Department of Mechanical Engineering

Allen Robinson, David and Susan Coulter Head of Mechanical Engineering and Raymond J. Lane Distinguished University Professor of Mechanical Engineering

Location: Scaife Hall 401
www.cmu.edu/me (http://www.cmu.edu/me/)

Educational Objectives

According to ABET (http://www.abet.org/), which evaluates applied science, computing, engineering and technology programs for accreditation, "program educational objectives are broad statements that describe what graduates are expected to attain within a few years of graduation."

The core objective of our undergraduate program is to provide our students an education that enables them to be productive, impactful, and fulfilled professionals throughout their careers. In light of this vision, the objectives of the Bachelor of Science in Mechanical Engineering at Carnegie Mellon are to produce graduates who:

- distinguish themselves as effective problem solvers by applying fundamentals of Mechanical Engineering;
- are innovative and resourceful in their professional activities;
- excel in multidisciplinary team settings;
- become leaders in their organizations, their profession, and in society;
- conduct themselves in a professional and ethical manner in the workplace;
- excel in diverse career paths within and beyond the engineering profession, including in industry and academia.

Educational Outcomes

The undergraduate curriculum in the Department of Mechanical Engineering offers students significant opportunities to pursue directions of personal interest, including minors, double majors, participation in research projects, and study abroad. Design and teamwork experiences occur at regular intervals in the curriculum, and graduates have significant hands-on experience through laboratories and projects.

The faculty of the Department has endorsed the following set of skills, or outcomes that graduates of the program are expected to have:

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- an ability to communicate effectively with a range of audiences
- an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Curriculum

Minimum units required for B.S. in Mechanical Engineering: 382

The following template outlines the four-year B.S. program through the standard and recommended course sequence. To ensure that prerequisites are completed and to prevent scheduling conflicts, students should discuss any changes to this sequence with their department academic advisor.

Freshman Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>24-101</td>
<td>Fundamentals of Mechanical Engineering</td>
</tr>
<tr>
<td>33-141</td>
<td>Physics I for Engineering Students</td>
</tr>
<tr>
<td>99-101</td>
<td>Computing @ Carnegie Mellon</td>
</tr>
<tr>
<td>76-101</td>
<td>Interpretation and Argument</td>
</tr>
<tr>
<td>46</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-122</td>
<td>Integration and Approximation</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Second Introductory Engineering Course</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Physics II/Chemistry/Computer Science*</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
</tr>
<tr>
<td>41-43</td>
<td></td>
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Sophomore Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-221</td>
<td>Thermodynamics</td>
</tr>
<tr>
<td>24-261</td>
<td>Statics</td>
</tr>
<tr>
<td>21-254 or 24-282</td>
<td>Linear Algebra and Vector Calculus for Engineers or Special Topics: Linear Algebra and Vector Calculus for Engineers</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Physics II/Chemistry/Computer Science*</td>
</tr>
<tr>
<td>24-xxx</td>
<td>Machine Shop/Intro to CAD **</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Lab requirement ***</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
</tr>
<tr>
<td>39-210</td>
<td>Experiential Learning I</td>
</tr>
<tr>
<td>51-54</td>
<td></td>
</tr>
</tbody>
</table>
Spring
21-260 Differential Equations 9
24-231 Fluid Mechanics 10
24-262 Stress Analysis 10
xx-xxx Physics II/Chemistry/Computer Science* 10-12
24-370 Machine Shop/Intro to CAD ** 1-2
xx-xxx Lab requirement ***
xx-xxx General Education Course 9
39-220 Experiential Learning II 0

** Machine Shop 24-200 and Introduction to CAD 24-202 should be completed by the end of sophomore year.

*** Mechanical engineering undergraduates must satisfy a Science Laboratory requirement to graduate. The lab requirement may be fulfilled with one of the following courses:

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-101 Introduction to Experimental Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>42-203 Biomedical Engineering Laboratory</td>
<td>9</td>
</tr>
<tr>
<td>03-124 Modern Biology Laboratory</td>
<td>9</td>
</tr>
<tr>
<td>33-100 Basic Experimental Physics</td>
<td>6</td>
</tr>
<tr>
<td>33-104 Experimental Physics</td>
<td>9</td>
</tr>
</tbody>
</table>

Junior Year

Fall
24-302 Mechanical Engineering Seminar I - taken either fall or spring **** 2
24-322 Heat Transfer 10
24-370 Engineering Design I: Methods and Skills or 24-352 Dynamic Systems and Controls 12
24-351 Dynamics 10
36-220 Engineering Statistics and Quality Control Students are encouraged to take 19-250 or 36-225 instead of 36-220 to meet the engineering statistics requirement. 36-219 will also count for the statistics requirement. 9
xx-xxx General Education Course 9
39-310 Experiential Learning III 0

Spring
24-321 Thermal-Fluids Experimentation 12
24-311 Numerical Methods 12
24-352 Dynamic Systems and Controls or 24-370 Engineering Design I: Methods and Skills 12
xx-xxx General Education Course 9

Notes on the Curriculum

1. Students need a minimum of 382 units to complete the B.S. degree.
2. During the first year, students complete 24-101 Fundamentals of Mechanical Engineering and another introductory engineering course. Students who do not take 24-101 during their first year should take 24-101 Fundamentals of Mechanical Engineering during the fall semester of their sophomore year in place of the General Education Course. They can then replace that General Education Course in their junior or senior year.
3. Students must pass the following three courses before they begin the core Mechanical Engineering courses in the fall of their sophomore year:
   • 21-120 Differential and Integral Calculus
   • 21-122 Integration and Approximation
   • 33-141 Physics I for Engineering Students
4. All Mathematics courses (21-xxx) required for the engineering degree must have a minimum grade of C in order to fulfill the graduation requirement for the BS engineering degree and to count as a prerequisite for engineering core classes.
5. Students are required to complete an engineering statistics course. The department strongly encourages students to take 19-250 or 36-225 instead of 36-220, which may be scheduled in any semester. Students may also take 36-219 to fulfill this requirement.
6. To fulfill the capstone design requirement, students must take either 24-441 Engineering Design II: Conceptualization and Realization or 24-671 Electromechanical Systems Design (Spring only). Students may take 24-441 or 24-671 in either fall or spring of senior year. BME and Robotics double majors/minors may use the capstone for their double major/minor instead of the above listed MechE capstone design classes.

Mechanical Engineering Technical Electives

Students must take at least one approved non-core Mechanical Engineering course labeled as “Mechanical Engineering Technical Elective” in the example course sequence. The course must be an approved 24-xxx course (9-unit minimum) at the 300 level or above to fulfill the technical elective requirement. 24-292 Renewable Energy Engineering and 24-291 Special Topics: Environmental Systems on a Changing Planet are the only 200 level courses that may be used as a Mechanical Engineering Technical Elective.

Students can also take mechanical engineering graduate courses to fulfill the technical elective requirement. However, students must have the appropriate prerequisites and the instructor must approve taking the course. Undergraduates do not have priority for graduate level courses.

Students can find a list of graduate courses we offer on the Carnegie Mellon Schedule of Classes (https://enr-apps.as.cmu.edu/open/SOC/SOCservlet) (https://enr-apps.as.cmu.edu/open/SOC/SOCservlet)

Course offerings are variable, please check the Schedule of Classes (above) to see the most current list of classes.
Another option is cooperative education, which provides a student with professional internships during summer breaks. Opportunities important educational options for its undergraduate Education Program.

Internships and Co-operative programs/curriculum/majors-minors.html. A complete description of majors and minors in engineering can be found on Robotics.

Mechanical Engineering students may pursue double majors and minors, the highest grade obtained between Mechanical Engineering core courses, in order to achieve the QPA requirement. When a course is repeated, all grades will be recorded on the official academic transcript. Note, however, the cumulative QPA that appears on the student's final transcript will be calculated based on all grades in all courses taken, including freshman year. The Mechanical Engineering Department requires that students attain a quality point average of 2.00 or higher for all required Mechanical Engineering core courses.

Pursuant to university rules, students can repeat a course in which a grade below C was attained in order to achieve the QPA requirement. When a course is repeated, all grades will be recorded on the official academic transcript and will be calculated in the student's QPA. For all required Mechanical Engineering core courses, the highest grade obtained between the original and the repeated class will be used to calculate the Mechanical Engineering QPA.

Credit Overload Policy
Mechanical Engineering students can register for a maximum of 54 units per semester. A student can request additional units from the Undergraduate Education Committee based on their QPA. The policy is outlined in the Mechanical Engineering Undergraduate Handbook (https://www.meche.engineering.cmu.edu/files/documents/handbooks/ug-handbook20.pdf).

Double Majors and Minors
Mechanical Engineering students may pursue double majors and minors in a variety of subjects, taking advantage of the free elective courses to satisfy the requirements for the major or minor. The College of Engineering has added designated minors to promote flexibility and diversity among engineering students. Common double majors for Mechanical Engineering students include Engineering and Public Policy, Biomedical Engineering and Robotics.

A complete description of majors and minors in engineering can be found on the College of Engineering website (https://engineering.cmu.edu/education/undergraduate-programs/curriculum/majors-minors.html).

Quality Point Average Requirements
To be eligible to graduate, undergraduate students must complete all course requirements for their program with a cumulative Quality Point. Average of at least 2.00 for all courses taken. For undergraduate students who enrolled at Carnegie Mellon as freshmen and whose freshman grades cause the cumulative QPA to fall below 2.0, this requirement is modified to be a cumulative QPA of at least 2.0 for all courses taken after the freshman year. Note, however, the cumulative QPA that appears on the student’s final transcript will be calculated based on all grades in all courses taken, including freshman year. The Mechanical Engineering Department requires that students attain a quality point average of 2.00 or higher for all required Mechanical Engineering core courses.

Free Electives
A Free Elective is defined as any graded course offered by any academic unit of the university (including research institutes such as the Robotics Institute (http://www.ri.cmu.edu)) and the Software Engineering Institute (http://www.sei.cmu.edu/)). Free electives offer students the opportunity to add additional majors and minors, pursue additional interests or deepen their experience in Mechanical Engineering. Typically, once the core requirements are completed, there remain about 45 units of free electives to reach the minimum of 382 to complete the degree. Up to 9 units of Student Taught Courses (StuCO) and Physical Education courses, or other courses taken as Pass/Fail, may also be used toward Free Electives.

Students cannot use research or project courses to fulfill the technical elective requirement. However, these courses, with limitations, will count as free elective units. Up to 27 units of project/research may be counted in the free electives. Project/research courses that do not fulfill the technical elective requirements are:

- 24-391/24-392 Mechanical Engineering Project
- 24-491/24-492 Department Research Honors
- 39-xxx CIT series courses

Study Abroad
In today's global society, a study abroad experience can be an integral part of an undergraduate engineering education. An academic experience abroad is encouraged and assistance is provided for course choices and curriculum sequencing. The Mechanical Engineering department offers scholarships for international experiences to support and encourage students to take advantage of study and work abroad experiences.

Integrated Master's/Bachelor's Program (IMB)
Interested undergraduates may plan a course of study that leads to both the Bachelor's and Master's in Mechanical Engineering. Beyond eight semesters, at least one semester of full-time graduate student status is required. Please refer to the Integrated Master's/Bachelor's Degree Program section in the Graduate Handbook for 2019-2020 (https://www.meche.engineering.cmu.edu/education/graduate-programs/handbooks.html) for additional information.

Full-Time Faculty
AMIR BARATI FARIMANI, Assistant Professor of Mechanical Engineering – Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon, 2018–
MARK BEDILLION, Associate Teaching Professor of Mechanical Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2016–
SARAH BERGMBREITER, Professor of Mechanical Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 2018–
JACK LEE BEUTH, Professor of Mechanical Engineering – Ph.D., Harvard University; Carnegie Mellon, 1992–
JONATHAN CAGAN, George Tallman and Florence Barrett Ladd Professor of Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 1990–
MAARTEN P. DE BOER, Professor of Mechanical Engineering – Ph.D., University of Minnesota; Carnegie Mellon, 2007–
NESTOR GOMEZ, Visiting Assistant Teaching Professor of Mechanical Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2018–
DIANA HAIDAR, Assistant Teaching Professor of Mechanical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 2017–
ENI HALILAJ, Assistant Professor of Mechanical Engineering – Ph.D., Brown University; Carnegie Mellon, 2018–
B. REEJA JAYAN, Associate Professor of Mechanical Engineering – Ph.D., University of Texas at Austin; Carnegie Mellon, 2015–
AARON M. JOHNSON, Assistant Professor of Mechanical Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2016–
LEVENT BURAK KARA, Professor of Mechanical Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–
SHAWN LITSTER, Professor of Mechanical Engineering – Ph.D., Stanford University; Carnegie Mellon, 2008–
CARME MAJDI, Professor of Mechanical Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 2011–
JONATHAN A. MALEN, Professor of Mechanical Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 2009–
ALAN J.H. MCGAUGHEY, Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2005–
JEREMY J. MICHALEK, Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2007–
O. BURAK OZDOGANLAR, Ver Planck Professor of Mechanical Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005–
JEREMY J. MICHALEK, Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2007–
JONATHAN A. MALEN, Professor of Mechanical Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 2009–
ALAN J.H. MCGAUGHEY, Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2005–
O. BURAK OZDOGANLAR, Ver Planck Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2004–
RAHUL PANAT, Associate Professor of Mechanical Engineering – Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon, 2017–
ALBERT PRESTO, Associate Research Professor of Mechanical Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2012–

Department of Mechanical Engineering
YOED RABIN, Professor of Mechanical Engineering – D.Sc., Technion-Israel Institute of Technology; Carnegie Mellon, 2000–

ALLEN L. ROBINSON, David and Susan Couter Head of Mechanical Engineering; Raymond J. Lane Distinguished University Professor of Mechanical Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 1998–

EDWARD STEPHEN RUBIN, Alumni Chair Professor of Environmental Engineering and Science – Ph.D., Stanford University; Carnegie Mellon, 1969–

SHENG SHEN, Professor of Mechanical Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2011–

KENJI SHIMADA, Theodore Ahrens Professor of Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1996–

SATBIR SINGH, Associate Teaching Professor of Mechanical Engineering – Ph.D., University of Wisconsin at Madison; Carnegie Mellon, 2012–

PAUL S. STEIF, Associate Department Head and Professor of Mechanical Engineering – Ph.D., Harvard University; Carnegie Mellon, 1983–

RYAN SULLIVAN, Associate Professor of Mechanical Engineering – Ph.D., University of California at San Diego; Carnegie Mellon, 2012–

REBECCA TAYLOR, Assistant Professor of Mechanical Engineering – Ph.D., Stanford University; Carnegie Mellon, 2016–

CONRAD TUCKER, Professor of Mechanical Engineering – Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon, 2019–

VENKAT VISWANATHAN, Associate Professor of Mechanical Engineering – Ph.D., Stanford University; Carnegie Mellon, 2014–

DOUGLAS WEBER, Professor of Mechanical Engineering – Ph.D., Arizona State University; Carnegie Mellon, 2020–

VICTORIA WEBSTER-WOOD, Assistant Professor of Mechanical Engineering – Ph.D., Case Western Reserve University; Carnegie Mellon, 2018–

KATE S. WHITEFOOT, Assistant Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2016–

YONGJIE ZHANG, George Tallman and Florence Barrett Ladd Professor of Mechanical Engineering – Ph.D., University of Texas at Austin; Carnegie Mellon, 2007–

DING ZHAO, Assistant Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2018–

Emeriti

ADNAN AKAY, Lord Emeritus Professor of Mechanical Engineering – Ph.D., North Carolina State University; Carnegie Mellon, 1992–

NORMAN CHIGIER, Emeritus Professor of Mechanical Engineering – Sc.D., University of Cambridge; Carnegie Mellon, 1981–

JERRY HOWARD GRIFFIN, William J. Brown Emeritus Professor of Mechanical Engineering – Ph.D., California Institute of Technology; Carnegie Mellon, 1981–

WILFRED THOMAS ROULEAU, Emeritus Professor of Mechanical Engineering – Ph.D., Carnegie Institute of Technology; Carnegie Mellon, 1954–

SHI-CHUNE YAO, Emeritus Professor of Mechanical Engineering – Ph.D., University of California, Berkeley; Carnegie Mellon, 1977–