

# Biomedical Engineering, Cellular and Biomolecular Engineering (BSBiomedE)

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The major objective of this concentration is to teach students how to integrate knowledge in cell and molecular biology with engineering analysis, so that they can address problems in molecular-based medicine. Two career emphases are available in this area: biomaterials/regenerative medicine and nanotechnology.

## Biomedical Engineering

The mission of the Department of Biomedical Engineering is to develop clinically translatable solutions for human health by training the next generation of biomedical engineers, cultivating leaders, and nurturing the integration of science, engineering, and medicine in a discovery-centered environment. The main educational objective is to provide a thorough training in the fundamentals of engineering science, design, and biology. The curriculum is designed to provide concepts central to understanding living systems from the molecular and cellular levels to the tissue and organismal levels. The curriculum incorporates principles of vertical integration, leading to the choice of a concentration (biomedical imaging and instrumentation, cellular and biomolecular engineering, computational biomedical engineering, or molecular, cellular, and tissue biomechanics), and culminates in a team capstone design experience. Students are expected to develop an understanding of industrial, research, and clinical biomedical engineering environments; an understanding of regulatory issues and biomedical ethics; the ability to create, identify, formulate, and solve biomedical engineering problems; the ability to design systems to meet needs in medical/life science applications; an understanding of life processes at the molecular, cellular, tissue, and organismal levels; the ability to use instrumentation and to make measurements and interpret data in living systems; and an appreciation of the interdisciplinary nature of biomedical engineering research.

## Concentrations

Concentrations allow the student to build on the biomedical engineering curriculum. Students choose coursework in one of four concentrations: biomedical imaging and instrumentation; cellular and biomolecular engineering; computational biomedical engineering; or molecular, cellular and tissue biomechanics. Within some concentrations, career emphases are available for students to focus coursework toward a particular career track. Students have flexibility to take technical elective coursework from more than one career emphasis under the same concentration.

## Minors and Certificate Programs

Biomedical engineering students may enrich their education through minors and certificate programs. For a full list please see [Minor and Certificate Programs](#). Common examples of certificates completed by biomedical engineering students are as follows:

*Business Foundations Minor.* Students who wish to learn about fundamental business concepts and practices may take supplemental coursework that leads to the Business Foundations Minor, awarded by

the Red McCombs School of Business. The certificate description is provided in the [program's page](#).

*Health Care Reform and Innovation Minor.* The Red McCombs School of Business offers this minor to prepare students for the unique challenges and opportunities in the field of healthcare. The minor description is provided in the [program's page](#).

*Computational Science and Engineering (CSE) Certificate.* This certificate offers the opportunity for in-depth study and research in computational science and engineering, including computational and applied mathematics, numerical simulation, scientific computation, and visualization. The certificate is administered by the Oden Institute for Computational Engineering and Sciences and its description is provided in the [program's page](#).

*Programming and Computation Certificate.* Students who wish to learn about computer science may take the coursework that leads to the Programming and Computation Certificate, awarded by the Department of Computer Science. The certificate description is provided in the [program's page](#).

*Pre-Health Professions Certificate.* This certificate provides majors outside of the College of Natural Sciences (CNS) access to the courses required to complete health professions prerequisites. The certificate description is provided in the [program's page](#).

## Licensure

### Preparation for Health Professions

Students who plan to attend medical or dental school in Texas must complete coursework in addition to that required for the degree to meet professional school admission requirements; those who plan to attend schools outside Texas may need additional coursework. The student is responsible for knowing and meeting these additional requirements, and assistance and information are available in the Health Professions Office in Natural Sciences. Additional information about preparation for health professions is available [online](#).

### Preparation for Law

There is no sequential arrangement of courses prescribed for a pre-law program. The Association of American Law Schools puts special emphasis on comprehension and expression in words, critical understanding of the human institutions and values with which the law deals, and analytical power in thinking. Courses relevant to these objectives deal with communication of ideas, logic, mathematics, social sciences, history, philosophy, and the physical sciences. Services for pre-law students are provided to students in all colleges by Liberal Arts Career Services, and to engineering students by the Engineering Career Assistance Center (ECAC). Additional information about preparation for law is available [online](#).

## Objectives

Achievement of the program outcomes gives students the foundation for accomplishing the biomedical engineering program educational objectives. A few years after graduation, students are expected to be able to:

- Conduct themselves with exemplary professional ethics and highest integrity
- Demonstrate a quantitative, analytical, and systems approach to problem solving in their professional practice
- Demonstrate a continuous quest for professional excellence and success

- Participate in continuing education to expand their knowledge of contemporary professional issues
- Exhibit effective scientific, technical, communication, and resource management skills in their professional practice

## Outcomes

Graduates of the biomedical engineering program are expected to have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, as well as global, cultural, societal, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

## Total Hours Required: 132

## Plan of Study

The Plan of Study is a suggested four-year course sequence to support academic planning and serves as a helpful guide. Currently enrolled students should meet with their academic advisor to tailor their course selections and timelines to their individual goals and circumstances.

| Course                                   | Title                                                                  | Hours     |
|------------------------------------------|------------------------------------------------------------------------|-----------|
| <b>Year 1</b>                            |                                                                        |           |
| <b>Semester 1</b>                        |                                                                        |           |
| BME 303L                                 | Introduction to Biomedical Engineering Design                          | 3         |
| CH 401                                   | Principles of Chemistry I                                              | 4         |
| BIO 311C                                 | Introductory Biology I                                                 | 3         |
| BIO 206L                                 | Introductory Laboratory Experiments in Biology                         | 2         |
| M 408C                                   | Differential and Integral Calculus                                     | 4         |
| <u>First-Year Signature Course (090)</u> |                                                                        | 3         |
| <b>Hours</b>                             |                                                                        | <b>19</b> |
| <b>Semester 2</b>                        |                                                                        |           |
| BME 303                                  | Introduction to Computing                                              | 3         |
| CH 402                                   | Principles of Chemistry II                                             | 4         |
| M 408D                                   | Sequences, Series, and Multivariable Calculus                          | 4         |
| PHY 303K                                 | Engineering Physics I                                                  | 3         |
| PHY 105M                                 | Laboratory For Physics 302K, 303K, and 317K                            | 1         |
| RHE 306                                  | Rhetoric and Writing                                                   | 3         |
| <b>Hours</b>                             |                                                                        | <b>18</b> |
| <b>Year 2</b>                            |                                                                        |           |
| <b>Semester 1</b>                        |                                                                        |           |
| BME 214L                                 | Computational Fundamentals of Biomedical Engineering Design            | 2         |
| BME 311                                  | Network Analysis in Biomedical Engineering (advisor approval required) | 3         |
| CH 328M<br>or CH 320M                    | Organic Chemistry I<br>or Organic Chemistry I                          | 3         |
| M 427J                                   | Differential Equations with Linear Algebra                             | 4         |

|                                             |                                                             |            |
|---------------------------------------------|-------------------------------------------------------------|------------|
| PHY 303L                                    | Engineering Physics II                                      | 3          |
| PHY 105N                                    | Laboratory For Physics 302L, 303L, and 317L                 | 1          |
| <b>Hours</b>                                |                                                             | <b>16</b>  |
| <b>Semester 2</b>                           |                                                             |            |
| E S 333T                                    | Engineering Communication                                   | 3          |
| BME 313L                                    | Introduction to Numerical Methods in Biomedical Engineering | 3          |
| BME 335                                     | Engineering Probability and Statistics                      | 3          |
| BME 344                                     | Biomechanics (advisor approval required)                    | 3          |
| BCH 369                                     | Fundamentals of Biochemistry                                | 3          |
| <u>Social and Behavioral Sciences (080)</u> |                                                             | 3          |
| <b>Hours</b>                                |                                                             | <b>18</b>  |
| <b>Year 3</b>                               |                                                             |            |
| <b>Semester 1</b>                           |                                                             |            |
| BME 245L                                    | Experimental Principles of Biomedical Engineering Design    | 2          |
| BME 343                                     | Biomedical Engineering Signal and Systems Analysis          | 3          |
| BME 365R                                    | Quantitative Engineering Physiology I                       | 3          |
| BME 352                                     | Engineering Biomaterials                                    | 3          |
| Technical Elective                          |                                                             | 3          |
| <u>Humanities (040)</u>                     |                                                             | 3          |
| <b>Hours</b>                                |                                                             | <b>17</b>  |
| <b>Semester 2</b>                           |                                                             |            |
| BME 261L                                    | Development and Analysis in Biomedical Engineering Design   | 2          |
| BME 349                                     | Biomedical Instrumentation                                  | 3          |
| BME 365S                                    | Quantitative Engineering Physiology II                      | 3          |
| BME 353                                     | Transport Phenomena in Living Systems                       | 3          |
| Technical Elective                          |                                                             | 3          |
| BME 355                                     | Molecular Engineering (advisor approval required)           | 3          |
| <b>Hours</b>                                |                                                             | <b>17</b>  |
| <b>Year 4</b>                               |                                                             |            |
| <b>Semester 1</b>                           |                                                             |            |
| BME 370                                     | Biomedical Engineering Capstone Design I                    | 3          |
| Technical Elective                          |                                                             | 3          |
| <u>Visual and Performing Arts (050)</u>     |                                                             | 3          |
| <u>U.S. History (060)</u>                   |                                                             | 3          |
| <u>American and Texas Government (070)</u>  |                                                             | 3          |
| <b>Hours</b>                                |                                                             | <b>15</b>  |
| <b>Semester 2</b>                           |                                                             |            |
| BME 371                                     | Biomedical Engineering Capstone Design II                   | 3          |
| Technical Elective                          |                                                             | 3          |
| <u>U.S. History (060)</u>                   |                                                             | 3          |
| <u>American and Texas Government (070)</u>  |                                                             | 3          |
| <b>Hours</b>                                |                                                             | <b>12</b>  |
| <b>Total Hours</b>                          |                                                             | <b>132</b> |

## Requirements

All requirements are listed below, starting with the most specialized moving to the most general. Additional requirements may follow the table, so be sure to read the entire page. Some required courses listed below may also satisfy [General Education](#) requirements, including [Core Curriculum](#).

| Code                                                                          | Title | Hours |
|-------------------------------------------------------------------------------|-------|-------|
| <b>Concentration</b>                                                          |       |       |
| <i>Career Emphasis</i>                                                        |       |       |
| Hours chosen from: Within engineering for a single career emphasis            |       | 6     |
| Biomaterials/Regenerative Medicine (see course list tab)                      |       |       |
| Nanotechnology (see course list tab)                                          |       |       |
| Hours chosen from: Within or outside engineering for the same career emphasis |       | 6     |
| Biomaterials/Regenerative Medicine (see course list tab)                      |       |       |

|                                                                   |            |
|-------------------------------------------------------------------|------------|
| Nanotechnology (see course list tab)                              |            |
| <i>Subtotal</i>                                                   | 12         |
| <b>Degree (see details below)</b>                                 | <b>96</b>  |
| Free Elective                                                     | 0          |
| <i>Subtotal</i>                                                   | 96         |
| <b>General Education</b>                                          |            |
| <u>Remaining Core Curriculum (42 hours total)</u>                 | 24         |
| <u>Foreign Language other than English, Beginning Proficiency</u> |            |
| <i>Subtotal</i>                                                   | 24         |
| <u>College Requirements - Engineering</u>                         |            |
| <u>General University Requirements</u>                            |            |
| <b>Total Hours</b>                                                | <b>132</b> |

## Degree-Bachelor of Science in Biomedical Engineering (BSBiomedE)

### Requirements

| Code                            | Title                                                                  | Hours |
|---------------------------------|------------------------------------------------------------------------|-------|
| <b>Degree</b>                   |                                                                        |       |
| <i>Biomedical Engineering</i>   |                                                                        |       |
| BME 214L                        | Computational Fundamentals of Biomedical Engineering Design            | 2     |
| BME 245L                        | Experimental Principles of Biomedical Engineering Design               | 2     |
| BME 261L                        | Development and Analysis in Biomedical Engineering Design              | 2     |
| BME 303                         | Introduction to Computing                                              | 3     |
| BME 303L                        | Introduction to Biomedical Engineering Design                          | 3     |
| BME 311                         | Network Analysis in Biomedical Engineering (advisor approval required) | 3     |
| BME 313L                        | Introduction to Numerical Methods in Biomedical Engineering            | 3     |
| BME 335                         | Engineering Probability and Statistics                                 | 3     |
| BME 343                         | Biomedical Engineering Signal and Systems Analysis                     | 3     |
| BME 344                         | Biomechanics (advisor approval required)                               | 3     |
| BME 349                         | Biomedical Instrumentation                                             | 3     |
| BME 352                         | Engineering Biomaterials                                               | 3     |
| BME 353                         | Transport Phenomena in Living Systems                                  | 3     |
| BME 355                         | Molecular Engineering                                                  | 3     |
| BME 365R                        | Quantitative Engineering Physiology I                                  | 3     |
| BME 365S                        | Quantitative Engineering Physiology II                                 | 3     |
| BME 370                         | Biomedical Engineering Capstone Design I                               | 3     |
| BME 371                         | Biomedical Engineering Capstone Design II                              | 3     |
| <i>Subtotal</i>                 |                                                                        | 51    |
| <i>Biochemistry and Biology</i> |                                                                        |       |
| BCH 369                         | Fundamentals of Biochemistry                                           | 3     |
| BIO 206L                        | Introductory Laboratory Experiments in Biology                         | 2     |
| BIO 311C                        | Introductory Biology I                                                 | 3     |
| <i>Subtotal</i>                 |                                                                        | 8     |
| <i>Chemistry</i>                |                                                                        |       |
| CH 401                          | Principles of Chemistry I                                              | 4     |
| CH 402                          | Principles of Chemistry II                                             | 4     |
| CH 320M                         | Organic Chemistry I                                                    | 3     |
| or CH 328M                      | Organic Chemistry I                                                    |       |
| <i>Subtotal</i>                 |                                                                        | 11    |

|                                  |                                               |           |
|----------------------------------|-----------------------------------------------|-----------|
| <i>Mathematics</i>               |                                               |           |
| M 408C                           | Differential and Integral Calculus            | 4         |
| M 408D                           | Sequences, Series, and Multivariable Calculus | 4         |
| M 427J                           | Differential Equations with Linear Algebra    | 4         |
| <i>Subtotal</i>                  |                                               | 12        |
| <i>Physics</i>                   |                                               |           |
| PHY 105M                         | Laboratory For Physics 302K, 303K, and 317K   | 1         |
| PHY 105N                         | Laboratory For Physics 302L, 303L, and 317L   | 1         |
| PHY 303K                         | Engineering Physics I                         | 3         |
| PHY 303L                         | Engineering Physics II                        | 3         |
| <i>Subtotal</i>                  |                                               | 8         |
| <i>Rhetoric and Writing</i>      |                                               |           |
| RHE 306                          | Rhetoric and Writing                          | 3         |
| <i>Additional Required Hours</i> |                                               |           |
| E S 333T                         | Engineering Communication                     | 3         |
| <i>Subtotal</i>                  |                                               | 6         |
| <b>Total Hours</b>               |                                               | <b>96</b> |

### Additional Requirements and Policies

Prior to registration, students must receive approval from the advising office for courses to be used to fulfill technical and nontechnical course requirements. The student must take all courses required for the degree on the letter-grade basis and must earn a grade of at least C- in each, except for those listed as remaining Core Curriculum.

Each student should choose a concentration by the end of the sophomore year and plan an academic program to meet the area requirements during the next two years.

### Plan II Honors Program

Students enrolled in the Plan II Honors Program are encouraged to contact the Biomedical Engineering Academic Advising Office, in addition to the Plan II Office to ensure that requirements for both programs are met. Plan II courses may count toward biomedical engineering program requirements.

### Course List

The lists of technical elective area options reflect current course offerings and are subject to change by the faculty. Current lists are available on the departmental undergraduate advising office's website.

### Biomaterials/Regenerative Medicine Career Emphasis

The objective of this emphasis is to prepare students for a career in biomaterials and regenerative medicine engineering. This emphasis includes solid foundation in cell and tissue engineering, biomaterials, and pharmacology. While students are required to select hours from any of the concentration course options, the following are recommended for the biomaterials/regenerative medicine career emphasis:

| Code     | Title                               | Hours |
|----------|-------------------------------------|-------|
| BIO 325  | Genetics                            | 3     |
| BME 322  | Health Equity in Engineering Design | 3     |
| BME 336  | Cancer Bioengineering               | 3     |
| BME 344C | Introduction to Therapeutics        | 3     |
| BME 356  | Polymer and Bioconjugate Chemistry  | 3     |
| BME 359  | Cellular and Molecular Biomechanics | 3     |
| BME 362C | Advanced Engineering Biomaterials   | 3     |
| BME 363  | Bioelectronics and Biointerfaces    | 3     |

|                                                                                                          |                                                      |   |
|----------------------------------------------------------------------------------------------------------|------------------------------------------------------|---|
| BME 364                                                                                                  | Biological Responses to Medical Devices              | 3 |
| BME 365                                                                                                  | Tissue Microenvironments                             | 3 |
| BME 366                                                                                                  | Immune Engineering                                   | 3 |
| BME 369C                                                                                                 | Matrices, Organoids, and Microphysiological Systems  | 3 |
| BME 373                                                                                                  | Tissue, Scaffold, and Cell Biomechanics Applications | 3 |
| BME 375                                                                                                  | Stem Cells in Cell and Tissue Engineering            | 3 |
| BME 376                                                                                                  | Cell Engineering                                     | 3 |
| BME 379                                                                                                  | Tissue Engineering                                   | 3 |
| Hours chosen from the following approved topic courses:                                                  |                                                      | 3 |
| CHE 379                                                                                                  | Topics in Chemical Engineering                       |   |
| CH 320N                                                                                                  | Organic Chemistry II                                 | 3 |
| or CH 328N                                                                                               | Organic Chemistry II                                 |   |
| MBS 320                                                                                                  | Cell Biology                                         | 3 |
| MBS 326M                                                                                                 | Introductory Medical Microbiology and Immunology     | 3 |
| PHM 338                                                                                                  | Introduction to Pharmacology                         | 3 |
| An approved upper-division biomedical engineering, chemical engineering or mechanical engineering course |                                                      | 3 |

## Nanotechnology Career Emphasis

The objective of this emphasis is to prepare students for a career in nanotechnology. This emphasis includes solid foundation in nanodevices and sensors, biological physics, and nanocomposites. While students are required to select hours from any of the concentration course options, the following are recommended for the nanotechnology career emphasis:

| Code                                                                                                     | Title                                                                     | Hours |
|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-------|
| BME 337                                                                                                  | Nanomedicine                                                              | 3     |
| BME 346                                                                                                  | Computational Biomolecular Engineering                                    | 3     |
| BME 348P                                                                                                 | Introduction to Computational and Systems Biology                         | 3     |
| BME 354                                                                                                  | Molecular Sensors and Nanodevices for Biomedical Engineering Applications | 3     |
| BME 356                                                                                                  | Polymer and Bioconjugate Chemistry                                        | 3     |
| BME 358M                                                                                                 | Imaging Clinical Immersion                                                | 3     |
| BME 359                                                                                                  | Cellular and Molecular Biomechanics                                       | 3     |
| CHE 339P                                                                                                 | Introduction to Biological Physics                                        | 3     |
| Hours chosen from the following approved topic courses:                                                  |                                                                           | 3     |
| CHE 379                                                                                                  | Topics in Chemical Engineering                                            |       |
| CH 320N                                                                                                  | Organic Chemistry II                                                      | 3     |
| or CH 328N                                                                                               | Organic Chemistry II                                                      |       |
| Hours chosen from an approved topic course:                                                              |                                                                           | 3     |
| M E 379M                                                                                                 | Topics in Mechanical Engineering                                          |       |
| An approved upper-division biomedical engineering, chemical engineering or mechanical engineering course |                                                                           |       |