Undergraduate Designated Minors in Carnegie Institute of Technology

Undergraduate students in the Carnegie Institute of Technology can elect to complete an interdisciplinary Designated Minor in addition to their regular majors for B.S. degrees. Designated minors have been added to the curriculum of the Carnegie Institute of Technology to promote flexibility and diversity among the college's engineering students. Independent of a student's major, he or she is able to pursue a selected designated minor from the following list:

- Audio Engineering
- Automation and Controls
- Biomedical Engineering
- Colloids, Polymers and Surfaces Technology
- Electronic Materials
- Environmental Engineering
- Global Engineering
- Materials Science and Engineering
- Mechanical Behavior of Materials
- Robotics (see "CIT Minors for Non-Engineering Students (http://coursecatalog.web.cmu.edu/carnegieinstituteoftechnology/minorsfromnonengineeringstudents/)")

An engineering student may elect to complete a CIT designated minor. Generally, the student takes all the required courses in an engineering major but uses electives to take courses needed to fulfill the requirements of the designated minor. Upon completion of the requirements of a CIT designated minor and the engineering degree, the minor is a formally recognized on the student’s transcript.

Each of the CIT designated minors is administered by a Program Committee consisting of faculty from all major engineering departments who serve as faculty advisors. Each Program Committee certifies the completion of requirements of the designated minor. But the student’s major department is responsible for approving the degree with a designated minor. The student’s major department is responsible for approving the degree with a designated minor. Reviewing a student's entire academic record. Any substitution or departure from the published curriculum should be avoided. For example, non-technical courses may not be substituted for required technical courses or electives. Equivalent technical electives offered by a designated minor as substitutions for required courses in a major must be approved by the Head of the student’s major department.

Although a student generally can complete a designated minor without increasing the number of required units for graduation, early planning in electing a designated minor is important. A student also may find that some minors are more compatible with others with his/her major because of different relations between various major and minor requirements. The requirements for these CIT designated minors are listed below.

Audio Engineering Designated Minor

Tom Sullivan, Director

This sequence is for candidates who are engineering majors with interest in and/or have background in music, recording, sound-editing and/or other music technology areas; or majors from any discipline in the university who have the above interests and who can meet the prerequisite requirements for the engineering courses in the minor.

Note: Students who do not have the requisite engineering/science/math background should investigate the Minor in Music Technology offered by the School of Music.

Faculty Advisor

Tom Sullivan

Course Requirements

The student must have taken the appropriate prerequisite courses for the listed courses.

Prerequisite Courses, 0-3 units

Beginning Piano is required of students who do not pass a piano proficiency test.

57-103 Elective Studio (Beginning Piano Class) 3

Music Courses, 40-43 units

Basic Harmony I is required of students who do not qualify for entrance into Harmony I, based on their scores on the theory placement test.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-101</td>
<td>Introduction to Music Technology</td>
<td>6</td>
</tr>
<tr>
<td>57-149</td>
<td>Basic Harmony I</td>
<td>9</td>
</tr>
<tr>
<td>or 57-152</td>
<td>Harmony I</td>
<td>9</td>
</tr>
<tr>
<td>57-173</td>
<td>Survey of Western Music History</td>
<td>9</td>
</tr>
<tr>
<td>57-188</td>
<td>Repertoire and Listening for Musicians</td>
<td>1</td>
</tr>
<tr>
<td>57-337</td>
<td>Sound Recording</td>
<td>6</td>
</tr>
</tbody>
</table>

* co-requisite 57-188.

(choose two of the courses below)

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-322</td>
<td>Introduction to Computer Music</td>
<td>9</td>
</tr>
<tr>
<td>57-338</td>
<td>Sound Editing and Mastering</td>
<td>6</td>
</tr>
<tr>
<td>57-347</td>
<td>Electronic and Computer Music</td>
<td>6</td>
</tr>
<tr>
<td>57-438</td>
<td>Multitrack Recording</td>
<td>9</td>
</tr>
</tbody>
</table>

Technical Courses, 33 units

Other courses may be taken with the approval of the Audio Engineering Minor Advisor.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>33-114</td>
<td>Physics of Musical Sound</td>
<td>9</td>
</tr>
<tr>
<td>18-493</td>
<td>Electroacoustics</td>
<td>12</td>
</tr>
</tbody>
</table>

** prerequisites 18-220 and 18-290.

(choose one of the courses below)

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-210</td>
<td>Parallel and Sequential Data Structures and Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>or 15-214</td>
<td>Principles of Software Construction: Objects, Design, and Concurrency</td>
<td>12</td>
</tr>
<tr>
<td>18-320</td>
<td>Microelectronic Circuits</td>
<td>12</td>
</tr>
<tr>
<td>18-348</td>
<td>Embedded Systems Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-349</td>
<td>Embedded Real-Time Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-391</td>
<td>Noisy Signal Representation and Processing</td>
<td>12</td>
</tr>
</tbody>
</table>

* prerequisite 18-290.
** prerequisite 18-240 and 18-213.
+ prerequisite 18-220.

Units required for minor: 73-79

Automation and Controls Designated Minor

Erik Ydstie, Director

Office: DH 4210 A

The objective of the Designated Minor in Automation and Control Engineering is to expose CIT students to the breadth of knowledge required by the modern practice of control and automation. With this objective in mind, the requirements include not only two courses in control system analysis and design, but also courses on real-time computation, software engineering, hardware implementation, and applications. The minor is expected to attract primarily students from Chemical Engineering, Electrical and Computer Engineering, and Mechanical Engineering. The main interdisciplinary component of the minor is between engineering and computer science, although many opportunities exist for creating a program across several CIT departments.

Faculty Advisor

All CIT departments — Erik Ydstie
Course Requirements

The minor requires a minimum of six courses as described below:

Note: The course lists below are not necessarily current or complete. Appropriate courses not listed below may be counted toward the requirements for the minor upon approval by one of the departmental faculty advisors. Students interested in the Automation and Control Engineering Designated Minor are encouraged to look for applicable courses each semester in CIT, CS, and Robotics.

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>One basic control course:</td>
<td></td>
</tr>
<tr>
<td>18-370 Fundamentals of Control</td>
<td>12</td>
</tr>
<tr>
<td>24-451 Feedback Control Systems</td>
<td>12</td>
</tr>
<tr>
<td>One course on control system analysis and design:</td>
<td></td>
</tr>
<tr>
<td>06-708 Advanced Process Dynamics and Control</td>
<td>12</td>
</tr>
<tr>
<td>18-771 Linear Systems</td>
<td>12</td>
</tr>
<tr>
<td>One course on computing and software</td>
<td></td>
</tr>
<tr>
<td>15-211 Fundamental Data Structures and Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>12-741 Data Management</td>
<td>6</td>
</tr>
<tr>
<td>18-549 Embedded Systems Design</td>
<td>12</td>
</tr>
<tr>
<td>18-649 Distributed Embedded Systems</td>
<td>12</td>
</tr>
<tr>
<td>One course on hardware implementation:</td>
<td></td>
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<tr>
<td>06-423 Unit Operations Laboratory</td>
<td>9</td>
</tr>
<tr>
<td>18-474 Embedded Control Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-578 Mechatronic Design</td>
<td>12</td>
</tr>
<tr>
<td>One course on applications:</td>
<td></td>
</tr>
<tr>
<td>06-606 Computational Methods for Large Scale Process</td>
<td>9</td>
</tr>
<tr>
<td>16-311 Introduction to Robotics</td>
<td>12</td>
</tr>
<tr>
<td>16-761 Mobile Robots</td>
<td>12</td>
</tr>
<tr>
<td>24-356 Engineering Vibrations</td>
<td>11</td>
</tr>
<tr>
<td>24-351 Dynamics</td>
<td>10</td>
</tr>
<tr>
<td>xx-xxx Independent project</td>
<td>12</td>
</tr>
<tr>
<td>One elective course:</td>
<td></td>
</tr>
<tr>
<td>xx-xxx Any course in the list above excluding the basic control course category</td>
<td>6-12</td>
</tr>
<tr>
<td>15-381 Artificial Intelligence: Representation and Problem Solving</td>
<td>9</td>
</tr>
<tr>
<td>15-385 Introduction to Computer Vision</td>
<td>6</td>
</tr>
<tr>
<td>15-413 Software Engineering Practicum</td>
<td>12</td>
</tr>
<tr>
<td>15-440 Distributed Systems-Time Software</td>
<td>12</td>
</tr>
<tr>
<td>18-348 Embedded Systems Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-349 Embedded Real-Time Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-491 Fundamentals of Signal Processing</td>
<td>12</td>
</tr>
<tr>
<td>18-771 Linear Systems</td>
<td>12</td>
</tr>
<tr>
<td>24-341 Manufacturing Sciences</td>
<td>9</td>
</tr>
</tbody>
</table>

Requirements

College of Engineering Students (5 courses):

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>42-101 Introduction to Biomedical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>(co-req. or pre-req. 03-121)</td>
<td></td>
</tr>
<tr>
<td>42-202 Physiology</td>
<td>9</td>
</tr>
<tr>
<td>(pre-req. 03-121 or permission of instructor)</td>
<td></td>
</tr>
<tr>
<td>xx-xxx Elective I (&gt;= 9 units)</td>
<td>#</td>
</tr>
<tr>
<td>xx-xxx Elective II (&gt;= 9 units)</td>
<td>+</td>
</tr>
</tbody>
</table>

Non-Engineering Students (6 courses)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>42-101 Introduction to Biomedical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>(co-req. or pre-req. 03-121)</td>
<td></td>
</tr>
<tr>
<td>42-202 Physiology</td>
<td>9</td>
</tr>
<tr>
<td>(pre-req. 03-121 or permission of instructor)</td>
<td></td>
</tr>
<tr>
<td>xx-xxx Elective I (&gt;= 9 units)</td>
<td>#</td>
</tr>
<tr>
<td>xx-xxx Elective II (&gt;= 9 units)</td>
<td>+</td>
</tr>
<tr>
<td>xx-xxx A second Introductory Engineering Course* or Any 42-xxx Course Numbered 42-3xx or Higher and worth at Least 9 Units</td>
<td></td>
</tr>
</tbody>
</table>

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.

Notes

- Elective I cannot be a required course in the student’s major. It may be
  1. Any track gateway, restricted elective, or track elective course selected from any of the four Biomedical Engineering tracks. See the online catalog (http://www.bme.cmu.edu/ugprog/catalog.html) for a listing of courses.
  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). The course has a limited capacity and priority is given to students who have declared the Additional Major in Biomedical Engineering.
  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 CIT Honors Research Project. The project must be supervised by a core or courtesy Biomedical Engineering faculty member and for 9 or more units.

- Elective II must be a Biomedical Engineering track gateway, track elective, or restricted Elective course that is offered by one of the Engineering 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. Organic Chemistry 09-217 is a pre-requisite of 03-232.

* Selected from 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 Introduction to the Materials of the Future, or 24-101 Fundamentals of Mechanical Engineering. Note that these courses may involve co-requisites.

** 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.

Biomedical Engineering Minor

Conrad M. Zapanta, Ph.D.
www.bme.cmu.edu
Campus Office for Student Affairs: Doherty Hall 2100

The minor program is designed for engineering students who desire exposure to biomedical engineering but may not have the time to pursue the Biomedical Engineering additional major. The program is open to students of all colleges and is popular among science majors. In conjunction with other relevant courses, the program may provide a sufficient background for jobs or graduate studies in biomedical engineering. Students interested in a medical career may also find this program helpful.

The Biomedical Engineering minor curriculum is comprised of three core courses and two or three electives. Students pursuing the minor may contact BME Associate Head (http://www.bme.cmu.edu/people/staff.html#ADH) of Biomedical Engineering or the Biomedical Engineering Undergraduate Program Coordinator (http://www.bme.cmu.edu/people/staff.html#UPC).
Colloids, Polymers and Surfaces Designated Minor

Annette Jacobson, Director
Office: Doherty Hall 310B
Website: http://www.cit.cmu.edu/current_students/services/majors_minors/engineering_minors/cps.html

The sequence of courses in the Colloids, Polymers and Surfaces (CPS) designated minor provides an opportunity to explore the science and engineering of fine particles and macromolecules as they relate to complex fluids and interfacially engineered materials. These topics are very relevant to technology and product development in industries that manufacture pharmaceuticals, coatings and paints, pulp and paper, biomaterials, surfactants and cleaning products, cosmetics and personal care products, food, textiles and fibers, nanoparticles, polymer/plastics, composite materials.

Course Requirements

This minor requires a total of five classes. The following four courses are mandatory:

- 06-609/09-509 Physical Chemistry of Macromolecules 9
- 06-607 Physical Chemistry of Colloids and Surfaces 9
- 06-426 Experimental Colloid Surface Science 9
- 06-466 Experimental Polymer Science 9

In addition, the student must take one course from the following list:

- 06-221 Thermodynamics 9
- 24-221 Thermodynamics I 10
- 27-215 Thermodynamics of Materials 12
- 33-341 Thermal Physics I 10
- 09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry 9

Electronic Materials Designated Minor

David W. Greve, Director
Office: Hamerschlag Hall B204
Lisa A. Porter, Co-Director
Office: Roberts Engineering Hall 145
Website: http://www.cit.cmu.edu/current_students/services/majors_minors/engineering_minors/electronic_materials.html

Many of the technological changes in recent decades—notably the rise of digital data processing—have been made possible by continuing advances in the performance of electronic devices. These advances include continuous improvement in microprocessor performance, optical communication bandwidth, and magnetic disk storage capacity. Other areas of innovation include the development of micromechanical systems and the development of flat panel display technology. These advances depend on interactions between engineers from many different disciplines. In particular, there is a strong interaction between device design and materials engineering and processing.

The Electronic Materials Minor is intended to provide students with a firm basis for the application of electronic materials in advanced systems. This minor is well suited for students who intend to pursue careers in the electronics industry (cluded, but not limited to, semiconductor integrated circuit design and manufacturing, and magnetic storage engineering). The minor also provides an excellent preparation for students interested in pursing graduate work in MSE, ECE, or Applied Physics.

This minor is primarily intended to offer ECE and MSE students an understanding of the important features that must be built into a material during processing so that it will function as required in an electronic or magnetic device. Other interested in pursuing the minor should consult their advisors to determine whether it will be practical in their own curriculum. Such students are expected to take both 18-100 and 27-201 as introductory courses.

Students in the Electronic Materials program are urged to consider registering for an undergraduate project in addition to the requirements below, especially if they intend to apply to graduate school. The co-directors will make every effort to arrange a suitable project for interested students.

Course Requirements

The minor requires an introductory course together with a minimum of 48 additional units as specified below.

Required Introductory Courses:

- 18-100 Introduction to Electrical and Computer Engineering (MSE students) 12
- 27-201 Structure of Materials (ECE students) 9

Elective Courses:

- 48 additional units, with 24 units from Group A and 24 units from Group B. Some courses are a required part of either the curricula and consequently cannot be counted again for the minor program.
- We have determined that “courses which are a required part of a curriculum” are those which are specifically named in the curriculum requirements. Consequently technical electives and breadth and depth electives may be double-counted.

Group A

- 27-202 Defects in Materials (ECE students only) 9
- 06-619 Semiconductor Processing Technology 9
- 27-542 Processing and Properties of Thin Films 9
- 27-217 Phase Relations and Diagrams (ECE students only) 12
- 27-533 Principles of Growth and Processing of Semiconductors 6
- 27-433 Dielectric, Magnetic, Superconducting Properties of Materials & Related Devices (only if not required in your curriculum) 9
- 27-551 Properties of Ceramics and Glasses 9
- 27-216 Transport in Materials 9 (ECE students only)
- 33-225 Quantum Physics and Structure of Matter (ECE students only) 9

Group B

- 18-310 Fundamentals of Semiconductor Devices 12
- 18-715 Physics of Applied Magnetism 12
- 18-716 Advanced Applied Magnetism 12
- 18-8xx — An appropriate 800-level course (for example, 18-813, 18-815, 18-819).

Note: Other appropriate courses may be substituted with the approval of the coordinators in the event that limited course offerings make it impossible to satisfy the requirements as described above.

Environmental Engineering and Sustainability Designated Minor

Neill M. Donahue, Director
Office: Doherty Hall 2116

Concern for the environment now influences a wide range of public, private and engineering decisions. Environmental Engineering is widely recognized as a discipline at the graduate and professional level, and undergraduate training in environmental issues and processes can provide the preparation necessary to pursue this career path, or serve as a useful complement to a career in any of the traditional areas of engineering. Sustainability issues are not considered critical across engineering disciplines. Effective preparation requires broad knowledge and skills in the areas of environmental engineering, sustainability, and environmental policy.

Pursuit of the minor program of study provides an introduction to environmental sustainability issues as well as a preparation for graduate work in Environmental Engineering and Sustainability.
Faculty Advisors
The Environmental Engineering program is a focus for faculty members from diverse engineering backgrounds. The faculty are actively engaged in teaching and conducting research in this field. Current faculty advisors are:

- Biomedical Engineering — Robert Tilton
- Chemical Engineering – Meagan Mauter
- Civil and Environmental Engineering — Peter Adams and Scott Matthews
- Electrical and Computer Engineering — Marija Ilic
- Engineering and Public Policy — Edward Rubin
- Mechanical Engineering — Ryan Sullivan
- Materials Science and Engineering — Robert Heard

Course Requirements
The requirements include two core courses, three technical electives, and two policy electives.

(12 units) A1. Core Courses in Sustainability
Select one course from:
12-712/19-717 Introduction to Sustainable Engineering 12
12-714 Environmental Life Cycle Assessment 12

(9 units) A2. Core Courses in Environmental Engineering
Select one course from:
12-351 Environmental Engineering 9
24/14-424 Energy and the Environment 9
12-651 Air Quality Engineering 9
24-425 Combustion and Air Pollution Control 9
12-702 Fundamentals of Water Quality Engineering 12

(27 units) B. Technical Electives in Environmental Engineering and Sustainability
Select three from the following list:
03-121 Modern Biology 9
09-106 Modern Chemistry II 10
09-510 Introduction to Green Chemistry 9
12-201 Geology 9
12-351 Environmental Engineering 9
12-651 Air Quality Engineering 9
12-702 Fundamentals of Water Quality Engineering 12
12-657 Water Resources Engineering 9
12-658 Hydraulic Structures 9
12-718 Sustainable Engineering Project 12
24/14-424 Energy and the Environment 9
24-425 Combustion and Air Pollution Control 9
27-322 Processing of Metals or 27-323 Powder Processing of Materials, but not both 9
27-367 Selection and Performance of Materials * 6
27-421 Processing Design * 6
27-594 Electrochemical Degradation of Materials 9
48-315 Environment I: Climate & Energy 9
79-289 Animal Planet: An Environmental History of People and Animals 9
* 6 units; must be combined with 3 additional units

C. Policy Electives (18 units)
Select two from the following list of humanities/social science-oriented courses:
19-448 Science, Technology & Ethics 9
48-576 Mapping Urbanism 9
73-148 Environmental Economics 9
73-357 Regulation: Theory and Policy 9
73-358 Economics of the Environment and Natural Resources 9
73-359 Benefit-Cost Analysis 9
76-319 Environmental Rhetoric 9
79-303 Pittsburgh and the Transformation of Modern Urban America 6
79-372 Perspectives on the Urban Environment 9
80-244 Environmental Ethics 9
88-220 Policy Analysis I 9
88-221 Policy Analysis II 9
88-223 Decision Analysis and Decision Support Systems 9
90-758 Ethics & Public Policy in a Global Society 6
90-765 Cities, Technology and the Environment 6
90-789 Sustainable Community Development 12
90-798 Environmental Policy & Planning 12

NOTES:
1. Courses cannot be double-counted for lists A and B.
2. Courses used to fulfill the first year restricted technical electives for CIT cannot be double counted for list B requirements.
3. A group of three environmental policy courses, from List C, excluding Heinz courses, may be counted as fulfilling the general education depth requirement required of all CIT students if and only if the student completes the Environmental Engineering and Sustainability Minor. Approval of the selected courses from List C for fulfillment of this CIT depth sequence is required from the student’s home department advisor.
4. Courses required within a student’s CIT major can be double counted for list A or B course requirements, with the exception that 12-351 Environmental Engineering can be counted toward completion of the minor for non-CEE students only.
5. Students may take up to two list B courses in their home department. One list B course must be from outside their home department. EPP double majors should NOT consider EPP their home department. BME double majors should NOT consider BME their home department.
6. At most ONE 48-xxx course can be used as a List B course and one as a List C course. The 48-xxx courses may not be acceptable as technical electives by some CIT engineering departments.
7. Other environmentally related technical electives with similar or related content may be substituted for List B courses only with written permission of the Director.
8. Other humanities and social science courses with similar or related content may be substituted for Type C courses only with written permission of the Director.
9. A list of available courses for the minor in each semester is provided to students who have declared the minor to all faculty advisors for the minor.

Global Engineering Designated Minor
Treci Bonime, Director
Office: Scaife Hall 110

Many engineers work on international projects or for multinational companies. Carnegie Mellon is an international community, with a significant fraction of international students and many events featuring foreign speakers and cultural experiences. This minor is intended for engineering students interested in broadening their background in international experiences and global awareness and engagement.

Course Requirements
International Management (1 course)
Complete one course in international management or business such as:
70-342 Managing Across Cultures 9
70-365 International Trade and International Law 9
70-381 Marketing I 9
70-430 International Management 9
88-384 Conflict and Conflict Resolution in International Relations 9

Or approved equivalent.

Regional Specialization (1 course)
Complete one course in non-US History, international politics, or literature in a single region of the world. See the list at http://www.cit.cmu.edu/global/courses_degrees.html below for examples (Note: Please consult with the Global Engineering director before planning your course schedule, as some course information may have changed).
The student must select a minimum of 24 units from the following list:

Core Courses (21 units)

- 27-211 Structure of Materials (Minor Option) 6
- 27-212 Defects in Materials (Minor Option) 6
- 27-217 Phase Relations and Diagrams 9

The laboratories with these courses are not required as core but will be counted as elective units if desired.

Elective Courses (24 units minimum)

The student must select a minimum of 24 units from the following list:

- 27-100 Engineering the Materials of the Future 12
- 27-301 Microstructure and Properties I 9
- 27-302 Microstructure and Properties II 9
- 27-311 Polymeric Biomaterials 9
- 27-312 Metallic and Ceramic Biomaterials 9
- 27-322 Processing of Metals 9
- 27-323 Powder Processing of Materials 9
- 27-324 Introduction to Polymer Science and Engineering 9
- 27-325 Polymer Physics and Morphology 9
- 27-357 Introduction to Materials Selection 6
- 27-367 Selection and Performance of Materials 6
- 27-582 Phase Transformations in Solids 9
- 27-433 Dielectric, Magnetic, Superconducting Properties of Materials & Related Devices 9
- 27-421 Processing Design 6
- 27-512 Diffraction Methods in Materials Science 9
- 27-510 Polymeric Biomaterials 9
- 27-511 Introduction to Molecular Biomaterials 12
- 27-591 Mechanical Behavior of Materials 9
- 27-530 Advanced Physical Metallurgy 9
- 27-454 Supervised Reading Var.
- 27-533 Principles of Growth and Processing of Semiconductors 6
- 27-555 Materials Project I Var.
- 27-565 Nanostructured Materials 9
- 27-542 Processing and Properties of Thin Films 9
- 27-551 Properties of Ceramics and Glasses 9
- 27-566 Special Topics in MSE: Using Matlab Informatics to Assess Societal Impact of Mats 9
- 27-592 Solidification Processing 9
- 27-594 Electrochemical Degradation of Materials 9
- 42-444 Medical Devices 9

Materials Science and Engineering Designated Minor

Michael E. McHenry, Director
Office: Roberts Engineering Hall 243

The Designated Minor in Materials Science and Engineering provides the CIT student with a background in the field of Materials Science and Engineering. This minor is open to all CIT students, with the exception of MSE majors. All required and elective courses are taught within the MSE Department.

Course Requirements

The minor requires a minimum of 45 units, with two semester long required courses (the first being a sequence of two minis).

Prerequisites

Students wishing to take the MSE minor must have prerequisite thermodynamics and transport courses. The prerequisite MSE courses may be substituted for by a thermodynamics and transport course in another engineering discipline.

Core Courses (21 units)

- 27-211 Structure of Materials (Minor Option) 6
- 27-212 Defects in Materials (Minor Option) 6
- 27-217 Phase Relations and Diagrams 12

Study/Work Abroad

Study or engineering internship work abroad for a semester or a summer. The region visited should be consistent with the language and regional culture/history studied.

Materials Science and Engineering — Warren M. Garrison, Jr.
Mechanical Engineering — Paul S. Steif
Electrical and Computer Engineering — David W. Greve
Chemical Engineering — Paul Sides

Mechanical Behavior of Materials Designated Minor

Warren M. Garrison, Jr., Director
Office: Wean Hall 3303

An understanding of mechanical behavior is important to both the development of new materials and the selection of appropriate materials for many applications. The mechanical behavior of materials is best investigated and understood by integrating solid mechanics with the microstructural basis of flow and fracture. The purpose of this minor is to allow a formal basis for students to pursue an integrated approach to the mechanical behavior of materials.

Although this minor is open to all CIT students, only students in the departments of Civil Engineering, Materials Science and Engineering, and Mechanical Engineering can take advantage of the double counting permitted for some courses in their department majors. Students in other departments may have difficulty in fulfilling the requirements in four years.

Faculty Advisors

- Chemical Engineering — Paul Sides
- Electrical and Computer Engineering — David W. Greve
- Mechanical Engineering — Paul S. Steif

Course Requirements

The minor requires six courses: three core courses, two solid mechanics courses, and one materials science course. In satisfying these course requirements, each student must take three out-of-department courses. Each student is required to complete three core courses:

Core Courses:

- 27-201 Structure of Materials 9
- 27-591 Mechanical Behavior of Materials 9-12
- 27-791 Mechanical Behavior of Materials 9
- 24-261 Statics 9

Group A: Materials Science Courses

Each student must take one course from this list of Materials Science courses:

- 27-202 Defects in Materials 1 9
- 27-357 Introduction to Materials Selection 2 6
- 27-551 Properties of Ceramics and Glasses 9
- 27-530 Advanced Physical Metallurgy 9
- 42-411 Engineering Biomaterials 9
1 27-202 cannot be used by MSE students to satisfy the requirements of the minor.

2 27-357 cannot be used by MSE students to satisfy the requirements of the minor.

Group B: Solid Mechanics Courses
Each student must take two of the following Solid Mechanics courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-231</td>
<td>Solid Mechanics</td>
<td>9</td>
</tr>
<tr>
<td>or 24-262</td>
<td>Stress Analysis</td>
<td></td>
</tr>
<tr>
<td>12-635</td>
<td>Structural Analysis</td>
<td>9</td>
</tr>
<tr>
<td>or 24-351</td>
<td>Dynamics</td>
<td></td>
</tr>
<tr>
<td>24-751</td>
<td>Introduction to Solid Mechanics I</td>
<td>12</td>
</tr>
</tbody>
</table>

Students should check with the director of the program or their faculty advisor for an up-to-date list of relevant courses that will count towards this minor. For more information, please consult the Undergraduate Course Catalog and the current Schedule of Classes.