MECHANICAL ENGINEERING

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FACULTY OF THE DEPARTMENT OF MECHANICAL ENGINEERING AND MATERIALS SCIENCE

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Mechanical engineering is among the most diversified of the traditional engineering disciplines. The mechanical engineer builds machines to extend our physical and mental capabilities and to convert traditional and novel energy sources into useful forms.

The role of the mechanical engineer has changed dramatically over the past few decades with the extensive use of high-performance computers (in such areas as computational fluid dynamics, materials design, control, and manufacturing), the interfacing of microelectromechanical systems and actuators via microprocessors to build high-precision sensors and devices, and the advent of advanced materials (e.g., composites, shape-memory alloys, ceramics, and superconductors) for new applications (e.g., coatings, biomaterials, and computer storage). These areas offer mechanical engineering students special opportunities for creativity, demanding that they learn not only in depth but also in breadth. Demands for increased energy efficiency and reduced environmental impact— as might be realized, for example, in novel gas turbine or electric hybrid vehicles—require that students understand the fundamentals of mechanics, thermodynamics, fluid mechanics, combustion, and materials science. In all these tasks, the utmost consideration of the modern mechanical engineer is improving the quality of human life. The engineer must also be constantly aware both of the finiteness of Earth’s resources and its environment and of the burden that engineering places on them.

The educational mission of the Department of Mechanical Engineering and Materials Science is to provide an excellent education that will prepare students to become members of the next generation of mechanical engineers. To implement this mission, the department adheres to the following set of educational objectives: to provide a balanced technical and nontechnical education to enable graduates to enter highly selective graduate schools and/or to pursue technical careers in industry or government laboratories; to enable graduates to improve and adapt their skills to accommodate rapid technological changes; to prepare graduates to communicate effectively and to understand the ethical responsibilities and impact on society of their profession. To achieve these objectives, the following fundamental educational goals have been established for the Department of Mechanical Engineering and Materials Science: to provide a comprehensive introduction to basic science and mathematics, which form the foundation of mechanical engineering; to provide thorough training in analytical and experimental methods and in data analysis, including problem formulation; to provide instruction in the fundamentals of the design process, including project innovation, synthesis, and management, both individually and in a team setting; to provide both a technical and a nontechnical program of study in which oral and written communication skills are developed; to instill in students an understanding of their professional and ethical responsibilities, which affect society and their profession.

At Yale, three mechanical engineering programs are offered: a B.S. degree program with a major in Mechanical Engineering, a B.S. degree program with a major in Engineering Sciences (Mechanical), and a B.A. degree program with a major in Engineering Sciences (Mechanical). Prospective majors in both B.S. programs are advised to complete introductory physics and mathematics through calculus (MATH 115) by the end of their freshman year.

A student’s undergraduate engineering program may include one or more special project courses (MENG 471, 472), in which the student pursues a particular research interest through design-oriented projects and experimental investigations. Projects may be initiated by the student, may be performed in a team, or may be derived from the ideas of faculty members who place undergraduates in their ongoing research projects. All interested students should contact the director of undergraduate studies for more information on special project courses.

The major for the Class of 2018 and previous classes Students in the Class of 2018 and previous classes may fulfill the requirements of the major that were in place when they entered the program in Mechanical Engineering, as described in previous editions of this bulletin. Alternatively, they may fulfill the requirements for the major as described below for the Class of 2019 and subsequent classes.

The major for the Class of 2019 and subsequent classes For all three degree programs, the major requires a group of prerequisites or equivalents; several courses beyond the prerequisites; and a senior requirement, as indicated below.

B.S. degree program in Mechanical Engineering This is the most technically intensive mechanical engineering degree program and is accredited by the Engineering Accreditation Commission of ABET, Inc. This program is appropriate for students who plan careers as
practicing engineers in industry, consulting firms, or government as well as for students who are considering a career in research and plan to pursue an advanced degree in engineering.

The prerequisites in mathematics are MATH 112, 115, and ENAS 151, or the equivalent. The basic science prerequisites are PHYS 180, 181, or 200, 201; one laboratory from PHYS 165L or 205L, and one from PHYS 166L or 206L, or equivalents.

Nineteen term courses beyond the prerequisites are required as follows:

1. Advanced mathematics: ENAS 194 and MATH 222 or 225
2. Mechanical engineering and related: MENG 211, 280, 285, 286L, 361, 363L, 383, 389, 390, 489 (the senior requirement), ENAS 130, EENG 200, and at least one lecture course in chemistry numbered CHEM 161 or higher
3. Technical electives: four approved technical electives chosen in consultation with the director of undergraduate studies; either MENG 471 or 472 (not both) may be counted as one of the four technical electives

The curriculum in this program is arranged in prescribed patterns, but some departures from it are possible with approval of the director of undergraduate studies.

**B.S. degree program in Engineering Sciences (Mechanical)**  This non-ABET degree program is suitable for students who wish to gain significant expertise within mechanical engineering while combining their engineering studies with related disciplines. For example, a number of students have taken courses in architecture while pursuing a program in mechanical engineering that emphasizes structural mechanics; similarly, a student with an interest in computer graphics might combine engineering courses in computer-aided design with programming courses from the Department of Computer Science. The major requires twelve approved term courses in engineering, beyond the prerequisites and including the senior project, which can cover a broad array of topics within the subject provided that they contribute to a coherent program. Students should consult with the director of undergraduate studies at the beginning of their sophomore year.

The prerequisites in mathematics are MATH 112, 115, and ENAS 151, or the equivalent. The basic science prerequisites are PHYS 180, 181, or 200, 201; one laboratory from PHYS 165L or 205L, and one from PHYS 166L, 206L, or MENG 286L.

**B.A. degree program in Engineering Sciences (Mechanical)**  In a society with increasing levels of technical sophistication, a well-rounded individual must have some background in science and technology. The non-ABET B.A. program is designed for students who may be planning careers in business, law, medicine, journalism, or politics but need to understand the impact that science and technology can have on society at large. An understanding of engineering methods and practices, combined with a traditional liberal arts education, provides a strong background for a variety of careers. The program is well suited for students who wish to fulfill the requirements of two majors.

The prerequisites in mathematics are MATH 112 and 115. The basic science prerequisite is physics at least to the level of PHYS 170, 171.

The program requires eight approved term courses beyond the prerequisites, including the senior project.

**Senior requirement** For the B.S. degree program in Mechanical Engineering accredited by ABET, MENG 489 satisfies the senior project requirement. For the non-accredited B.S. degree program, students satisfy the senior project requirement by completing MENG 404, 471, 472, 489, or another upper-level design course (taken during the senior year) chosen in consultation with the DUS. For the B.A. degree program, students satisfy the senior project requirement by completing MENG 471, 472, or another upper-level design course (taken during their senior year) chosen with the DUS.

**Credit/D/Fail** No courses taken Credit/D/Fail may be counted toward the Mechanical Engineering major, including prerequisites.

**Courses for majors in the humanities and social sciences** Mechanics and mechanical engineering content can be found in several courses intended for those not majoring in science. See under Engineering and Applied Science (http://catalog.yale.edu/archive/2016-2017/ycps/subjects-of-instruction/engineering-applied-science).

**REQUIREMENTS OF THE MAJOR**

**MECHANICAL ENGINEERING, B.S.**

**Prerequisites** MATH 112, 115, and ENAS 151, or equivalent; PHYS 180, 181, or 200, 201, and 2 labs (1 from PHYS 165L or 205L, and one from PHYS 166L or 206L, or equivalents)

**Number of courses** 19 term courses beyond prerequisites (incl senior req)

**Specific courses required** ENAS 130 and 194; EENG 200; MATH 222 or 225; MENG 211, 280, 285, 286L, 361, 363L, 383, 389, 390

**Distribution of courses** 4 technical electives chosen in consultation with DUS (only one of MENG 471 or MENG 472); 1 term course in chem

**Substitution permitted** With DUS approval

**Senior requirement** MENG 489

**ENGINEERING SCIENCES (MECHANICAL), B.S.**
Prerequisites  MATH 112, 115, and ENAS 151, or equivalent; PHYS 180, 181, or 200, 201, and 2 labs (1 from PHYS 165L or 205L; 1 from PHYS 166L, 206L, or MENG 286L)
Number of courses  12 term courses beyond prerequisites (incl senior project)
Substitution permitted  With DUS approval
Senior requirement  MENG 489, 404, 471, or 472, or another upper-level design course chosen in consultation with the DUS

ENGINEERING SCIENCES (MECHANICAL), B.A.

Prerequisites  MATH 112, 115; PHYS 170, 171
Number of courses  8 term courses beyond prerequisites (incl senior req)
Substitution permitted  With DUS approval
Senior requirement  MENG 471 or 472, or another upper-level design course chosen in consultation with the DUS