

# Bioengineering, BSBioE

Bioengineering is engineering in a biological context such as the human body, an ecosystem, or a bioreactor. In every case, the interface between engineered and biological systems places unique constraints on the design and implementation of devices, instruments, or implants. These depend on the properties of the biological system involved and the functionality that is being created.

The interface of engineering and medicine as embodied in bioengineering will be one of the most exciting endeavors and greatest adventures of the 21st century. Job opportunities are expected to expand dramatically with a focus on development of entirely new classes of products, instrumentation, and implants. The impact to human health will be extraordinary.

Bioengineering is intrinsically multidisciplinary and it is essential that students learn the languages used by multidisciplinary teams. To that end, our curriculum is structured around a core of six courses that analyze biological systems from every possible quantitative point of view. On the completion of the core, students choose one of four concentrations, which provides the opportunity to develop a deep level of expertise in a specific area of bioengineering.

Bioengineering students will have unique opportunities in the classroom, research labs, and experiential learning. The projects that they may be able to contribute to include bio-bandages that monitor bacterial growth or that help damaged ligaments heal faster; sheets of cells folded like origami to form a working kidney; and new materials that—like a leaf in the sun—automatically sense and adapt to changes in the environment.

Our undergraduate program includes four research concentrations, including:

- Biomechanics and Mechanobiology
- Biomedical Devices and Bioimaging
- Molecular, Cell, and Tissue Engineering
- Systems, Synthetic, and Computational Bioengineering

## Program Educational Objectives

Program educational objectives describe what graduates are expected to attain within a few years after graduation. The program educational objectives of the BS in bioengineering program are to prepare graduates to:

- Be technically proficient, innovative, and rigorous problem solvers who excel in the professional practice of engineering while maintaining a high standard of professional and ethical responsibility.
- Be multifaceted and able to work with and demonstrate leadership in multidisciplinary teams.
- Be able to pursue advanced studies in engineering, medicine, and other fields that leverage their technical and problem-solving skills.

## Program Requirements

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- Concentrations and course offerings may vary by campus and/or by program modality. Please consult with your advisor or admissions coach for the course availability each term at your campus or within your program modality.
  - Certain options within the program may be *required* at certain campuses or for certain program modalities. Please consult with your advisor or admissions coach for requirements at your campus or for your program modality.

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Complete all courses listed below unless otherwise indicated. Also complete any corequisite labs, recitations, clinicals, or tools courses where specified and complete any additional courses needed beyond specific college and major requirements to satisfy graduation credit requirements.

## Universitywide Requirements

All undergraduate students are required to complete the Universitywide Requirements (<https://catalog.northeastern.edu/undergraduate/university-academics/university-wide-requirements/>).

## NUpath Requirements

All undergraduate students are required to complete the NUpath Requirements (<https://catalog.northeastern.edu/undergraduate/university-academics/nupath/>).

NUpath requirements: Interpreting Culture (IC), Understanding Societies and Institutions (SI), Engaging Differences and Diversity (DD), and Integrating Knowledge and Skills Through Experience (EX) are not explicitly satisfied by required engineering coursework. Successful completion of a cooperative education experience fulfills the EX requirement. Students are responsible for satisfying unfulfilled NUpath requirements with general elective coursework.

**Engineering**

| Code   | Title  | Hours |
|--|--|-------|
| <b>Required Engineering</b>  |  |       |
| BIOE 2350  | Biomechanics   | 4     |
| BIOE 2355  | Quantitative Physiology for Bioengineers   | 4     |
| BIOE 2365<br>and BIOE 2366   | Bioengineering Measurement, Experimentation, and Statistics<br>and Lab for BIOE 2365 | 5     |
| BIOE 3210  | Bioelectricity   | 4     |
| BIOE 3310  | Transport and Fluids for Bioengineers  | 4     |
| BIOE 3380  | Biomolecular Dynamics and Control  | 4     |
| <b>Bioengineering Capstone</b>   |  |       |
| BIOE 4790  | Capstone Design 1  | 4     |
| BIOE 4792  | Capstone Design 2  | 4     |
| <b>Supplemental Credit</b>   |  |       |
| 2 semester hours from the following course count toward the engineering requirement: |  | 2     |
| GE 1501  | Cornerstone of Engineering 1 <sup>1</sup>  |       |
| 3 semester hours from the following course count toward the engineering requirement: |  | 3     |
| GE 1502  | Cornerstone of Engineering 2 <sup>1</sup>  |       |

**Concentration**

Complete one concentration:

- Biomechanics and Mechanobiology (p. 3)
- Biomedical Devices and Bioimaging (p. 4)
- Molecular, Cell, and Tissue Engineering (p. 4)
- Systems, Synthetic, and Computational Bioengineering (p. 5)

**Supporting Courses: Mathematics/Science**

Complete all mathematics/science courses with a minimum of 30 semester hours.

| Code  | Title  | Hours |
|---|--|-------|
| <b>Required Mathematics/Science</b>   |  |       |
| BIOL 1111<br>and BIOL 1112  | General Biology 1<br>and Lab for BIOL 1111   | 5     |
| CHEM 1151<br>and CHEM 1153  | General Chemistry for Engineers<br>and Recitation for CHEM 1151  | 4     |
| MATH 1341   | Calculus 1 for Science and Engineering   | 4     |
| MATH 1342   | Calculus 2 for Science and Engineering   | 4     |
| MATH 2321   | Calculus 3 for Science and Engineering   | 4     |
| MATH 2341   | Differential Equations and Linear Algebra for Engineering  | 4     |
| PHYS 1171<br>and PHYS 1172<br>and PHYS 1173<br>or PHYS 1151<br>and PHYS 1152<br>and PHYS 1153 | Physics 1 for Bioscience and Bioengineering<br>and Lab for PHYS 1171<br>and Interactive Learning Seminar for PHYS 1171<br>Physics for Engineering 1<br>and Lab for PHYS 1151<br>and Interactive Learning Seminar for PHYS 1151 | 5     |
| PHYS 1175<br>and PHYS 1176<br>and PHYS 1177<br>or PHYS 1155<br>and PHYS 1156<br>and PHYS 1157 | Physics 2 for Bioscience and Bioengineering<br>and Lab for PHYS 1175<br>and Interactive Learning Seminar for PHYS 1175<br>Physics for Engineering 2<br>and Lab for PHYS 1155<br>and Interactive Learning Seminar for PHYS 1155 | 5     |
| <b>Supplemental Credit</b>  |  |       |
| 1 semester hour from the following course counts toward the mathematics/science requirement:  |  | 1     |
| GE 1501   | Cornerstone of Engineering 1 <sup>1</sup>  |       |

**Professional Development**

| Code  | Title                                       | Hours |
|---|---|-------|
| GE 1000   | First-Year Seminar                          | 1     |
| ENCP 2000   | Introduction to Engineering Co-op Education | 1     |
| ENCP 3000   | Professional Issues in Engineering          | 1     |
| <b>Additional Required Courses</b>  |   |       |
| 1 semester hour from the following course counts toward the professional development requirement: |   | 1     |
| GE 1501   | Cornerstone of Engineering 1 <sup>1</sup>   |       |
| 1 semester hour from the following course counts toward the professional development requirement: |   | 1     |
| GE 1502   | Cornerstone of Engineering 2 <sup>1</sup>   |       |

**Writing Requirements**

| Code                                | Title   | Hours |
|-------------------------------------|---|-------|
| A grade of C or higher is required: |   |       |
| ENGW 1111                           | First-Year Writing                                    | 4     |
| ENGW 3302                           | Advanced Writing in the Technical Professions         | 4     |
| or ENGW 3315                        | Interdisciplinary Advanced Writing in the Disciplines |       |

**Required General Electives**

| Code  | Title | Hours |
|---|-------|-------|
| Complete 28 SH of academic, nonremedial, nonrepetitive courses. |       | 28    |

<sup>1</sup> Students can substitute Engineering Design (GE 1110) and Engineering Problem Solving and Computation (GE 1111) for Cornerstone of Engineering 1 (GE 1501) and Cornerstone of Engineering 2 GE 1502.

**Major GPA Requirement**

2.000 minimum GPA required in BIOE coursework

**Program Requirement**

135 total semester hours required

**CONCENTRATION IN BIOMECHANICS AND MECHANOBIOLOGY**

| Code  | Title   | Hours |
|---|---|-------|
| <b>Required Courses</b>   |   |       |
| Complete three of the following:  |   | 12    |
| BIOE 5630   | Physiological Fluid Mechanics                 |       |
| BIOE 5640   | Computational Biomechanics                    |       |
| BIOE 5650   | Multiscale Biomechanics                       |       |
| BIOE 5660   | Integrative Mechanobiology                    |       |
| ME 5665   | Musculoskeletal Biomechanics                  |       |
| <b>Elective Courses</b>   |   |       |
| Complete two of the following. Any course on the required course list not used toward the core requirement may also be taken. |   | 8     |
| BIOE 4991   | Research                                      |       |
| BIOE 5060   | Special Topics in Bioengineering              |       |
| BIOE 5115   | Dynamical Systems in Biological Engineering   |       |
| BIOE 5440   | The Cell as a Machine                         |       |
| BIOE 5820   | Biomaterials                                  |       |
| or CHME 5631  | Biomaterials Principles and Applications      |       |
| CHME 5105   | Materials Characterization Techniques         |       |
| CHME 5632   | Advanced Topics in Biomaterials               |       |
| ME 4508   | Mechanical Engineering Computation and Design |       |
| ME 4555   | System Analysis and Control                   |       |

**CONCENTRATION IN BIOMEDICAL DEVICES AND BIOIMAGING**

| Code  | Title   | Hours |
|---|---|-------|
| <b>Required Courses</b>   |   |       |
| BIOE 5800   | Systems, Signals, and Controls for Bioengineers                     | 4     |
| Complete two of the following:  |   | 8     |
| BIOE 5235<br>or BIOE 5648   | Biomedical Imaging<br>Biomedical Optics                             |       |
| BIOE 5250   | Regulatory and Quality Aspects of Medical Device Design             |       |
| BIOE 5810   | Design of Biomedical Instrumentation                                |       |
| <b>Elective Courses</b>   |   |       |
| Complete two of the following. Any course on the required course list not used toward the core requirement may also be taken. |   | 8     |
| BIOE 4991   | Research  |       |
| BIOE 5060   | Special Topics in Bioengineering                                    |       |
| BIOE 5115   | Dynamical Systems in Biological Engineering                         |       |
| BIOE 5510   | Bioengineering Products/Technology Commercialization                |       |
| BIOE 5820<br>or CHME 5631   | Biomaterials<br>Biomaterials Principles and Applications            |       |
| BIOE 5850   | Design of Implants  |       |
| CHME 5632   | Advanced Topics in Biomaterials                                     |       |
| EECE 2530   | Fundamentals of Electromagnetics                                    |       |
| EECE 2750   | Enabling Engineering  |       |
| EECE 3468   | Analysis of Random Phenomena in Electrical and Computer Engineering |       |
| ME 2340<br>and ME 2341  | Introduction to Material Science<br>and Lab for ME 2340             |       |
| ME 4508   | Mechanical Engineering Computation and Design                       |       |

**CONCENTRATION IN MOLECULAR, CELL, AND TISSUE ENGINEERING**

| Code                           | Title  | Hours |
|--------------------------------|--|-------|
| <b>Required Courses</b>        |  |       |
| BIOE 5410<br>or BIOE 5411      | Molecular Bioengineering<br>Applied Molecular Bioengineering | 4     |
| BIOE 5420                      | Cellular Engineering   | 4     |
| BIOE 5430                      | Principles and Applications of Tissue Engineering            | 4     |
| <b>Elective Courses</b>        |  |       |
| Complete two of the following: |  | 8     |
| BIOE 3410                      | Experimental Laboratory Methods                              |       |
| BIOE 4991                      | Research   |       |
| BIOE 5060                      | Special Topics in Bioengineering                             |       |
| BIOE 5115                      | Dynamical Systems in Biological Engineering                  |       |
| BIOE 5411                      | Applied Molecular Bioengineering                             |       |
| BIOE 5440                      | The Cell as a Machine  |       |
| BIOE 5450                      | Stem Cell Engineering  |       |
| BIOE 5510                      | Bioengineering Products/Technology Commercialization         |       |
| BIOE 5650                      | Multiscale Biomechanics                                      |       |
| BIOE 5660                      | Integrative Mechanobiology                                   |       |
| BIOE 5710                      | Experimental Systems and Synthetic Bioengineering            |       |
| BIOE 5720                      | Physical Bioengineering                                      |       |
| BIOE 5820<br>or CHME 5631      | Biomaterials<br>Biomaterials Principles and Applications     |       |
| CHME 5630                      | Biochemical Engineering                                      |       |
| CHME 5632                      | Advanced Topics in Biomaterials                              |       |

**CONCENTRATION IN SYSTEMS, SYNTHETIC, AND COMPUTATIONAL BIOENGINEERING**

| Code                             | Title  | Hours |
|----------------------------------|--|-------|
| <b>Required Courses</b>          |  |       |
| Complete three of the following: |  | 12    |
| BIOE 5115                        | Dynamical Systems in Biological Engineering            |       |
| BIOE 5710                        | Experimental Systems and Synthetic Bioengineering      |       |
| BIOE 5720                        | Physical Bioengineering                                |       |
| BIOE 5750                        | Modeling and Inference in Bioengineering               |       |
| <b>Elective Courses</b>          |  |       |
| Complete two of the following:   |  | 8     |
| BIOE 4991                        | Research   |       |
| BIOE 5060                        | Special Topics in Bioengineering                       |       |
| BIOE 5440                        | The Cell as a Machine                                  |       |
| BIOE 5510                        | Bioengineering Products/Technology Commercialization   |       |
| BIOE 5640                        | Computational Biomechanics                             |       |
| BIOE 5760                        | Method and Logic in Systems Biology and Bioengineering |       |
| BIOE 5860                        | Engineering Approaches to Precision Medicine I         |       |
| BIOE 5870                        | Engineering Approaches to Precision Medicine II        |       |
| BIOE 5880                        | Computational Methods in Systems Bioengineering        |       |
| CHME 5630                        | Biochemical Engineering                                |       |

**Plan of Study****Sample Plan of Study****FOUR YEARS, TWO CO-OPS IN SUMMER 2/FALL**

| Year 1                 |       |                        |       |                          |       |                    |          |
|------------------------|-------|------------------------|-------|--------------------------|-------|--------------------|----------|
| Fall                   | Hours | Spring                 | Hours | Summer 1                 | Hours | Summer 2           | Hours    |
| CHEM 1151 (ND)         |       | 4 GE 1502 (ER)         |       | 4 BIOL 1111 (ND)         |       | 4 General elective | 4        |
| CHEM 1153              | 0     | MATH 1342 (FQ)         |       | 4 BIOL 1112              |       | 1 General elective | 4        |
| ENGW 1111 (WF)         | 4     | PHYS 1171 or 1151 (ND) |       | 3 General elective       |       | 4                  |          |
| GE 1000                | 1     | PHYS 1172 or 1152 (AD) |       | 1                        |       |                    |          |
| GE 1501                | 4     | PHYS 1173 or 1153      |       | 1                        |       |                    |          |
| MATH 1341 (FQ)         | 4     | General elective       |       | 4                        |       |                    |          |
|                        |       | <b>17</b>              |       | <b>17</b>                |       | <b>9</b>           | <b>8</b> |
| Year 2                 |       |                        |       |                          |       |                    |          |
| Fall                   | Hours | Spring                 | Hours | Summer 1                 | Hours | Summer 2           | Hours    |
| BIOE 2365 (AD, WI)     |       | 4 MATH 2321 (FQ)       |       | 4 BIOE 3310              |       | 4 Co-op            | 0        |
| BIOE 2366              | 1     | BIOE 2350              |       | 4 General elective       |       | 4                  |          |
| MATH 2341              | 4     | BIOE 2355              |       | 4                        |       |                    |          |
| PHYS 1175 or 1155 (ND) |       | 3 ENCP 2000            |       | 1                        |       |                    |          |
| PHYS 1176 or 1156 (AD) |       | 1 General elective     |       | 4                        |       |                    |          |
| PHYS 1177 or 1157      |       | 1                      |       |                          |       |                    |          |
| General elective       |       | 4                      |       |                          |       |                    |          |
|                        |       | <b>18</b>              |       | <b>17</b>                |       | <b>8</b>           | <b>0</b> |
| Year 3                 |       |                        |       |                          |       |                    |          |
| Fall                   | Hours | Spring                 | Hours | Summer 1                 | Hours | Summer 2           | Hours    |
| Co-op                  |       | 0 BIOE 3210            |       | 4 BIOE 4790 (EI, CE, WI) |       | 4 Co-op            | 0        |
|                        |       | BIOE 3380              |       | 4 ENGW 3302 or 3315 (WD) |       | 4                  |          |
|                        |       | ENCP 3000              |       | 1                        |       |                    |          |
|                        |       | BIOE concentration     |       | 4                        |       |                    |          |
|                        |       | BIOE concentration     |       | 4                        |       |                    |          |
|                        |       | <b>0</b>               |       | <b>17</b>                |       | <b>8</b>           | <b>0</b> |

**Year 4**

| Fall  | Hours    | Spring                   | Hours     |
|-------|----------|--------------------------|-----------|
| Co-op |          | 0 BIOE 4792 (EI, CE, WI) | 4         |
|       |          | BIOE concentration       | 4         |
|       |          | BIOE concentration       | 4         |
|       |          | BIOE concentration       | 4         |
|       | <b>0</b> |                          | <b>16</b> |

**Total Hours: 135****FOUR YEARS, TWO CO-OPS IN SPRING/SUMMER 1****Year 1**

| Fall           | Hours     | Spring                   | Hours     | Summer 1                 | Hours     | Summer 2           | Hours    |
|----------------|-----------|--------------------------|-----------|--------------------------|-----------|--------------------|----------|
| CHEM 1151 (ND) |           | 4 GE 1502 (ER)           |           | 4 BIOL 1111 (ND)         |           | 4 General elective | 4        |
| CHEM 1153      |           | 0 MATH 1342 (FQ)         |           | 4 BIOL 1112              |           | 1 General elective | 4        |
| ENGW 1111 (WF) |           | 4 PHYS 1171 or 1151 (ND) |           | 3 PHYS 1175 or 1155 (ND) |           | 3                  |          |
| GE 1000        |           | 1 PHYS 1172 or 1152 (AD) |           | 1 PHYS 1176 or 1156 (AD) |           | 1                  |          |
| GE 1501        |           | 4 PHYS 1173 or 1153      |           | 1 PHYS 1177 or 1157      |           | 1                  |          |
| MATH 1341 (FQ) |           | 4 General elective       |           | 4                        |           |                    |          |
|                | <b>17</b> |                          | <b>17</b> |                          | <b>10</b> |                    | <b>8</b> |

**Year 2**

| Fall               | Hours     | Spring  | Hours    | Summer 1 | Hours    | Summer 2         | Hours    |
|--------------------|-----------|---------|----------|----------|----------|------------------|----------|
| BIOE 2355          |           | 4 Co-op |          | 0 Co-op  |          | 0 BIOE 3210      | 4        |
| BIOE 2365 (AD, WI) |           | 4       |          |          |          | General elective | 4        |
| BIOE 2366          |           | 1       |          |          |          |                  |          |
| ENCP 2000          |           | 1       |          |          |          |                  |          |
| MATH 2321 (FQ)     |           | 4       |          |          |          |                  |          |
| MATH 2341          |           | 4       |          |          |          |                  |          |
|                    | <b>18</b> |         | <b>0</b> |          | <b>0</b> |                  | <b>8</b> |

**Year 3**

| Fall               | Hours     | Spring  | Hours    | Summer 1 | Hours    | Summer 2                 | Hours    |
|--------------------|-----------|---------|----------|----------|----------|--------------------------|----------|
| BIOE 2350          |           | 4 Co-op |          | 0 Co-op  |          | 0 BIOE 4790 (EI, CE, WI) | 4        |
| BIOE 3380          |           | 4       |          |          |          | General elective         | 4        |
| BIOE concentration |           | 4       |          |          |          |                          |          |
| General elective   |           | 4       |          |          |          |                          |          |
|                    | <b>16</b> |         | <b>0</b> |          | <b>0</b> |                          | <b>8</b> |

**Year 4**

| Fall                   | Hours     | Spring                   | Hours     |
|------------------------|-----------|--------------------------|-----------|
| BIOE 3310              |           | 4 ENGW 3302 or 3315 (WD) | 4         |
| BIOE 4792 (EI, CE, WI) |           | 4 BIOE concentration     | 4         |
| ENCP 3000              |           | 1 BIOE concentration     | 4         |
| BIOE concentration     |           | 4 BIOE concentration     | 4         |
| General elective       |           | 4                        |           |
|                        | <b>17</b> |                          | <b>16</b> |

**Total Hours: 135****FIVE YEARS, THREE CO-OPS IN SUMMER 2/FALL****Year 1**

| Fall           | Hours | Spring                   | Hours | Summer 1   | Hours | Summer 2 | Hours |
|----------------|-------|--------------------------|-------|------------|-------|----------|-------|
| CHEM 1151 (ND) |       | 4 GE 1502 (ER)           |       | 4 Vacation |       | Vacation |       |
| CHEM 1153      |       | 0 MATH 1342 (FQ)         |       | 4          |       |          |       |
| ENGW 1111 (WF) |       | 4 PHYS 1171 or 1151 (ND) |       | 3          |       |          |       |
| GE 1000        |       | 1 PHYS 1172 or 1152 (AD) |       | 1          |       |          |       |

|                |           |                   |           |  |          |  |          |
|----------------|-----------|-------------------|-----------|--|----------|--|----------|
| GE 1501        | 4         | PHYS 1173 or 1153 | 1         |  |          |  |          |
| MATH 1341 (FQ) | 4         | General elective  | 4         |  |          |  |          |
|                | <b>17</b> |                   | <b>17</b> |  | <b>0</b> |  | <b>0</b> |

**Year 2**

| Fall                   | Hours     | Spring           | Hours     | Summer 1   | Hours    | Summer 2 | Hours    |
|------------------------|-----------|------------------|-----------|------------|----------|----------|----------|
| BIOE 2365 (AD, WI)     |           | 4 BIOE 2350      |           | 4 Vacation |          | Co-op    | 0        |
| BIOE 2366              | 1         | BIOE 2355        | 4         |            |          |          |          |
| BIOL 1111 (ND)         | 4         | ENCP 2000        | 1         |            |          |          |          |
| BIOL 1112              | 1         | MATH 2341        | 4         |            |          |          |          |
| MATH 2321 (FQ)         | 4         | General elective | 4         |            |          |          |          |
| PHYS 1175 or 1155 (ND) | 3         |                  |           |            |          |          |          |
| PHYS 1176 or 1156 (AD) | 1         |                  |           |            |          |          |          |
| PHYS 1177 or 1157      | 1         |                  |           |            |          |          |          |
|                        | <b>19</b> |                  | <b>17</b> |            | <b>0</b> |          | <b>0</b> |

**Year 3**

| Fall  | Hours    | Spring                 | Hours     | Summer 1           | Hours    | Summer 2 | Hours    |
|-------|----------|------------------------|-----------|--------------------|----------|----------|----------|
| Co-op | 0        | BIOE 3210              |           | 4 BIOE 3310        |          | 4 Co-op  | 0        |
|       |          | BIOE 3380              |           | 4 General elective |          | 4        |          |
|       |          | ENGW 3302 or 3315 (WD) |           | 4                  |          |          |          |
|       |          | BIOE concentration     |           | 4                  |          |          |          |
|       | <b>0</b> |                        | <b>16</b> |                    | <b>8</b> |          | <b>0</b> |

**Year 4**

| Fall  | Hours    | Spring             | Hours     | Summer 1                 | Hours    | Summer 2 | Hours    |
|-------|----------|--------------------|-----------|--------------------------|----------|----------|----------|
| Co-op | 0        | ENCP 3000          |           | 1 BIOE 4790 (EI, CE, WI) |          | 4 Co-op  | 0        |
|       |          | BIOE concentration |           | 4 General elective       |          | 4        |          |
|       |          | BIOE concentration |           | 4                        |          |          |          |
|       |          | BIOE concentration |           | 4                        |          |          |          |
|       |          | General elective   |           | 4                        |          |          |          |
|       | <b>0</b> |                    | <b>17</b> |                          | <b>8</b> |          | <b>0</b> |

**Year 5**

| Fall  | Hours    | Spring                 | Hours     | Summer 1 | Hours | Summer 2 | Hours |
|-------|----------|------------------------|-----------|----------|-------|----------|-------|
| Co-op | 0        | BIOE 4792 (EI, CE, WI) |           | 4        |       |          |       |
|       |          | BIOE concentration     |           | 4        |       |          |       |
|       |          | General elective       |           | 4        |       |          |       |
|       |          | General elective       |           | 4        |       |          |       |
|       | <b>0</b> |                        | <b>16</b> |          |       |          |       |

**Total Hours: 135**
**FIVE YEARS, THREE CO-OPS IN SPRING/SUMMER 1**
**Year 1**

| Fall           | Hours     | Spring                 | Hours     | Summer 1   | Hours    | Summer 2 | Hours    |
|----------------|-----------|------------------------|-----------|------------|----------|----------|----------|
| CHEM 1151 (ND) | 4         | GE 1502 (ER)           |           | 4 Vacation |          | Vacation |          |
| CHEM 1153      | 0         | MATH 1342 (FQ)         | 4         |            |          |          |          |
| ENGW 1111 (WF) | 4         | PHYS 1171 or 1151 (ND) | 3         |            |          |          |          |
| GE 1000        | 1         | PHYS 1172 or 1152 (AD) | 1         |            |          |          |          |
| GE 1501        | 4         | PHYS 1173 or 1153      | 1         |            |          |          |          |
| MATH 1341 (FQ) | 4         | General elective       | 4         |            |          |          |          |
|                | <b>17</b> |                        | <b>17</b> |            | <b>0</b> |          | <b>0</b> |

**Year 2**

| Fall               | Hours | Spring | Hours | Summer 1 | Hours | Summer 2   | Hours |
|--------------------|-------|--------|-------|----------|-------|------------|-------|
| BIOE 2365 (AD, WI) | 4     | Co-op  |       | 0 Co-op  |       | 0 Vacation |       |
| BIOE 2366          | 1     |        |       |          |       |            |       |

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|                        |           |  |  |          |  |          |          |
|------------------------|-----------|--|--|----------|--|----------|----------|
| BIOL 1111 (ND)         | 4         |  |  |          |  |          |          |
| BIOL 1112              | 1         |  |  |          |  |          |          |
| ENCP 2000              | 1         |  |  |          |  |          |          |
| MATH 2321 (FQ)         | 4         |  |  |          |  |          |          |
| PHYS 1175 or 1155 (ND) | 3         |  |  |          |  |          |          |
| PHYS 1176 or 1156 (AD) | 1         |  |  |          |  |          |          |
| PHYS 1177 or 1157      | 1         |  |  |          |  |          |          |
|                        | <b>20</b> |  |  | <b>0</b> |  | <b>0</b> | <b>0</b> |

**Year 3**

| Fall             | Hours     | Spring | Hours    | Summer 1 | Hours    | Summer 2         | Hours    |
|------------------|-----------|--------|----------|----------|----------|------------------|----------|
| BIOE 2350        | 4         | Co-op  | 0        | Co-op    | 0        | BIOE 3210        | 4        |
| BIOE 2355        | 4         |        |          |          |          | General elective | 4        |
| MATH 2341        | 4         |        |          |          |          |                  |          |
| General elective | 4         |        |          |          |          |                  |          |
|                  | <b>16</b> |        | <b>0</b> |          | <b>0</b> |                  | <b>8</b> |

**Year 4**

| Fall                   | Hours     | Spring | Hours    | Summer 1 | Hours    | Summer 2               | Hours    |
|------------------------|-----------|--------|----------|----------|----------|------------------------|----------|
| BIOE 3310              | 4         | Co-op  | 0        | Co-op    | 0        | BIOE 4790 (EI, CE, WI) | 4        |
| BIOE 3380              | 4         |        |          |          |          | General elective       | 4        |
| ENCP 3000              | 1         |        |          |          |          |                        |          |
| ENGW 3302 or 3315 (WD) | 4         |        |          |          |          |                        |          |
| BIOE concentration     | 4         |        |          |          |          |                        |          |
|                        | <b>17</b> |        | <b>0</b> |          | <b>0</b> |                        | <b>8</b> |

**Year 5**

| Fall                   | Hours     | Spring             | Hours     |
|------------------------|-----------|--------------------|-----------|
| BIOE 4792 (EI, CE, WI) | 4         | BIOE concentration | 4         |
| BIOE concentration     | 4         | BIOE concentration | 4         |
| BIOE concentration     | 4         | General elective   | 4         |
| General elective       | 4         | General elective   | 4         |
|                        | <b>16</b> |                    | <b>16</b> |

**Total Hours: 135**