Engineering Minors for Non-Engineering Students

Biomedical Engineering Minor

(for non-engineering students)

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www.bme.cmu.edu
Campus Office for Student Affairs: Doherty Hall 2100

BME offers a minor program for those non-CIT students who desire coordinated training in BME. The Biomedical Engineering Minor is designed to train students to apply engineering techniques to problems in medicine and biology. Emphasis is placed on describing biological organisms as engineering systems and on applying engineering technology to clinical and laboratory situations.

Upon completing the Biomedical Engineering Minor, the student may elect to continue graduate studies in Biomedical engineering or basic biomedical sciences at either the master's or Ph.D. level. In addition, some of the courses in BME minor will assist students in preparing for medical school. Students who pursue jobs in biomedical engineering are involved in developing and improving medical devices, automating medical procedures using information technology, characterizing the operation of physiological systems, designing artificial organs, and altering microbes and mammalian cells for the production of useful drugs and chemicals.

Students in the minor program can choose from a wide range of electives to build skills in a number of areas of biomedical engineering. Students who wish to complete the Biomedical Engineering Designated Minor should complete the CIT Minor Request Form (http://www.cit.cmu.edu/files/documents/minor_request.pdf) and return it to the Associate Head of the Department of Biomedical Engineering (http://www.bme.cmu.edu/contact.html).

Requirements for non-CIT students: six courses, minimum of 60 units

03-121	Modern Biology	9
42-101	Introduction to Biomedical Engineering	12
42-202	Physiology (pre-req. 03-121 or permission of instructor)	9
xx-xxx	Elective I [#]	
xx-xxx	Elective II [+]	
xx–xxx	A second Introductory Engineering Course* or Any 42-xxx Course Numbered 42-3xx or Higher and Worth at Least 9 Units	

Some Special Topics, newly offered or intermittently offered 42-xxx may be acceptable as electives. Students should consult with their advisors and petition the Biomedical Engineering Undergraduate Affairs Committee for permission to include such courses as track electives.

Notes:
This course cannot be a required course in the student's major. It may be
1. Any Track Gateway, Track Elective, Restricted Elective, or Track Capstone course selected from any of the four Biomedical Engineering tracks. A list of track courses is provided under the BME Additional Major listing in the catalog and is periodically updated on the website.
2. Any 42-xxx course with a 42-300 or higher number and worth at least 9 units.
3. 42-203 Biomedical Engineering Laboratory (or the cross-listed version 03-206 for students in the Health Professions Program)**.
4. One semester of 42-200 Sophomore BME Research Project, 42-300 Junior BME Research Project, 42-400 Senior BME Research Project or 39-500 Honors Research Project, as long as the research project is supervised by a regular or courtesy Biomedical Engineering faculty member and the project is conducted for 9 or more units of academic credit.

+ Elective II must be a Biomedical Engineering Track Gateway, Track Elective, Restricted Elective, or Track Capstone course that is offered by one of the CIT Departments (06-xxx, 12-xxx, 18-xxx, 19-xxx, 24-xxx, 27-xxx or 42-xxx). The only exception is that 03-232, the biotechnology-focused version of Biochemistry taught each Spring by the Department of Biological Sciences, is also acceptable, provided students meet the prerequisites and corequisites for that course.

***** Select either 06-100 Introduction to Chemical Engineering, 12-100 Introduction to Civil and Environmental Engineering, 18-100 Introduction to Electrical and Computer Engineering, 19-101 Introduction to Engineering and Public Policy, 27-100 Engineering the Materials of the Future, or 24-101 Fundamentals of Mechanical Engineering. Note that corequisites are required for these courses

** Priority for enrollment in 42-203 or 03-206 will be given to students who have declared the Additional Major in Biomedical Engineering. If sufficient room in the course remains after all majors have been accommodated in a given semester, students who have declared the Biomedical Engineering Designated Minor will be given the next priority for enrollment. If space still allows, other students will be enrolled.

Engineering Studies Minor

(for non-engineering students)

Kurt Larsen, Director
Office: Scaife Hall 110

Carnegie Mellon undergraduate students enrolled in colleges other than engineering can complete a Minor in Engineering Studies in addition to their regular majors. Students pursuing this minor are required to complete courses from at least two different engineering departments in order to assure some breadth of exposure to engineering. In addition, the minor provides students the opportunity to pursue an in-depth concentration in a particular field of engineering.

For the Minor in Engineering Studies, students must complete five engineering courses as follows and must earn a cumulative QPA of 2.00 in these five courses. Students may declare the minor by contacting the Director after they have successfully completed two introductory engineering courses (from list #1 below).

Double counting of core courses in student's primary major is not permitted.

Because of the nature of the courses offered by Engineering and Public Policy, only two EPP courses (including 19-101) can be used toward the minor requirements. Students need special permission to use an Engineering and Public Policy course (EPP-19-xxx) toward minor requirements. Students interested in EPP coursework should consider the Technology and Policy minor instead.

Requirements

1. Two of the following:

12-100	Introduction to Civil and Environmental Engineering	12
18-100	Introduction to Electrical and Computer Engineering	12
19-101	Introduction to Engineering and Public Policy	12
24-101	Fundamentals of Mechanical Engineering	12
27-100	Engineering the Materials of the Future	12
42-101	Introduction to Biomedical Engineering	12
06-100	Introduction to Chemical Engineering	12

2. Three courses of at least 9 units each from one or more CIT departments
3. Up to <u>one</u> of the following Robotics courses can count toward the ES minor. But it cannot be double-counted with the Robotics minor or double major.

16-311	Introduction to Robotics	12
16-362	Mobile Robot Programming Laboratory	12
16-384	Robot Kinematics and Dynamics	12
16-385	Computer Vision	9
16-421	Vision Sensors	12
16-474	Robotics Capstone	12

4. <u>NOTE:</u> The following courses may NOT be included as part of the Minor in Engineering Studies. In addition to the courses listed, most EPP courses (19-xxx) are not permissible for the minor and students should contact the Director for prior approval of EPP courses.

06-262	Mathematical Methods of Chemical Engineering	12
12-201	Geology	9
15-213	Introduction to Computer Systems	12
18-090	Twisted Signals: Multimedia Processing for the Arts	10
18-099	Special Topics: Mobile App Design & Development	12
18-200	ECE Sophomore Seminar	1
18-202	Mathematical Foundations of Electrical Engineering	12
18-213	Introduction to Computer Systems	12
24-311	Numerical Methods	12
39-200	Business for Engineers	9
42-202	Physiology	9

Technology and Policy Minor

(for non-engineering students)

Deanna H. Matthews, Director
Office: Baker Hall 129

The Technology and Policy Minor is administered by the Department of Engineering and Public Policy (EPP) for students who are majoring in areas other than engineering. The Technology and Policy Minor is designed to give students a basic understanding of the interactions between technology, society and policy and some project experience in problems involving technology and policy.

Pre-requisites

Students should have prerequisite knowledge in economics (73-102 Principles of Microeconomics or higher level economics course) and statistics (36-202 Methods for Statistics and Data Science or higher level statistics course) in order to pursue the Technology and Policy Minor.

Course Requirements

19-101	Introduction to Engineering and Public Policy	12
19-301	Decision Making Methods for Engineers and Scientists or other approved Decision Science course	9
or 19-351	Applied Methods for Technology-Policy Analysis	
19-451	EPP Projects	12
or 19-452	EPP Projects	
xx-xxx	Two EPP Technology-Policy Electives	18

EPP Technical Electives include courses in CIT, MCS, or SCS that address problems at the society-technology interface and the means of analyzing these issues. A list of qualifying Technology-Policy electives is assembled each semester and is available from the EPP Department. Example Technology-Policy electives include:

19-211	Ethics and Policy Issues in Computing	9
19-365	Water Technology Innovation and Policy	9
19-402	Telecommunications Technology, Policy & Management	12
19-411	Global Competitiveness: Firms, Nations and Technological Change	9
19-424	Energy and the Environment	9

Students must earn a cumulative QPA of 2.0 in all courses taken for the minor. Required courses taken for a student's primary major may not be counted toward the Technology and Policy Minor. Elective courses for a student's primary major or courses fulfilling general education requirements may be counted, however.

Robotics Minor

Director: Dr. Howie Choset
Administrative Coordinator: Barbara (B.J.) Fecich
Website: http://undergrad.ri.cmu.edu/academics/minor/

The Minor in Robotics provides an opportunity for undergraduate students at Carnegie Mellon to learn the principles and practices of robotics through theoretical studies and hands-on experience with robots. The Minor is open to students in any major of any college at Carnegie Mellon. Students initially learn the basics of robotics in an introductory robotics overview course. Additional required courses teach control systems and robotic manipulation. Students also choose from a wide selection of electives in robotics, perception, computer vision, cognition and cognitive science, or computer graphics. Students have a unique opportunity to undertake independent research projects, working under the guidance of Robotics Institute faculty members; this provides an excellent introduction to robotics research for those considering graduate studies.

All Robotics Minors are required to take Introduction to Robotics (16-311). This course is designed to help students understand the big picture of what is going on in robotics through topics such as kinematics, mechanisms, motion planning, sensor based planning, mobile robotics, sensors, and vision. The minor also requires students to take a controls class and a kinematics class. These courses provide students with the necessary intuition and technical background to move on to more advanced robotics courses. In addition to the required courses, students must take 2 electives. The student must have course selection approved by the Director during the application submission process.

A 2.5 QPA in the Minor curriculum is required for graduation. Courses that are taken Pass/Fail or audited cannot be counted for the Minor.

Admission

Admission to the Undergraduate Minor in Robotics is limited to current Carnegie Mellon students. Students interested in signing up for the minor should fill out the application form available on the program website.

Prerequisite

Successful candidates for the Robotics Minor will have prerequisite knowledge of C language, basic programming skills, and familiarity with basic algorithms. Students can gain this knowledge by taking 15-122 Principles of Imperative Computation.

Required Courses

Overview:		Units
16-311	Introduction to Robotics	12
Controls (choose one of the following):		
06-464	Chemical Engineering Process Control	9
24-451	Feedback Control Systems	12
18-370	Fundamentals of Control	12
16-299	Introduction to Feedback Control Systems (Computer Science)	12
16-xxx	Upper-level RI course with instructor and Program Director's permission	
Kinematics (choose one of the following):		
16-384	Robot Kinematics and Dynamics	12
16-xxx	Upper-level RI course with instructor and Program Director's permission	

Electives

Two Electives (chosen from the following):		Units
10-401	Introduction to Machine Learning (Undergrad) (or 10-601 Introduction to Machine Learning)	12
11-344	Machine Learning in Practice	12
15-381	Artificial Intelligence: Representation and Problem Solving	9
15-424	Foundations of Cyber-Physical Systems	12
15-462	Computer Graphics	12
15-463	Computational Photography	12
15-491	Special Topic: CMRoboBits: AI and Robots for Daily-Life Problems	12
15-494	Cognitive Robotics: The Future of Robot Toys	12
16-264	Humanoids	12
16-362	Mobile Robot Programming Laboratory	12
16-385	Computer Vision	9
16-421	Vision Sensors	12
16-423	Designing Computer Vision Apps	12
16-597	Undergraduate Reading and Research	Var.
18-342	Fundamentals of Embedded Systems	12
18-349	Introduction to Embedded Systems	12
18-578	Mechatronic Design	12
85-370	Perception	9
85-395	Applications of Cognitive Science	9
85-412	Cognitive Modeling	9
85-419	Introduction to Parallel Distributed Processing	9
85-426	Learning in Humans and Machines	9

Graduate level Robotics courses may be used to meet the elective requirement with permission from the Program Director. Graduate level Mechanical Engineering and Electrical and Computer Engineering courses that are relevant to robotics may be used to meet the elective requirement with permission from the Program Director.

Students may count up to 12 units of 16-597 Undergraduate Reading and Research towards the degree requirements.

Double-Counting Restriction

Courses being used to satisfy the requirements for the Robotics Minor may not be counted towards another minor. Students are permitted to double count a maximum of two courses from their Major (excluding General Education requirements) towards the Minor in Robotics. Free electives are not subject to the double counting policy.