS-PETE, allocate 3 hours to core communications course (ENG 210, COMM 203, COMM 205, or COMM 243) and/or 3 hours to UCC elective. For BS-MEEN, allocate 3 hours to core communications course (ENG 203, ENG 210, or COMM 205) and/or 3 hours to UCC elective.

6 Additional hours (12) of laboratory and lecture courses may be chosen to meet the 17 hours of laboratory and lecture courses and 3 hours of upper division technical electives (4-6 credit hours) for BS-PETE and BS-MEEN. For BS-PETE, the technical electives can be from the following: BMEN, CHEN and MSEN. For BS-MEEN, the technical electives can be from the following: BMEN, CHEN and MSEN.
### Third Year

#### Fall
- BMEN 321 Circuits, Signals, and Systems 1 3
- BMEN 351 Biomedical and Health Data Science 3
- BMEN 353 Biomedical Engineering Device Design II 1
- BMEN 361 Biomedical Engineering Mechanics 6 3
- CHEM 227 Organic Chemistry I 1 3
- University Core Curriculum (http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/) 1,3 3
- High Impact Experience 7 0
- BMEN 399 Engineering Professional Development 16

#### Semester Credit Hours 16

#### Spring
- BMEN 311 Imaging Living Systems 1 3
- BMEN 341 Biotransport 1 3
- BMEN 343 Biomedical Engineering Materials 1 3
- BMEN 344 Biological Interactions and Testing 1 3
- BMEN 354 Biomedical Engineering Design III 1 2
- University Core Curriculum (http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/) 3 3

#### Semester Credit Hours 17

### Fourth Year

#### Fall
- BMEN 453 Analysis and Design Project I 1,8 3
- University Core Curriculum (http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/) 3 3
- Technical electives 1,8 9

#### Semester Credit Hours 15

#### Spring
- BMEN 454 Analysis and Design Project II 1 3
- University Core Curriculum (http://catalog.tamu.edu/undergraduate/general-information/university-core-curriculum/) 3 6
- Technical electives 1,8 6

#### Semester Credit Hours 15

#### Total Semester Credit Hours 96

6 Writing intensive course.
7 All students are required to complete a high-impact experience in order to graduate. A list of possible high-impact experiences is available in the BMEN advising office.
8 Technical electives are to be selected from the course list below. Students must select one of the following tracks and take 15 hours from within that track: Bioinstrumentation, Biomaterials, Biomechanics, or Biomolecular and Cellular Engineering. Course selection should be done in consultation with student's advisor and track coordinator, may use up to 3 hours of BMEN 491. Please note ACCT 640 is for students pursuing the MSF program and ENGR 410 is for students pursuing the International Engineering Certificate.

### Total Program Hours 128

#### Biomechanics

**Required courses**
- BMEN 463 Soft Tissue Mechanics and Finite Element Methods 1

**Select one of the following:**
- BMEN 457 Orthopedic Biomechanics 1
- BMEN 458 Motion Biomechanics 1
- BMEN 461 Cardiac Mechanics 1

**Select from the following:**
- BMEN 432 Molecular and Cellular Biomechanics 1
- BMEN 457 Orthopedic Biomechanics 1
- BMEN 458 Motion Biomechanics 1
- BMEN 461 Cardiac Mechanics 1
- BMEN 491 Research 1
- MEEN 363 Dynamics and Vibrations 1
- MEEN 368 Solid Mechanics in Mechanical Design 1

#### Cellular and Molecular Bioengineering

**Required Courses:**
- BICH 410 Comprehensive Biochemistry I 1
- BMEN 431 Biomolecular Engineering 1
- BMEN 432 Molecular and Cellular Biomechanics 1

**Select from the following:**
- BICH 411 Comprehensive Biochemistry II 1
- BMEN 480 Biomedical Engineering of Tissues 1
- BMEN 486 Biomedical Nanotechnology 1
- BMEN 487 Drug Delivery 1
- BMEN 491 Research 1
- ECEN 414 Biosensors 1

#### Computational Bioengineering

**Required courses**
- BMEN 401 Principles and Analysis of Biological Control Systems 1
- BMEN 471 Numerical Methods in Biomedical Engineering 1

**Select from the following:**
- BIOL 350 Computational Genomics 1
- BMEN 463 Soft Tissue Mechanics and Finite Element Methods 1
- BMEN 491 Research 1
- MEEN 442 Computer Aided Engineering 1
- MEEN 444 Finite Element Analysis in Mechanical Engineering 1

#### Imaging and Photonics

**Required Courses**
- BMEN 420 Medical Imaging 1
- BMEN 425 Biophotonics 1

**Select from the following:**
- BIOL 350 Computational Genomics 1
- BMEN 463 Soft Tissue Mechanics and Finite Element Methods 1
- BMEN 491 Research 1
- MEEN 442 Computer Aided Engineering 1
- MEEN 444 Finite Element Analysis in Mechanical Engineering 1
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMEN 402</td>
<td>Biomedical Optics Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>BMEN 422</td>
<td>Biocell electromagnetism</td>
<td>1</td>
</tr>
<tr>
<td>BMEN 427</td>
<td>Magnetic Resonance Engineering</td>
<td>1</td>
</tr>
<tr>
<td>BMEN 491</td>
<td>Research</td>
<td>1</td>
</tr>
<tr>
<td>ECEN 411</td>
<td>Introduction to Magnetic Resonance Imaging and Magnetic Resonance Spectroscopy</td>
<td>1</td>
</tr>
<tr>
<td>ECEN 412</td>
<td>Ultrasound Imaging</td>
<td>1</td>
</tr>
<tr>
<td>ECEN 447</td>
<td>Digital Image Processing</td>
<td>1</td>
</tr>
</tbody>
</table>

**Medical Devices**

Required courses: 9

- BMEN 404 FDA Good Laboratory and Clinical Practices
- BMEN 406 Medical Device Path to Market
- BMEN 469 Entrepreneurial Pathways in Medical Devices

Select from the following: 3-6

- BMEN 491 Research
- MEEN 440 Bio-inspired Engineering Design
- MEEN 441 Design of Mechanical Components and Systems
- MEEN 442 Computer Aided Engineering

**Regenerative Medicine**

Required courses: 6

- BMEN 480 Biomedical Engineering of Tissues
- BMEN 482 Polymeric Biomaterials
  - or BMEN 488 Polymeric Biomaterial Synthesis

Select from the following: 6-9

- BMEN 482 Polymeric Biomaterials
- BMEN 483 Polymeric Biomaterial Synthesis
- BMEN 486 Biomedical Nanotechnology
- BMEN 491 Research
- CHEM 466 Polymer Chemistry
- CHEM 451 Introduction to Polymer Engineering
- MEEN 458 Processing and Characterization of Polymers
- MSEN 410 Materials Processing
- MSEN 420 Polymer Science

**Sensing and Monitoring**

Required courses: 6

- BMEN 322 Biosignal Analysis
- BMEN 401 Principles and Analysis of Biological Control Systems

Select from the following: 6-9

- BMEN 428/Embedded Systems for Medical Applications
- BMEN 448 Healthcare Technology in the Developing World
- BMEN 491 Research
- ECEN 414 Biosensors

Select from the following to apply to any of the tracks above: 0-3

ACCT 640 Accounting Concepts and Procedures I (MSF Students only)
BMEN 400/History of Human and Veterinary Medicine
VTPP 401 Medicine in Europe
BMEN 404 FDA Good Laboratory and Clinical Practices
BMEN 448 Healthcare Technology in the Developing World
BMEN 469 Entrepreneurial Pathways in Medical Devices
CHEM 228 Organic Chemistry II
ENGR 385 Problems for Co-Op Students
ENGR 410 Global Engineering Design
VTPB 410 Cell Mechanisms of Disease

400-Level BMEN with department approval
(http://catalog.tamu.edu/undergraduate/course-descriptions/bmen/)