# BIOMEDICAL ENGINEERING (BS)

College of Engineering

Program Website (https://www.engineering.cornell.edu/bme/major/)

**CIP:** 14.0501 | **HEGIS:** 0905.00 | **NYSED:** 37457

## Program Description

This major is accredited by: NY State Department of Education. Cornell's vision for Biomedical Engineering centers around a quantitative approach to understanding biology across length and time scales, with a focus on issues related to human health. The quantitative nature of this program distinguishes the major from traditional programs in biology, while the focus on human health is distinct from other programs in engineering that include the study of biological systems (e.g. Biological and Environmental Engineering and Chemical and Biomolecular Engineering). Additionally, its focus on multiscale analysis of biological systems is a unique signature of Cornell Biomedical Engineering relative to programs at peer institutions.

## Academic Standing

Majors in Biomedical Engineering are expected to meet the following standards:

1. Semester GPA > 2.3
2. Cumulative GPA > 2.1
3. No grade below C- in any Core or Concentration Course Required for Graduation (note1)
4. No failing grade
5. Minimum of 12 credits per semester completed with passing grades (note2)

Notes:

- Only one course below a C- within major required courses is allowed for graduation.
- No course with a grade lower than C- may be used to satisfy a prerequisite for a subsequent BME course.

## Honors Program

To participate in this honors program, students must meet the Majors Honors Programs criteria as delineated above and must have at least 9 credits beyond the minimum required for graduation in BME (therefore the minimum number of credits to graduate with honors is 138). These 9 credits shall include:

- A significant research experience or honors project under the supervision of a BME faculty member using BME 4900 - Independent Undergraduate Project in Biomedical Engineering (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt3019) and BME 4901 - Honors Thesis (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt9776), to be completed in their fourth year. A written senior honors thesis must be submitted as part of the second component. A minimum grade of A- in both courses is required for successful completion of this honors requirement. The two research courses will be taken in consecutive semesters. (6+ credits)
- A significant teaching experience under the supervision of a BME faculty member or as part of a regularly recognized course in the department under BME 4970 (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt3551): Undergraduate Teaching. (3+ credits)

Please note: BTRY 3020 (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt5678): Biological Statistics II, or ILRST 2110 (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt6383): Introductory Statistics for the Social Sciences (4 credits) —with a grade of at least B+ is also required for the Honors Program and may be counted as an Advisor-approved Elective in the BME major (not included in the 9 credit minimum above).

### Additional criteria:

1. The student must present a poster or oral presentation in a public research forum such as a national or regional professional society meeting, Bio Expo, or other public university event by the end of the student's project.

2. Project teams are not acceptable for Honors Thesis research unless there is a clearly defined project outside of the team effort attested by the project faculty advisor.

3. No research, independent study, or teaching experience for which the student is paid may be counted towards the credits required for the honors program.

### Application Timing:

All interested students must complete a written application (available 121B Weill Hall) no later than the end of the third week of their 7th semester, but students are encouraged to make arrangements with a faculty member during their junior year.

## Program Information

- Instruction Mode: In Person
- Location: Ithaca, NY
- Minimum Credits for Degree: 130

## Program Requirements

### Engineering Distribution Courses

| Code | Title | Hours |
|---|---|---|
| **Required Courses** | | |
| ENGRD 2111 | Biomolecular Thermodynamics | 3 |
| ENGRD 2020 | Statics and Mechanics of Solids [1] | 4 |

[1] ENGRD 2020 Statics and Mechanics of Solids satisfies the Common Curriculum distribution requirement and also fulfills a required Major course. It is best taken during semester 3 and must be completed before semester 5. If taken as a second ENGRD, then total required credits to graduate drop to 125 credits rather than 129 credits.

## Core Courses

| Code | Title | Hours |
|---|---|---|
| **Required Courses** | | |
| BIOMG 1350 | Introductory Biology: Cell and Developmental Biology | 3 |
| BME 2010 | Physiology of Human Health and Disease | 3 |
| BME 2080 | Experiential Learning Seminar | 1 |
| BME 2081 | | 1 |
| BME 2000 | Biomedical Transport Phenomena | 3 |
| BME 2210 | Biomaterials: Foundations and Application in Medicine | 3 |
| BME 3010 | Cellular Principles of Biomedical Engineering | 3 |
| BME 3020 | Molecular Principles of Biomedical Engineering (crosslisted) | 3 |
| BME 3030 | Biomedical Circuits, Signals and Systems | 5 |
| BME 4010 | Biomedical Engineering Analysis of Metabolic and Structural Systems (crosslisted) | 3 |
| BME 4020 | Electrical and Chemical Physiology | 3 |
| BME 4080 | Biomedical Engineering Design I | 3 |
| BME 4090 | Biomedical Engineering Design II | 3 |
| BTRY 3010 | Statistics I (crosslisted) [1] | 4 |
| ENGRD 2020 | Statics and Mechanics of Solids [2] | 4 |

1 ENGRD 2700 Eng Probability and Statistics: Modeling and Data Science or STSCI 2150 Introductory Statistics for Biology alternatively satisfies this course.

2 ENGRD 2020 Statics and Mechanics of Solids satisfies the Common Curriculum distribution requirement and also fulfills a required Major course. It is best taken during semester 3 and must be completed before semester 5. If taken as a second ENGRD, then total required credits to graduate drop to 125 credits rather than 129 credits.

## Biomedical Engineering Concentrations

(must choose one: 12 credits minimum)

### Molecular, Cellular, and Systems Engineering (MCSE)

| Code | Title | Hours |
|---|---|---|
| **Required Courses** | | |
| CHEM 1570 | Introduction to Organic and Biological Chemistry [1] | 3 |
| BME 3110 | Cellular Systems Biology | 3 |
| BME 4190 | Laboratory Techniques for Molecular, Cellular, and Systems Engineering | 3 |
| **Elective Courses** | | |
| Select six credits of the following: | | 6 |
| BIONB 4910 | Principles of Neurophysiology | |
| BIOMG 4390 | Molecular Basis of Disease | |
| BME 5110 | Stem Cell Bioengineering | |
| BME 5830 | Cell-Biomaterials Interactions | |
| BME 5850 | Current Practice in Tissue Engineering | |
| BME 6410 | Cell and Molecular Mechanobiology | |
| BIOCB 4381 | Biomedical Data Mining and Modeling | |
| BIOCB 4830 | Quantitative Genomics and Genetics | |
| BIOCB 4840 | Computational Genetics and Genomics | |
| CHEM 4810 | Computational Methods in Chemistry | |
| CHEME 5430 | Bioprocess Engineering | |
| CS 3780 | Introduction to Machine Learning | |
| or ECE 4200 | Fundamentals of Machine Learning | |
| or INFO 395( | Data Analytics for Information Science | |
| CS 4786 | | |
| One 3xxx/4xxx course from another BME concentration | | |

1 The Common Curriculum requires a fourth science course. In Biomedical Engineering this course is determined by your concentration. CHEM 1570 (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt5098) is required for the MCSE concentration. Students may substitute CHEM 3570 for CHEM 1570.

### Biomedical Materials and Drug Delivery (BMDD)

| Code | Title | Hours |
|---|---|---|
| **Required Courses** | | |
| BME 3210 | Multiscale Biomaterial Analysis | 3 |
| BME 4190 | Laboratory Techniques for Molecular, Cellular, and Systems Engineering | 3 |
| or BME 4490 | Biomechanics Laboratory | |
| CHEM 1570 | Introduction to Organic and Biological Chemistry [1] | 3 |
| **Elective Courses** | | |
| Select six credits of the following: | | 6 |
| BEE 3400 | Design and Analysis of Biomaterials | |
| BIOAP/BIOMS 4140 | Principles of Pharmacology | |
| BME 5830 | Cell-Biomaterials Interactions | |
| BME 5750 | Biomaterials and Drug Delivery in the Immune System | |
| BME 5760 | Engineering the Human Body: From Artificial Joints to Living Organs | |
| BME 5850 | Current Practice in Tissue Engineering | |
| BME 6210 | Engineering Principles for Drug Delivery | |
| CHEME 5430 | Bioprocess Engineering | |
| MAE 4670 | Polymer Mechanics | |
| MSE 5210 | Properties of Solid Polymers | |
| MSE 5620 | Biomineralization: The Formation and Properties of Inorganic Biomaterials | |
| BME 5810 | Soft Tissue Biomechanics | |
| or MAE 4640 | Orthopaedic Tissue Mechanics | |
| or MSE 4020 | Mechanical Properties of Materials, Processing, and Design | |
| or MAE 6670 | Soft Tissue Biomechanics II: Viscoelasticity and Phasic Theory | |
| MSE 4610 | Biomedical Materials and Their Applications | |

1 The Common Curriculum requires a fourth science course. In Biomedical Engineering this course is determined by your concentration. CHEM 1570 (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt5098) is required for the BMDD concentration. Students may substitute CHEM 3570 for CHEM 1570.

### Biomedical Imaging and Instrumentation (BMII)

| Code | Title | Hours |
|---|---|---|
| **Required Courses** | | |
| BME 3310 | Medical and Preclinical Imaging | 3 |
| BME 4390 | Circuits, Signals and Sensors: Instrumentation Laboratory | 3 |
| PHYS 2214 | Physics III: Oscillations, Waves, and Quantum Physics [1] | 4 |
| **Elective Courses** | | |
| Select six credits of the following: | | 6 |
| AEP 4400 | Nonlinear and Quantum Optics | |
| BIONB 4910 | Principles of Neurophysiology | |
| BME 6330 | Optical Tools for Studying Living Systems | |
| BME 6350 | Introduction to Neurotechnology | |
| CS 3110 | Data Structures and Functional Programming | |
| CS 3780 | Introduction to Machine Learning | |
| or ECE 4200 | Fundamentals of Machine Learning | |
| or INFO 395( | Data Analytics for Information Science | |
| CS 4786 | | |
| ECE 3100 | Introduction to Probability and Inference for Random Signals and Systems | |
| ECE 3140/ CS 3420 | Embedded Systems | |
| or ECE 5725 | Design with Embedded Operating Systems | |
| ECE 4300 | Lasers and Optoelectronics | |
| ECE 4320 | Integrated Micro Sensors and Actuators: Bridging the Physical and Digital Worlds | |
| ECE 4370 | Photonics: Fundamentals and Devices | |
| ECE 4760 | Digital Systems Design Using Microcontrollers | |
| ECE 5470 | Computer Vision | |
| ECE 6690 | Computer Analysis of Biomed Images | |
| HD 4630 | Introduction to Functional MRI Analysis for Human Neuroimaging | |
| PHYS 3316 | Basics of Quantum Mechanics | |

[1] The Common Curriculum requires a fourth science course. In Biomedical Engineering this course is determined by your concentration. PHYS 2214 (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt9150) is required for the BMII concentration.

### Biomedical Mechanics and Mechanobiology (BMMB)

| Code | Title | Hours |
|---|---|---|
| **Required Courses** | | |
| BME 3410 | Systems Mechanobiology | 3 |
| BME 4490 | Biomechanics Laboratory | 3 |
| PHYS 2214 | Physics III: Oscillations, Waves, and Quantum Physics [1] | 4 |
| or CHEM 1570 | Introduction to Organic and Biological Chemistry | |
| **Elective Courses** | | |
| Select six credits of the following: | | 6 |
| BME 6410 | Cell and Molecular Mechanobiology | |
| BEE 3310 | Bio-Fluid Mechanics | |
| or BME 4410 | Biofluid Mechanics | |
| or MAE 4650 | Biofluid Mechanics | |
| BEE 3500 | Heat and Mass Transfer in Biological Engineering | |
| or MAE 3240 | Heat Transfer | |
| BEE 4530 | Computer-Aided Engineering: Applications to Biological Processes | |
| BME 5810 | Soft Tissue Biomechanics | |
| MAE 3230 | Introductory Fluid Mechanics | |
| MAE 3783 | Mechatronics | |
| MAE 4640 | Orthopaedic Tissue Mechanics | |
| MAE 4670 | Polymer Mechanics | |
| MAE 4700 | Finite Element Analysis for Mechanical and Aerospace Design | |
| MAE 6670 | Soft Tissue Biomechanics II: Viscoelasticity and Phasic Theory | |
| MSE 4020 | Mechanical Properties of Materials, Processing, and Design | |

[1] The Common Curriculum requires a fourth science course. In Biomedical Engineering this course is determined by your concentration. CHEM 1570 (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt9662) or PHYS 2214 (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30249&print#tt8893) is required for the BMMB concentration. Students may substitute CHEM 3570 for CHEM 1570.

## Additional Requirements

In addition to the two First-year Writing Seminars, a technical writing course must be taken. This requirement will be satisfied with the BME Concentration Laboratory.

# University Graduation Requirements Requirements for All Students

In order to receive a Cornell degree, a student must satisfy academic and non-academic requirements.

## Academic Requirements

A student's college determines degree requirements such as residency, number of credits, distribution of credits, and grade averages. It is the student's responsibility to be aware of the specific major, degree, distribution, college, and graduation requirements for completing their chosen program of study. See the individual requirements listed by each college or school or contact the college registrar's office (https://registrar.cornell.edu/service-resources/college-registrar-directory/) for more information.

## Non-academic Requirements

**Conduct Matters**. Students must satisfy any outstanding sanctions, penalties or remedies imposed or agreed to under the Student Code of Conduct (Code) or Policy 6.4. Where a formal complaint under the Code or Policy 6.4 is pending, the University will withhold awarding a degree otherwise earned until the adjudication process set forth in those procedures is complete, including the satisfaction of any sanctions, penalties or remedies imposed.

**Financial Obligations**. Outstanding financial obligations will not impact the awarding of a degree otherwise earned or a student's ability to access their official transcript. However, the University may withhold

issuing a diploma until any outstanding financial obligations owing to the University are satisfied.

# Additional Requirements for Undergraduate Students

The University has two requirements for graduation that must be fulfilled by all undergraduate students: the swim requirement, and completion of two physical education courses. For additional information about fulfilling University Graduation Requirements, see the Physical Education website (https://scl.cornell.edu/pe/).

## Physical Education

All incoming undergraduate students are required to take two credits (two courses) of Physical Education prior to graduation. It is recommended they complete the two courses during their first year at Cornell. Credit in Physical Education may be earned by participating in courses offered by the Department of Athletics and Physical Education (https://courses.cornell.edu/preview_program.php?catoid=60&poid=30232) and Cornell Outdoor Education, by being a registered participant on a varsity athletic team, or performing in the marching band.

Students with medical concerns should contact the Office of Student Disability Services (http://sds.cornell.edu/).

## Swim Requirement

The Faculty Advisory Committee on Athletics and Physical Education has established a basic swimming and water safety competency requirement for all undergraduate students. Normally, the requirement is taken during the Fall Orientation process at Helen Newman Hall or Teagle Hall pools. The requirement consists of the following: jump or step feet-first into the deep end of the pool, float or tread for one minute, turn around in a full circle, swim 25 yards using any stroke(s) of choice without touching the bottom or holding on to the sides (there is no time limit) and exit from the water. Students who do not complete the swim requirement during their first year, during a PE swim class or during orientation subsequent years, will have to pay a $100 fee. Any student who cannot meet this requirement must register for PE 1100 Beginning Swimming as their physical education course before electives can be chosen.

If a student does not pass the swim requirement in their first Beginning Swimming PE class, then the student must take a second Beginning Swimming PE class (PE 1100 or PE 1101). Successful completion of two Beginning Swimming classes (based on attendance requirements) with the instructor's recommendation will fulfill the University's swim requirement.

Students unable to meet the swim requirement because of medical reasons should contact the Office of Student Disability Services (http://sds.cornell.edu/). When a waiver is granted by the Faculty Committee on Physical Education, an alternate requirement is imposed. The alternate requirement substitute is set by the Director of Physical Education.

# College of Engineering Graduation Requirements

## Undergraduate Study

Students in the College of Engineering spend most of their first two years of undergraduate studies in the Common Curriculum, which is administered by the College Curriculum Governing Board (CCGB) through the associate dean for undergraduate programs and Engineering Advising. By the end of their third semester, they typically apply to affiliate with an Engineering major and must be affiliated by the start of their fifth semester.

Criteria for affiliation with the majors are described in this section under "Affiliation with a Major". The Undergraduate Engineering Majors are listed on the College of Engineering Programs page (https://catalog.cornell.edu/engineering/#programstext).

Many of the majors have a corresponding minor, in which the student can pursue a secondary interest if eligible. In addition, there are minors that cut across majors including applied mathematics, engineering management, engineering statistics, game design, artificial intelligence, information science, and business. See Engineering Minors section of the College of Engineering Programs page (https://catalog.cornell.edu/engineering/#programstext) for a listing of Undergraduate Minors.

## Engineering Core Requirements - Engineering Major

### Engineering Majors

To receive the bachelor of science degree, students must meet the requirements of the Common Curriculum (outlined below) as set forth by the College of Engineering, including the requirements of their chosen major, as established by the school or department that administers the major. (Further explanation of the revised Common Curriculum and major flow charts are provided in the *Engineering Undergraduate Handbook*.)

| Course Category | Credits |
|---|---|
| Mathematics (major-specific) | 14-16 |
| Physics (major-specific) | 8-13 |
| Chemistry (major-specific) | 4-8 |
| First-year writing seminars | ≥6 |
| Engineering Communication[1] | 1-3 |
| Computing | 4 |
| Engineering Distribution | |
| a. One introduction to engineering (ENGRI) | 3-4 |
| b. Two engineering distributions (ENGRD) | 6-8 |
| Liberal studies distribution (6 courses min.) | ≥18 |
| Advisor Approved electives | ≥6 |
| Major program | |
| a. Major-required courses | ≥30 |
| b. Major-approved electives | ≥9 |
| c. Courses outside the major | ≥9 |
| Two semesters of physical education and demonstration of proficiency in swimming (university requirement) | |

[1] Engineering-communication courses may simultaneously fulfill another requirement.

Total credits required for graduation vary by major (see Engineering Majors).

#### Mathematics

The normal program in mathematics includes MATH 1910, MATH 1920, MATH 2930 or MATH 2940 depending on the major), and a major-specific math course for some majors. At least C– must be attained in these courses; if not, the course must be repeated immediately before the next course in the sequence is taken. Failure to achieve at least C– the second time will result in, at minimum, an automatic required leave of absence

for one semester from the College of Engineering. Courses that are taken a second time do not yield additional credit toward a degree.

**Physics**
The normal program in physics includes PHYS 1112, PHYS 1110, PHYS 2213, and PHYS 2214 or the corresponding honors courses (PHYS 1116, PHYS 1110, PHYS 2210, PHYS 2217, and PHYS 2218). Engineering students should attain at least C– in each math prerequisite of a physics course before taking the physics course (e.g., C– in MATH 1910 before taking PHYS 1112 and C– in MATH 1920 before taking PHYS 2213). Substitutions for PHYS 2214 are possible in certain majors. Please consult the Engineering Undergraduate Handbook (https://cornellengineeringhandbook.freeflowdp.com/cornellengineeringhandbook/library/) for details.

**Chemistry**
CHEM 2090 and CHEM 2091 is required. While the content of CHEM 2090 and CHEM 2091is the same as that of CHEM 2070 and span class="structuredcontent" college="all" contenteditable="false" department="CHEM" id="courseinline24" title="Inline Course - Double Click to Edit">CHEM 2071, Engineering students are expected to take CHEM 2090 and CHEM 2091.

Typically, CHEM 2090 and CHEM 2091 is taken during the first year, but students who wish to first complete the physics sequence (PHYS 1112, PHYS 1110, PHYS 2213, and PHYS 2214, depending on the major) may postpone CHEM 2090 and CHEM 2091 until the sophomore year.

Students considering chemical engineering or a health-related career such as medicine must take CHEM 2090 and CHEM 2091 in the fall of their first year and CHEM 2080 and CHEM 2081 in the spring semester.

**Computing**
Students must complete one Introduction to Computing course during either semester of the first year. Students can take either CS 1110 or CS 1112. Some majors may have a preference of either CS 1110 or CS 1112, however, either one will count toward the degree requirement.

## First-Year Writing Seminars

Each semester of their first year, students choose a first-year writing seminar from courses offered by over 30 different departments across the university. These courses offer the student practice in writing English prose and college level discourse within a small class (<20) setting.

## Engineering Communications

Students can fulfill the Engineering Communications Requirement using one of the options below. See the Engineering Communications Program website (https://www.engineering.cornell.edu/courses-requirements/bachelor-science-requirements/engineering-communications-requirement/) for more information.

**Category A: Via the Engineering Communications Program Courses and Opportunities**

1. **Engineering Communication Program Courses**
   Courses in this category, offered by the Engineering Communications Program (ECP), develop communication skills in a variety of genres, including writing, presenting, multimodal forms, graphics, charts, posters, and other. These courses fulfill the Engineering Communication Requirement for Cornell's College of Engineering.

| Code | Title | Hours |
|---|---|---|
| ENGRC 3025 | Creating and Communicating Your Digital Professionalism | 1 |
| ENGRC 3026 | Engineering Presentations and Expert Presence | 1 |
| ENGRC 3027 | Cross-cultural Communications and Ethics in the Workplace | 1 |
| ENGRC 3340 | Independent Study in Engineering Communications | 1-3 |
| ENGRC 3350 | Organizational Communications for Engineers | 3 |
| ENGRC 3500 | Engineering Communications | 3 |
| ENGRC 3700 | Communications Consulting for Engineers | 3 |

2. **Complete a Communication-Intensive Co-op, listed as ENGRC 3024**
   This is an opportunity to combine work and academics. Some co-op students do a significant amount of writing and other communicative work on the job; under certain circumstances, a set of authentic work artifacts combined with on-site manager reviews and guide, reflective summary assignments with an ECP instructor will satisfy the Engineering Communications Requirement. This option does not count toward the Liberal Studies requirements for engineers. Students should begin organizing this request the semester prior to being on-site for the co-op or internship. Not offered AY 2025-2026.
3. **Enroll in and pass** ENGRC 3023
   A one credit attachment to an engineering course that is not one of the officially designated W-I or C-I courses. CE instructors may occasionally wish to extend communication competencies with added work inside their course for a given semester so that it will fulfill the Engineering Communications Requirement. With approval from the College Curriculum Governing Board (CCGB) Subcommittee on Engineering Communications, instructors may have students co-register in ENGRC 3023, which may be taken more than once with different courses by permission of the engineering instructors. This option does not count toward the Liberal Studies requirement for engineers, even via petition. More information can be found at the Cornell Engineering website (https://www.engineering.cornell.edu/courses-requirements/bachelor-science-requirements/engineering-communications-requirement/engrc-3023/).
   To begin,& send an email to engrcomm_info@cornell.edu, requesting the full ENGRC 3023 information packet. Please insert "3023 request" in the subject line.
   Paperwork is due by the last Wednesday in January for the Spring semester.
4. **Complete and Pass a One Credit Partner Course**
   The current options are below, and they require enrollment in the departmental course (usually three credits) and its corresponding ENRGRC course (one credit). The below courses do not count toward the Liberal Studies requirement for engineers, even via petition:

| Code | Title | Hours |
|---|---|---|
| ENGRC 3120 | Communications for Practical Tools for Operations Research, Machine Learning and Data Science [1] | 1 |
| ENGRC 3152 | Communication for Game Development [2] | 1 |
| ENGRC 3610 | Communication for Transportation Engineering [3] | 1 |
| ENGRC 4152 | Communication for Advanced Game Development [4] | 1 |
| ENGRC 4590 | Communications for Physical Design in Biological Engineering [5] | 1 |

[1] 1cr partnered with ORIE 3120 Practical Tools for Operations Research, Machine Learning and Data Science
[2] 1cr partnered with CS 3152 Introduction to Computer Game Architecture/INFO 3152 Introduction to Computer Game Design

[3] 1cr partnered with CEE 3610 Introduction to Transportation Engineering
[4] 1cr partnered with CS 4152 Advanced Topics in Computer Game Architecture/INFO 4152 Advanced Topics in Computer Game Design
[5] 1cr partnered with BEE 4590 Physical Design in Biological Engineering

5. **Apply for** ENGRC 3341 Guided Fieldwork for Engineering Communications
   Occasionally, a student will be doing a significant amount and variety of engineering or technical communication elsewhere in the College of Engineering, usually as part of a research team, as part of leadership in a project team, and the like. It may be appropriate to petition the CCGB's Subcommittee on Engineering Communications for permission to use as ENGRC 3341 as an option for upcoming projects (not past ones) to meet the Engineering Communications Requirement. This option does not count toward the Liberal Studies requirement for engineers, even via petition. It is essential for students and their mentoring Engineering faculty to prepare well in advance for this option.Request the information packet and form by emailing engrcomm_info@cornell.edu with "3341 request" in the subject line. This option is not to be used for work done by teaching assistants, nor is it to be used to finish up work from prior semesters in another course. More information can be found at the Cornell Engineering website (https://www.engineering.cornell.edu/courses-requirements/bachelor-science-requirements/engineering-communications-requirement/engrc-3341/).
   Paperwork is due by the last Wednesday in August for the Fall semester and the last Wednesday in January for the Spring semester.

**Category B: Via Other Paths**

1. **Take an officially designated Writing-Intensive (W-I) or Communication-Intensive (C-I) engineering course.**

- Note: The following course list is not comprehensive, as different engineering departments may offer W-I or C-I courses on an ad-hoc basis. Indeed, these offerings can change each semester. Students need to check with their major advisors each semester to confirm if a course will fulfill the Engineering Communications Requirement; curriculum approvals are made by each major via CCGB approval. W-I or C-I courses are based in a major, as part of that major's regular core offerings to its declared/affiliated undergraduate majors.
  This option does not count toward the Liberal Studies requirement for engineers, even via petition. See also the CE Undergraduate Handbook (https://www.engineering.cornell.edu/engineering-undergraduate-handbook/).
- It's important to note that these options usually only fulfill the Engineering Communications Requirement for their own majors. Students, advisors, and departments need to cross check against each student's major requirements for graduation. The Engineering Communications Program does not control, monitor, or assess for these courses. This option does not count toward the Liberal Studies requirement for engineers, even via petition.

| Code | Title | Hours |
|---|---|---|
| BEE 4530 | Computer-Aided Engineering: Applications to Biological Processes (crosslisted) | 3 |
| BEE 4730 | Watershed Engineering | 4 |
| BEE 4590 | Physical Design in Biological Engineering | 3 |
| BME 4190 | Laboratory Techniques for Molecular, Cellular, and Systems Engineering | 3 |
| BME 4390 | Circuits, Signals and Sensors: Instrumentation Laboratory | 3 |
| BME 4490 | Biomechanics Laboratory (crosslisted) | 3 |
| CHEME 4320 | Chemical Engineering Laboratory | 4 |
| ECE 4920 | ECE Technical Writing | 1 |
| MAE 4272 | Fluids and Heat Transfer Laboratory | 3 |
| MSE 4030 | Senior Materials Laboratory I | 4 |
| ORIE 4100 | Manufacturing Systems Design: A Consulting Boot Camp | 4 |

2. **Enroll in and Pass** COMM 3020 or COMM 3030

- Enroll in and pass COMM 3020 or COMM 3030 taught by the Department of Communication (in the College of Agriculture and Life Sciences). The Engineering Communications Program does not control, monitor, or assess for these courses. This option does not count toward the Liberal Studies requirement for engineers, even via petition. See also the CE Undergraduate Handbook (https://www.engineering.cornell.edu/students/undergraduate-students/curriculum/engineering-undergraduate-handbook/).

  **Introduction-to-Engineering Course:**

  An introduction-to-engineering course (designated ENGRI) is expected to be completed by the end of a student's first year. This course introduces students to the engineering process and provides a substantive experience in an open-ended problem-solving context. See the Introduction-to-Engineering course listing for current course offerings.

3. **Enroll in and pass HADM 3670, taught through the Nolan School**

- The Engineering Communications Program does not control, monitor, or assess for these courses. This option does not also fulfill the Liberal Studies requirement, even via petition. See also the Engineering Undergraduate Handbook (https://www.engineering.cornell.edu/engineering-undergraduate-handbook/).

## Engineering Distribution

Two engineering distribution (ENGRD) courses (6–8 credits) must be selected from two different categories listed below. A student may use any one of the possible substitutions described.

1. **Scientific computing:**

| Code | Title | Hours |
|---|---|---|
| ENGRD 2110 | Object-Oriented Programming and Data Structures (crosslisted) | 4 |
| ENGRD 2112 | Object-Oriented Design and Data Structures - Honors (crosslisted) | 4 |
| ENGRD 2140 | Computer Systems Programming (crosslisted) | 4 |
| ENGRD 3200 | Engineering Computation (crosslisted) | 4 |

2. **Materials Science:**
   ENGRD 2610 Mechanical Properties of Materials: From Nanodevices to Superstructures
   ENGRD 2620 Electronic Materials for the Information Age
3. **Mechanics:**
   ENGRD 2020 Statics and Mechanics of Solids

Note: Majors in Engineering Physics may use AEP 3330 as an ENGRD in this category.

4. **Probability and statistics:**
   ENGRD 2700 Eng Probability and Statistics: Modeling and Data Science
   Note: Majors in Engineering Physics may substitute MATH 4710 for ENGRD 2700. Majors in Civil Engineering, Biological Engineering, and Environmental Engineering may substitute CEE 3040 for ENGRD 2700.
   ENGRD 2720
5. **Electrical sciences:**

| Code | Title | Hours |
|---|---|---|
| ENGRD 2100 | Introduction to Circuits for Electrical and Computer Engineers (crosslisted) | 4 |
| ENGRD 2300 | Digital Logic and Computer Organization (crosslisted) | 4 |
| ENGRD 2550 | Engineering Quantum Information Hardware (crosslisted) | 3 |

6. **Thermodynamics and energy balances:**

   ENGRD 2111 Biomolecular Thermodynamics
   ENGRD 2190 Chemical Process Design and Analysis
   ENGRD 2210 Thermodynamics

1. **Earth and life sciences:**

| Code | Title | Hours |
|---|---|---|
| ENGRD 2250 | The Earth System (crosslisted) | 4 |
| ENGRD 2510 | Engineering Processes for Environmental Sustainability (crosslisted) | 3 |
| ENGRD 2600 | Principles of Biological Engineering (crosslisted) | 3 |

2. **Biology and chemistry:**

| Code | Title | Hours |
|---|---|---|
| ENGRD 2202 | Biomedical Transport Phenomena (crosslisted) | 3 |
| CHEM 3890 | Honors Physical Chemistry I | 4 |
| ENGRD 2520 | The Physics of Life (crosslisted) | 3 |
| BIOMG 3300 | Principles of Biochemistry, Individualized Instruction | 4 |
| or BIOMG 331( | Principles of Biochemistry: Proteins and Metabolism | |
| or BIOMG 335( | Principles of Biochemistry: Proteins, Metabolism, and Molecular Biology | |

**Additional Information**
Some majors may require completion of 9 specific engineering distribution courses for affiliation (acceptance into the major), or as a prerequisite for upper-class courses. For complete information, please see Affiliation with a Major and the flow charts for each major in the Engineering Undergraduate Handbook (https://www.engineering.cornell.edu/engineering-undergraduate-handbook/).

Note: Some majors require additional distribution courses after affiliation.

## Liberal Studies Distribution

Global and diverse societies require that engineers have an awareness of historical patterns, an appreciation for different cultures, professional ethics, the ability to work in multifaceted groups, and superior communication skills. Cornell has a rich curriculum in the humanities, arts, and social sciences, enabling every engineering student to obtain a truly liberal education. The rationale for these distribution courses is discussed in the Requirements for Graduation section of the *Engineering Undergraduate Handbook* and these courses should be chosen with as much care and foresight as courses from technical areas.

Requirements:

- At least six courses (totaling at least 18 credits)
- The six courses must be chosen from the categories listed and come from at least three different groups outlined in the following section
- At least 3 or more credits must be chosen from Group 7
- No more than two courses may be chosen from Group 6 (CE)
- At least two courses must be at the 2000 level or higher

The categories outlined above have been organized into seven Groups based on common themes in content. Those Groups are as follows:

**Group 1. Cultural Analysis, Literature and the Arts, Social Differences**
- Cultural Analysis (CA)
- Literature and the Arts (LA)
- Literature, the Arts and Design (LAD)
- Arts, Literature, and Culture (ALC)
- Social Difference (SCD-HA only. SCD-AS not allowed in this group.)

**Group 2. Historical Analysis**
- Historical Analysis (HA/ HST)

**Group 3. Ethics, Cognition, and Moral Reasoning**
- Knowledge, Cognition, and Moral Reasoning (KCM)
- Ethics and the Mind (ETM)

**Group 4. Social Science and Global Citizenship**
- Social and Behavioral Analysis (SBA)
- Social Sciences (SSC)
- Global Citizenship (GLC)

**Group 5. Foreign Languages (not literature courses) (FL)**
- Courses teaching language skills, inclusive of reading, writing, listening, and spoken non-English languages, at beginning to advanced levels.

**Group 6. Communications in Engineering (CE)**
- Engineering specific courses exploring communication as a way of acting in the world
- Courses must be specifically designated by CCGB as satisfying the CE category (no petitions)
- No more than two courses from this category may be used to satisfy the liberal studies requirement

**Group 7. Race and Equity**
- Social Difference (SCD-AS only. SCD-HA not allowed in this group)
- Diversity (D-AG only. D-HE not allowed in this group)

Students should utilize the current Courses of Study as the master list of approved liberal studies courses. Refer to Cornell Engineering Advising's Liberal Studies Policies (https://liberal-studies.engineering.cornell.edu/) webpage for complete lists of additional approved courses and unacceptable courses. Please direct any questions to Engineering Advising, 180 Rhodes Hall.

**Electives**

- **Advisor-Approved electives:** 6 credits required (approved by the faculty advisor[1]). Because these courses should help develop and broaden the skills of the engineer, faculty advisors generally accept the following as approved electives (as long as they are not being used elsewhere toward degree requirements):
- One additional introduction-to-engineering course (ENGRI)
- Engineering distribution courses
- Courses stressing written or oral communication
- Upper-level engineering courses
- Advanced courses in mathematics
- Rigorous courses in the biological and physical sciences
- Courses in business, economics, or language (when they serve the student's educational and academic objectives)
- Courses that expand the major or another part of the curriculum, including liberal studies electives not already being used toward the Liberal Studies Distribution requirement.
- Up to 6 credits of approved electives may come from ROTC courses at the 3000-level or higher.
- **Major-approved electives:** 9 credits (approved by the major and faculty advisors in the major). Refer to the major curricula for descriptions of courses in this category.
- **Outside-the-major electives:** 9 credits of courses outside the major to ensure breadth of engineering studies; these courses may be subject to major specific requirements for appropriateness.

[1] In the event a student and their faculty advisor disagree regarding the suitability of an approved elective, the student may appeal the decision to the Director of Undergraduate Studies (Associate Director) for their major department or to the Associate Dean for Undergraduate Programs.

## First-Year Requirements

During the first year, engineering students are expected to complete (or receive credit for) the following core requirements:

| Code | Title | Hours |
|---|---|---|
| MATH 1910 & MATH 1920 | Calculus for Engineers and Multivariable Calculus for Engineers | 4 |
| Select two of the following: | | 4-8 |
| CHEM 2080 | General Chemistry II | |
| CHEM 2081 | General Chemistry II Laboratory [1] | 1 |
| CHEM 2090 | Engineering General Chemistry | |
| PHYS 1112 | Physics I: Mechanics and Heat | |
| PHYS 1110 | Introduction to Experimental Physics | |
| PHYS 2213 | Physics II: Electromagnetism | |
| PHYS 2214 | Physics III: Oscillations, Waves, and Quantum Physics (or the Honors equivalent) [2] | |
| One of: CS 111X | | |
| Two first-year writing seminars | | |
| One introduction to engineering (ENGRI) course | | |
| Two physical education courses and the university swim test | | |

[1] Depends on the major.

[2] Depending on the major, students interested in chemical engineering, pre-med, or other health-related careers should enroll in the CHEM 2090 and CHEM 2091- CHEM 2080 and CHEM 2081 sequence during their first year.
Students interested in biomedical engineering should additionally complete BIOMG 1350 during the first year.

## Affiliation with a Major

Students are encouraged to apply for affiliation with a major during the first semester of their sophomore year, although earlier affiliation may be granted at the discretion of the major. This is done by completing the Application for Major Affiliation via the Engineering Registrar's website. To affiliate, students must:

1. make good progress toward completing required courses in the common curriculum,
2. have a GPA ≥ 2.0, and
3. have satisfied the major's course and grade requirements as specified below:

Students must be affiliated or conditionally affiliated with a major by the beginning of their fifth semester or they will be withdrawn from the College of Engineering, and therefore Cornell.

**Biological Engineering** [1]
Minimum cumulative GPA of 2.5 and at most one grade below C– in any math, chemistry, physics, and engineering courses: CS 1110 , CS 1112, ENGRI, ENGRD, and any engineering course cross-listed with ENGRI or ENGRD. Completion of BEE 2600/ENGRD 2600 or ENGRD 2510 with at least C–,and one year of Introductory Biology (two lectures and a lab) with grades of at least C–. Allowable courses include BIOMG 1350, BIOG 1440, BIOG 1445 BIOG 1500, and BIOEE 1610. No more than two credits of research/project team and two credits of arts performance courses will count toward the cumulative GPA required for affiliation.

**Biomedical Engineering**
Minimum GPA of 2.4 in designated math, science, and engineering courses completed with grades of C- or higher.

To apply for affiliation in the third semester, a student must be on track to complete the following requirements by the end of the third semester: BIOMG 1350 (or a score of 5 on the CEEB AP Exam (or equivalent)), MATH 1910, MATH 1920, MATH 2930, PHYS 1112, PHYS 1110, PHYS 2213, CHEM 2090 CHEM 2091, ENGRD 2111, CS 111X, and any ENGRI. BIOG 1440 cannot be used to satisfy this requirement for students entering Fall 2017 and after.

To apply for affiliation in the fourth semester, a student must be on track to complete the above courses plus the following additional courses by the end of the fourth semester: MATH 2940, ENGRD 2020, BME 2000, and BME 2010.

**Chemical Engineering**
At most one grade below C- in chemistry, math, physics, and chemical engineering courses, and a GPA ≥2.2 in math, science, and engineering courses (except independent study, seminar, research, or project teams).

To apply for affiliation in the third semester, a student must be on track to complete the following requirements by the end of the semester:

- Mathematics: MATH 1910 , MATH 1920 , and MATH 2930
- Chemistry: CHEM 2090 & CHEM 2091 , and CHEM 2080 & CHEM 2081 (or a score of 5 on the CEEB Advanced Placement exam for Chemistry and CHEM 2150 or CHEM 2080 & CHEM 2081 )
- Physics: PHYS 1112 , PHYS 1110 , and PHYS 2213

- Computing: CS 111X
- Engineering Distribution: One Introduction to Engineering course (ENGRI 1XXX), ENGRD 2190 , and CHEM 3890
- Two First-Year Writing Seminars
- One Liberal Studies Distribution course

Students applying in the fourth semester must be on track to complete the following prerequisites for junior year as well as the core requirements listed above: MATH 2940 or CEE 3040 or ENGRD 2700 , CHEM 2900 , CHEME 2200 , CHEME 3230 , and additional Liberal Studies Distribution course.

**Civil Engineering**
GPA ≥ 2.0 in all engineering, math, and science courses that have been completed at the time of affiliation. C grade or higher in ENGRD 2020.

**Computer Science**
At least C (not C-) in all completed CS courses and all critical math courses. GPA ≥ 2.5 in CS 2110/ CS 2112 and CS 2800/ CS 2802, or ECE 2400/ENGRD 2140 and CS 2800/CS 2802 and CS 3110. CS GPA calculation may be supplemented by the following courses: CS 3110 and CS 3410/ CS 3420. GPA ≥ 2.3 between MATH 1920 and any other completed critical math course(s): MATH 2940, MATH 4710, BTRY 3080/STSCI 3080, CS 4850, ECON 3130, ECE 3100, ENGRD 2700. If only AP/CASE credit appears, then another Cornell critical math course must be taken to affiliate. Qualifying courses must be taken at Cornell for a letter grade. A required supplemental application must be submitted along with the College of Engineering Application for Major Affiliation.

**Earth and Atmospheric Sciences**
The following courses must be completed or currently enrolled in at the time of affiliation: MATH 1910, MATH 1920, MATH 2930, MATH 2940, PHYS 1112, PHYS 1110, PHYS 2213, CHEM 2090 & CHEM 2091, CHEM 2080 & CHEM 2081 (or CHEM 1570 and CHEM 1580). Must have at least a C- in all courses taken and a cumulative GPA of 2.3 or higher.

**Electrical and Computer Engineering**
At least C+ in: MATH 2930 or MATH 2940, PHYS 2213, and one of ECE 2100/ENGRD 2100, ECE 2720 or ECE 2300/ENGRD 2300.

Must have a GPA ≥ 2.5 in (if completed):
MATH 1920, MATH 2930, MATH 2940,
PHYS 2213, ENGRD 2110, ECE 2400/ENGRD 2140, ECE 2300/ENGRD 2300, ECE 2100/ENGRD 2100, ECE 2720/ENGRD 2720.

**Engineering Physics**
At least B– in all required math and physics courses: MATH 1910, MATH 1920, MATH 2930, MATH 2940, PHYS 1110, PHYS 1112 / PHYS 1116, PHYS 1110, PHYS 2213 / PHYS 2217, PHYS 2214 / PHYS 2218, PHYS 2210.

**Environmental Engineering1**
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GPA ≥ 2.0 in all math, science, and engineering courses. At least C– in BEE 2510/ENGRD 2510.

**Independent Major**
Students must submit, and receive approval for, a proposed program including endorsement from advisors for a primary and secondary area. See the IM website (https://www.engineering.cornell.edu/independent-major/) for specific requirements and deadlines.

**Information Science Systems, and Technology**
At least a C in two of MATH 2940, CS 2110/ENGRD 2110, and ENGRD 2700 (must have taken at least two of these courses at time of affiliation). GPA ≥ 2.5 between CS 2110/ENGRD 2110,ENGRD 2700, and all completed MATH and ISST Major core courses. Qualifying courses must be taken at Cornell, and for a letter grade. A required supplemental application (https://affiliations.coecis.cornell.edu/is/) must be submitted to ISST in addition to the College of Engineering's Application for Major Affiliation.

Students in their senior year of study intending to change majors to ISST or add ISST as a second major must submit a course plan to demonstrate they can complete all degree requirements by their current expected graduation date.

**Materials Science and Engineering**
On track to complete by the end of the fourth semester the following required courses, and completion of at least 24 credits from these courses, when applying for affiliation: MATH 1910, MATH 1920, MATH 2930, MATH 2940 (all with a minimum grade of C),PHYS 1110, PHYS 1112/PHYS 1116, PHYS 2213/PHYS 2213, CHEM 2090 & CHEM 2091, and CS 1110/CS 1112.

Additionally, cumulative GPA ≥2.0 in the completed required math, physics, and chemistry courses (including MSE 3010 if taken) and at least C in ENGRD 2610 or ENGRD 2620.

For any course that is repeated, the most recent grade will be used for affiliation requirements. However, repeated grades will be included for GPA calculations.

Students who will not satisfy these requirements by the end of the fourth semester should contact the MSE department about alternative paths to affiliation.

**Mechanical Engineering**
At least C– in ENGRD 2020 and all completed required math, physics, chemistry, and computer science courses. ENGRD 2210 is recommended prior to affiliation. GPA > 2.5 in these courses: ENGRD 2210 (if taken), MATH 2930, PHYS 2213, and ENGRD 2020.

**Operations Research and Engineering**
At least C in each of ENGRD 2700 and MATH 2940. GPA ≥ 2.2 in math, science, and engineering courses (both overall and in the term immediately before affiliation). At least C– in all ORIE courses completed thus far. Good academic standing in the College of Engineering.

[1] Students may major in biological engineering and environmental engineering through the College of Engineering or the College of Agriculture and Life Sciences (CALS). Students who do so through the College of Agriculture and Life Sciences are jointly administered by the College of Engineering and the College of Agriculture and Life Sciences.

## Honors Program Within Majors

Many of the engineering majors supplement the major with an honors program.

### Eligibility

The B.S. degree with honors is granted to engineering students who, in addition to having completed the requirements for a B.S. degree in a major, satisfactorily complete the honors program in the major and are recommended for the degree by the honors committee of that major. To enter an honors program, the student must be on track to graduate with

distinction, and a student who does not stay on track to graduate with distinction is will be dropped from the honors program.

At least 9 extra credit hours are required for the honors degree, and a student must be in the program for at least two semesters before graduation. Courses taken to satisfy the honors requirement may not be used to satisfy any other B.S. degree requirements.

No research, independent study, or teaching for which the student is paid may be counted toward the honors program.

### Procedures

An applicant to the honors program in a major must have an honors advisor: a faculty member from that major who will supervise the honors program and direct any research or project. The honors advisor need not be the student's advisor in the major.

The application for the honors program should be a letter from the student that describes the proposed honors program in detail and includes the explicit approval of the honors advisor.

Students must complete a written application no later than the beginning of the first semester of their senior year, but they are encouraged to make arrangements with the honors advisor during the second semester of their junior year. Each major may place further constraints on timing.

### Major-Specific Information

Each major defines the content of the honors program and may also place other requirements on the program, in terms of timing, content, and procedures. Information is given within the description of the individual majors.

## Learning Outcomes

Biomedical Engineering is a leader in developing research that spans the Ithaca and New York City campuses, including Weill Cornell Medical College and Cornell Tech. Our objective is to create world-class graduates to meet the 21st century needs of biomedical-related industries focused on medical devices and pharmaceuticals, as well as government and private consulting practice. We also aim to produce intellectual and technical leaders for graduate education in medicine or engineering. Most importantly, we aim to create a diverse community of life-long learners who are innovation confident, collaborative across disciplines, and community engaged.

- Teach our students to apply engineering principles to understand and predict the behavior of biological and physiological systems relevant to human health and disease.
- Train our students in the theory and practice of biomedical engineering design and technology creation.
- Train our students to engineer robust solutions within highly variable and complex biomedical problems.
- Build critical leadership, interpersonal and professional skills to thrive within diverse team environments and prepare for life-long learning.
- Provide our students with opportunities for an experiential learning approach based on biomedical applications.
- To provide a complementary liberal education in humanities, history and social sciences.