

# GRADUATE PROGRAM

## Mechanical Engineering

~~2013-2014~~

### Mission Statement

The Department of Mechanical Engineering at the University of Delaware offers masters and doctoral degree programs geared toward preparing students for leadership positions in industry, government, and academia. The curriculum for the master's degree is rooted in the fundamentals of mechanical engineering but allows for some flexibility through elective courses. The department offers a research-oriented master's degree with thesis (MSME) and a coursework-only degree (MEM). Recognizing that technology and research is rapidly becoming more cross-disciplinary, the doctoral program (Ph.D.) in the department provides significant flexibility and the ability to tailor one's program to meet the challenges of a broad array of research environments. In addition, the department offers a direct Ph.D. program without the requirements of a master's degree and the ability to accommodate students with backgrounds in mathematics, physics and other engineering disciplines into the program.

### Admission to Program

Students are admitted into the graduate program for either a Master's or a doctoral, Ph.D., degree. For students with a bachelor's degree in engineering the following minimum criteria will normally be applied:

1. A baccalaureate degree in mechanical engineering or in a closely related field of science or mathematics.
2. An undergraduate grade point average in engineering, science and mathematics courses of at least 3.0 on a 4.0 scale.
3. A minimum of at least three letters of strong support from former teachers or supervisors.
4. A minimum combined Quantitative and Verbal score of 308 (1200) on the Graduate Record Examination Aptitude Test.
5. A minimum score of 600 (or IBT equivalent) in the Test of English as a Foreign Language for students whose first language is not English. This test is not required of students whose first language is English and who have received an undergraduate or post-graduate degree from a College or University in which English is the sole language of instruction.

Admission to the graduate program is competitive. Those who meet stated requirements are not guaranteed admission, nor are those who fail to meet all of those requirements necessarily precluded from admission if they offer other appropriate strengths.

For applicants with no prior training in engineering, the same minimum criteria will apply. In addition, their records will be reviewed in relation to the intended program of study. Provisional status with specific remedial work may be a basis for acceptance of such applicants.

The acceptance of applicants who have already received a Master's degree in engineering will be based on the above minimum criteria and the results of their graduate work.

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**Advisement**

A temporary academic advisor is assigned to new students when they are admitted to the Department. Students select their permanent advisor once they become familiar with the department, and clear about their research interests. The permanent advisor will be someone whose interest matches the interest of the student insofar as possible. For students on Research Assistantships, the advisor directs their research and advises them on course selection.

## **MASTER of SCIENCE in MECHANICAL ENGINEERING (MSME)**

The Master of Science in Mechanical Engineering (MSME) program consists of 24 credit hours of graduate level coursework, plus 6 credits of Master's Thesis. Coursework must be completed with a grade point average of 3.0 or higher (see [Graduate Catalog](#) for relevant details). The requirements are designed both to provide a balanced program in Mechanical Engineering and to allow for a degree of specialization. Students should be able to complete all degree requirements, including the thesis, in 18 to 24 months of full-time study.

### **I. Course Requirements**

A. The following four courses are required (12 credits):

- MEEG 690 Intermediate Engineering Mathematics
- Three from the following list:
  - MEEG 610 Intermediate Solid Mechanics
  - MEEG 620 Intermediate Dynamics
  - MEEG 630 Intermediate Fluid Mechanics
  - MEEG 640 Intermediate Heat Transfer
  - MEEG 683 Orthopedic Biomechanics

Students may petition the Graduate Committee to substitute a more advanced (e.g., 800-level) course on the same topic for one of these required courses.

B. One additional graduate level course (3 credits) in mathematics or numerical methods. The student makes this selection with the documented approval of the Department's Graduate Committee, which has the authority to decide on acceptable courses.

C. Three additional elective graduate level courses (9 credits) in engineering or mathematical, physical or biological sciences. The student makes these selections with the documented approval of the department's Graduate Committee, which has the authority to decide on acceptable courses.

D. At least one semester of MEEG 600 Seminar (0 credits). Special arrangements can be made for part-time students to fulfill this requirement.

E. 6 credits of MEEG 869 Master's Thesis.

### **II. Thesis Requirements**

A thesis is required which demonstrates the student's ability to conduct scholarly research. Entering graduate students are expected to choose a thesis advisor and research topic during their first semester in the Department so that they can initiate research and choose appropriate elective courses.

At the completion of the thesis research, candidates for the MSME degree must defend their thesis orally to a committee of at least three faculty members. The committee will be chaired by the thesis advisor who, along with at least one other committee member, must be regular full-time faculty in the Department of Mechanical Engineering. The thesis is to be submitted to committee members at least two weeks in advance of the defense and shall meet the academic

and professional standards set forth by the University. Upon acceptance of the thesis, the Committee recommends approval to the Department Chairperson.

### **III. Learning Outcomes and Assessment**

A. The student will demonstrate the ability to apply graduate-level mathematics to the solution of engineering problems in at least two of the general areas of solid mechanics, fluid mechanics, dynamics and heat transfer.

Direct assessment: Student learning relative to this outcome is assessed by the student's course grades in: MEEG 610 Intermediate Solid Mechanics; MEEG 620 Intermediate Dynamics; MEEG 630 Intermediate Fluid Mechanics; MEEG 640 Intermediate Heat Transfer; and MEEG 690 Intermediate Engineering Mathematics.

Indirect assessment: A current and updated employment listing will serve as indirect evidence of student attainment of the learning goal.

B. The student will demonstrate the ability to conduct, present and defend graduate-level research including literature review, motivation, methodology utilized, results, unique contributions, and conclusions generated.

Direct assessment: Student learning relative to this outcome is assessed by the quality of the written master's thesis and performance in the thesis defense.

Indirect assessment: A current and updated employment listing will serve as indirect evidence of student attainment of the learning goal.

## MASTER OF ENGINEERING: MECHANICAL (MEM)

The Master of Engineering: Mechanical (MEM) program consists of 30 credit hours of graduate level coursework. Coursework must be completed with a grade point average of 3.0 or higher (see [Graduate Catalog](#) for relevant details). The requirements are designed to provide a general program and to allow for some concentration of study within Mechanical Engineering. It will be possible to complete this program taking courses in the late afternoon, early evening, and/or in a distance format.

[Engineering Outreach](#) can help facilitate part-time graduate education. This degree is not available to students who have been enrolled in the MSME degree program.

### I. Course Requirements

A. The following five courses are required (15 credits):

- MEEG 690 Intermediate Engineering Mathematics
- Four from the following list:
  - MEEG 610 Intermediate Solid Mechanics
  - MEEG 620 Intermediate Dynamics
  - MEEG 630 Intermediate Fluid Mechanics
  - MEEG 640 Intermediate Heat Transfer
  - MEEG 683 Orthopedic Biomechanics

Students may petition the Graduate Committee to substitute a more advanced (e.g., 800-level) course on the same topic for one of these required courses.

B. One additional graduate level course (3 credits) in mathematics or numerical methods. The student makes this selection with the documented approval of the Department's Graduate Committee, which has the authority to decide on acceptable courses.

C. One additional graduate level course (3 credits) in Mechanical Engineering. Three credits of MEEG 868 Research can be used toward this requirement. The student makes this selection with the documented approval of the department's Graduate Committee, which has the authority to decide on acceptable courses.

D. Three additional graduate level courses (9 credits) in engineering, mathematical, physical or biological sciences or business and economics. The student makes these selections with the documented approval of the department's Graduate Committee, which has the authority to decide on acceptable courses.

### II. Learning Outcomes and Assessment

A. The student will demonstrate the ability to apply graduate-level mathematics to the solution of engineering problems in at least two of the general areas of solid mechanics, fluid mechanics, dynamics and heat transfer.

Direct assessment: Student learning relative to this outcome is assessed by the student's course grades in: MEEG 610 Intermediate Solid Mechanics; MEEG 620 Intermediate

Dynamics; MEEG 630 Intermediate Fluid Mechanics; MEEG 640 Intermediate Heat Transfer; and MEEG 690 Intermediate Engineering Mathematics.

Indirect assessment: A current and updated employment listing will serve as indirect evidence of student attainment of the learning goal.

## PH.D. in MECHANICAL ENGINEERING

The Ph.D. program in Mechanical Engineering consists of 33 credits of graduate level course work plus 9 credits of Doctoral Dissertation. The Ph.D. program is designed to allow for considerable flexibility in course selection and specialization of study. Course work must be completed with a cumulative grade point average of 3.0 or higher (see [Graduate Catalog](#) for relevant details). In addition, the student must pass the Qualifying Examination, Candidacy Examination and fulfill the teaching requirement prior to completing the dissertation requirements. The Ph.D. should be obtainable in four years of full-time study after entering the program. There is no foreign language requirement for the Ph.D.

### I. Course Requirements

- A. At least four courses (12 credits) at the 600 or higher level in Mechanical Engineering (MEEG)
- B. At least three courses (9 credits) at the 800 level.
- C. At least one course (3 credits) in mathematics (other than MEEG690).
- D. At least three semesters of MEEG 600 Seminar (0 credits). Special arrangements can be made for part-time students to fulfill this requirement.
- E. 9 credits of MEEG 969 Doctoral Dissertation.

An individual course can be used to meet more than one of the requirements A, B or C provided the total number of credits is at least 33. MEEG 868 cannot be used toward these requirements.

With the written approval of the thesis advisor and of the Graduate Committee, requirements A and C may be fully or partially waived for a student who has been awarded a Master's degree in Mechanical Engineering. With similar approval, to the extent that courses at the 800 level (other than MEEG 868 or MEEG 869) were used to satisfy the Master's degree requirements, requirement B may be fully or partially waived. Evidence must be given to show that courses taken for the Master's degree are equivalent to those being waived. If any course waivers are granted, the total number of course credits required for the PhD will be reduced by the number of credits equivalent to those being waived. Under no circumstances will requirements equivalent to more than 12 credits be waived.

Students will submit a proposed course plan (including any requests for course waivers as described above) to the Dissertation Committee at the time of their candidacy exam. Upon approval, it will enter into the candidate's file. Deviations from the proposed plan must be approved by the Dissertation Committee. A copy of the course plan must be sent to the University Office of Graduate Studies.

### II. Dissertation Requirements

A dissertation is required which demonstrates the student's ability to conduct independent research. A Dissertation Committee is selected by the advisor and approved by the Department

Chairperson. This committee will also serve as the student's Candidacy Examination Committee. At least three Mechanical Engineering Department faculty members and at least one faculty member from another department will serve on the Dissertation Committee. The Committee will be chaired by the research advisor, who must be a regular full-time member of the Department of Mechanical Engineering Faculty. During the course of the research, the student will periodically review progress with the Committee.

The student must orally present the dissertation before the Dissertation Committee at an open defense. The student shall supply final draft copies of the dissertation to members of the Committee at least two weeks before the oral defense. The dissertation must meet the academic and professional standards set forth by the University.

### **III. Qualifying Examination**

The purpose of the qualifying examination is to assess the aptitude of a doctoral student in the early stages of the program. A student must be enrolled in the Ph.D. program, have a minimum GPA of 3.2 and a minimum of 12 graduate coursework credits to complete the qualifying exam.

The qualifying exam will consist of three parts

- a) a research aptitude exam based on the student's research interest area
- b) one math exam (based on the content in MEEG 690)
- c) one mechanical engineering topic exam (based on undergraduate-level mechanical engineering and the content in one of the core courses, MEEG 610, MEEG 620, MEEG 630, MEEG 640)

Part a) will be offered between the end of the first semester and the end of the second semester of study and will:

- i) Include a 2-3 page report reviewing and summarizing typically 3 or 4 published peer reviewed journal articles from the literature, in the student's research interest area. The journal articles will be selected by the student's advisor and no more than one of them shall have been authored by the advisor.
- ii) Include a 20 minute oral presentation of the above described report, followed by a period of questioning related to the selected papers.
- iii) Be graded by a committee of at least three faculty members, including the student's research advisor and two other faculty members, not advising the student, appointed by the department chair. The criteria for grading will be established by the faculty and provided to the student ahead of the exam.

Parts b) and c) will be written exams, offered in early June and must be taken at the first opportunity after the completion of 12 graduate coursework credits toward the Ph.D.

In judging student performance on this examination, the faculty has three options: (i) outright passing, (ii) giving a second chance, and (iii) outright failing. If the student is given a second chance, the faculty will specify the parameters for taking and passing the second chance exam. These decisions will be made in a faculty meeting held as soon as possible following the grading of the exams. There will be no third chance given. A student who ultimately fails the Qualifying Examination is not eligible to continue in the Ph.D. program, but may apply to change his/her matriculation to the MSME program.



#### **IV. Candidacy Examination**

The Ph.D. Candidacy Examination must be taken within one and a half years of successful completion of the Qualifying Examination and at least one year prior to the dissertation defense. The student will prepare a comprehensive, written research proposal and defend it orally before the Candidacy Examination Committee (the composition of which is specified in II). The Candidacy Examination is intended to test the student's ability to synthesize knowledge in the formulation of an independent research proposal. Performance is judged by the Candidacy Examination Committee, and any additional requirements they wish to impose must be satisfied before the student is admitted to candidacy. Additional requirements could include, but are not limited to: taking additional course work, modifying the written research proposal, and defending the revised proposal before the Candidacy Examination Committee. Satisfactory completion of any additional requirements must be approved by the student's Candidacy Examination Committee.

#### **V. Teaching Requirement**

The ability to communicate effectively is an essential skill for all PhD graduates. Therefore, all PhD students are required to fulfill a teaching requirement, which consists of serving as a Teaching Assistant (TA) for one or two semesters, depending on the assignment. Students are expected to continue to be actively involved in their research while serving as a TA.

International graduate students are required to take International Teaching Assistant (ITA) training through the University's English Language Institute (ELI) prior to their first semester as a graduate student. Training and assessment are part of the University's requirements for the proficiency of international TA's. A final decision on how to resolve any deficiency is made by the Graduate Program Coordinator in consultation with the student's thesis advisor and the Department Chair.

Teaching Assistant positions are assigned by the Graduate Curriculum Chair in advance for the upcoming semester. Students are encouraged to submit their preferences for specific TA positions early to facilitate the process. Although every effort is made to satisfy these requests, students should recognize that this might not be possible in all cases. In addition, the educational needs of the Department may require the Graduate Curriculum Chair to ask students to fill specific TA positions.

NOTE: Students already enrolled in the Ph.D. program can choose to switch to the new guidelines, or continue under the current guidelines.

#### **VI. Learning Outcomes and Assessment**

A. The student will demonstrate the ability to apply graduate-level mathematics to the solution of engineering problems in at least two of the general areas of solid mechanics, fluid mechanics, dynamics and heat transfer.

Direct assessment: Student learning relative to this outcome is assessed by the student's performance on the written Ph.D. Qualifying exam.

Indirect assessment: A current and updated employment listing will serve as indirect evidence of student attainment of the learning goal.

B. The student will demonstrate the ability to conduct, present and defend graduate-level research including literature review, motivation, methodology utilized, results, unique contributions, and conclusions generated.

Direct assessment: Student learning relative to this outcome is assessed by the quality of the written dissertation and performance in the dissertation defense.

Indirect assessment: A current and updated employment listing will serve as indirect evidence of student attainment of the learning goal.

C. The student will demonstrate the ability to propose and present relevant graduate-level research including the description of importance of a problem, a literature review of potential topics where unique contributions can be made and anticipated methodology.

Direct assessment: Student learning related to this outcome is assessed by performance on the Candidacy Examination.

Indirect assessment: A current and updated employment listing will serve as indirect evidence of student attainment of the learning goal.