

Department of Biomedical Engineering

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www.bme.cmu.edu

Biomedical engineers apply engineering principles to advance our understanding of living systems and to improve human health. They accomplish this by integrating fundamental engineering science knowledge with knowledge of biology, physiology and clinical practice. Biomedical engineers are employed in the pharmaceutical, biopharmaceutical, biotechnical and medical device industrial sectors as well as in clinical healthcare settings. A significant number of graduates also choose to pursue graduate studies or medical school. Our approach to biomedical engineering education reflects our belief that successful biomedical engineers in these sectors and settings will be deeply trained in both engineering and the life sciences. To underscore this, we use an additional major B.S. degree format for our undergraduate education program. Carnegie Institute of Technology (CIT) undergraduates will elect any one of these following majors with Biomedical Engineering: Chemical Engineering, Civil & Environmental Engineering, Electrical & Computer Engineering, Materials Science & Engineering, or Mechanical Engineering. Each of the additional major degree programs is designed to be completed in four, very full and rich, years.

Our curriculum is structured to provide both breadth and depth within biomedical engineering. Graduates will have a firm understanding of biology and physiology; the ability to apply advanced mathematics, science and engineering to solve problems at the interface between engineering and the life sciences; and the ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems.

The BME curriculum is comprised of three parts: the BME core, the BME track elective system and the BME capstone design course. All biomedical engineering additional majors will share a common exposure to the many facets of biomedical engineering in the BME Intro, Professional Issues and Laboratory courses and will build a common life sciences background in the Modern Biology and Physiology courses that comprise the BME core requirements.

Following the core is our track system. Each student will select a track to build depth within biomedical engineering in the bioimaging, biomaterials and tissue engineering, biomechanics, or cellular and molecular biotechnology areas.

Bioimaging is the study of bio/medical phenomena based on the information provided in digital images. It draws upon advances in signal processing, optics, probe chemistry, molecular biology, and machine learning to provide answers to biological and medical questions from the growing numbers of biological and medical images acquired in digital form. This track aligns most naturally with BME/ECE double majors. A bioimaging specialist will have a broad background and can expect to find work in biomedical industrial labs, pursue further education by going to either graduate or medical school, or be employed by one of the numerous biomedical tech companies developing new instrumentation and/or algorithms for digital imaging.

The Biomaterials and Tissue Engineering track addresses fundamental issues at the interface of materials science, biology and engineering. The course work includes the design and development of materials for biological applications. Students will understand how materials, cells, tissues and organ systems interact and direct rational, practical therapeutic solutions for clinical issues. Characterization techniques for measuring the outcome of biomaterials and biological interactions will be included in the track. BME/ChE and BME/MSE are well suited for additional major matches. Job opportunities for the students trained in materials and tissue engineering include work in biotechnology industries or further studies in graduate or medical school. Significant opportunities are expected for engineers trained in the development and production of biological materials, medical devices, and combination drug-cell-material devices.

Biomechanics refers to the application of principles of solid, fluid, and continuum mechanics to the study of the structure, function, and behavior of biological and medical systems under the influence of mechanical forces. Biomechanics draws on advances in biology, continuum mechanics, experimentation, imaging, applied mathematics, and scientific computing. Biomechanics models

provide quantitative descriptions of molecule, cell, tissue, organ, and whole organism behavior under mechanical stimuli, and are employed to characterize human health, disease, and injury. Biomechanics models are also used in the design of rehabilitative devices and strategies. BME/CEE and BME/ME additional majors are strong matches with this track. A broad background in biomechanics enables students to work in the medical device industry, to work as a rehabilitation engineer, the ability to conduct fundamental biomechanics modeling and experimental research, or to pursue medical or graduate school.

The Cellular and Molecular Biotechnology track emphasizes fundamentals and applications of biochemistry, biophysics, and cell biology. It is ideally suited to the BME/ChE additional major, which provides a strong core of chemistry and molecular processing principles, and is also appropriate for BME/CEE and BME/ME additional majors who have interests in molecular and cellular level detail. The track can also suit molecularly-oriented BME/ECE additional majors with interests in biosensing. This track prepares students for careers or advanced education involving bio/pharmaceutical manufacture, pharmacology, medical diagnostics, biosensors, drug delivery devices, and biological aspects of environmental engineering. Students pursuing the Cellular and Molecular Biotechnology track will acquire a deeper understanding of the molecular and cellular bases for the life processes. One of the unique characteristics of this track is an emphasis on processes and structures occurring on the nanometer to micrometer size scale range. Students following this track will acquire insights and quantitative modeling skills needed to develop biotechnologies based on live cell cultures, as well as technologies that exploit the unique properties of biomolecules in non-biological settings.

Each track requires a track gateway course which provides a common foundation for all who choose that track. The gateway course is typically followed by three electives chosen from a longer list of track electives. A dynamic listing of available track electives is maintained on the departmental web site. The areas of biomedical engineering represented by these tracks correspond to those areas in which Carnegie Mellon has coordinated research strengths. As a result, the courses are taught by experts who have direct, current experience and active research in that specialty. While there are natural alignments between the Biomedical Engineering track and the student's engineering major, there are no restrictions; all biomedical engineering tracks are open to all engineering majors. A general biomedical engineering track is also available for those students intending on pursuing graduate studies or medical school.

The additional major degree program culminates in the BME Design courses – a 3 unit mini-course, "Foundations of BME Design," taught in the fall semester of the senior year, followed by a 9 unit course, "BME Design" taught in the spring semester of the senior year. These courses pull together biomedical engineering students from all engineering backgrounds into design teams. The design teams tackle industry- and clinic-sponsored projects to develop products and product concepts relevant to human healthcare and the life sciences. The projects typically result in the production of a prototype and have resulted in patent applications and the pursuit of licensing opportunities.

Several questions naturally arise. Why the additional major? Why not a stand-alone BME degree? Where's the medical school? Again, we aim to graduate students who are educated in the use of traditional, fundamental engineering tools and analytical techniques as well as in the life sciences and clinical applications of technology. Due to its polydisciplinary nature, the field of biomedical engineering requires broad exposure to a wide variety of engineering principles. We feel this breadth of exposure should be complemented by the in-depth training in engineering fundamentals that the additional major format affords. While Carnegie Mellon does not have a medical school, the western Pennsylvania area is rich in medical research activity. We leverage our efforts with extensive collaboration with researchers and instructors from the University of Pittsburgh Medical Center, the Western Pennsylvania/Allegheny Hospital System, and the Children's Hospital systems. These collaborations reinforce the clinical relevance of our education and research activities. Our

approach to education is very different from that of the biomedical engineering community at large. And as the number of biomedical engineering degree programs continues to grow, we expect this difference, in particular the additional major degree training of our graduates, will confer a distinct and marketable advantage. Our graduates will shape the future of industrial, clinical and academic biomedical engineering and healthcare.

Biomedical Engineering also offers a minor program for those students who desire coordinated training in biomedical engineering but who may not have the time available in their schedules to permit pursuit of the additional major. The minor aims to provide undergraduates from within CIT and outside CIT with significant and meaningful exposure to specific biomedical engineering applications. Participants in the minor program can choose from course offerings within the elective track system to build marketable skills in a particular area of biomedical engineering.

The dynamism of the biomedical engineering field has created an incredibly exciting environment for students, faculty and staff alike at Carnegie Mellon. We invite you to share your educational experience with us.

Course Requirements for the Additional Major Degree

The requirements include five BME core courses, participation in a BME elective track consisting of a coherent program of four courses, and the BME design course. Core courses will be taken by all students to insure that a basic foundation is acquired in the life sciences. The BME Intro and Laboratory courses are designed to provide broad exposure to the elective track areas and to help students choose an elective track in which to participate. The elective track sequences will allow students to explore in more depth an area of biomedical engineering that complements their major; these courses are explicitly focused on technical aspects of biomedical engineering or the underpinning life sciences. The design course is a project course where students with some common background, yet different expertise, work on a substantial problem in biomedical engineering. Courses that fulfill these requirements are listed below; sample curricula for several of the most common additional majors are also provided.

Core Courses (all required)

42-101	Introduction to Biomedical Engineering Fall and Spring (coreq. or prereq.: 03-121)
42-201	Professional Issues in Biomedical Engineering Fall and Spring
42-202	Physiology Fall and Spring (prereq.: 03-121 or permission of instructor)
42-203	Biomedical Engineering Laboratory Fall and Spring (prereqs.: 42-101 and 42-202; students may substitute 03-124 Modern Biology Laboratory to fulfill pre-medical requirements).
03-121	Modern Biology Fall and Spring
42-401	Foundations of BME Design * Fall (prereqs: Senior BME additional-major status)
42-402	BME Design Spring

*42-401 is a mini that is scheduled for the last half of the fall semester; it begins the day of Mid-semester and ends the last day of classes. It is the precursor for 42-402 BME Design scheduled in the spring.

Elective Tracks (participation in one track required)

The track areas are: Bioimaging (BIMG), Biomaterials and Tissue Engineering (BMTE), Biomechanics (BMEC), Cellular and Molecular Biotechnology (CMBT), and General Biomedical Engineering (GBME). Track courses include a "gateway" required track course taken typically during the junior year, in addition to three electives at the junior or senior level, chosen from a set of track electives. A student may replace one track elective with a research project, either 42-200 Sophomore BME Research Project, 42-300 Junior BME Research Project, 42-400 Senior BME Research Project, 39-500 CIT Honors Project, as long as the research project is on a BME topic, supervised by a regular or courtesy BME faculty member, and the project is conducted for 9 or more units of credit, OR take 42-506 Surgery for Engineers. You cannot take a research course AND 42-506 Surgery for Engineers to replace 2 track electives.

Bioimaging (BIMG) Track

BIMG Gateway Course (required)

18-396 Signals and Systems – Spring

BIMG Track Electives (choose 3)

03-534	Biological Imaging and Fluorescent Spectroscopy
18-491	Digital Signal Processing
18-798	Image, Video, and Multimedia
18-799A	Special Topics in Signal Processing: Bioimage Registration
42-334	Introduction to Computational Biology OR 42-334 Computational Biology (OR 42-434)
42-431	Bioimage Informatics – Spring
42-506	Surgery for Engineers ** – Fall/Spring
42-735/16-725	Medical Image Analysis – Spring
42-X00	BME Research **

** Please note that 42-506 (Surgery for Engineers) and 42-X00 (BME Research) cannot both be used as track electives. You may select one for a track elective.

Biomaterials and Tissue Engineering (BMTE) Track

BMTE Gateway and Capstone Course (required)

03-232	Biochemistry – Spring (MSE majors may substitute 03-231)
42-419	Biomaterial/Host Interactions – Fall

BMTE Electives (choose 2)

03-240	Cell Biology - Spring
09-217	Organic Chemistry I - Fall
09-218	Organic Chemistry II - Spring
42-311/27-510	Polymeric Biomaterials - Spring
42-312/27-511	Metallic and Ceramic Biomaterials - Fall
42-413	Biomaterials Interfaces - Spring
42-424	Biological Transport - Spring
42-506	Surgery for Engineers** - Fall/Spring
42-507	Microfluidics - Spring
42-X00	BME Research

**Please note that 42-506 (Surgery for Engineers) and 42-X00 (BME Research) cannot BOTH be used as track electives. You may select one as a track elective.

Courses that count both as BMTE and MSE electives:

42-311/27-510	Polymeric Biomaterials
42-312/27-511	Metallic and Ceramic Biomaterials

Biomechanics (BMEC) Track

BMEC Gateway Course (required)

42-431 Introduction to Biomechanics – Spring

BMEC Electives (choose 3)

42-312/27-511	Metallic and Ceramic Biomaterials - Spring
42-347	Rehabilitation Engineering - Fall
42-424	Biological Transport - Spring
42-441	Cardiovascular Biomechanics
42-444	Medical Devices - Fall
42-506	Surgery for Engineers** - Fall/Spring
42-507	Microfluidics - Spring
42-508	Molecular Bioengineering – Spring
42-645	Cellular Biomechanics - Spring
42-X00	BME Research**
BIOE 1720	Biomechanics II: Biodynamics of Movement (Univ. of Pittsburgh Dept. of Bioengineering)
BIOE 1064	Biomechanics III: Tissues and Organs (Univ. of Pittsburgh Dept. of Engineering)

**Please note that 42-506 (Surgery for Engineers) and 42-X00 (BME Research) cannot BOTH be used as track electives. You may select one for a track elective.

Courses that count both as BMEC and MechE Electives:

42-445/24-415	Special Topics: Microfluidics – intermittent
42-502/24-655	Cellular Biomechanics – intermittent
42-508/24-539	Special Topics in Technology: Molecular Bioengineering Structure, Mechanics & Energetics

Cellular and Molecular Biotechnology (CMBT) Track

CMBT Gateway Course (required):

42-321 Cellular and Molecular Biotechnology

CMBT Track Electives (choose 3)

03-232 Biochemistry - Spring
 03-240 Cell Biology - Spring
 42-422 Bioprocess Design - Spring
 42-424 Biological Transport - Spring
 42-426 Biosensors and BioMEMS - Spring
 42-445 Microfluidics - Spring
 42-502/24-655 Cellular Biomechanics - Spring - intermittent
 42-506 Surgery for Engineers** - Fall/Spring
 42-508 Molecular Bioengineering - Spring
 42-621 Biological Processes in Environmental Systems - Spring
 42-x00 BME Research **

** Please note that 42-506 Surgery for Engineers and 42-X00 (BME Research) cannot BOTH be used as track electives. You may select one as a track elective.

Courses that count both as CMBT and Meche Electives:

42-502/24-655 Cellular Biomechanics - intermittent
 42-445/24-415 Special Topics: Microfluidics - intermittent
 42-508/24-539 Special Topics: Molecular Bioengineering/Special Topics in Technology: Molecular Bioengineering Structure, Mechanics & Energetics - Spring

Courses that count both as CMBT and CHE Electives:

42-508/06-815 Special Topics: Molecular Bioengineering
 42-621/06-621 Biological Processes in Environmental Systems

Minimum number of units to graduate: 401

General Biomedical Engineering (GBME) Track:

- Core courses required
- One gateway course from those listed in the above tracks.
- 42-401 BME Foundations of Design (Fall)
- 42-401 BME Design (Spring)
- Three track elective courses selected from any of those listed with the BIMG, BMTE, BMEC or CMBT tracks above.

Undergraduate Course Requirements

for the Minor

For CIT students

General Requirements: (five courses, minimum of 48 units)

42-101 Introduction to Biomedical Engineering (coreq. or prereq.: 03-121)
 42-202 Physiology (prereq.: 03-121 or permission of instructor)
 03-121 Modern Biology
 xx-xxx BME track course
 xx-xxx BME track course

For non-CIT students

General Requirements: (six courses, minimum of 60 units).

42-101 Introduction to Biomedical Engineering (coreq. or prereq.: 03-121)
 xx-xxx A second Introductory Engineering Course
 42-202 Physiology (prereq.: 03-121 or permission of instructor)
 03-121 Modern Biology
 xx-xxx BME track course *
 xx-xxx BME track course **

* This course cannot be a required course in your home department

** This course must be offered by one of the CIT Departments (06-xxx, 12-xxx, 18-xxx, 19-xxx, 24-xxx, 27-xxx or 42-xxx)

Both CIT and non-CIT students may replace one BME track course in the minor program with a research project, either 42-200 Sophomore BME Research, 42-300 Junior BME Research, 42-400 Senior BME Research or 39-500 CIT Honors Thesis, as long as the research project is supervised by a regular or courtesy BME faculty member and the project is conducted for 9 or more units of credit.

Advising

Each student who declares a BME additional major or minor will be assigned a BME faculty member as an academic advisor; for double majors, this may be in addition to an advisor assigned in the second CIT department. Faculty members associated with other departments may also serve as information resources for those students contemplating participation in the double major or minor program. By department, these faculty members include:

Biological Sciences: Profs. Amy Burkert; Robert Murphy
 Chemical Engineering: Profs. Kris Dahl, Michael Domach, Todd Przybycien, Robert Tilton, Steinar Hauan, and James Schneider
 Chemistry: Prof. Newell Washburn
 Civil & Environmental Engineering: Prof. Jeanne VanBriesen
 Electrical & Computer Engineering: Profs. Jelena Kovacevic, Kerem Pekkan, Gustavo Rohde, Stefan Zappe and José Moura
 Materials Science & Engineering: Profs. Newell Washburn and Lisa Porter
 Mechanical Engineering: Profs. Jim Antaki, Conrad Zapanta, and Phil LeDuc

Mrs. Hilda Diamond, located in Doherty Hall 2100, will also help with aspects of advising and attention to details, including student course requirements, scheduling of BME courses and working with departments to avoid conflicts. Coordination of advising with an additional major's second engineering department is essential. Note that for double majors, the second engineering department advisor must approve final schedules. Professor Zapanta and Mrs. Diamond will serve as advisors to BME Minor program students from the SCS and H&SS colleges.

If you are pursuing an additional major in Biomedical Engineering:

1. Always select your Engineering Core courses first: Many times it becomes very difficult to make up these courses, as they will inevitably conflict with required courses expected to be taken in subsequent years. In a few majors, BME substitutions occur for a few courses. If you are ahead of schedule, consult with your advisor about possible options.
2. Make sure you take the BME required (core) courses as soon as possible. Again, the likelihood of a major conflict increases if you wait, as these courses are scheduled so as to minimize conflicts in the year and semester they are most likely to be taken.
3. 42-101 Introduction to Biomedical Engineering should be taken, ideally, in the freshman year. If this is not possible, the fall of the sophomore year is the next best choice.
4. Minimum units to graduate: Additional majors must satisfy the minimum course requirements established by the second major department to graduate.
5. QPA requirements: The QPA for BME core, track and design courses must be 2.00 or better to graduate with the BME double major. In addition, CIT has the following requirement for graduation: "A student must also achieve a cumulative quality point average of 2.00 in a series of core courses, up to a maximum of 184 units, specified by the department. When more than one possibility exists for meeting a specific requirement (e.g., Breadth), the courses will be chosen as to maximize the QPA. Similarly, when a course is retaken, the better grade will be used in the computation of the minimum QPA in the above courses."

Sample schedule for BME-CEE Double Majors in the BMEC Track

Civil Engineering

First Year

	Fall	Units
12-100	Intro. to Civil & Environmental Engineering	12
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	H&SS Elective	9
		46

	Spring	Units
xx-xxx	Introduction to Engineering	12
21-122	Integration, Differential Equations, & Approximations	10
33-107	Physics II for Engineers	12
xx-xxx	H&SS Elective	9
		43

Second Year

	Fall	Units
12-212	Statics	9
15-100	Introduction/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
xx-xxx	H&SS Elective	9
		50

	Spring	Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
21-260	Differential Equations	9
12-271	Computer Applications in Civil & Environmental Engineering	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 1	9
		48

Third Year

	Fall	Units
12-301	Civil & Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics & Materials Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 2	9
		51

	Spring	Units
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Material Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
xx-xxx	Elective 3	9
xx-xxx	Elective 4	9
		48

Fourth Year

	Fall	Units
12-401	Civil & Environmental Engineering Design	15
12-411	Project Management	9
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 5	9
		48

	Spring	Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 6	9
xx-xxx	Elective 7	9
xx-xxx	Elective 8	9
		45

Civil Engineering and BME

First Year

	Fall	Units
12-100	Intro. to Civil & Environmental Engineering	12
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	General Education Course	9
		46

	Spring	Units
42-101	Intro. to Biomedical Engineering	12
21-122	Integration, Differential Equations, & Approximations	10
33-107	Physics II for Engineers	12
03-121	Modern Biology	9
xx-xxx	General Education Course	9
		52

Second Year

	Fall	Units
12-212	Statics	9
15-100	Introduction/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
42-202	Physiology	9
-or-		
42-203	BME Laboratory	9
42-201	Professional Issues in BME	3
		53

	Spring	Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
21-260	Differential Equations	9
12-271	Computer Applications in Civil & Environmental Engineering	9
xx-xxx	General Education Course	9
42-202	Physiology	9
-or-		
42-203	BME Laboratory	9
		48

Third Year

	Fall	Units
12-301	Civil & Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics & Materials Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
42-341	Introduction to Biomechanics	9
		51

	Spring	Units
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Material Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
42-4xx	BMEC Track Elective	9
xx-xxx	Elective	9
		48

Fourth Year

	Fall	Units
12-401	Civil & Environmental Engineering Design	15
12-411	Project Management	9
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
42-401	Foundations of BME Design	3
42-4xx	BMEC Track Elective	9
		51

	Spring	Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective	9
42-xxx	BMEC Track Elective	9
42-402	BME Design	9
		45

Minimum number of units required for degree: 394

Sample schedule for BME-CEE Double Majors in the CMBT Track

Civil Engineering
First Year

	Fall	Units
12-100	Intro to Civil & Environmental Eng.	12
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	General Education Course	9

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	Spring	Units
xx-xxx	Introduction to Engineering	12
21-122	Integration, Differential Equations, & Approximations	10
33-107	Physics II for Engineers	12
xx-xxx	H&SS Elective	9

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Second Year

	Fall	Units
12-212	Statics	9
15-100	Introduction/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
xx-xxx	H&SS Elective	9

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	Spring	Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
21-260	Differential Equations	9
12-271	Computer Applications in Civil & Environmental Engineering	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 1	9

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Third Year

	Fall	Units
12-301	Civil & Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics & Materials Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 2	9

51

	Spring	Units
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Material Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
xx-xxx	Elective 3	9
xx-xxx	Elective 4	9

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Fourth Year

	Fall	Units
12-401	Civil & Environmental Engineering Design	15
12-411	Project Management	9
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 5	9

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	Spring	Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 6	9
xx-xxx	Elective 7	9
xx-xxx	Elective 8	9

45

Civil Engineering and BME
First Year

	Fall	Units
12-100	Intro to Civil & Environmental Eng.	12
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	General Education Course	9

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	Spring	Units
42-101	Intro. to Biomedical Engineering	12
21-122	Integration, Differential Equations, & Approximations	10
33-107	Physics II for Engineers	12
03-121	Modern Biology	9
xx-xxx	General Education Course	9

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Second Year

	Fall	Units
12-212	Statics	9
15-100	Introduction/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9

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	Spring	Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
21-260	Differential Equations	9
12-271	Computer Applications in Civil & Environmental Engineering	9
xx-xxx	General Education Course	9
42-202	Physiology -or-	9
42-203	BME Laboratory	9

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Third Year

	Fall	Units
12-301	Civil & Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics & Materials Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
42-321	Cellular and Molecular Biotechnology	9

51

	Spring	Units
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Material Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
42-4xx	CMBT Track Elective	9
xx-xxx	Elective	9

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Fourth Year

	Fall	Units
12-401	Civil & Environmental Engineering Design	15
12-411	Project Management	9
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
42-401	Foundations of BME Design	3
42-4xx	CMBT Track Elective	9

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	Spring	Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective	9
42-xxx	CMBT Track Elective	9
42-402	BME Design	9

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Minimum number of units required for degree: 394

Sample schedule for ChemE/BME Double Majors in the BMTE Track

Chemical Engineering

First Year		Units
	Fall	
21-120	Differential & Integral Calculus	10
76-xxx	Designated Writing Course	9
99-101	Computing@Carnegie Mellon	3
06-100	Intro. to Chemical Engineering	12
09-105	Modern Chemistry	10
		44

	Spring	Units
21-122	Integration, Differential Equations & Approximations	10
xx-xxx	Intro. to Engineering Course	12
33-106	Physics I for Engineers	12
xx-xxx	General Education Course	9
		43

Second Year

Fall		Units
06-222	Sophomore ChemE Seminar	1
21-259	Calculus in Three Dimensions	9
06-221	Thermodynamics	9
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
xx-xxx	General Education Course	9
		48

Spring		Units
06-261	Fluid Mechanics I	9
06-262	Math: Methods of Chem. Engineering	12
09-221	Lab I: Introduction to Chemical Analysis	12
33-107	Physics II for Engineers	12
xx-xxx	General Education Course	9
		54

Third Year

Fall		Units
06-321	Chemical Engineering Thermodynamics	9
06-322	Junior ChemE Seminar	2
06-323	Heat and Mass Transfer	9
09-217	Organic Chemistry I	9
09-347	Advanced Physical Chemistry	12
xx-xxx	General Education Course	9
		50

Spring		Units
06-361	Unit Operations of ChemE	9
06-362	Chemical Engineering Process Control	9
06-363	Transport Process Laboratory	6
02-232	Biochemistry	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		51

Fourth Year

Fall		Units
06-421	Chemical Process System Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		48

Spring		Units
06-461	Process Design Project	6
06-462	Economics & Optimization	6
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

Chemical Engineering and BME

First Year		Units
	Fall	
21-120	Differential & Integral Calculus	10
76-xxx	Designated Writing Course	9
99-101	Computing@Carnegie Mellon	3
06-100	Intro to Chemical Engineering	12
09-105	Modern Chemistry	10
		44

	Spring	Units
21-122	Integration, Differential Equations & Approximations	10
42-101	Intro to Biomedical Engineering	12
33-106	Physics I for Engineers	12
03-121	Modern Biology	9
xx-xxx	General Education Course	9
		52

Second Year

Fall		Units
06-222	Sophomore ChemE Seminar	1
21-259	Calculus in Three Dimensions	9
06-221	Thermodynamics	9
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		48

Spring		Units
06-261	Fluid Mechanics I	9
06-262	Math: Methods of Chem. Engineering	12
09-221	Lab I: Introduction to Chemical Analysis	12
33-107	Physics II for Engineers	12
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		57

Third Year

Fall		Units
06-321	Chemical Engineering Thermodynamics	9
06-323	Heat and Mass Transfer	9
09-217	Organic Chemistry I	9
09-347	Advanced Physical Chemistry	12
xx-xxx	General Education Course	9
		48

Spring		Units
06-361	Unit Operations of ChemE	9
06-362	ChemE Process Control	9
06-363	Transport Process Laboratory	6
03-232	Biochemistry	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		51

Fourth Year

Fall		Units
06-421	Chemical Process System Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
42-401	Foundations of BME Design	3
42-419	Biomaterials/Host Interactions	9
xx-xxx	General Education Course	9
		51

Spring		Units
06-461	Process Design Project	6
06-462	Economics & Optimization	6
42-402	BME Design	9
xx-xxx	BMTE Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		48

Minimum no. units to graduate: 399

Sample schedule for ChemE/BME Double Majors in the CMBT Track

Chemical Engineering

First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
76-xxx	Designated Writing Course	9
99-101	Computing@Carnegie Mellon	3
06-100	Intro. to Chemical Engineering	12
09-105	Modern Chemistry	10

44

	Spring	Units
21-122	Integration, Differential Equations & Approximations	10
xx-xxx	Intro. to Engineering Course	12
33-106	Physics I for Engineers	12
xx-xxx	General Education Course	9

43

Second Year

	Fall	Units
06-222	Sophomore ChemE Seminar	1
21-259	Calculus in Three Dimensions	9
06-221	Thermodynamics	9
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
xx-xxx	General Education Course	9

48

	Spring	Units
06-261	Fluid Mechanics I	9
06-262	Math: Methods of Chem. Engineering	12
09-221	Lab I: Introduction to Chemical Analysis	12
33-107	Physics II for Engineers	12
xx-xxx	General Education Course	9

54

Third Year

	Fall	Units
06-321	Chemical Engineering Thermodynamics	9
06-322	Junior ChemE Seminar	2
06-323	Heat and Mass Transfer	9
09-217	Organic Chemistry I	9
09-347	Advanced Physical Chemistry	12
xx-xxx	General Education Course	9

50

	Spring	Units
06-361	Unit Operations of ChemE	9
06-362	Chemical Engineering Process Control	9
06-363	Transport Process Laboratory	6
02-232	Biochemistry	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9

51

Fourth Year

	Fall	Units
06-421	Chemical Process System Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9

48

	Spring	Units
06-461	Process Design Project	6
06-462	Economics & Optimization	6
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9

48

Chemical Engineering and BME

First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
76-xxx	Designated Writing Course	9
99-101	Computing@Carnegie Mellon	3
06-100	Intro to Chemical Engineering	12
09-105	Modern Chemistry	10

44

	Spring	Units
21-122	Integration, Differential Equations & Approximations	10
42-101	Intro to Biomedical Engineering	12
33-106	Physics I for Engineers	12
03-121	Modern Biology	9
xx-xxx	General Education Course	9

52

Second Year

	Fall	Units
06-222	Sophomore ChemE Seminar	1
21-259	Calculus in Three Dimensions	9
06-221	Thermodynamics	9
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
42-202	Physiology -or-	9
42-203	BME Laboratory	9

48

	Spring	Units
06-261	Fluid Mechanics I	9
06-262	Math: Methods of Chem. Engineering	12
09-221	Lab I: Introduction to Chemical Analysis	12
33-107	Physics II for Engineers	12
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9

57

Third Year

	Fall	Units
06-321	Chemical Engineering Thermodynamics	9
09-217	Organic Chemistry I	9
06-323	Heat and Mass Transfer	9
09-347	Advanced Physical Chemistry	12
42-321	Cellular and Molecular Biotechnology	9
xx-xxx	General Education Course	9

57

	Spring	Units
06-361	Unit Operations of ChemE	9
06-362	ChemE Process Control	9
06-363	Transport Process Laboratory	6
03-232	Biochemistry	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9

51

Fourth Year

	Fall	Units
06-421	Chemical Process System Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
42-401	Foundations of BME Design	3
42-xxx	CMBT Track Elective	9
xx-xxx	General Education Course	9

51

	Spring	Units
06-461	Process Design Project	6
06-462	Economics & Optimization	6
42-402	BME Design	9
42-xxx	CMBT Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9

48

Minimum no. units to graduate: 408

Sample schedule for ECE/BME Double Majors in the BIMG Track

Electrical & Computer Engineering

First Year		Units
Fall		
18-100	Intro. to ECE	12
15-100	Introductory/Intermediate Programming	10
21-120	Differential and Integral Calculus	10
xx-xxx	General Education Course	9
99-102	Computing@Carnegie Mellon	3
		44

Spring		Units
xx-xxx	Intro. to Engineering Course	12
33-106	Physics I for Engineers	12
21-122	Integration, Differential Equations and Approximation	10
76-xxx	Designated Writing Course	9
		43

Second Year

Fall		Units
18-200	Emerging Trends in ECE	1
18-240	Fundamentals of Computer Engineering	12
21-127	Concepts of Mathematics	9
33-107	Physics II for Engineers	12
xx-xxx	General Education Course	9
		43

Spring		Units
18-202	Mathematical Foundations of Electrical Engineering	12
18-220	Fundamentals of Electrical Engineering	12
15-123	Effective Programming in C and Unix	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		51

Third Year

Fall		Units
15-213	Introduction to Computer Systems	12
xx-xxx	ECE Breadth Course 1	12
36-217	Probability and Statistics	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		51

Spring		Units
18-290	Signal and Information Processing	12
18-xxx	ECE Breadth Course 2	12
xx-xxx	Math/Science Elective	9
xx-xxx	Engineering Elective	9
xx-xxx	General Education Course	9
		51

Fourth Year

Fall		Units
18-5xx	Capstone Design	12
xx-xxx	Math/Science Elective 2	9
18-xxx	ECE Depth	12
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		51

Spring		Units
18-xxx	ECE Coverage	12
xx-xxx	Free Elective	12
xx-xxx	Free Elective	12
xx-xxx	General Education Course	9
		45

Electrical & Computer Engineering and BME

First Year		Units
Fall		
18-100	Intro. to ECE	12
15-100	Introductory/Intermediate Programming	10
21-120	Differential and Integral Calculus	10
xx-xxx	General Education Course	9
99-102	Computing@Carnegie Mellon	3
		44

Spring		Units
42-101	Introduction to BME	12
33-106	Physics I for Engineers	12
21-122	Integration, Differential Equations and Approximation	10
76-xxx	Designated Writing Course	9
03-121	Modern Biology (core)	9
		52

Second Year

Fall		Units
18-200	Emerging Trends in ECE	1
18-240	Fundamentals of Computer Engineering	12
21-127	Concepts of Mathematics	9
33-107	Physics II for Engineers	12
42-201	Professional Issues in BME	3
42-202	Physiology (core)	9
-or-		
42-203	BME Laboratory	9
		46

Spring		Units
18-202	Mathematical Foundations of Electrical Engineering	12
18-220	Fundamentals of Electrical Engineering	12
15-123	Effective Programming in C and Unix	9
42-202	Physiology	9
-or-		
42-203	BME Laboratory	9
xx-xxx	General Education Course	9
		51

Third Year

Fall		Units
15-213	Introduction to Computer Systems	12
18-396	Signals and Systems	12
36-217	Probability and Statistics	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		51

Spring		Units
18-290	Signal and Information Processing	12
18-xxx	ECE Breadth Course 2	12
42-xxx	BIMG Track Elective	12
xx-xxx	Math/Science Elective	9
xx-xxx	General Education Course	9
		53

Fourth Year

Fall		Units
18-xxx	ECE Depth	12
42-401	Foundations of BME Design	3
42-xxx	BIMG Track Elective	12
42-xxx	BIMG Track Elective	9
xx-xxx	General Education Course	9
		45

Spring		Units
18-xxx	ECE Coverage	12
18-xxx	ECE Design	12
42-402	BME Design	9
xx-xxx	General Education Course	9
		42

Minimum no. of units to graduate: 384

Sample schedule for MechE/BME Double Majors in the BMEC Track

Mechanical Engineering
First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
24-101	Fundamentals of Mechanical Eng.	12
33-106	Physics for Engineering Students I	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	Writing/Expression Course	9
		46

	Spring	Units
21-122	Integration, Differential Equations, & Approximations	10
xx-xxx	Second Introductory Engineering Course	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		41-44

Second Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics of Deformable Solids	10
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		48-51

	Spring	Units
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		50-53

Third Year

	Fall	Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
36-220	Engineering Statistics	9
xx-xxx	General Education Course	9
		50-52

	Spring	Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-321	Thermal-Fluids Experimentation and Design	12
24-452	Mechanical Systems Experimentation	12
24-370	Engineering Design I	12
xx-xxx	General Education Course	9
		45-47

Fourth Year

	Fall	Units
24-441	Engineering Design II	12
24-452	Mechanical Systems Experimentation	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

	Spring	Units
24-xxx	ME Tech Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		45

Mechanical Engineering and BME
First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
24-101	Fundamentals of Mechanical Eng.	12
33-106	Physics for Engineering Students I	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	Writing/Expression Course	9
		46

	Spring	Units
21-122	Integration, Differential Equations, & Approximations	10
42-101	Introduction to BME	12
15-100 or		
15-111	Introductory/Intermediate Programming	10
03-121	Modern Biology	9
xx-xxx	General Education Course	9
		50

Second Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics of Deformable Solids	10
33-107	Physics for Engineering Students II	12
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		53

	Spring	Units
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
09-105	Modern Chemistry I	10
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		50

Third Year

	Fall	Units
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
42-341	Introduction to Biomechanics	9
36-220	Engineering Statistics	9
		50

	Spring	Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-321	Thermal-Fluids Experimentation and Design	12
24-352	Mechanical Systems Experimentation	12
42-502	Cellular Biomechanics -or-	9
42-508	Special Topics: Molecular Bioengineering	9
24-370	Engineering Design I	12
xx-xxx	General Education Course	9
		56

Fourth Year

	Fall	Units
24-441	Engineering Design II	12
24-452	Mechanical Systems Experimentation	9
42-401	Foundations of BME Design	3
42-xxx	BMEC Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		51

	Spring	Units
42-401	BME Design	9
42-xxx	BMEC Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		45

Minimum no. of units to graduate: 401

Sample schedule for MechE/BME Double Majors in the CMBT Track

Mechanical Engineering

First Year		Units
Fall		
21-120	Differential & Integral Calculus	10
24-101	Fundamentals of Mechanical Eng.	12
33-106	Physics for Engineering Students I	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	Writing/Expression Course	9
		46

Spring		Units
21-122	Integration, Differential Equations, & Approximations	10
xx-xxx	Second Introductory Engineering Course	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		41-44

Second Year

Fall		Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics of Deformable Solids	10
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		48-51

Spring		Units
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		50-53

Third Year

Fall		Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
36-220	Engineering Statistics	9
xx-xxx	General Education Course	9
		50-52

Spring		Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-321	Thermal-Fluids Experimentation and Design	12
24-452	Mechanical Systems Experimentation	12
24-370	Engineering Design I	12
xx-xxx	General Education Course	9
		45-47

Fourth Year

Fall		Units
24-441	Engineering Design II	12
24-452	Mechanical Systems Experimentation	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

Spring		Units
24-xxx	ME Tech Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		45

Mechanical Engineering and BME

First Year		Units
Fall		
21-120	Differential & Integral Calculus	10
24-101	Fundamentals of Mechanical Eng.	12
33-106	Physics for Engineering Students I	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	Writing/Expression Course	9
		46

Spring		Units
21-122	Integration, Differential Equations, & Approximations	10
42-101	Introduction to BME	12
15-100 or		
15-111	Introductory/Intermediate Programming	10
03-121	Modern Biology	9
xx-xxx	General Education Course	9
		50

Second Year

Fall		Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics of Deformable Solids	10
33-107	Physics for Engineering Students II	12
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		53

Spring		Units
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
09-105	Modern Chemistry I	10
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		50

Third Year

Fall		Units
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
42-321	Cellular & Molecular Biotech	9
36-220	Engineering Statistics	9
		50

Spring		Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-321	Thermal-Fluids Experimentation and Design	12
24-452	Mechanical Systems Experimentation	12
42-502	Cellular Biomechanics -or-	9
42-508	Special Topics: Molecular Bioengineering	9
24-370	Engineering Design I	12
xx-xxx	General Education Course	9
		56

Fourth Year

Fall		Units
24-441	Engineering Design II	12
24-452	Mechanical Systems Experimentation	9
42-401	Foundations of BME Design	3
42-xxx	CMBT Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		51

Spring		Units
42-402	BME Design	9
42-xxx	CMBT Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		45

Minimum no. of units to graduate: 401

Sample schedule for MSE/BME Double Majors in the BMTE Track

Materials Science & Engineering
First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
27-100	Materials in Engineering	12
xx-xxx	General Education Elective	9
		43

	Spring	Units
21-122	Integration, Differential Equations, & Approximations	10
15-100	Intro/Intermediate Programming	10
99-101	Computing@Carnegie Mellon	3
xx-xxx	Introductory Engineering Elective	12
xx-xxx	General Education Elective	9
		44

Second Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
27-201	Structure of Materials	9
27-202	Defects in Materials	9
27-215	Thermodynamics of Materials	12
27-299	Professional Development I	1
33-107	Physics II for Engineers	12
21-126	Intro to Mathematical Software	3
		55

	Spring	Units
09-101	Introduction to Experimental Chemistry	3
09-105	Modern Chemistry I	10
21-260	Differential Equations	9
27-205	Materials Characterization Lab	3
27-216	Transport in Materials	9
27-217	Phase Relations and Diagrams	12
xx-xxx	General Education Course	9
		55

Third Year

	Fall	Units
27-399	Professional Development II	1
27-301	Microstructure and Properties I	9
33-225	Quantum Physics & Structure of Matter <i>OR</i>	9
09-217	Organic Chemistry I <i>OR</i>	9
03-121	Modern Biology	9
xx-xxx	Free Elective	9
27-xxx	MSE Restricted Elective	9
xx-xxx	General Education Elective	9
		46

	Spring	Units
27-367	Selection and Performance	6
36-220	Engineering Statistics & Quality Control	9
xx-xxx	General Education Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
27-xxx	MSE Restricted Elective	9
		51

Fourth Year

	Fall	Units
27-401	MSE Capstone (1)	12
27-499	Professional Development III	1
xx-xxx	Free Elective	9
xx-xxx	General Education Elective	9
xx-xxx	General Education Elective	9
27-xxx	MSE Restricted Elective	9
		49

	Spring	Units
xx-xxx	Free Elective	9
27-xxx	MSE Restricted Elective	9
27-xxx	MSE Restricted Elective	9
xx-xxx	General Education Elective	9
		36

Materials Science & Engineering and BME
First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
27-100	Materials in Engineering	12
03-121	Modern Biology	9
		43

	Spring	Units
21-122	Integration, Differential Equations, & Approximations	10
15-100	Intro/Intermediate Programming	10
99-101	Computing@Carnegie Mellon	3
42-101	Intro to Biomedical Engineering	12
33-107	Physics II for Engineers	12
		47

Second Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
27-201	Structure of Materials	9
27-202	Defects in Materials	9
27-215	Thermodynamics of Materials	12
27-299	Professional Development I	1
21-126	Intro to Mathematical Software	3
42-201	Professional Issues in BME	3
42-202	Physiology <i>-or-</i>	9
42-203	BME Lab	9
		55

	Spring	Units
09-101	Introduction to Experimental Chemistry	3
09-105	Modern Chemistry I	10
21-260	Differential Equations	9
27-205	Materials Characterization Lab	3
27-216	Transport in Materials	9
27-217	Phase Relations and Diagrams	12
42-202	Physiology <i>-or-</i>	9
42-203	BME Lab	9
		55

Third Year

	Fall	Units
27-399	Professional Development II	1
27-301	Microstructure and Properties I	9
03-231	Biochemistry	9
27-xxx	MSE Restricted Elective	9
xx-xxx	General Education Elective	9
xx-xxx	General Education Course	9
		46

	Spring	Units
27-367	Selection and Performance	6
36-220	Engineering Statistics & Quality Control	9
42-xxx	BMTE Track Elective	9
xx-xxx	General Education Elective	9
xx-xxx	General Education Elective	9
27-xxx	MSE Restricted Elective	9
		51

Fourth Year

	Fall	Units
27-401	MSE Capstone (1)	12
27-499	Professional Development III	1
42-401	Foundations of BME Design	3
42-419	Host/Biomaterial Interactions	9
xx-xxx	General Education Elective	9
xx-xxx	General Education Elective	9
27-xxx	MSE Restricted Elective	9
		52

	Spring	Units
27-xxx	MSE Restricted Elective	9
42-402	BME Design	9
42-xxx	BMTE Track Elective	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		45

Minimum no. of units to graduate: 394