# Graduate Handbook
# for
# Mechanical Engineering

Department of Mechanical Engineering and Materials Science
Swanson School of Engineering
University of Pittsburgh

**Academic Year 2022-2023**

# Contents

# 1 Mechanical Engineering

The Mechanical Engineering program offers broad-based educational and research opportunities that apply the fundamentals mechanical engineering to the solution of real-world engineering problems. The program offers education and research at the cutting edge of thermal-fluid sciences, computational and data-enabled science and engineering, artificial intelligence and machine learning, solid mechanics, biomechanics, advanced manufacturing and design, and dynamic systems and control. Each graduate student's program is developed individually within very broad limits and is carefully designed to focus on his or her individual interests and chosen field of specialization.

The range of research programs in the department reflects the broad spectrum of faculty interest. Importantly, the fundamentals of mechanical engineering is a unifying thread. Department research investigates basic phenomena and develops fundamental methods and tools to address the hardest technological and social challenges.

**Contact**

ME Graduate Director: Inanc Senocak, PhD
1105 Benedum Hall
phone: 412-624-5430
E-mail: senocak@pitt.edu

MEMS Graduate Administrator: Richard Mishler
636D Benedum Hall
phone: 412-624-9722
E-mail: rim76@pitt.edu

# 2 Doctor of Philosophy Program

The aim of the doctoral program is to develop individuals to be independent researchers and to prepare them for careers in research. Students learn how to conduct research at development to solve cutting-edge technology problems. This work requires a strong background in the fundamentals of engineering with a focus on a specialty area of interest to the student. The program is flexible to meet the needs of PhD students' research interests under the guidance of their PhD advisors. The program's primary emphasis is on innovative and distinctive research at the forefront of engineering, science, and technology. Students wishing to pursue the PhD should have an outstanding academic background and a desire and ability to carry out original research. As the studies progress, students develop an understanding at the highest level in their area of specialization that must lead to an original contribution to the field in the PhD dissertation. PhD students here are given independence and responsibility. They are not only encouraged, but are expected to, develop research ideas, which they propose and defend. They work closely with their faculty research advisors and participate in research addressing relevant engineering problems. To supplement their research, students take advanced courses in areas related to their research work. Candidates for the PhD degree achieve a high level of proficiency through this advanced course work and individual study in their research and related areas.

## 2.1 Admission

A bachelor's or master's degree holder applying to the program must have a QPA equal to or higher than 3.3 (B+) or equivalent. Students who do not meet this requirement may be able to

enter the program based on experience demonstrating their excellence, as evaluated by the Graduate Committee.

In some cases, depending on previous background and quality point average (QPA) or cumulative grade point average (CGPA), students may be admitted initially on a provisional basis. This usually requires students to secure grades of 3.3 (B+) or better in courses that are required to obtain a better background courses as deemed necessary by the Graduate Admissions Committee.

The PhD student is expected to attend full time. It is possible, however, to seek candidacy as a part-time student provided the PhD students spends at least one full-time academic year on campus.

## 2.2 Plan of Study

During the first term in the doctoral program the student must submit a plan of study for approval by the Graduate Committee. This plan of study should be prepared under the guidance of the student's major advisor.

### 2.2.1 Course requirements

Completion of the PhD program requires a total of 72 credits of which

- At least 36 credits must be didactic (classroom based) courses
  - ME 2095/2097/3095 do not count as didactic courses
  - Only one professional preparation course (ME/ENGR 2052 or ME 3100) may count toward the 36 credits didactic coursework requirement
- At least 18 credits of dissertation research consisting of
  - ME 3997 - Research, PhD, (must be taken before admission to PhD candidacy) or
  - ME 3999 - PhD Dissertation (must be taken after admission to PhD candidacy, **minimum 12 credits of ME 3999** are required to meet graduation requirements)
- All full-time students must enroll in ME 2085 Graduate Seminar and attend the seminars in each semester. Students who have teaching assistant duties or conflict with other graduate classes can request an excuse to not register for ME 2085 in the semester of the conflict

**PhD candidates who met all credit requirements as outlined above but have not completed their research should enroll in zero-credit Full Time Dissertation Hour (FTDH) until their final defense and graduation.**

Up to 30 credits may be transferred for a prior MS degree in an engineering closely related field. Up to 6 credits of graduate courses taken during the undergraduate education can be transferred toward PhD course requirements. However, those 6 credits must not be counted toward the undergraduate degree. Students must initiate course transfers in their first semester. Other requirements apply depending upon the student's path to the PhD degree as detailed below:

**Direct entry to the PhD program with a BS degree:** Students who are admitted to the PhD program directly after completing their BS degree must meet the following course requirements in addition to the general course requirements.

- At least 18 course credits (six courses) must come from mechanical engineering (ME) specific didactic graduate courses. The following professional preparation courses do not count toward ME-specific courses:

  - ME/ENGR - Technical Communications
  - ME 3100 - Engineering Research Leadership and Management
  - ME 2095/3095 Graduate Projects
  - ME 2097 Special Study
- At least one of the following mathematics courses:
  - ME 2001 - Differential Equations
  - ME 2002 - Linear and Complex Analysis
  - ME/ECE - 2646 Linear System Theory [1]

**Entry to the PhD program with an MS degree:** Students who have completed a masters degree in an engineering or a closely related field [2] must meet the following requirements:

- At least 12 course credits (four courses) must be earned through didactic graduate courses and completed within the first year with a QPA of 3.3 or higher.
- Students holding an **MS degree in a field not related to mechanical engineering** must complete at least 12 credits from ME-specific graduate didactic courses with a minimum QPA of 3.3 or higher in their first year.
- The following professional preparation courses do not count toward the minimum 12 graduate course credits requirement:
  - ME/ENGR 2052 - Technical Communications
  - ME 3100 - Engineering Research Leadership and Management
- Students who have not taken an equivalent graduate-level mathematics course are required to take one of the following mathematics courses:
  - ME 2001 - Differential Equations
  - ME 2002 - Linear and Complex Analysis
  - ME/ECE - 2646 Linear System Theory[1]

### 2.2.2 QPA requirement

Students must maintain a minimum cumulative QPA of 3.30 in courses to be eligible to take the preliminary and comprehensive examinations and to graduate.

Quality Point Average (QPA) and Grade Point Average (GPA) are numerical indications of a student's academic achievement. QPA is the average of letter grades earned toward a degree, whereas GPA is the average of total letter grades earned.

## 2.3 Doctoral Committee

Before admission to candidacy for the PhD degree, the student's major advisor will work with the student to propose a dissertation committee. This committee must review and approve the proposed research project before the student may be admitted to candidacy. This doctoral committee has the responsibility to advise the student during the progress of the candidate's research and has the authority to require high quality research and/or the rewriting of any portion or all of the dissertation. It conducts the final oral examination and determines whether the dissertation meets acceptable standards.

[1] typically recommended for students studying in the *Dynamics Systems and Control* area

[2] e.g., Aerospace Engineering, Engineering Mechanics, Instrument Science and Engineering, Vehicle Engineering, Mechatronics Engineering, Energy and Power Engineering, Nuclear Engineering

The doctoral committee must consist of a minimum of four current members of the graduate faculty. The graduate faculty roster can be found at this **link**. At least three of these graduate faculty members, including the major advisor, must be from the Mechanical Engineering Faculty in the Department of Mechanical Engineering and Materials Science. At least one of the committee members (i.e. external member) must be a graduate faculty whose primary appointment is outside of the MEMS department. The external member can be from a different university that has a similar graduate program. The majority of the committee, including the major adviser, must be full or adjunct members of the Graduate Faculty. Other graduate and non-graduate faculty members may also serve on the committee provided that aforementioned criteria on the composition of the committee is met.

Meetings of the doctoral candidate and his/her dissertation committee must occur at least annually from the time the student gains admission to doctoral candidacy. During these meetings, the committee should assess the student's progress toward degree and discuss objectives for the following year and a timetable for completing degree requirements.

## 2.4 Course of Study

### 2.4.1 PhD Qualifying Exam (preliminary evaluation)

The PhD Qualifying Exam or preliminary evaluation is designed to assess the breadth of the student's knowledge of the discipline, the student's achievement during the first year of graduate study, and the potential to apply research methods independently. The qualifying exam must be attempted in the first year after the student begins the PhD program. The student must be enrolled or have completed a minimum of 12 credits of coursework before taking the qualifying exam. Special students (less prepared) may delay until the second year if the PhD advisor petitions the Graduate Committee.

The evaluation is used to identify those students who may be expected to complete a doctoral program successfully and to reveal areas of weakness in the student's preparation. The qualifying exam in the mechanical engineering PhD program is a two-component examination that includes the submission of a **written research proposal** to an examining committee and a **formal oral presentation** on the proposed research with a **period of open questioning** by an examining committee. This period of open questioning may include topics relevant to achieving a PhD degree in the chosen field of study by the examining committee as it evaluates the student's case toward PhD candidacy.

**Guidelines and detailed instructions for the PhD Qualifying Exam are available at the end of this handbook**.

### 2.4.2 Comprehensive Examination & Dissertation Proposal

The comprehensive examination and dissertation proposal may be separate examinations, but are often combined. Note that the dissertation proposal is separate from the student-driven research proposal that is part of the PhD qualifying exam that takes place in the first year of the PhD program.

**Comprehensive Examination** The Comprehensive Examination assesses the student's mastery of mechanical engineering doctoral study, the student's acquisition of both depth and breadth in mechanical engineering, and the ability to use the research methods of the discipline.

The timing of the Comprehensive Examination should meet the following guidelines:

- It should be administered at approximately the time of the completion of the formal course requirements with a cumulative QPA of at least 3.30.
- It should be passed at least one (1) full term after successfully completing the Preliminary Examination (Qualifier).
- It should be passed at least eight (8) months before the scheduling of the final oral examination and dissertation defense.
- In no case may the comprehensive examination be taken in the same term in which the student is graduated.

A copy of the comprehensive exam document, signed by the major advisor, must be submitted to the ME Graduate Office. Examination results must be reported promptly to the Dean's office but no later than the last day of the term in which the examination is administered.

**Dissertation Research Proposal** Each student must prepare a dissertation proposal for presentation to the doctoral committee at a formal dissertation overview or prospectus meeting. The proposal requires the student to carefully formulate a plan for his or her doctoral research. The overview and prospectus meeting lets the doctoral committee members provide guidance in shaping the conceptualization and methodology of that plan.

The members of the doctoral committee will review the proposal and either reject, suggest revisions to the plan, or accept the proposed research project. The doctoral committee must unanimously approve the dissertation research topic, plan, and proposal before the student may be admitted to candidacy for the doctoral degree. Approval of the proposal does not imply either the acceptance of a dissertation prepared in accord with the proposal or the restriction of the dissertation to this original proposal.

The student is responsible for ensuring that all appropriate regulatory approvals are obtained for the proposed research. For example, if the research proposed in the overview or prospectus involves human subjects, that proposed research must be approved by the University Institutional Review Board (IRB) before it may be carried out.

The dissertation proposal should be scheduled as soon as the candidate is prepared to present his or her proposal, since there must be at least two full terms between its successful completion and the Final Oral Examination (dissertation defense).

### 2.4.3 PhD Candidacy

Admission to candidacy for the Doctor of Philosophy degree constitutes a promotion of the student to the most advanced stage of graduate study and provides formal approval to devote essentially exclusive attention to the research and the writing of the dissertation. To qualify for admission to candidacy, students must meet the following criteria:

- be in full graduate status,
- passed the preliminary examination (qualifier),
- have completed formal course work with a minimum QPA of 3.30,
- have passed the comprehensive examination, and
- have received approval of the proposed subject and plan of the dissertation from the doctoral committee following an overview or prospectus meeting of the committee.

Admission to candidacy is a prerequisite to registration for dissertation credits, ME 3999 PhD Dissertation. PhD students need a minimum 12 credits of ME 3999, which can be taken in one semester.

#### 2.4.4 Final Oral Examination (Dissertation Defense)

This is the final examination of the PhD program, conducted by the doctoral committee, in which the student defends the validity of and the contributions made by his or her dissertation research as well as his or her ability to comprehend, organize, and contribute to the chosen field of research. The examination needs not be confined to materials in and related to the dissertation. It is the student's responsibility to check all pertinent dates for graduation and plan the defense date as early as possible in coordination with the dissertation committee. One copy of the dissertation must be submitted to each member of the doctoral committee at least two weeks before the date set for the final oral examination. Other qualified individuals may be invited by the committee to participate in the examination. This examination begins with a seminar presented by the student that is open to all members of the University. Therefore the date, place, and time of the examination should be published at least a week in advance by submitting the dissertation title and abstract to the ME Graduate Administrator. Only members of the doctoral committee may vote on whether the candidate has passed the examination. The student must be registered in the term in which the degree is granted. Students who have met the minimum 72 credits requirement can enroll in zero-credit Full-Time Dissertation Study (FTDH)

### 2.5 PhD Dissertation

Each student must prepare a dissertation embodying an extended original, independent investigation of a problem of significance in the student's field of specialization. The dissertation must add to the general store of knowledge or understanding in that field. After the dissertation has been prepared and approved by the major advisor, the final oral examination shall be held. Non-native English speakers are encouraged to take ENGR 2050 Technical Writing early in their graduate study (however this course does not count toward graduation).

#### 2.5.1 Dissertation Copies

Dissertations should be submitted in accordance with the Electronic Thesis and Dissertation guidelines: https://etd.pitt.edu/. After the final oral examination is successfully completed, the candidate must have their dissertation reviewed by the school before it can be submitted to the graduate school.

The student's committee should have completed the PhD rubric sheet (sample in the appendix) and returned it to the Graduate Administrator.

## 3 Master of Science Program

The goal of the Master of Science (MS) program is for the student to develop an advanced understanding in a specific area of interest. Students can tailor their individual MS program to emphasize different aspects of science and engineering. The Department offers MS degree programs that have two tracks: a professional track and a research/thesis track.

### 3.1 MS Research/Thesis Track

The Research MS Track is designed for individuals seeking an in-depth research experience in mechanical engineering. Students are required to identify a major advisor who is willing to advise them on a research project of mutual interest. Students are strongly encouraged to identify a major research advisor as soon as they are admitted to the program, ideally with the first semester of

joining the program. Students will gain a deep understanding of their area of interest through an extended research project. This option is particularly appropriate for students interested in pursuing a PhD degree and/or involving in a research and development career in the industry. Students working under the MS research option are required to conduct a thesis project and present and defend a thesis that demonstrates marked attainment and mastery in some area of the student's major subject, as well as acquisition of the methods and techniques of scientific investigation.

### 3.1.1 Admissions

A bachelor's or master's degree holder applying to the program must have QPA equal to or higher than 3.0 (B) or equivalent. Students who do not meet this requirement may be able to enter the program based on experience demonstrating their excellence, as evaluated by the Graduate Committee.

In some cases, depending on previous background and QPA, students may be admitted initially on a provisional basis. This usually requires students to secure grades of 3.0 (B) or better in courses that are required to obtain a better background in mechanical engineering and/or other graduate-level courses as deemed necessary by the Graduate Admissions Committee.

### 3.1.2 Plan of Study

During the first term in the master's program the student must submit a plan of study for approval by the department. This plan of study should be prepared under the guidance of the student's major advisor. Students could also choose one of the study tracks planned for the professional MS degree (see Appendix D) and tailor it to meet their goals under the guidance of their major advisor.

### 3.1.3 Credit requirements

Completion of the MS Research/Thesis track requires a total of 30 credits of which

- At least 24 credits must be from didactic (classroom based) courses
  - At least one of the courses must be a mathematics course from the following list:
    - ME 2001 - Differential Equations
    - ME 2002 - Linear and Complex Analysis
    - ME/ECE - 2646 Linear System Theory[3]
  - At most 9 credits may be from courses taken from other engineering, mathematics, or physics departments.
- At least 6 credits must be ME 2999 - MS Thesis

In addition, each full-time MS student is required to register for ME 2085 - Graduate Seminar during each fall and spring terms.

### 3.1.4 QPA requirement

Students must maintain a minimum cumulative QPA of 3.0.

Quality Point Average (QPA) and Grade Point Average (GPA) are numerical indications of a student's academic achievement. QPA is the average of letter grades earned toward a degree, whereas GPA is the average of total letter grades earned.

[3] typically recommended for students studying in the Dynamics Systems and Control area

### 3.1.5 Master's Thesis

Each student must prepare a thesis embodying an extended investigation of a problem of significance in the student's field of specialization. The thesis must add to the general store of knowledge or understanding in that field. After the thesis has been prepared and approved by the major advisor, the final oral examination shall be held. Non-native English speakers are encouraged to take ENGR 2050 Technical Writing (however this course does not count toward graduation).

### 3.1.6 Thesis Copies

Theses should be submitted in accordance with the Electronic Thesis and Dissertation guidelines: https://etd.pitt.edu/. After the final oral examination is successfully completed, the candidate must have their thesis reviewed by the school before it can be submitted to the graduate school.

The student's committee should have completed the MS rubric sheet (sample in the appendix) and returned to the Graduate Administrator.

## 3.2 MS Professional Track

The Professional MS program is a course-only, non-thesis MS program designed for individuals seeking advanced study in mechanical engineering. The program is convenient for part-time students currently working in industry.

### 3.2.1 Admissions

A bachelor's or master's degree holder applying to the program must have cumulative grade point average (QPA) equal to or higher than 3.0 (B) or equivalent. Students who do not meet this requirement may be able to enter the program based on experience demonstrating their excellence, as evaluated by the Graduate Committee.

In some cases, depending on previous background and QPA, students may be admitted initially on a provisional basis. This usually requires students to secure grades of 3.0 (B) or better in courses that are required to obtain a better background in materials science and engineering and/or other graduate-level courses as deemed necessary by the Graduate Admissions Committee.

### 3.2.2 Plan of Study

Upon admission or within the first term in the MS program, students must select one of the following study tracks offered by the MEMS department and complete the course requirements

- Advanced Manufacturing and Design
- Computational and Data-enabled Science and Engineering
- Controls
- Dynamic Systems
- Fluids Engineering
- Thermal Engineering
- Solid Mechanics

Course plans for each of the track are included in the Appendix D of this handbook. Students are required to inform the Graduate Administrator of their track selection.

Students should consult with their faculty advisor for track selection as well as any technical electives they plan to choose as part of their track.

#### 3.2.3 Course requirements

Completion of the MS program requires a total of 30 didactic (classroom based) course credits. At least one of the courses must be a mathematics course from the following list:

- ME 2001 - Differential Equations
- ME 2002 - Linear and Complex Analysis
- ME/ECE - 2646 Linear System Theory[4]

Of the 30 credits, at most 9 credits may be from courses taken from other engineering, mathematics, or physics departments.

#### 3.2.4 QPA requirement

Students must maintain a minimum cumulative QPA of 3.0.

Quality Point Average (QPA) and Grade Point Average (GPA) are numerical indications of a student's academic achievement. QPA is the average of letter grades earned toward a degree, whereas GPA is the average of total letter grades earned.

## 4 Academic Integrity

Students are expected to read and abide by the Academic Integrity Code of the University of Pittsburgh.

Students have rights under the Guidelines on Academic Integrity. If matters cannot be resolved between the student and professor, the matter will be referred next to the Department Chair, followed by the Associate Dean of Academic Affairs, and ultimately the University, if resolutions are not met at the lower levels. Sanctions range from receiving zero grade on an assignment to dismissal from the University, depending upon the seriousness of the offense.

It is the student's responsibility to familiarize themselves with forms of violations of academic integrity. Some examples include plagiarism, unauthorized sharing of computer code or other work, receiving or giving unauthorized aid from/to other students.

Students should assume that they are to perform independent work, unless otherwise authorized by the faculty. If there is any confusion, please consult the faculty for guidance.

### 4.1 Student Obligations

A student has an obligation to exhibit honesty and to respect the ethical standards of the profession in carrying out his or her academic assignments. Without limiting the application of this principle, a student may be found to have violated this obligation if he or she:

1. Refers during an academic evaluation to materials or sources, or employs devices, not authorized by the faculty member.
2. Provides assistance during an academic evaluation to another person in a manner not authorized by the faculty member.
3. Receives assistance during an academic evaluation from another person in a manner not authorized by the faculty member.
4. Engages in unauthorized possession, buying, selling, obtaining, or use of a copy of any materials intended to be used as an instrument of academic evaluation in advance of its administration.

[4] typically recommended for students studying in the Dynamics Systems and Control area

5. Acts as a substitute for another person in any academic evaluation process.
6. Uses a substitute in any academic evaluation proceeding.
7. Practices any form of deceit in an academic evaluation proceeding.
8. Depends upon the aid of others in a manner expressly prohibited by the faculty member, in the research, preparation, creation, writing, performing, or publication of work to be submitted for academic credit or evaluation.
9. Provides aid to another person, knowing such aid is expressly prohibited by the faculty member, in the research, preparation, creation, writing, performing, or publication of work to be submitted for academic credit or evaluation.
10. Presents as one's own, for academic evaluation, the ideas, representations, or words of another person or persons without customary and proper acknowledgment of sources.
11. Submits the work of another person in a manner which represents the work to be one's own.
12. Knowingly permits one's work to be submitted by another person without the faculty member's authorization.
13. Attempts to influence or change one's academic evaluation or record for reasons other than achievement or merit.
14. Indulges, during a class (or examination) session in which one is a student, in conduct which is so disruptive as to infringe upon the rights of the faculty member or fellow students.
15. Fails to cooperate, if called upon, in the investigation or disposition of any allegation of dishonesty pertaining to a fellow student.
16. Violates the canons of ethics of mechanical engineering.

# A PhD Qualifying Exam Guidelines

See next page.

# General Guidelines for the ME PhD Qualifying Exam

The PhD Qualifying Exam or preliminary evaluation is designed to assess the breadth of the student's knowledge of the discipline, the student's achievement during the first year of graduate study, and the potential to apply research methods independently. The evaluation is used to identify those students who may be expected to complete a doctoral program successfully and to reveal areas of weakness in the student's preparation.

The qualifying exam in the mechanical engineering PhD program is a two-component examination that includes the submission of a **written research proposal** to an examining committee and **a formal oral presentation** on the proposed research with **a period of open questioning** by an examining committee. *This period of open questioning may include topics relevant to achieving a PhD degree in the chosen field of study by the examining committee as it evaluates the student's case toward PhD candidacy.*

## Scheduling

*The qualifying exam will be offered in the fall and spring semesters of the 2020-2021 Academic Year.*

A student should take the exam as soon as he/she has completed the necessary coursework and other preparations such as minimum average quality point average (QPA) greater than 3.3, and involvement of some research activities. The qualifying exam must be attempted in the first year after the student begins the PhD program. The student must be enrolled or have completed a minimum of 12 credits of coursework before taking the qualifying exam. In no case shall a student be admitted to PhD candidacy before successfully completing the qualifying exam.

At the beginning of each spring semester, all ME graduate students will be invited to inform the PhD Qualifying Exam Coordinator and the Graduate Coordinator if they are going to take the PhD Qualifying Exam that semester. A timeline for the qualifying exam in that semester will be available as part of this invitation. If a student intends to take the exam that semester, he/she must consult with their PhD advisor and fill the application form and submit it to the PhD Qualifying Exam Coordinator according to the announced timeline.

A student on provisional, inactive, or special status or on probation or has a QPA less than 3.3 is not eligible to take the PhD Qualifying Exam.

## General Information

The PhD Qualifying Exam (preliminary evaluation) is a crucial aspect of the PhD program in that it is intended to evaluate a student's engineering knowledge, ability to conduct independent research, and capacity for critical thinking. Therefore, the ideas and content of the proposal must be the student's work. ***It will be deemed an honor violation if a student solicits or receives help on any of the specific technical points of the research proposal.*** Special consideration is given for department sanctioned seminars and help sessions for this exam.

All ME faculty members are encouraged to attend the exams and any SSOE faculty member may attend. A student's entire exam shall be closed to other students.

## Formation of the Examining Committee

An Examining Committee will be appointed each year by the ME Graduate Committee for each of the following tracks:

1) Dynamic Systems and Control
2) Heat Transfer and Thermal sciences
3) Solid Mechanics and Biomechanics
4) Design and Manufacturing
5) Computational Methods
6) Fluid Mechanics

Students, in consultation with their advisor, must choose a track that is closely related to their intended area of PhD dissertation research. The examining committee consists of a minimum of three faculty members and **should not include the advisor of the student**. All members of the examining committee must be present at the oral exam.

## Format of the PhD Qualifying Exam

The PhD qualifying examination is a research proposal in a general topic area suited to each student's anticipated research project. The student will write a technical report and then present the report orally. The oral exam consists of a 30-minute presentation by the student and oral questions about the proposal and related core course material by the examining committee. The anticipated duration for the entire exam is 90 minutes. If needed, the examining committee can consult the advisor on proper questions on the subject.

**Topic:** The topic for the research proposal should be in the same general field as the student's PhD research but not exactly the same as their specific PhD dissertation topic. The topic cannot be a prior MS thesis or undergraduate project or a proposal from the ME 3100 class. Appropriate topic descriptions should be developed by the student in consultation with their PhD advisor as a technical abstract (*maximum 250 words*) and submitted to the qualifying exam committee for review in advance. Both the student and the advisor must attest the originality of the proposed topic. After the committee reviews the submitted topic and, if needed, makes a change to it, the committee notifies the final topic of the qualifying exam to the student.

**Written Research Proposal:** The student will then write a document on the topic agreed to by the Committee. **The written report must be submitted to the examination committee chair at least one week prior to the oral presentation.** The written document should be no more than 10 pages long (the format and content of the written document are detailed in the section titled *Student Guidelines for the Written Research Proposal* at the end of this document). The Committee will then review the submitted document and decide if the student should progress to the oral exam stage. The review of the written document must be formally completed by the examining committee before the start of the oral exam.

A student must pass both the written proposal and oral presentation parts of the exam. These will be evaluated separately and in sequence. **The written proposal is a gateway to the oral presentation, and if a student fails the written proposal, they have failed the exam.** A student has two attempts to pass the qualifying exam, and on the second attempt the student may

submit the written proposal from their first attempt with revisions or may submit a new original proposal. A second attempt would occur in the following semester.

**Timing of first attempts:** The qualifier is given at least once per year at the end of the spring term – all new PhD degree students entering the fall term must take the exam in the spring term of the first year. Special students (less prepared) may delay until the second year if the advisor petitions the Graduate Committee. For students starting in the spring term, the first attempt can be in November (along with any second attempt students).

**Timing of second attempts:** If the student does not pass the exam in the first attempt, a retake is allowed if the advisor petitions the graduate committee and commits to continuing to support the student for the second year. If the petition is accepted, the second attempt can occur in the spring semester or the fall semester. The committee of the second attempt must include the previous year's examining committee chair.

## Evaluation and Outcomes of the Exam

The Examining Committee shall assess the student's performance in three areas:

1) Written research proposal,
2) Oral presentation,
3) Performance during the oral examination.

Each member of the examining committee must complete the standard *Evaluation Form for the ME PhD Qualifying Exam.*

The 30-minute oral presentation will be followed by a maximum of one-hour question/answer session conducted by the Examining Committee. Performance on the oral exam will be evaluated based on the technical content of the presentation and how well the student responds to questions from the examining committee.

## Outcomes of the Exam

The examining committee shall recommend the "Pass" or "Fail" outcome to the PhD Qualifying Exam Coordinator for the academic year. The ME Graduate Committee is the final arbiter regarding the Ph.D. Qualifying Exam.

## Student Guidelines for the Written Research Proposal

Your research proposal should consist of three major parts: a Project Summary, a Project Description, and References. In addition, your proposal should have a cover page with your project title, your name, name of your PhD advisor, and the specific track you have selected for your qualifying exam. Use single-spaced, 12-pt Times New Roman font, and 1-inch margins on all sides a letter-sized paper consistently throughout the main body of document. Figures and tables should be appropriately sized and carefully captioned. The font size of tables and figures and their captions can be smaller than the standard font size of the main text. A larger font size can be used for section titles. Project summary should not exceed one page. The project description should be limited to 10 pages including figures, tables. References are not included in the 10-page limit.

**Project Summary:** (*maximum one page*)

Your proposal must contain a summary of the proposed science and/or engineering research project. The Project Summary consists of a concise *overview* of the project, an explanation of the *intellectual merit* of the proposed activity, and a statement on the *broader impacts* of the proposed research. The *overview* includes a description of the proposed activities and objectives, and the methods that will be used. The statement on *intellectual merit* should describe how the proposed work will advance knowledge in the field. The statement on *broader impacts* should describe the potential of the proposed research to benefit society.

**Project Description:** (*maximum ten pages, including figures and tables, excluding citations*)

The *Project Description* should provide a clear statement of the work to be undertaken. In the first part of *Project Description*, a discussion of the present state of knowledge in the field and the important technical challenges remaining is required (*Background* or *Literature Review*). The *Project Description* should include the motivation showing why the proposed work is of general importance. The *Project Description* should also describe, in sufficient detail, the plan of work and its objectives, the specific activities to be undertaken, and the experimental methods and/or theoretical/computational techniques and/or the methods of interpretation that will be used. Each method must be explained in terms of why it was selected and how the data will be analyzed and interpreted. The student must clearly establish what the student proposes to do, why the student wants to do it, how the student plans to do it, how success will be measured, and what the benefits will be if the project is successful. The benefits of the project could include, for instance, improved fundamental technical understanding, potential scientific/engineering breakthroughs, and a positive impact on society as a whole.

**References:** (*no page limit*)

Literature reviewed, online resources, software and data repositories that have been discussed in the project description should be properly cited. Students should select a referencing style used in a representative journal of the field of research and apply it consistently. Use of a reference manager such as EndNote or Bibtex is highly recommended.

**Academic Integrity and Avoiding Plagiarism:** The writing must represent student's own original work. Student must paraphrase information from textbooks or research articles into their own writing. All sources and statements must be properly cited. **Students are required to enroll**

**in the University's online Academic Integrity Canvas Course & Badge** available at the following link: https://pitt.libguides.com/academicintegrity/plagiarism

**Plagiarism Checking:** Students are required to submit a plagiarism report obtained from an online plagiarism detection software that allows uploading a written document and checking it against a massive record of published material. This report must be submitted along with the written research proposal. The University recommends iThenticate. Students can register for an account at the following link: https://www.osp.pitt.edu/ithenticate. Turnitin is also another acceptable option for plagiarism checking. https://www.etskb-fac.cidde.pitt.edu/other-applications/turnitin/

# B Admission to Candidacy Form

See next page.

**APPLICATION FOR ADMISSION TO CANDIDACY FOR DOCTORAL DEGREE**

**SWANSON SCHOOL OF ENGINEERING -- UNIVERSITY OF PITTSBURGH**

***PLEASE PRINT OR TYPE ALL ENTRIES***

| NAME OF APPLICANT | PSID | DEPARTMENT |
|---|---|---|
| | | |

**PART I (To be completed by the applicant). When approved, copies will be forwarded to the adviser and departmental office.**

I hereby petition the Graduate Faculty of the Swanson School of Engineering to be admitted to candidacy for the degree of Doctor of Philosophy. I have successfully completed all prerequisites of admission of candidacy: the Ph.D. Comprehensive Examination, the Non-Engineering Minor Requirement, and any Special Departmental Requirement.

It is requested that Professor_____be designated as my major advisor to direct my research and the preparation of my doctoral dissertation. My proposed subject of research is:

_____

_____

I will work with my proposed major advisor on a dissertation proposal and present my plan of research to the Doctoral Committee at a Dissertation Proposal Conference.

I understand that no final action will be taken until the Doctoral Committee approves my dissertation proposal.

| APPLICANT'S SIGNATURE AND DATE | ADDRESS |
|---|---|
| | |

| ROUTING INSTRUCTIONS-AFTER PART 1 IS COMPLETED BY THE APPLICANT AND THE SIGNATURE OF THE GRADUATE COORDINATOR IS OBTAINED, FORWARD THE APPLICATION TO THE PROPOSED MAJOR ADVISOR. | CERTIFIED DEPARTMENTAL GRADUATE COORDINATOR SIGNATURE |
|---|---|

**PART II (To be completed by the major advisor and members of the proposed doctoral committee).**

This will indicate my willingness to serve as the major advisor and chair of the Doctoral Committee for the applicant. The subject of the proposed research is acceptable to me. I recommend that the following persons be appointed to serve as the Doctoral Committee for this student.

| NAMES OF FACULTY MEMBERS | DEPARTMENT AFFILIATION |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

| ROUTING INSTRUCTIONS- FORWARD THE APPLICATION TO THE ASSOCIATE DEAN FOR GRADUATE PROGRAMS. COPY WILL BE RETURNED TO THE GRADUATE COORDINATOR AFTER THE COMMITTEE IS APPROVED. | SIGNATURE OF MAJOR ADVISOR AND DATE |
|---|---|
| | SIGNATURE OF DEPARTMENT CHAIR AND DATE |

**ACTION ON PROPOSED DOCTORAL COMMITTEE**

_____

_____

_____

_____

_____

_____

_____

**ASSOCIATE DEAN FOR GRADUATE PROGRAMS AND DATE**

_____

| NAME OF APPLICANT | DEPARTMENT |
|---|---|
| | |

**PART III (To be completed by the members of the Doctoral Committee at the conclusion of the Dissertation Proposal Conference).**

To – Members of the Proposed Doctoral Committee

On the recommendation of Professor_____, your services are requested as members of the Doctoral Committee, under their chairship, for the applicant who has petitioned for admission to candidacy for the Doctor of Philosophy degree.

Based on your judgement of the student's progress and their presentation of the Dissertation Proposal, please indicate below "Yes" or "No" on the line with your signatures, your replies to the two questions concerning the application:

(1) Do you recommend that this student be admitted to the Ph.D. candidacy?

(2) Are you willing to accept membership of his/her Doctoral Committee?

| (1) YES OR NO | (2) YES OR NO | SIGNATURES OF COMMITTEE MEMBERS | DATES |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Note: Committee members who do not approve this application or who are unwilling or unable to serve on this committee may (if they wish) forward comments directly to the Associate Dean for Graduate Programs, Swanson School of Engineering.

ROUTING INSTRUCTIONS- AFTER PART III IS COMPLETED: THE MAJOR ADVISOR WILL FORWARD APPLICATION TO THE ASSOCIATE DEAN FOR GRADUATE PROGRAMS FOR FINAL ACTION.

**REMARKS AND ADDITIONAL INFORMATION**

**FINAL APPROVAL ON APPLICATION**

**ASSOCIATE DEAN FOR GRADUATE PROGRAMS AND DATE**

# C Graduate Engineering Action Form

See next page.

# GRADUATE ENGINEERING ACTION FORM

STUDENT'S NAME - LAST FIRST MI PEOPLESOFT ID

DEPARTMENT

## MASTER DEGREE PROGRAM

### STATUS

FULL PROVISIONAL

EFFECTIVE DATE (MONTH/DAY/YEAR)_____

_____

GRADUATE COORDINATOR/ADVISOR SIGNATURE

### COMPREHENSIVE EXAM

PASS FAIL

DATE OF EXAM (MONTH/DAY/YEAR)_____

_____

GRADUATE COORDINATOR/ADVISOR SIGNATURE

### FINAL DEFENSE (ORAL)

PASS FAIL

DATE OF ORAL (MONTH/DAY/YEAR)_____

_____

_____

_____

_____

_____

_____

CHAIR'S SIGNATURE

### NON-THESIS OPTION

### THESIS OPTION

TITLE: _____

_____

FORMAT APPROVED:

_____

REVIEWER DATE

COPY RECEIVED:

_____

GRADUATE COORDINATOR DATE

_____

OFFICE OF ADMINISTRATION DATE

## DOCTORAL DEGREE PROGRAM

### STATUS

FULL PROVISIONAL

EFFECTIVE DATE (MONTH/DAY/YEAR)_____

_____

GRADUATE COORDINATOR/ADVISOR SIGNATURE

### PRELIMINARY/QUALIFIER EXAM

PASS FAIL

DATE OF EXAM (MONTH/DAY/YEAR)_____

_____

GRADUATE COORDINATOR/ADVISOR SIGNATURE

### COMPREHENSIVE EXAM

PASS FAIL

DATE OF EXAM (MONTH/DAY/YEAR)_____

_____

GRADUATE COORDINATOR/ADVISOR SIGNATURE

### ADMISSION TO CANDIDACY

PASS FAIL

EFFECTIVE DATE (MONTH/DAY/YEAR)_____

_____

GRADUATE COORDINATOR/ADVISOR SIGNATURE

### FINAL DEFENSE

PASS FAIL

DATE OF ORAL (MONTH/DAY/YEAR)_____

_____

GRADUATE COORDINATOR/ADVISOR SIGNATURE

### DISSERTATION

TITLE: _____

_____

FORMAT APPROVED:

_____

REVIEWER DATE

COPY RECEIVED:

_____

GRADUATE COORDINATOR DATE

_____

OFFICE OF ADMINISTRATION DATE

### DEPARTMENTAL RELEASE

RETURNED ALL KEYS TO THE DEPARTMENT_____

VACATED ALL LAB AND OFFICE SPACE _____

CANCELLED ALL COMPUTER CHARGE NUMBERS_____

RETURNED ALL EQUIPMENT TO THE DEPARTMENT _____

APPROPRIATE DEPARTMENTAL SIGNATURES/DATE

# D Study Tracks for the Professional MS degree

Detailed plans for the following tracks are available in the next page.

- Advanced Manufacturing and Design
- Computational and Data-enabled Science and Engineering
- Controls
- Dynamic Systems
- Fluids Engineering
- Thermal Engineering
- Solid Mechanics

## Professional MS in Mechanical Engineering – Advanced Manufacturing & Design Track

The Advanced Manufacturing and Design track prepares the student for advanced manufacturing processes, design, metrology, materials, and data analytics. Core courses include design for additive manufacturing, smart manufacturing, additive manufacturing materials, metrology, and process control. The student will not only learn the fundamental principles but will also gain hands-on experience in manufacturing.

### Degree Requirements

Semesters with **red font** are courses that are offered every other year

| | |
|---|---|
| **Required core courses (12 credits)**<br>*Students must complete the following courses*<br><br>*Choose one of the following mathematics courses*<br>ME 2001 Differential Equations (recommended for Design focus) (Fall, Spring)<br>ME 2646 Linear System Theory (recommended for Process focus) (Fall)<br><br>*Complete the following three manufacturing courses*<br>ME 2081 Smart Manufacturing – Key to Innovations (Spring)<br>ME 2083 Introduction to Additive Manufacturing (Fall)<br>MSE 2120 Intro. to Additive Manuf. Materials (Spring) | 12 credits |
| **Advanced Manufacturing (AM) Electives**<br>*Choose two courses from the same focus area*<br><br>**Design Focus:**<br>ME 2047 Finite Element Analysis I (Fall)<br>ME 2086 Design and Mech. for 3D Printed Mat. and Struc. (Spring)<br>(*Prerequisite: ME 2047 Finite Element Analysis I*)<br><br>**Process Focus:**<br>ME 2045 Linear Control Theory (Fall)<br>ME 2088 Advanced Manufac. Metrology and Process Control (Fall)<br>(*Prerequisite: undergraduate level dynamic systems & control*) | 6 credits |
| **ME Technical Electives**<br>*Students can choose any graduate-level ME courses aligned with their technical interests in consultation with their advisors* | 3-12 credits |
| **Non-ME Technical Electives**<br>*Students can take up to 9 credits from other engineering, math, and science programs. Advisor's approval is needed.* | 0-9 credits |
| **Total (minimum)** | **30 credits** |

- Full-time status requires registration for minimum 9 credit hours per semester. Students cannot register for more than 15 credit hours.
- All full-time students must register for the zero credit ME 2085 Graduate Seminar course

## Suggested Technical Electives for Advanced Manufacturing Track

ME 2033 Fracture Mechanics for Product Design and Manufacturing
ME 2045 Linear Control Systems
ME 2046 Digital Control Systems
ME 2047 Finite Element Analysis I
ME 2227 Finite Element Analysis II
ME 2247 Introduction to Nonlinear Control Design
ME 2053 Heat and Mass Transfer
ME 2252 Conduction Heat Transfer
ME 2254 Convection Heat Transfer
ME 2256 Applied Computational Heat and Mass Transfer
ME 2005 Structure of Materials
ME 2009 Processing of Materials
MSE 2018 Kinetics in Materials Science
MSE 2041 Advanced Physical Metallurgy I
MSE 2055 Principles of Solidification Engineering
MSE 2046 Physical Metallurgy of Engineering Alloys

# Professional MS in Mechanical Engineering – Computational & Data-Enabled Engineering (CDEE) Track

Computational methods have made a huge impact on the solution of science and engineering problems governed by the laws of mechanics. This track prepares the student for the field of computational and data science in mechanical engineering. Students will develop competency in the areas of applied mathematics, computational methods, and data science. Students are expected to augment their computational competency through domain specific technical electives in mechanical engineering.

**Degree Requirements**

Semesters with **red font** are courses that are offered every other year

| | |
|---|---|
| **Required core courses (9 credits)**<br>*Students must complete the following courses*<br><br>*Choose one of the math courses from the following list:*<br>ME 2001 Differential Equations (Fall/Spring)<br>ME 2002 Linear and Complex Analysis (Spring)<br>ME/ECE 2676 Linear System Theory (Fall)<br><br>*Complete two courses from the following list:*<br>ME 2060 Numerical Methods (Spring)<br>ME 2063 Data-driven Modeling for Engineers (Spring)<br>ME 2300 Linear Algebra for Machine Learning (Fall) | 9 credits |
| **CDEE Track Electives**<br>*Choose two courses from the following list:*<br><br>ME 2054 Parallel Computing for Engineers (Fall)<br>ME 2055 Computer-aided Anal. Transport Phen. (Fall)<br>ME 2060 Numerical Methods (Spring)<br>ME 2061 Reduced-order Modeling (Fall)<br>ME 2063 Data-driven Modeling for Engineers (Spring)<br>ME 2300 Linear Algebra for Machine Learning (Fall)<br>ME 2047 Finite Element Theory I (Fall)<br>ME 2227 Finite Element Theory II (Spring)<br>ECE/ME 2671 Optimization (Fall)<br>ME 2256 Applied Comput. Heat & Mass Trans. (Spring) | 6 credits |
| **ME Technical Electives**<br>*Students can choose any graduate-level courses with the ME classification in consultation with their advisors.* | 6-15 credits |
| **Non-ME Technical Electives**<br>*Students can take up to 9 credits from other engineering, math, and science programs. Advisor's approval is needed.* | 0-9 credits |
| **Total (minimum)** | **30 credits** |

# Professional MS in Mechanical Engineering – Controls Track

The Controls track prepares the student for analysis and design of feedback control, estimation, and related systems. Core courses develop a foundation in analytical dynamics, classical and state space control, and linear system theory to prepare the student for advanced courses. Elective courses offer the opportunity to broaden perspectives in topics such as nonlinear controls, measurement systems, signal processing, digital and intelligent control systems, and fabrication of sensors and actuators.

## Degree Requirements

Semesters with **red font** are courses that are offered every other year

| | |
|---|---|
| **Required core courses (9 credits)**<br>*Students must complete the following courses*<br><br>ME 2045 Linear Control Systems (Fall)<br>ECE/ME 2646 Linear System Theory (Fall)<br>ME 2027 Advanced Dynamics (Spring) | 9 credits |
| **Dynamics Systems and Controls (DSC) Electives**<br>*Choose two courses from the following list:*<br><br>ME 2020 Mechanical Vibrations (Spring)<br>ME 2043 Machine Learning-based Methods for Dynamics and Control (Spring)<br>ME (ECE) 2046 Digital Control Systems (Spring)<br>ME 2082 Electromechanical Sensors and Actuators (Spring)<br>ME 2243 Bayesian Signal Processing (Spring)<br>ECE (ME) 2247 Introduction to Nonlinear Control Design<br>ME 2440 Fundamentals of Acoustics and Vibrations (Fall)<br>ME 2441 Measurement and Analysis of Random Data from Dynamical Systems (Fall) | 6 credits |
| **ME Technical Electives**<br>*Students can choose any graduate-level ME courses aligned with their technical interests in consultation with their advisors* | 6-15 credits |
| **Non-ME Technical Electives**<br>*Students can take up to 9 credits from other engineering, math, and science programs. Advisor's approval is needed.* | 0-9 credits |
| **Total (minimum)** | **30 credits** |

- Full-time status requires registration for minimum 9 credit hours per semester. Students cannot register for more than 15 credit hours.
- All full-time students must register for the zero credit ME 2085 Graduate Seminar course

**Suggested non-ME Technical Electives for Controls Track**

ECE 2372 Pattern Recognition,
ECE 2390 Image Processing and Computer Vision
ECE 2523 Digital Signal Processing,
ECE 2525 Detection Estimation Theory
ECE 2521 Analysis of Stochastic Processes
ECE 2555 Biomedical Signal Processing
ECE 2680 Adaptive Control
ECE 3650 Optimal control,
ECE/ME 2671 Optimization,
PHYS 2373 Mathematical Methods in Physics

# Professional MS in Mechanical Engineering – Dynamic Systems Track

Dynamic Systems (DS) track prepares the student for analysis and design of dynamical systems. Foundation courses focus on the solution of ordinary and partial differential equations, mechanical vibrations, and advanced Newtonian and analytical dynamics. Elective courses offer the opportunity to broaden perspectives in topics such as controls, acoustics, signal processing, and fabrication of sensors and actuators.

## Degree Requirements

Semesters with red font are courses that are offered every other year

| | |
|---|---|
| **Required core courses (12 credits)**<br>*Students must complete the following courses*<br><br>ME 2001 Differential Equations (Fall) or ME 2002 Linear and Complex Analysis (Spring)<br>ME 2020 Mechanical Vibrations (Spring)<br>ME 2027 Advanced Dynamics (Spring) | 9 credits |
| **Dynamics Systems and Controls (DSC) Electives**<br>*Choose two courses from the following list:*<br><br>ME 2043 Machine Learning-based Methods for Dynamics and Control (Spring)<br>ME 2045 Linear Control Systems (Fall)<br>ME (ECE) 2046 Digital Control Systems (Spring)<br>ME 2082 Electromechanical Sensors and Actuators (Spring)<br>ME 2243 Bayesian Signal Processing (Spring)<br>ECE (ME) 2247 Introduction to Nonlinear Control Design<br>ME 2440 Fundamentals of Acoustics and Vibrations (Fall)<br>ME 2441 Measurement and Analysis of Random Data from Dynamical Systems (Fall) | 6 credits |
| **ME Technical Electives**<br>*Students can choose any graduate-level ME courses aligned with their technical interests in consultation with their advisors* | 6-15 credits |
| **Non-ME Technical Electives**<br>*Students can take up to 9 credits from other engineering, math, and science programs. Advisor's approval is needed.* | 0-9 credits |
| **Total (minimum)** | **30 credits** |

- Full-time status requires registration for minimum 9 credit hours per semester. Students cannot register for more than 15 credit hours.
- All full-time students must register for the zero-credit ME 2085 Graduate Seminar course.

**Suggested non-ME Technical Electives for Dynamic Systems Track**

ECE 2372 Pattern Recognition
ECE 2523 Digital Signal Processing
ECE 2525 Detection Estimation Theory
ECE 2521 Analysis of Stochastic Processes
ECE 2555 Biomedical Signal Processing
ECE 3650 Optimal Control
ECE/ME 2671 Optimization
PHYS 2373 Mathematical Methods in Physics

# Professional MS in Mechanical Engineering – Fluids Engineering Track

The Fluids Engineering track prepares the student for theoretical and computational analysis of flow physics in engineering systems. Technical electives offer the student the opportunity to develop new skills in computational analysis of transport phenomena and broaden their understanding of the role fluid mechanics play in other related fields, such as heat transfer and combustion.

## Degree Requirements

Semesters with **red font** are courses that are offered every other year

| | |
|---|---|
| **Required core courses (9 credits)**<br>*Students must complete the following courses*<br>ME 2001 Differential Equations (fall, spring)<br>ME 2003 Continuum Mechanics (fall)<br>ME 2074 Advanced Fluid Mechanics 1 (spring) | 9 credits |
| **Fluid Mechanics (FM) Electives**<br>*Choose at least one course from the following list:*<br>ME 2070 Microfluidics (fall)<br>ME 2075 Advanced Fluid Mechanics 2 (fall)<br>*Choose one course from the following list:*<br>ME 2055 Computer Aided Analysis of Transport Phenomena (fall)<br>ME 2256 Applied Computational Heat and Mass Transfer (spring)<br>ME 2056 Combustion (fall)<br>ME 2254 Convection Heat Transfer (spring) | 6 credits |
| **ME Technical Electives**<br>*Students can choose any graduate-level ME courses aligned with their technical interests in consultation with their advisors* | 6-15 credits |
| **Non-ME Technical Electives**<br>*Students can take up to 9 credits from other engineering, math, and science programs. Advisor's approval is needed.* | 0-9 credits |
| **Total (minimum)** | **30 credits** |

- Full-time status requires registration for minimum 9 credit hours per semester. Students cannot register for more than 15 credit hours.
- All full-time students must register for the zero credit ME 2085 Graduate Seminar course.

# Professional MS in Mechanical Engineering – Thermal Engineering Track

Thermal Engineering (TE) track prepares the student for analysis and design of heat transfer and energy conversion systems. Core courses develop a foundation in heat transfer process and classical thermodynamics to prepare the student for advanced courses. Elective courses offer the opportunity to broaden perspectives in topics such as advanced treatment of thermal conduction and convection, transport phenomena in micro and nanoscales, combustion process, and computational tools for thermal engineering.

## Degree Requirements

Semesters with **red font** are courses that are offered every other year

| | |
|---|---|
| **Required core courses (9 credits)**<br>*Students must complete the following courses*<br>ME 2001 Differential Equations (fall, spring)<br>ME 2050 Thermodynamics (spring)<br>ME 2053 Heat and Mass Transfer (fall) | 9 credits |
| **Thermal Engineering (TE) Electives**<br>*Choose at least one of the following:*<br>ME 2252 Conduction Heat Transfer (spring)<br>ME 2254 Convection Heat Transfer (spring)<br>*Choose one more course from the following list as needed:*<br>ME 2056 Introduction to Combustion (fall)<br>ME 2074 Advanced Fluid Mechanics 1 (spring)<br>ME 2055 Computer Aided Analysis of Transport Phenomena (fall)<br>ME 2256 Applied Computational Heat and Mass Transfer (spring)<br>ME 2257 Transport Phenomena in Nano-to-Micro Scale (fall) | 6 credits |
| **ME Technical Electives**<br>*Students can choose any graduate-level ME courses aligned with their technical interests in consultation with their advisors* | 6-15 credits |
| **Non-ME Technical Electives**<br>*Students can take up to 9 credits from other engineering, math, and science programs. Advisor's approval is needed.* | 0-9 credits |
| **Total (minimum)** | **30 credits** |

- Full-time status requires registration for minimum 9 credit hours per semester. Students cannot register for more than 15 credit hours per semester.
- All full-time students must register for the zero credit ME 2085 Graduate Seminar course.

# Professional MS in Mechanical Engineering – Solid Mechanics Track

The Solid Mechanics (SM) track prepares the student for stress, deformation and failure analysis of solid components and structures. Solid mechanics can encompass experimental, computational, and theoretical methods at the meso, micro and nano levels. Foundation courses focus on the solution of ordinary and partial differential equations, fracture mechanics, continuum mechanics, and advanced solid mechanics and finite element analysis. Elective courses offer the opportunity to broaden a professional student's perspectives in topics such as biomechanics, elasticity, manufacturing and mechanics of sensors and actuators.

## Degree Requirements

Semesters with **red font** are courses that are offered every other year

| | |
|---|---|
| **Required core courses (9 credits)**<br>*Students must complete the following courses*<br><br>ME 2001 Differential Equations (fall, spring)<br>ME 2022 Applied Solid Mechanics (fall)<br>ME 2047 Finite Element Theory (fall) | 9 credits |
| **Solid Mechanics (SM) Electives**<br>*Choose two courses from the following list:*<br>ME 2003 Continuum Mechanics (fall)<br>ME 2004 Elasticity (spring)<br>ME 2033 Fracture Mechanics (spring)<br>ME 2209 Soft Material Mechanics (spring)<br>ME 2227 Finite Element Theory 2 (spring)<br>ME 2086 Design and Mech. 3D Printed Materials and Struc. (spring) | 6 credits |
| **ME Technical Electives**<br>*Students can choose any graduate-level ME courses aligned with their technical interests in consultation with their advisors* | 6-15 credits |
| **Non-ME Technical Electives**<br>*Students can take up to 9 credits from other engineering, math, and science programs. Advisor's approval is needed.* | 0-9 credits |
| **Total (minimum)** | **30 credits** |

- Full-time status requires registration for minimum 9 credit hours per semester. Students cannot register for more than 15 credit hours per semester.
- All full-time students must register for the zero credit ME 2085 Graduate Seminar course.

# E Schedule of Frequently Offered Courses

The full list of graduate courses offered in mechanical engineering program can be found in this **link**. A tentative schedule of frequently offered courses is available in the next page. Please note that some courses may be canceled due to a lack student enrollment and faculty availability to teach a course.

Updated on April 12, 2023

## Frequently offered Mechanical Engineering Graduate Courses

†Offered every 2-3 years depending on student interest

*Offered every other year

| Fall Semesters | |
|---|---|
| **ME 2001** | Differential Equations |
| **ME 2003** | Continuum Mechanics |
| ***ME 2016** | Nonlinear Dynamical Systems I |
| **ME 2022** | Applied Solid Mechanics |
| ***ME 2023** | Tribology: The Study of Adhesion, Friction, Lubrication, and Wear |
| †**ME 2035** | Composite Materials |
| **ME 2045** | Linear Control Systems |
| **ME 2047** | Finite Element Analysis |
| ***ME 2054** | Parallel Computing for Engineers |
| **ME 2055** | Computer Aided Analysis of Transport Phenomena |
| †**ME 2056** | Intro to Combustion Theory |
| ***ME 2061** | Reduced Order Modeling for Engineering |
| †**ME 2070** | Microfluidics |
| †**ME 2075** | Advanced Fluid Mechanics 2 |
| **ME 2083** | Introduction to Additive Manufacturing |
| **ME 2088** | Advanced Manufacturing Metrology and Process Control |
| **ME 2255** | Two Phase Flow and Heat Transfer |
| ***ME 2257** | Transport Phenomena and Nano-To-Micro Scale |
| ***ME 2440** | Fundamentals of Acoustics and Vibration |
| ***ME 2441** | Measurement & Analysis of Random Data from Dynamical Sys. |
| **ME 2646** | Linear System Theory (*cross-listed with ECE*) |
| **ME2671** | Optimization Methods (*cross-listed with ECE*) |
| **ME 2901** | Introduction to Engineering Communication (1-credit) |

| | |
|---|---|
| †ME 3079 | Turbulence |
| *ME 3100 | Engineering Research Leadership and Management |
| | |

| Spring Semesters | |
|---|---|
| **ME 2001** | Differential Equations |
| **ME 2002** | Linear and Complex Analysis |
| ***ME 2004** | Elasticity |
| ***ME 2006** | Modeling Material Behavior |
| †**ME 2010** | Nanomechanics |
| †**ME 2011** | Fundamentals of Micro and Nanomanufacturing |
| **ME 2012** | Computational Materials Science |
| †**ME 2017** | Nonlinear Dynamical Systems II |
| **ME 2020** | Mechanical Vibrations |
| **ME 2027** | Advanced Dynamics |
| **ME 2033** | Fracture Mechanics |
| ***ME 2043** | Machine Learning-Based Methods for Dynamics and Control |
| ***ME 2046** | Digital Control Systems |
| ***ME 2050** | Thermodynamics |
| **ME 2053** | Heat and Mass Transfer |
| **ME 2060** | Numerical Methods |
| **ME 2063** | Data-Driven Modeling for Engineers |
| **ME 2067** | Musculoskeletal Biomechanics (offered by Bioengineering) |
| **ME 2074** | Advanced Fluid Mechanics 1 |
| **ME 2081** | Smart Manufacturing-Key to Innovations |
| ***ME 2082** | Electromechanical Sensors & Actuators |
| **ME 2086** | Design & Mechanics of 3D Printed Materials and Structures |

| | |
|---|---|
| †ME 2087 | Structural Topology Optimization for Additive Manufacturing |
| †ME 2208 | Mechanics and Physics of Soft Material |
| †ME 2227 | Finite Element Analysis 2 |
| *ME 2243 | Bayesian Signal Processing |
| †ME 2247 | Introduction to Nonlinear Control Design |
| *ME 2252 | Conduction Heat Transfer |
| *ME 2254 | Convection Heat Transfer |
| *ME 2256 | Applied Computational Heat and Mass Transfer |
| †ME 3003 | Theory of Continuous Media |
| | |

See next page.

# F Rubrics for PhD and MS Defenses

See next page.

**Rubric for Evaluating PhD Dissertation** *(This page to be filled out by Committee Chair or Graduate Director)*

Student _____ Advisor _____

Dissertation Title _____

Date of entry into PhD Program[⊥] _____ Student was (check one) _____ part time or _____ full time.

Date of Passing Preliminary Exam _____ Date of Proposal _____ Date of Defense _____

Total time to complete PhD degree (circle one): > 5.0 years 4.5-5.0 years 3.5-4.5 years 3.0-3.5 years < 3.0 years

| This student produced (fill in the number): | Scoring Factor (SF): | Raw Scores: (Number × SF) |
|---|---|---|
| ____ Accepted or published journal articles | 1.5 | _____ |
| ____ Additional Submitted journal articles | 1.0 | _____ |
| ____ Conference publications | 0.5 | _____ |
| ____National Conference presentations | 0.3 | _____ |
| ____Additional Potential Journal publications | 0.2 | _____ |

Total Publication Performance Score: _____

Committee Members (and Department):

_____ _____

_____ _____

_____ _____

_____ _____

- At the conclusion of the defense, each committee member should fill out the response sheet. For each attribute which a committee member feels is somewhat or very deficient, a short explanation should be provided.
- This document should be completed, even if the committee feels that the thesis is unacceptable.
- Please attach a copy of the abstract and conclusions to this evaluation form. The adviser should also include copies of any journal publications or referred conference proceedings that have already resulted from this dissertation
- Place of employment or additional graduate study, if known _____

[⊥]Either when the student successfully completed an MS degree, successfully completed 8 courses beyond the BS degree if skipping the MS degree, or changed projects and/or research advisors.

**Ph.D. Thesis Response Sheet**

*(one for each committee member – circle response and return directly and confidentially to designated department administrative staff)*

| Attribute | Very Deficient | Somewhat Deficient | Acceptable | Very Good | Outstanding | Comments |
|---|---|---|---|---|---|---|
| Quality of dissertation research | Barely acceptable, among the bottom 10% of dissertations at Pitt | Acceptable, but disappointing ($10^{th}$ to $25^{th}$ percentile of dissertations at Pitt) | Acceptable (25th to 75th percentile of dissertations at Pitt) | Among 75th to $90^{th}$ percentile of dissertations at Pitt | Among top 10% of dissertations at Pitt. | |
| Contributions | • Requires committee to stretch to find contribution.<br>• Closer to MS than outstanding PhD dissertation | • Extends prior knowledge to some degree;<br>• In total is a contribution, but contains no single major contribution. | • Demonstrates originality<br>• Makes some contributions<br>• Introduces new methodology or techniques to field. | • Very original work;<br>• At least one important contribution | • Original and creative.<br>• Novel and important technical contributions; | |
| Quality of writing | • Requires a professional editor<br>• Sentence structure, language and style deficient<br>• Major revisions required for technical content | • Writing is weak<br>• A number of typos, grammatical and spelling errors<br>• A number of technical changes required. | • Limited number of typos (grammatical errors and spelling) that do not detract from work<br>• Some changes necessary<br>Some new technical contributions | • Very well written;<br>• Easy to read and understand<br>• Few changes or additions required.<br>Significant technical contributions | • Well organized, relevant, and technically complete<br>• Excellent clarity and use of references<br>• Well edited | |

| Attribute | Very Deficient | Somewhat Deficient | Acceptable | Very Good | Outstanding | |
|---|---|---|---|---|---|---|
| Defense | • Very poorly organized.<br>• Disjointed presentation.<br>• Unable to answer a number of questions.<br>• Slides of very poor quality | • Not well organized;<br>• Rambled; dwelt too long on less important aspects<br>• Had difficulty with questions.<br>• Some slides difficult to read<br>• Typos and other errors in slides. | • Acceptable – slides clear<br>• Good presentation skills<br>• Able to answer most questions | • Well thought out slides.<br>• Professional presentation<br>• Almost all questions addressed in a professional manner | • Well organized, very professional,<br>• All questions addressed in a knowledgeable and respectable manner.<br>• Slides outstanding. | |
| Other – explain | | | | | | |

*(09/16/2008)*

Any additional comments and explanations for any perceived deficiencies:

**Rubric for Evaluating Masters Thesis** (*This page filled out by Committee Chair or Graduate Director*)

Student _____ Advisor _____

Thesis Title _____

Date of entry into MS Program _____ Student was (check one) _____ part time or _____ full time.

Date of Defense _____

Total time to complete MS degree (circle one): > 36 mos 30-36 mos 24-30 mos 18-24 mos <18 mos (Time Score 1 to 5)

| This student has produced (fill in the number): | Scoring Factor (SF): | Raw Scores: (Number × SF) |
|---|---|---|
| ____ Accepted or published journal articles | 2.5 | _____ |
| ____ Additional submitted journal articles | 2.0 | _____ |
| ____ Conference publications | 1.5 | _____ |
| ____ National Conference presentations | 1.0 | _____ |
| ____Additional potential Journal publications | 0.5 | _____ |

Total Publication Performance Score: _____

Committee Members (and Department):

_____ _____

_____ _____

_____ _____

_____ _____

- At the conclusion of the defense, each committee member should fill out the response sheet. For each attribute which a committee member feels is somewhat or very deficient, a short explanation should be provided.
- This document should be completed, even if the committee feels that the thesis is unacceptable.
- Please attach a copy of the abstract and conclusions to this evaluation form. The adviser should also include copies of any journal publications or referred conference proceedings that have already resulted from this dissertation
- Place of employment or additional graduate study, if known _____

**MS Thesis Response Sheet**

*(one for each committee member – circle response and return directly and confidentially to designated department administrative staff)*

| Attribute | Very Deficient | Somewhat Deficient | Acceptable | Very Good | Outstanding | Comments |
|---|---|---|---|---|---|---|
| Quality of thesis. | Barely acceptable, among the bottom 10% of theses that we've reviewed | Acceptable, but disappointing (10th to 25th percentile of theses at Pitt.) | Acceptable (25th to 75th percentile of theses at Pitt.) | Among 75th to 90th percentile of theses at Pitt | Among top 10% of theses at Pitt | |
| Contributions | • Requires committee to stretch to find originality<br>• Closer to BS than MS work | Shows a little originality, but mostly pedantic and plodding | • Demonstrates originality<br>• Makes limited contributions | • Original, creative work;<br>• At least one good contribution for an MS thesis. | • Original and creative.<br>• Several important contributions for an MS thesis.<br>• Novel technical contributions; could be the basis of PhD work. | |
| Quality of writing | • Requires a professional editor<br>• Sentence structure, language and style deficient<br>• Major revisions required for technical content | • Writing is weak<br>• A number of typos, grammatical and spelling errors<br>A number of technical changes required. | • Limited number of typos (grammatical errors and spelling) that do not detract from work<br>• Some changes necessary<br>• Some new technical contributions | • Very well written;<br>• Easy to read and understand<br>• Few changes or additions required.<br>• Significant technical contributions | • Well organized, relevant, and technically complete<br>• Excellent clarity and use of references<br>• Well edited | |

| Attribute | Very Deficient | Somewhat Deficient | Acceptable | Very Good | Outstanding | Comments |
|---|---|---|---|---|---|---|
| Defense | • Very poorly organized.<br>• Disjointed presentation.<br>• Unable to answer a number of questions.<br>• Slides of very poor quality | • Not well organized;<br>• Rambled; dwelt too long on less important aspects<br>• Had difficulty with questions.<br>• Some slides difficult to read<br>• Typos and other errors in slides. | • Acceptable – slides clear<br>• Good presentation skills<br>• Able to answer most questions | • Well thought out slides.<br>• Professional presentation<br>• Almost all questions addressed in a professional manner | • Well organized, very professional,<br>• All questions addressed in a knowledgeable and respectable manner.<br>• Slides outstanding. | |
| Student has potential for PhD work | No | May have difficulty completing PhD at Pitt; should consider a lesser institution | Yes | Definitely at Pitt or an aspiration institution. | Without a doubt at Pitt or one of the top five institutions | |

*(09/10/2008) –*

Any additional comments and explanations for any perceived deficiencies: