DEPARTMENT OF MECHANICAL ENGINEERING

Graduate Study

The Department of Mechanical Engineering (MechE) provides opportunities for graduate work leading to the following degrees: Master of Science in Mechanical Engineering, Master of Science in Ocean Engineering, Master of Science in Naval Architecture and Marine Engineering, Master of Science in Oceanographic Engineering, Master of Engineering in Manufacturing, degree of Mechanical Engineer, degree of Naval Engineer, and the Doctor of Philosophy (PhD) or Doctor of Science (ScD), which differ in name only.

The Master of Engineering in Manufacturing degree is a 12-month professional degree intended to prepare students for technical leadership in the manufacturing industries.

The Mechanical Engineer's and Naval Engineer's degrees offer preparation for a career in advanced engineering practice through a program of advanced coursework that goes well beyond the master's level. These degrees are not a stepping stone to the PhD.

The Doctor of Philosophy (or Science), the highest academic degree offered, is awarded upon the completion of a program of advanced study and significant original research, design, or development.

Admission Requirements for Graduate Study

Applications to the mechanical engineering graduate program are accepted from persons who have completed, or will have completed by the time they arrive, a bachelor's degree if they are applying for a master's degree, or a master's degree if they are applying for a PhD. Most incoming students have a degree in mechanical engineering or ocean engineering, or some related branch of engineering. The department's admission criteria are not specific, however, and capable students with backgrounds in different branches of engineering or in science may gain entry. Nevertheless, to qualify for a graduate degree, the candidate is expected to have had at least an undergraduate-level exposure to the core subject areas in mechanical engineering (applied mechanics, dynamics, fluid mechanics, thermodynamics, materials, control systems, and design) and to be familiar with basic electrical circuits and electromagnetic field theory.

Applications for September entry are due on December 15 of the previous year and decisions are reported in March. International students applying from abroad may be admitted, but they will be allowed to register only if they have full financial support for the first year.

All applicants to the graduate program in mechanical engineering must submit the GRE test results. International students whose native language is not English are required to take either the International English Language Testing System (IELTS) exam and receive a minimum score of 7 or the TOEFL exam with a minimum acceptable score of 577 (PBT), 233 (CBT) or 100 (iBT).

Early Admission to Master's Degree Programs in Mechanical Engineering

At the end of the junior year, extraordinarily qualified students in the Department of Mechanical Engineering will be invited to apply for early admission to the graduate program. Students who are admitted will then be able to enroll in core graduate subjects during the senior year and to find a faculty advisor who is willing to start and advise research for the master's thesis while the student is still in the senior year. With the consent of the faculty advisor, the student may also use a portion of the work conducted towards the master's thesis in the senior undergraduate year to satisfy the requirements of the bachelor's thesis.

Writing Ability Requirement

The Mechanical Engineering Department requires that all incoming graduate students demonstrate satisfactory English writing ability, or successfully complete appropriate training in writing. This requirement reflects the faculty's conviction that writing is an essential skill for all engineers. All incoming graduate students, native as well as international, must take the departmental writing ability test, which is administered online in June. Depending on the results, a student will either pass or be required to take a short course during the Independent Activities Period (IAP) (*https://catalog.mit.edu/mit/undergraduate-education/academic-research-options/independent-activities-period*) in January.

Master of Science in Mechanical Engineering

To qualify for the Master of Science in Mechanical Engineering, a student must complete at least 72 credits of coursework, not including thesis. Of these, at least 48 must be graduate subjects (refer to the Guide to Graduate Study [PDF] (*http://meche.mit.edu/documents/MechE_Grad_Guide.pdf*) on the MechE website). The remainder of the 72 units may include advanced undergraduate subjects that are not requirements in the undergraduate mechanical engineering curriculum.

At least three of the graduate subjects must be taken in mechanical engineering sciences (refer to the Guide to Graduate Study [PDF] (*http://meche.mit.edu/documents/MechE_Grad_Guide.pdf*) on the MechE website). Students must take at least one graduate mathematics subject (12 units) offered by the MIT Mathematics Department. For the Master of Science in Oceanographic Engineering, see also the requirements listed in the Joint Program with Woods Hole Oceanographic Institution.

Finally, a thesis is required. The thesis is an original work of research, development, or design, performed under the advisement of a faculty or research staff member, and is a major part of any graduate program in the Mechanical Engineering Department. A master's student usually spends as much time on thesis work as on

coursework. A master's degree usually takes about one and one-half to two years to complete.

Master of Science in Ocean Engineering/Master of Science in Naval Architecture and Marine Engineering/Master of Science in Oceanographic Engineering

The requirements for each of these three degrees are that the student takes 72 credit units of graduate subjects and complete a thesis.

At least three of the subjects must be chosen from a prescribed list of ocean engineering subjects (refer to the Guide to Graduate Study [PDF] (*http://meche.mit.edu/documents/MechE_Grad_Guide.pdf*) on the MechE website). Students must also take at least one graduate mathematics subject (12 units) offered by MIT's Mathematics Department. For the Master of Science in Oceanographic Engineering, see also the requirements listed under the Joint Program with Woods Hole Oceanographic Institution.

The required thesis is an original work of research, development, or design, conducted under the advisement of a faculty or senior research staff member. The thesis usually takes between one and two years to complete.

Master of Engineering in Advanced Manufacturing and Design

The Master of Engineering in Advanced Manufacturing and Design (*http://web.mit.edu/meng-manufacturing*) is a 12-month professional degree in mechanical engineering that is intended to prepare the student to assume a role of technical leadership in the manufacturing industries. The degree is aimed at practitioners who will use this knowledge to become leaders in existing, as well emerging, manufacturing companies. To qualify for this degree, a student must complete a highly integrated set of subjects and projects that cover the process, product, system, and business aspects of manufacturing, totaling 90 units, plus complete a group-based thesis project with a manufacturing industry. While centered in engineering and firmly grounded in the engineering sciences, this degree program considers the entire enterprise of manufacturing. Students will gain both a broad understanding of the many facets of manufacturing and a knowledge of manufacturing fundamentals from which to build new technologies and businesses. The admission process is identical to that of the Master of Science degree, with the exception that two additional essay questions are required.

Learners who earn an MITx Principles of Manufacturing MicroMasters Credential (*https://www.edx.org/micromasters/mitx-principles-manufacturing*) may apply to the Advanced Manufacturing and Design program and, upon acceptance, would be credited 48 units of advanced standing credit (equivalent to approximately one-third of the full degree program and one semester on campus).

Mechanical Engineer's Degree

The Mechanical Engineer's degree provides an opportunity for further study beyond the master's level for those who wish to enter engineering practice rather than research. This degree emphasizes breadth of knowledge in mechanical engineering and its economic and social implications, and is quite distinct from the PhD, which emphasizes depth and originality of research.

The engineer's degree requires a broad program of advanced coursework in mechanical engineering totaling at least 162 credit units (typically about 14 subjects), including those taken during the master's degree program. The engineer's degree program is centered around the application of engineering principles to advanced engineering problems and includes a Mechanical Engineering examination and an applications-oriented thesis, which may be an extension of a suitable master's thesis. An engineer's degree typically requires at least one year of study beyond the master's degree.

Naval Engineer's Degree—Program in Naval Construction and Engineering

The Naval Construction and Engineering (NVE) program provides US Navy and US Coast Guard officers, foreign naval officers, and civilian students interested in ships and ship design a broad graduate-level education for a career as a naval engineer.

The program leads to the Naval Engineer's degree, which requires a higher level of professional competence and broader range of knowledge than is required for the degree of Master of Science in Naval Architecture and Marine Engineering or Ocean Engineering. Subjects in the areas of economics, industrial management, and public policy and law, and at least 12 units of comprehensive design are required, in addition to an in-depth curriculum that includes naval architecture, hydrodynamics, ship structures, materials science, and power and propulsion. The program is appropriate for naval officers and civilians who plan to participate in the design and construction of naval ships, as well as those interested in commercial ship design.

For students working toward a simultaneous Naval Engineer's degree and a master's degree, a single thesis is generally acceptable, provided it is appropriate to the specifications of both degrees, demonstrating an educational maturity expected of the Naval Engineer's degree.

Doctor of Philosophy and Doctor of Science

The highest academic degree is the Doctor of Science, or Doctor of Philosophy (the two differ only in name). This degree is awarded upon the completion of a program of advanced study, and the performance of significant original research, design, or development. Doctoral degrees are offered in all areas represented by the department's faculty.

Students become candidates for the doctorate by passing the doctoral qualifying examinations. The doctoral program includes a major program of advanced study in the student's principal area of interest, and a minor program of study in a different field. The MechE

Graduate Office should be consulted about the deadline for passing the qualifying exam.

The principal component of the program is the thesis. The thesis is a major, original work that makes a significant research, development, or design contribution in its field. The thesis and the program of study are done under a faculty supervisor and a doctoral committee selected by the student and his or her supervisor, and perhaps other interested faculty members. The committee makes an annual examination of the candidate's progress and makes a final recommendation for a public defense of the work. The doctoral program typically requires three years of work beyond the master's degree, although this time is strongly topic dependent.

Interdisciplinary Programs

Graduate students registered in the Department of Mechanical Engineering may elect to participate in interdisciplinary programs of study.

Computational Science and Engineering

The Master of Science in Computational Science and Engineering (CSE SM) (*https://cse.mit.edu/programs/sm*) is an interdisciplinary program for students interested in the development, analysis, and application of computational approaches to science and engineering. The curriculum is designed with a common core serving all science and engineering disciplines and an elective component focusing on specific disciplinary topics. Students may pursue the CSE SM as a standalone degree or as leading to the CSE PhD program described below.

The Interdisciplinary Doctoral Program in Computational Science and Engineering (CSE PhD) (*https://cse.mit.edu/programs/phd*) allows students to specialize at the doctoral level in a computation-related field of their choice through focused coursework and a thesis through one of the participating host departments in the School of Engineering or School of Science. The program is administered jointly by the Center for Computational Science and Engineering (CCSE) and the host departments; the emphasis of thesis research activities is the development of new computational methods and/or the innovative application of computational techniques to important problems in engineering and science.

For more information, see the program descriptions under Interdisciplinary Graduate Programs.

Joint Program with the Woods Hole Oceanographic Institution

The Joint Program with the Woods Hole Oceanographic Institution (WHOI) (*http://mit.whoi.edu*) is intended for students whose primary career objective is oceanography or oceanographic engineering. Students divide their academic and research efforts between the campuses of MIT and WHOI. Joint Program students are assigned an MIT faculty member as academic advisor; thesis research may be advised by MIT or WHOI faculty. While in residence at MIT, students follow a program similar to that of other students in their home department. The program is described in more detail (*https://catalog.mit.edu/interdisciplinary/graduate-programs/joint-program-woods-hole-oceanographic-institution*) under Interdisciplinary Graduate Programs.

Leaders for Global Operations

The 24-month Leaders for Global Operations (LGO) (*https://catalog.mit.edu/interdisciplinary/graduate-programs/leaders-global-operations*) program combines graduate degrees in engineering and management for those with previous postgraduate work experience and strong undergraduate degrees in a technical field. During the two-year program, students complete a six-month internship at one of LGO's partner companies, where they conduct research that forms the basis of a dual-degree thesis. Students finish the program with two MIT degrees: an MBA (or SM in management) and an SM from one of eight engineering programs, some of which have optional or required LGO tracks. After graduation, alumni lead strategic initiatives in high-tech, operations, and manufacturing companies.

Polymers and Soft Matter

The Program in Polymers and Soft Matter (PPSM) (*http://polymerscience.mit.edu*) offers students from participating departments an interdisciplinary core curriculum in polymer science and engineering, exposure to the broader polymer community through seminars, contact with visitors from industry and academia, and interdepartmental collaboration while working towards a PhD or ScD degree.

Research opportunities include functional polymers, controlled drug delivery, nanostructured polymers, polymers at interfaces, biomaterials, molecular modeling, polymer synthesis, biomimetic materials, polymer mechanics and rheology, self-assembly, and polymers in energy. The program is described in more detail (*https://catalog.mit.edu/interdisciplinary/graduate-programs/polymers-soft-matter*) under Interdisciplinary Graduate Programs.

Technology and Policy

The Master of Science in Technology and Policy is an engineering research degree with a strong focus on the role of technology in policy analysis and formulation. The Technology and Policy Program (TPP) (*http://tpp.mit.edu*) curriculum provides a solid grounding in technology and policy by combining advanced subjects in the student's chosen technical field with courses in economics, politics, quantitative methods, and social science. Many students combine TPP's curriculum with complementary subjects to obtain dual degrees in TPP and either a specialized branch of engineering or an applied social science such as political science or urban studies and planning. See the program description (*https://catalog.mit.edu/schools/mit-schwarzman-college-computing/data-systems-society*) under the Institute for Data, Systems, and Society.

Financial Support

The Department of Mechanical Engineering offers three types of financial assistance to graduate students: research assistantships, teaching assistantships, and fellowships.

The majority of students in the department are supported by research assistantships (RAs), which are appointments to work on particular research projects with particular faculty members. Faculty members procure research grants for various projects and hire graduate students to carry out the research. The research is almost invariably structured so that it becomes the student's thesis. An RA appointment provides a full-tuition scholarship (i.e., covers all tuition) plus a salary that is adequate for a single person. The financial details are outlined in a separate handout available from the MechE Graduate Office. An RA may register for a maximum of 24 units (about two subjects) of classroom subjects per regular term and 12 units in the summer term, and must do at least the equivalent of 24 units of thesis (i.e., research on the project) per term. (Please note that Master of Engineering in Manufacturing students are not eligible for RA or TA positions since their subject credits exceed these limits.)

Teaching assistants (TAs) are appointed to work on specific subjects of instruction. As the name implies, they usually assist a faculty member in teaching, often grading homework problems and tutoring students. In the Mechanical Engineering Department, TAs are very seldom used for regular full-time classroom teaching. Full-time TAs are limited to 24 units of credit per regular term, including both classroom subjects and thesis. The TA appointment does not usually extend through the summer.

A fellowship provides the student with a direct grant, and leaves the student open to select his or her own research project and advisor. A limited number of awards and scholarships are available to graduate students directly through the department. A number of students are also supported by fellowships from outside agencies, such as the National Science Foundation, Office of Naval Research, and Department of Defense. Scholarships are awarded each year by the Society of Naval Architects and Marine Engineers. These awards are normally granted to applicants whose interest is focused on naval architecture and marine engineering or on ocean engineering. Applications are made directly to the granting agency, and inquiries for the fall term should be made in the preceding fall term.

Prospective students are invited to communicate with the Department regarding any of these educational and financial opportunities.

Experience has shown that the optimum graduate program consists of about equal measures of coursework and research, consistent with an RA appointment. The main advantage of a fellowship is a greater freedom in choosing a research project and advisor. A teaching assistantship gives the student teaching experience and can also be extremely valuable for reviewing basic subject material—for example, in preparation for the doctoral qualifying exams. It does not, however, leave much time for thesis research and may extend the time that the student needs to complete his or her degree.

Inquiries

For additional information on mechanical engineering graduate admissions, contact Una Sheehan. For general inquiries on the mechanical engineering graduate program, contact Leslie Regan. All can be reached in the MechE Graduate Office (*me-gradoffice@mit.edu*), Room 1-112, 617-253-2291.