Department of Mechanical Engineering

Allen Robinson, Raymond J. Lane Distinguished Professor and Department Head
Scaife Hall 401
http://www.cmu.edu/me

General Overview

Mechanical engineers use their knowledge of mechanical systems to describe phenomena, propose solutions to problems, and build those solutions. Concerned with the principles of force, energy and motion, they use their knowledge of physical systems, design, manufacture, and operational processes to advance the world around us. Mechanical engineers work in a variety of sectors: small start-up companies, multi-national corporations, government agencies, national laboratories, consulting firms, and universities.

The Carnegie Mellon Mechanical Engineering curriculum emphasizes engineering theory, hands-on experience, and technical skills. Our students learn how to solve practical problems and analyze situations by converting ideas into reliable and cost-effective devices and processes.

A strong foundation in mechanical engineering fundamentals culminates in a design capstone class where student teams develop prototypes for new products. These projects expose students to the design process, from concept to product, and emphasize effective communication and presentations skills.

Our curriculum is intended to allow ample opportunity for students to pursue areas of personal interest. A student may choose to pursue a minor offered by departments in other colleges, or one of the designated minor programs offered in the College of Engineering, or to pursue an additional major. Students are encouraged to participate in research with department faculty members, explore their chosen field through internships, and take advantage of opportunities to study abroad and be exposed to other cultures. Students may also choose to pursue the Integrated Master's/Bachelor's Program (IMB) which allows students to earn both a bachelor's and a master's degree with an additional semester or year of study.

Mechanical Engineering students access Tech Spark for hands-on work in multiple courses. Tech Spark is the cornerstone of the College of Engineering's maker ecosystem, an integrated set of resources where faculty and students create and develop new ideas, concepts and products for courses and research. The space houses a simulation cluster, 3D printers, rapid prototyping equipment, electronic fabrication facilities, and traditional manual and CNC machining to allow students and faculty to design and fabricate at the nano, micro, and macro scales.

Accreditation

The Mechanical Engineering Undergraduate Program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org

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 apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multidisciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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

Fall		Units
21-120	Differential and Integral Calculus	10
24-101	Fundamentals of Mechanical Engineering	12
33-141	Physics I for Engineering Students	12
99-101	Computing @ Carnegie Mellon	3
76-101	Interpretation and Argument	9
		46

Spring		Units
21-122	Integration and Approximation	10
xx-xxx	Second Introductory Engineering Course	12
xx-xxx	Physics II/Chemistry/Computer Science*	
xx-xxx	General Education Course	9
		31

Sophomore Year

Fall		Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics	10
xx-xxx	Physics II/Chemistry/Computer Science*	10-12
24-xxx	Machineshop/Intro to CAD/ISC**	1-2
xx-xxx	Lab requirement ***	
xx-xxx	General Education Course	9
39-210	Experiential Learning I	0
		49-52

Spring		Units
21-260	Differential Equations	9

24-231	Fluid Mechanics	10
24-262	Stress Analysis See note #2	12
xx-xxx	Physics II/Chemistry/Computer Science*	10-12
24-xxx	Machine shop/Intro to CAD/ISC**	1-2
xx-xxx	Lab requirement ***	
xx-xxx	General Education Course	9
39-220	Experiential Learning II	0
		51-54

* Physics II/Chemistry/Computer Science: Students should complete 15-110 Principles of Computing or 15-112 Fundamentals of Programming and Computer Science as well as 33-142 Physics II for Engineering and Physics Students by the end of the Sophomore year. The recommended sequence is 33-141 /33-142 for engineering students, however, 33-151/ 33-152 will also meet the CIT Physics requirement. The Chemistry requirement is filled with 09-105

** Machine Shop, Introduction to CAD, and Introduction to Scientific Computing should be completed by the end of sophomore year. Machine shop may be fulfilled with 24-200 Machine Shop Practice or 24-203 Special Topics: Maker Series: Intro to Manual & CNC Machining (students must choose one). Introduction to CAD is 24-202 Introduction to Computer Aided Design and Introduction to Scientific Computing (ISC) is 24-281 Introduction to Scientific Computing.

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

09-101	Introduction to Experimental Chemistry	3
42-203	Biomedical Engineering Laboratory	9
03-124	Modern Biology Laboratory	9
33-100	Basic Experimental Physics	6
33-104	Experimental Physics	9

Junior Year

Fall		Units
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	12
24-351	Dynamics	10
36-220	Engineering Statistics and Quality Control	9
xx-xxx	General Education Course	9
39-310	Experiential Learning III	0
		52

Spring		Units
24-321	Thermal-Fluids Experimentation	12
24-311	Numerical Methods	12
24-352	Dynamic Systems and Controls	12
xx-xxx	General Education Course	9
		45

Senior Year

Fall		Units
24-441	Engineering Design II: Conceptualization and Realization- required either fall or spring; alternate with xx-xxx 9 unit elective	12
or 24-671	Special Topics: Electromechanical Systems Design	
BME and Robotics Double Majors may use the capstone for their double major instead of the above listed MechE capstone design classes		
24-452	Mechanical Systems Experimentation	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

Spring		Units
24-441	Engineering Design II: Conceptualization and Realization OR xx-xxx Elective	12
or 24-671	Special Topics: Electromechanical Systems Design	
BME and Robotics Double Majors may use the capstone for their double major instead of the above listed MechE capstone design classes		
24-xxx	Mechanical Engineering Technical Elective	9-12
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48-51

Notes on the Curriculum

1. Students need a minimum of 382 units to complete the B.S. degree.
2. To accommodate the new Introduction to Scientific Computing in the curriculum and maintain the 382 minimum units, starting Spring 2020, 24-262 Stress Analysis will be a 10 unit course.
3. During the first year, students complete 24-101 Fundamentals of Mechanical Engineering Fundamentals of Mechanical Engineering and another introductory engineering course. Students who do not take 24-101 during their first year should take 24-101 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.
4. 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*
5. 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.
6. Students are required to complete 36-220 Engineering Statistics and Quality Control, which may be scheduled in any semester. The sequence of calculus courses (21-120 , 21-122 , 21-259) and 21-260 Differential Equations, should be scheduled as indicated due to Mechanical Engineering Core class prerequisites.
7. The presentation skills requirement can be satisfied by completing one of the following options: 24-302 Mechanical Engineering Seminar I, 76-270 Writing for the Professions, 70-340 Business Communications
8. Students must take either 24-441 Engineering Design II: Conceptualization and Realization or 24-671 Special Topics: Electromechanical Systems Design (students may choose one for their capstone design class) in either fall or spring of senior year. *BME and Robotics Double Majors may use the capstone for their double major 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 200 level or above to fulfill the technical elective requirement.

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. 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

Course offerings are variable, please check the Schedule of Classes (above) to see the most current list of classes.

Students cannot use research or project courses to fulfill the technical elective requirement. However, these courses, with limitations, will count as general elective units. 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

Free Electives

Students must first complete five elective courses, as indicated in the example course sequence. Students can take either technical or non-technical courses to fill these five slots from either the mechanical engineering department, College of Engineering, or any other Carnegie Mellon department. However, students may only use one elective slot for an

ungraded class. We offer these electives so students can pursue individual interests or obtain a minor or double major.

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.

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 OPA.

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-handbook18.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).

Internships and Co-operative Education Program

The Mechanical Engineering Department considers experiential learning opportunities important educational options for its undergraduate students. Students in Mechanical Engineering are encouraged to undertake professional internships during summer breaks.

Another option is cooperative education, which provides a student with an extended period of exposure with a company. All co-ops must be at least 6 consecutive months in length, and must be a full-time, paid position with a single company.

Study Abroad

In today’s global society, a study abroad experience is crucial and should serve as an integral part of an undergraduate engineering education. An academic experience abroad is encouraged and assistance is provided for course choices and curriculum sequencing.

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 2018-2019 (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 BERGBREITER, 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, Professor of Mechanical Engineering, Associate Dean for Graduate and Faculty Affairs – 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–

B. REEJA JAYAN, Assistant Professor of Mechanical Engineering – Ph.D., University of Texas at Austin; Carnegie Mellon, 2015–

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–

LEVENT BURAK KARA, Professor of Mechanical Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–

AARON M. JOHNSON, Assistant Professor of Mechanical Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2016–

PHILIP R. LEDUC, William J. Brown Professor of Mechanical Engineering – Ph.D., The Johns Hopkins University; Carnegie Mellon, 2002–

SHAWN LITSTER, Professor of Mechanical Engineering – Ph.D., Stanford University; Carnegie Mellon, 2008–

CARMEL MAJIDI, Associate 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, Professor of Engineering and Public Policy – 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-–

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

ALLEN L. ROBINSON, Raymond J. Lane Distinguished Professor & Department Head – Ph.D., University of California at Berkeley; Carnegie Mellon, 1998–

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

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

KENJI SHIMADA, Theodore Ahrens Professor of Engineering, Professor of Mechanical 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 and Associate Professor of Chemistry – 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–

VENKAT VISWANATHAN, Assistant Professor of Mechanical Engineering – Ph.D., Stanford University; Carnegie Mellon, 2013–

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

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

YONGJIE ZHANG, 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–