About the Cover:

This image conveys the idea that the Handbook is a blueprint used by students to assemble and construct a degree in Mechanical Engineering at the University of Minnesota. It was created by 3D modelling the objects, applying realistic materials, and adding appropriate lighting. Texture displacement maps were also utilized to add additional details and for a better design.

**Artist:** Prashan Subasinghe, Current MSME Student, University of Minnesota
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Sample Graduate Degree Plan 45
Faculty members and staff of the Department of Mechanical Engineering wish you a rewarding experience in your graduate study, and look forward to working with you during your enrollment here. For additional assistance, consult:

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II. INTRODUCTION & DEGREE PROGRAMS

The purpose of this document is to provide an overview of the course and exam requirements for obtaining graduate degrees in mechanical engineering (ME). Additional information regarding the graduate programs, including information for prospective students, can also be found on the Department of Mechanical Engineering website. Two graduate degrees offered in the Department of Mechanical Engineering are:

- Master of Science in Mechanical Engineering (M.S. or M.S.M.E.)
- Doctor of Philosophy (Ph.D.)

There are three Master of Science degree plans; a thesis-based plan (Plan A), a project-based plan (Plan B), and a course-only plan (Plan C). A student admitted to the general M.S. program is free to choose any plan to pursue the master’s degree. A student may also be admitted to the course-only plan (Plan C), in which case the student must follow and fulfill the requirements of the course-only plan (for these students, switching to another plan is not allowed). For both M.S. and Ph.D. programs, a graduate degree plan (a sample of which is provided at the end of this handbook) must be on file well in advance of graduation (recommended within the first year of study for all students). The graduate degree plan lists all courses a student has completed or intends to complete towards their degree. It must be approved by the student’s adviser, the Director of Graduate Studies in Mechanical Engineering, the Director of Graduate Studies in the minor program (if the student elects to complete a minor), and the College of Science and Engineering (CSE). The graduate degree plan should be developed in consultation with one’s adviser. For this reason, it is essential that an adviser be identified no later than the end of the first semester of a student’s full-time enrollment. Identification of an adviser is ultimately up to each graduate student individually; advisers are not assigned by the department. The only exception to this is for course-only plan (Plan C) M.S. students; the director of graduate studies serves as the adviser for all course-only plan students.

Full-time graduate students are enrolled in a minimum of 6 or up to 14 course or thesis credits (or a full-time equivalent course, as discussed in the student FAQ) each semester. Full-time students in the Department of Mechanical Engineering (including those on fellowship or assistantship support) are expected to receive their master’s degree within two years and to receive their Ph.D. in four to five years after the B.S. degree or foreign equivalent. Students can take less than 6 credits without taking a full time equivalent course in selected instances; domestic students do not require prior permission to do so, while international students must register for reduced course load (RCL) with international student services (ISSS) to do this. Please consult with the director of graduate studies and graduate program manager if there is a semester where you will take fewer than 6 credits without a full time equivalency course.
Credit requirements for MSME degree

- **Thesis based M.S. plan (Plan A):** 10 thesis credits (ME 8777) and 20 graduate-level course credits taken on an A/F grade basis (with the exception of graduate seminar and ethics credits, which are taken on a S/N grade basis) must be completed. Coursework must include the following:
  - At least 14 course credits of graduate coursework in mechanical engineering (ME). Any ME 5XXX or ME 8XXX designated course is considered a mechanical engineering graduate course, except for independent research courses, which do not count towards the ME course credit requirement. Additional courses that meet the requirement for course credits in mechanical engineering are listed below:
    - AEM 8201 Fluid Mechanics I
    - AEM 8202 Fluid Mechanics II
    - AEM 5401 Intermediate Dynamics
    - AEM 5501 Continuum Mechanics
    - EE 5231 Linear Systems and Optimal Control
    - EE 8215 Nonlinear Systems
  - 6 credits should be completed beyond the 14 noted above, which should be earned in graduate-level courses with significant scientific or engineering content. These may include courses in mechanical engineering. The six credits may be taken for a designated minor.
  - One research and professional ethics course (3 credits maximum) taken on a S/N grade basis. Typically, this course is ME 8001 (0 credits).
  - 1 or 2 seminar credits taken on a S/N grade basis. Seminars may be taken in other CSE departments but must have significant scientific or engineering content. Note the same seminar course with the same designation may be taken in multiple semesters.

- **Project based M.S. plan (Plan B):** 30 graduate-level course credits taken on an A/F grade basis (with the exception of the graduate seminar, ethics, and Plan B project credits that are taken on a S/N grade basis) must be completed. Courses must include the following:
  - At least 14 course credits of graduate coursework in mechanical engineering (ME). Any ME 5XXX or ME 8XXX designated course is considered a mechanical engineering graduate course, except for independent research courses, which do not count towards the 14 ME course requirement. Additional courses that meet the requirement for course credits in mechanical engineering are listed below:
    - AEM 8201 Fluid Mechanics I
    - AEM 8202 Fluid Mechanics II
    - AEM 5401 Intermediate Dynamics
    - AEM 5501 Continuum Mechanics
    - EE 5231 Linear Systems and Optimal Control
    - EE 8215 Nonlinear Systems
  - 4 Plan B project credits selected from ME 8794 taken on a S/N grade basis.
  - 12 credits beyond the 14 noted above, which are earned in graduate-level courses within CSE with significant scientific or engineering content, including courses in mechanical engineering. Six of these credits may be taken for a designated minor.
  - One research and professional ethics course (3 credit maximum) taken on a S/N grade basis. Typically, this course is ME 8001 (0 credits).
  - 1 or 2 seminar credits taken on a S/N grade basis. Seminars may be taken in other CSE departments but must have significant scientific or engineering content. Note the same seminar course with the same designation may be taken in multiple semesters.
Course based M.S. plan (Plan C): 30 graduate-level course credits taken on an A/F grade basis (with the exception of the graduate seminar, ethics and independent study credits that are taken on a S/N grade basis) must be completed. Coursework must include the following:

- At least 24 course credits of graduate coursework in mechanical engineering (ME). Any ME 5XXX or ME 8XXX designated course is considered a mechanical engineering graduate course. Additional courses that meet the requirement for course credits in mechanical engineering are listed below:
  - AEM 8201 Fluid Mechanics I
  - AEM 8202 Fluid Mechanics II
  - AEM 5401 Intermediate Dynamics
  - AEM 5501 Continuum Mechanics
  - EE 5231 Linear Systems and Optimal Control
  - EE 8215 Nonlinear Systems

- 6 course credits earned in graduate-level courses with significant scientific or engineering content, including courses in mechanical engineering. The six credits may be taken for a designated minor.

- One research and professional ethics course (3 credits maximum) taken on a S/N grade basis. Typically, this course is ME 8001 (0 credits).

- 1 or 2 seminar credits taken on a S/N grade basis. Seminars may be taken in other CSE departments but must have significant scientific or engineering content. Note the same seminar course with the same designation may be taken in multiple semesters.

- In addition to the course credits noted above, all course-only M.S. plan students entering in Fall 2018 or later must either (i) have their 24 ME course credits from the “General Mechanical Engineering” flowchart, completing all core courses on this flow chart or (ii) submit with the graduate degree plan a two-page write-up (single spaced, 12 pt font) justifying their course selections. The director of graduate studies will only sign degree plans meeting requirements (i) or (ii).

M.S. degree program Notes:

- No more than six 4000-level course credits may be used for graduate-level course credit. Only the following 4000-level courses are acceptable coursework:
  - AEM 4511 Mechanics of Composite Materials
  - AEM 4581 Mechanics of Solids
  - CHEM 4502 Physical Chemistry II
  - EE 4541 Digital Signal Processing
  - MATH 4512 Differential Equations with Applications
  - PHYS 4051 Methods of Experimental Physics I
  - PHYS 4101 Quantum Mechanics
  - PHYS 4201 Statistical and Thermal Physics
  - PHYS 4211 Introduction to Solid-State Physics

- If a student wishes to include a different 4XXX-level course in their graduate degree plan, their adviser and the director of graduate studies must approve the course prior to enrollment. Such exceptions will not be granted for course-only (Plan C) students.

- For thesis-based MS degrees (Plan A), thesis credits (ME 8777) may be taken at any time during the degree plan.

- At least 60% of the graduate-level course credits (not including thesis credits) must be taken at the University of Minnesota. A maximum of 12 graduate-level course credits taken as a non-degree or non-admitted student may be considered for inclusion once the student is admitted and enrolled in the graduate program.
- All students must maintain a GPA of 2.80 or higher for courses included in the University of Minnesota graduate degree plan.
- At least 6 credits in mechanical engineering at the 5xxx or 8xxx level are required for a master's minor in mechanical engineering (this applies for students in M.S. programs in the College of Science and Engineering, which are outside the Department of Mechanical Engineering).
**Credit requirements for Ph.D. degree**

- The doctoral *graduate degree plan* is intended to ensure students plan to enroll in suitable coursework to carry out high level research in Mechanical Engineering. Ph.D. is a research-based degree, where coursework is intended to supplement dissertation research. The *graduate degree plan*, generated by each student and in discussion with their advisor, must be rigorous and must be appropriate for their dissertation research.

- Ph.D. degrees require successful completion of the following credits:
  - 38 graduate-level course credits taken on an A/F basis except as noted. Courses must include the following:
    - At least 18 course credits of graduate coursework in mechanical engineering (ME), which must be taken on an A/F grade bases. Any ME 5XXX or ME 8XXX designated course is considered a mechanical engineering graduate course, except for independent research courses, which Ph.D. students cannot enroll in and have count towards their Ph.D. degree (they are reserved for project-based M.S. plan students). Additional courses that can count as mechanical engineering courses are:
      - AEM 8201 Fluid Mechanics I
      - AEM 8202 Fluid Mechanics II
      - AEM 5401 Intermediate Dynamics
      - AEM 5501 Continuum Mechanics
      - EE 5231 Linear Systems and Optimal Control
      - EE 8215 Nonlinear Systems
    - 20 course credits beyond the 18 noted above, which are earned in graduate level courses with significant scientific or engineering content. In general, these should be 5XXX and 8XXX level courses offered within the College of Science and Engineering. 12 of these credits can be counted toward a designated minor.
    - At least twelve (12) 8XXX level course credits, must be taken on an A/F grade basis. Graduate seminar and ethics courses do not count towards this requirement.
    - One research and professional ethics course (3 credit maximum) taken on a S/N grade basis. Typically, this course is ME 8001 (0 credits).
    - 2 or 3 seminar credits taken on a S/N grade basis. Seminar courses may be taken in other departments, but they must have significant scientific or engineering content. Note the same seminar course may also be taken in multiple semesters.
    - A minimum of 24 doctoral thesis credits (course number ME 8888) taken on a non-graded basis, with the following restrictions:
      - Doctoral thesis credits or any other type of research credits earned at another university cannot be applied toward the thesis credit requirement.
      - A dissertation completed at another university cannot be transferred to the University of Minnesota.
      - Thesis credits may be taken only after successful completion of the Preliminary Oral Exam. [see Doctor of Philosophy (Ph.D) Section in III]

- **Ph.D. degree program Notes:**
  - No more than six 4000-level course credits may be used for graduate-level course credit. Only the following 4000-level courses are acceptable coursework:
    - AEM 4511 Mechanics of Composite Materials
    - AEM 4581 Mechanics of Solids
    - CHEM 4502 Physical Chemistry II
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 4541</td>
<td>Digital Signal Processing</td>
</tr>
<tr>
<td>MATH 4512</td>
<td>Differential Equations with Applications</td>
</tr>
<tr>
<td>PHYS 4051</td>
<td>Methods of Experimental Physics I</td>
</tr>
<tr>
<td>PHYS 4101</td>
<td>Quantum Mechanics</td>
</tr>
<tr>
<td>PHYS 4201</td>
<td>Statistical and Thermal Physics</td>
</tr>
<tr>
<td>PHYS 4211</td>
<td>Introduction to Solid-State Physics</td>
</tr>
</tbody>
</table>

- A minimum of 12 graduate course credits taken at the University of Minnesota. The number of course credits that can be transferred from another university will be determined on a case-by-case basis and must be approved by the adviser and Director of Graduate Studies.

- A maximum of 12 graduate course credits taken as a non-degree or non-admitted student may be considered for inclusion in the graduate degree plan once the student is enrolled in the graduate program.

- Ph.D. students must maintain a cumulative GPA of 3.00 or higher for all courses counted towards the degree and listed on the graduate degree plan.

- At least 12 credits in mechanical engineering at the 5xxx or 8xxx level are required for a doctoral minor in mechanical engineering (this applies for students in Ph.D. programs within the College of Science and Engineering which are outside the Department of Mechanical Engineering).
III. APPROVAL PROCESS STEPS IN DEGREE STUDY

Master of Science—Plans A, B and C (M.S.)

_____ 1. Choose a research adviser for the thesis based (Plan A) and project based (Plan B) M.S. degrees soon after beginning study, ideally in the first semester of full-time study. The adviser must be a Member of the Mechanical Engineering Graduate Faculty or an Affiliate Senior Member (see section I. Directory). Once an adviser has been chosen, notify the Graduate Program Manager as soon as possible, who will contact the adviser to confirm. Plan C students do not have a research adviser and the director of graduate studies becomes their adviser by default.

_____ 2. Complete the Graduate Degree Plan form with research adviser approval and submit it to the Graduate Program Manager. The form is due after one full-time academic semester or after completing 10 thesis credits. Only list the required credits for the MSME degree, do not list extraneous courses.

Notes:
- Complete all sections on the Graduate Degree Plan form: courses, major/minor-related field, ethics seminar, calendar time taken, credits, etc.
- If there is a need to change the Graduate Degree Plan after approval, complete a petition form, available at:
  https://onestop.umn.edu/sites/onestop.umn.edu/files/forms/_graduate_student_petition_gdp.pdf
- Return the completed and signed petition form to the Graduate Program Manager for Department Approval. Note that petition forms are approved by the Graduate School quickly, while the initial Graduate Degree Plan can take weeks for approval. For this reason, do not delay submitting the Graduate Degree Plan, even if there will be changes made via petition later.

_____ 3. Once the Graduate Degree Plan is approved, select the thesis or project defense committee members in consultation with the research adviser and in accordance with Graduate School Policy. The formal approval of the defense committee requires online submission by the student at the following link:
  https://onestop.umn.edu/academics/examination-committees
The committee will include the research adviser(s), an additional member or senior affiliate member of the Mechanical Engineering Graduate faculty (unless the student has a co-adviser), and one full-time, tenured or tenure-track faculty member who is a senior member of a graduate program outside of mechanical engineering. If the student has a minor, the third committee member must be from the minor program. Course only, Plan C students do not need to submit a committee as the degree does not have a research component.

_____ 4. Complete the Plan A thesis or Plan B project (The Plan C does not have a project or thesis only coursework). Submit the Plan A thesis or Plan B project report to the committee members. Please check with committee members to determine the time they will require to read the thesis/project report prior to the thesis/project defense. Do not assume committee members
will be accepting of the minimum time, which is **3 weeks** for the Department of Mechanical Engineering. Less than **3 weeks** between submission of the thesis and the project report is only permitted if all committee members agree in writing to a shorter period of time. Thesis and project based M.S. degree students are also encouraged to attend an evening informational session with the Graduate Program Manager early in the semester they intend to graduate. These informational sessions are scheduled each semester and the Graduate Program Manager will review each of the steps required for graduation, as well as answer individual questions for unique circumstances.

Please note the precise format of the thesis or project report is decided upon by the research adviser(s) and committee members. In general, M.S. theses will contain an *Introduction* chapter, 1 to 3 chapters of *Research Methods & Results* (with each chapter similar to a peer-reviewed paper or peer-reviewed conference submission), and a *Conclusions and Future Work chapter*. The University provides guidance on thesis formatting at: [https://onestop.umn.edu/academics/thesisdissertation-submission-and-formatting](https://onestop.umn.edu/academics/thesisdissertation-submission-and-formatting). For Plan B project reports, there is no required format, but a suggested format is a paper composed of a 300 word *Abstract*, an *Introduction* (including properly cited references), a *Materials & Methods Section* (either experimental, numerical, and/or theoretical methods, with schematic diagrams and schemes as needed), a *Results & Discussion* section (with figures and tables, with appropriate format and captions to best display research results), and a *Conclusions* section. Excluding the title page and abstract, the report ideally should not exceed 30 double spaced pages (including Figures and Tables) with 1” margins and 12 point, Times New Roman Font, or 11 point Arial or Calibri Font. An *Acknowledgements* section and *References* Section should be appended, but would not count in the suggested 30 page limit.

___ 5. Download the Graduation Packet, which includes the final oral exam form, and other graduation materials, including the application for degree, via the web at: [https://onestop.umn.edu/academics/apply-graduate](https://onestop.umn.edu/academics/apply-graduate)

If circumstances require a change of a committee member, simply resubmit the new committee:[https://onestop.umn.edu/academics/examination-committees](https://onestop.umn.edu/academics/examination-committees) Note there must be an approved Graduate Degree Plan form on file with the Department of Mechanical Engineering and the Graduate School before doing this step. In addition, the application for degree form must be submitted by the first day of the expected graduation month.

___ 6. Schedule the final oral examination for the defense of the Plan A thesis or Plan B project. The course only, Plan C degree does not have a final oral exam. The final examination is required for all thesis-based Plan A and project-based Plan B M.S. students, without exception. The exam is an oral presentation which is usually 20-30 minutes in length, followed by 60 minutes of questions from the defense committee. It is conducted by a minimum of three members of the graduate faculty assigned at the time the Graduate Degree Plan form is approved. (See Step #3). The final oral examination for all Plan A and Plan B M.S. degrees is conducted as a closed examination (both the presentation and question period), attended only by the student and the defense committee. The department will check on this and will disqualifying
examinations which do not follow proper policies. It is the student’s responsibility to schedule the final oral exam in consultation with their adviser and committee members.

The final oral examination may relate to a combination of both thesis content (for Plan B programs, project content) and technical course competence. The presentation should be well-prepared and succinct, focusing on the research completed. Be sure the committee is informed of impending examination, and schedule it to accommodate all examining faculty members. Students must provide the defense committee with a copy of the Plan A thesis or Plan B project at least 21 days before the scheduled date of the final examination.

For available rooms to hold the exam, please contact:
mereserv@umn.edu

Be sure to schedule your defense with the Graduate School, as this will trigger the release of the electronic Final Exam Form to the chair of your committee. The final oral examination form is then electronically submitted by your committee chair with Graduate School. This form is due by the last working day of the expected graduation month. The Plan C final oral exam form can be left with the Graduate Program Manager for departmental approval and the Director of Graduate Studies’s signature.

_____ 7. Complete final edits of the examined Plan A thesis or Plan B project. For the Plan A thesis, submit a PDF version via e-mail to the Graduate Program Manager. The adviser may also request a bound (maroon binding with white lettering) printed copy. Plan B project report does not need to be submitted to the department.

_____ 8. Check-out. To provide control of inventory, keys, and office space, each student must complete a Departmental Check-out Form prior to departure or beginning another degree objective within the Department:
http://www.me.umn.edu/education/graduate/current/pdf/CheckoutSheet618.pdf

Please be aware that all M.S. students need to complete their degrees within 5 years of admission.
Doctor of Philosophy (Ph.D.)

_____ 1. Choose a research adviser soon after beginning studies, but no later than December 15 of the first Fall semester. The adviser must be a Member of the Mechanical Engineering Graduate Faculty or an Affiliate Senior Member (section I. Directory). For most Ph.D. students, the adviser will be obligated to provide a research assistantship (RA) for portions of the first year of study, and the Graduate Program Manager will request a signed offer letter of RA support (based upon a template the Director of Graduate Studies and Graduate Program Manager will provide).

_____ 2. Register and take the Oral Qualifying Exams. The registration deadline for the exams is announced early in each semester and the exam is typically held in November during the Fall semester, and April during the Spring semester. For students who enter the Ph.D. program after completion of an M.S. in Mechanical Engineering, these exams must be taken in the first semester upon admission to the Ph.D. program. For all other students, the exams must be taken by the second semester in the Ph.D. program. An informational session, where study groups are formed, is held at the beginning of each semester. There may be instances where a student has an M.S. degree from another institution, but it is not clear if this is equivalent to an MSME degree at the University of Minnesota. In this instance, please consult with the Director of Graduate Studies well in advance of the qualifying examination.

_____ 3. Complete the Graduate Degree Plan form with adviser approval and submit it to the Graduate Program Manager within one semester of passing the Oral Qualifying Exams. Only list the required credits for the Ph.D. degree. Do not list extraneous courses. For students who wish to transfer credits from another institution, meet with the Director of Graduate Studies in advance to confirm what classes can be transferred, and confirm to request transfer credits with the adviser. The Graduate Degree Plan must be filed and approved before the Written Preliminary Exam can be completed. The Graduate Degree Plan form is available at: https://onestop.umn.edu/sites/onestop.umn.edu/files/forms/otr198_graduate_degree_plan.pdf

Notes:

- Complete all sections on the Graduate Degree Plan from: courses, major/minor-related field, ethics, seminar, calendar time taken, credits, etc.
- ME 8794 and master’s thesis credits may not be applied towards a Ph.D. degree.
- If need to change approved Graduate Degree Plan form, file a petition form: https://onestop.umn.edu/sites/onestop.umn.edu/files/forms/graduate_student_petition_gdp.pdf

Return the petition form to the Graduate Program Manager for Department Approval. Note that petition forms are approved by the Graduate School quickly, while the initial Graduate Degree Plan can take weeks for approval. For this reason, do not delay in submitting Graduate Degree Plan, even if necessary to change it via petition later.
4. Select Written and Oral Exam committee members in consultation with adviser and within two semesters of passing the Qualifying Exams. To assign committee members for the Preliminary Oral Examination, please submit selected committee members with the Graduate School at the following link:
https://onestop.umn.edu/academics/examination-committees
If circumstances require a change of a committee member, simply resubmit the new committee:
https://onestop.umn.edu/academics/examination-committees
The oral exam committee will include an adviser(s), two additional members or senior affiliate members of the Mechanical Engineering Graduate faculty, and one full-time, tenured or tenure-track faculty member who is a senior member of a graduate program outside of Mechanical Engineering. For a minor, the fourth committee member must be from the minor program.

5. Complete Written Preliminary Exam. The Written Preliminary Exam should be taken within 12 months of completing the Oral Qualifying Examination. It is recommended that students submit the written examination to the examination committee no later than the 8th week of the semester when they plan to complete the oral preliminary examination. The written examination must be passed at least one week prior to scheduling the preliminary oral examination, but ideally, allow two weeks or more.

The written preliminary exam format is available at:
http://www.me.umn.edu/education/graduate/current/pdf/writtenexamform.pdf
After the three Mechanical Engineering Graduate Faculty on the Oral Preliminary Examination committee have stated, in writing, that they approve of the Written Examination and that it is ready for defense, submit the preliminary written exam report form to the Graduate Program Manager in ME 1120.
For doctoral candidates who have not completed an M.S. degree in Mechanical Engineering, it is permissible to submit the written preliminary exam document in lieu of a Plan B, project based M.S. project report if the adviser approves this procedure. If all other requirements have been satisfied for the M.S. Plan B (including a completed M.S. Graduate Degree Plan following the requirements noted in this document) and with adviser consent, the Plan B M.S. final exam can be scheduled concurrently with the preliminary oral exam, i.e. the oral preliminary examination can serve as a M.S. Plan B final defense.

6. Schedule oral preliminary exam after passing the written preliminary exam. The oral preliminary exam is a closed exam with four committee members. The first portion of the exam is a 30-40 minute presentation, outline the work proposed in the written examination. The second portion is 60-90 minutes (for a total of less than two hours) of questions from the committee members. Questions should largely focus on the proposed research, but may also include information related to coursework completed. Have a copy of the Graduate Degree Plan available for the committee members during the oral preliminary exam. Schedule this
exam at least one week after submitting the preliminary written exam report form. Please see the following link for scheduling:
https://onestop.umn.edu/academics/doctoral-oral-exam-scheduling
Rooms may be scheduled via email at:
mereserv@umn.edu

The outcome of the exam will either be “pass”, “pass with reservations,” “fail with retake,” or “fail”. Students who receive “pass” or “pass with reservations,” may take thesis credits and should see the Graduate Program Manager concerning enrolling in these credits. In case the committee decides upon “Pass with Reservations,” the committee chair (who may or may not be the adviser, this is your decision), must provide a one page written document outlining what must be done to remove the reservations from the exam. There will be a minimum of 6 months to have reservations lifted, but no more than 12 months. Possible committee assignment could be additional literature review and write-up, additional coursework, or additional meeting with committee members. There is no restriction on a committee’s decision on conditions to lift, reservations, however. A “Fail with Retake” decision will require rescheduling the exam, at least three months after the original exam date, but no later than 6 months after the original exam date (otherwise the opportunity to retake the exam expires). A “fail” decision results in a dismissal from the Ph.D. program. For both the “fail with retake” and “fail” decisions, the committee chair with provide a written letter outlining the deficiencies in the exam. If the M.S. project defense is completed at the same time as the Ph.D. preliminary oral exam. Have the committee members complete the electronic exam forms for both the MS degree and PhD preliminary exam at the same time. Both forms will need to then be submitted by the committee chair.

_____7. After completing the oral preliminary examination, complete thesis credits as efficiently as possible, to be eligible for advanced graduate student status and to be able to enroll in ME 8444.

_____8. Complete dissertation research, submit manuscripts for peer-review, attend national and international conference to present research work, and continue to gain knowledge in the chosen research area. Meet with the adviser(s) regularly and decide upon the information which will go into the dissertation.

_____9. Complete the dissertation, following the style guideline provided by the University Guidelines:
https://onestop.umn.edu/academics/thesisdissertation-submission-and-formatting
Latex Template: https://github.com/agude/UMN-PhD-Thesis-Template

In the final semester, please attend one of the evening informational sessions held by the Graduate Program Manager outlining the steps required for graduation. At these informational sessions, questions related to the specific program can be better answered.

_____10. Assign the final defense committee. The final defense committee has the same requirements as the oral preliminary exam committee, but need not be the same committee members. The
adviser cannot be the chair of the final defense committee. For the final exam please register selected committee members with the Graduate School at the following link: 
https://onestop.umn.edu/examination-committees

11. Download the Graduation Packet, which includes the electronic Reviewers Report Form, and other graduation materials including the application for degree, at:
https://onestop.umn.edu/academics/apply-graduate
There must be an approved final defense committee with the Graduate School, before executing this step. The application for degree form must be submitted by the first working day of one’s expected graduation month.

12. Submit the dissertation to the final exam committee members. Check with each committee member to ascertain their required time to read the dissertation and provide feedback. In the Department of Mechanical Engineering, committee members must have a minimum of three weeks prior to scheduling the final defense, unless all committee members agree to a shorter period, in writing.

13. Once all of the final exam committee members approve of the dissertation, the electronic Reviewers Report is submit with the Graduate School. Then the electronic Final Exam form is generated and sent to the chair of your exam. This must be done at least one week before the scheduled final oral examination.

14. Schedule the final oral defense after all committee members have approved the dissertation for defense. Please remind all committee members that changes to the dissertation after signing the Dissertation Reviewer’s Report form are expected to be minimal and only relate to questions arising during the final defense.
https://onestop.umn.edu/doctoral-oral-exam-scheduling

The final exam is an oral exam, and is usually 120 minutes in duration total. The first part, the final oral presentation for the Ph.D. degree is conducted as an open examination (anyone can attend), and should focus on presentation of the work described in the dissertation. The second portion is a closed session attended only by the student and the examining committee. The final examination question period focuses primarily on the dissertation research but may include questions on related science and engineering competence related to the research. The final presentation should be well-prepared and succinct. The prepared formal oral presentation should be no more than 45 minutes in duration to allow time for questions and comments by the general audience, and then by the committee members.

It is each student’s responsibility to schedule the oral exam in consultation with their adviser and committee members. For available rooms, please contact:
mereserv@umn.edu
15. The Final Exam form is submitted electronically by the chair of your committee with the Graduate School.

16. Edit the examined dissertation, if required.

17. Formally submit the dissertation, making sure the adviser signs the title page. Submit one bound dissertation (black binding with white lettering) to the Graduate Program Manager, in ME 1120 and one copy to the adviser(s) (these are required). To provide control of inventory, keys, and office space, must also complete a Departmental Check-out Form prior to departure from the Department or prior to beginning another degree objective within the Department. [http://www.me.umn.edu/education/graduate/current/pdf/CheckoutSheet618.pdf](http://www.me.umn.edu/education/graduate/current/pdf/CheckoutSheet618.pdf)

Finally, please provide the Graduate Program Manager will the next employment position and contact information. The department is extremely proud of its Ph.D. alumni, and will want to remain in contact throughout your career.

Please be aware that each Ph.D. student needs to complete their degree within 8 years of admission.
IV. DOCTORAL EXAMINATION PROCEDURES

Ph.D. candidates in Mechanical Engineering must pass the following “qualifying” and “preliminary” examinations:

- Oral “qualifying” examinations in three subject areas
- A Written Preliminary Exam that will be constituted by the Ph.D. thesis proposal.
- An Oral Preliminary Exam that will consist of a presentation on the proposed research, followed by questioning that is focused on material and course work related to the proposed thesis.

Oral Qualifying Examinations

After entering the Ph.D. program and before taking the written Ph.D. preliminary exam, each student is required to take three Oral Qualifying Exams in three of six subjects.

Timing

For students who enter the Ph.D. program after completion of M.S. in Mechanical Engineering, the oral exams must be taken in the first semester upon admission. For all other students, the exams must be taken in the second semester in the Ph.D. program. There will be an announcement each semester with the exact dates of the exams and the deadline for registration.

Length of exams

Normally, the exams will be 30 minutes long. However, exams may be extended up to 60 minutes at the discretion of the examiners.

Choice of subjects

The subjects of the three exams must be selected from six core subjects. Descriptions of the level and content of the exams in each of these core subject areas will be detailed in the following page. The subjects are:

- Fluid mechanics
- Heat transfer
- Machine design
- Solid mechanics
- System dynamics and Control Theory
- Thermodynamics

Examining committees

The committee for each Oral Qualifying Exam will consist of two members of the Mechanical Engineering graduate faculty. The adviser cannot be on any of the examining committees.

Evaluation of examinations

Immediately following every examination, each examiner will independently grade the student’s performance on a 10-point scale. After all students have completed the qualifying examinations, the Mechanical Engineering Graduate Faculty will make final decisions regarding “pass”, “fail with retake” (at most one retake allowed) or “fail without retake”. Decisions are based on total scores. However, students are not permitted to know the total score or the score on any subject exam.
Students also may not ask examiners about the Oral Qualifying Examination after the subject examinations are completed. If the decision is “fail with retake”, a student must retake the entire qualifying examination, i.e. they must take three exams again, but can choose different exams. The retake of the examination must occur during the Oral Qualifying Exam week of the subsequent semester. If a student performs poorly upon retaking the Oral Qualifying Examinations, the adviser’s input will be considered before making the decision whether to “fail” the exams on retake. A “fail” score upon retake results in dismissal from the Ph.D. program.
Ph.D. Oral Qualifying Examination in Fluid Mechanics

Background
The qualifying examination in fluid mechanics will be used to assess the candidate’s understanding of fluid mechanics at an advanced undergraduate level. The successful student will demonstrate a working knowledge of hydrostatics, conservation of mass, conservation of linear momentum, conservation of energy, Lagrangian and Eulerian descriptions (frames of reference) as well as similitude and the Buckingham Pi theorem. These subject areas are present in the vast majority of undergraduate fluid mechanics courses/programs, and are the minimum required to enter a graduate-level course in fluid dynamics. Students should demonstrate a systematic approach to fluid systems analysis.

Topics that may be covered
- Hydrostatics (thermodynamics approach and force balances)
- Fluid kinematics, acceleration, Eulerian and Lagrangian descriptions
- System and control volume analysis, Reynolds transport theorem
- Incompressible Bernoulli equation and Euler’s equation, understanding their advantages and limitations
- General motion of a fluid element, differential analysis of a fluid element
- Conservation of mass, momentum, and energy
- Buckingham’s Pi theorem, dimensional analysis, similitude
- Viscous flows, e.g. pipe flows, planar Couette flow, lubrication, thin films, venturis, orifice plates, obstruction meters
- Boundary layers—laminar and turbulent: both fundamental understanding and appreciation for the role of boundary layers in external and internal flows; developing flows; lift and drag
- Understanding of important dimensionless groups in fluid mechanics, including Reynolds number, Mach number, Weber number, Froude or Richardson number, etc.

Relevant courses (at the University of Minnesota)
- ME 3332: Fluid Mechanics (essential)
- ME 5332: Intermediate Fluid Mechanics (beneficial)
- ME 8332: Advanced Fluid Dynamics in Mechanical Engineering (beneficial)

Suggested references
Pritchard P. J., & Mitchell J.W. Fox and McDonald's Introduction to Fluid Mechanics
White, F.M., Fluid Mechanics
Ph.D. Oral Qualifying Examination in Heat Transfer

Background
The qualifying examination in heat transfer will be used to assess the candidate’s understanding of heat transfer at an advanced undergraduate level. The successful student will demonstrate a working knowledge of the macroscopic and physical basis of the three primary modes of heat transfer: conduction, convection and thermal radiation. Demonstration is required of an ability to analytically apply the Fourier law of conduction and Newton’s law of cooling, to determine heat transfer rates in steady and transient situations in both one and two dimensions. Familiarity (not memorization) with widely used empirical correlations for forced and free convection is expected. For thermal radiation, students are expected to be able to compute heat transfer rates via thermal radiation in enclosures with non-participating gases. Students must also demonstrate the ability to conceptualize a thermal systems component or processing involving heat transfer to meet a desired need or engineering objective.

Topics that may be covered
- Thermodynamic foundation of heat transfer; heat transfer defined; Fourier’s law of heat transfer by conduction; thermal conductivity
- Steady thermal conduction in one and two dimensions; planar systems, cylindrical systems, spherical systems; overall heat transfer coefficient; insulation & R-values; critical thickness of insulation
- Steady conduction-convection systems; fins & thermal contact resistance; conduction in two dimensions; unsteady heat transfer; lumped system analysis; Heisler charts
- Convection fundamentals; thermal boundary layer concepts; laminar and turbulent flat plate boundary layers; energy equation in two dimensions; Newton’s law of cooling
- Empirical relationships for engineering systems under forced convection: pipe flows, flow across cylinders, spheres, tube banks
- Fundamentals and empirical relationships for natural convection systems
- Solid understanding of important dimensionless groups in heat transfer, including Reynolds number, Prandtl number, Nusselt number, Biot number, Grashof number, etc.
- Radiation heat transfer fundamentals; physical mechanisms; radiation properties; shape factors; radiation networks

Relevant courses (at the University of Minnesota)
- ME 3333: Heat Transfer III (essential)
- ME 4331: Thermal Energy Engineering Laboratory (beneficial)
- ME 8341: Conduction (beneficial)
- ME 8342: Convection (beneficial)

Suggested references
Holman, J.P., Heat Transfer
Ph.D. Oral Qualifying Examination in Machine Design

Background
The machine design qualifying exam covers topics on shaft design, failure theories, kinematics, dynamics, and machine elements. Most mechanical engineering programs address these topics in undergraduate or beginning graduate level courses in machine design and mechanisms. A detailed list of potential topics addressed in this exam is provided below. Courses where these topics are addressed at the University of Minnesota are also provided, as well as textbooks that are recommended for preparing for this exam.

Topics that may be covered
Mechanisms
- Degrees of freedom
- Displacement analysis: graphical & analytical displacement analysis; analysis of the four-bar linkage (& slider-crank); Grashof’s criteria
- Velocity analysis: general velocity equation; velocity polygons; instant centers; analytical velocity analysis; mechanical advantage; transmission and deviation angle
- Acceleration analysis: general acceleration equation; acceleration polygons; analytical acceleration analysis
- Mechanism dynamics: free body diagrams; parallel axis theorem; Newton’s second law; D’Alembert’s principle; work, energy and power; impulse and momentum; friction

Machine element design & selection
- Shaft design, including beam analysis and column buckling
- Failure theories
- Fatigue analysis
- Gears: the involute profile; types of gears; simple gear trains; planetary gear trains; tooth forces
- Machine element design, selection and analysis: shafts, bearings, bolts, screws, springs

Relevant Courses (at the University of Minnesota)
- ME 3221: Fundamentals of Design & Manufacturing
- ME 3222: Mechanisms & Machine Design
- AEM 2012: Dynamics
- AEM 2021: Statics and Dynamics

Suggested references


Ph.D. Oral Qualifying Examination in Solid Mechanics

Background
This examination is intended to assess both mastery of subject matter and ability to apply basic concepts in the analysis of mechanical systems. The general exam content is the description of loads, deformations, strains and stresses in deformable bodies subjected to complex loading, as studied in a course on the mechanics of materials and used in numerical stress analysis.

The typical solid mechanics content of undergraduate mechanical engineering curricula culminates with a course on deformable body mechanics. Prerequisite knowledge for the determination of structural loads and reactions for use in deformable body analyses is provided in courses on statics and dynamics.

As numerical methods are a basic skill in engineering analysis, there is a numerical simulation component of the examination. The emphasis of the finite element stress analysis part of the examination is the creation and use of numerical models that accurately represent reality, not a review of the basic formulation of finite elements and solution procedures.

Topics that may be covered
- Analytical and numerical analyses
  - Description of 2-dimensional and 3-dimensional elastic stress states
  - Elastic stress-strain relations in 2-dimensions and 3-dimensions
  - Determination of internal reaction forces, moments, torques
  - Compatibility of deformations
  - Determination of stresses in structures
- Complex mechanical structures requiring 3-dimensional analysis
  - Combined stresses
  - Stress transformations: equations, graphical representation (Mohr circle representation); determination of stress state at arbitrary orientation; principal stresses, principal strains, maximum shear stress
  - Useful, special stress states (e.g., plane stress, plane strain)
- Finite element modeling
  - Accurate representation of reality
  - 2-D vs. 3-D models, boundary conditions, applied loading
  - Choice of element type
  - Mesh refinement
  - Evaluation of results

Relevant courses (at the University of Minnesota)
- AEM 3031, Deformable Body Mechanics
- ME 5221, Computer-Assisted Product Realization
- ME 5228, Introduction to Finite Element Modeling, Analysis, and Design
- ME 5241, Computer-Aided Engineering
Suggested references

Gere J. M. and Timoshenko S. P. Mechanics of Materials,

Beer F. P. and Johnston E. R. Mechanics for Materials

Crandall S. H., Dahl N. and Lardner T. J. An Introduction to the Mechanics of Solids

Cook R. D. Finite Element Modeling for Stress Analysis

ANSYS: Release 10.0 Documentation -, Introduction: Basis Analysis Guide, Chapter 1, Getting Started with ANSYS, Tutorials related to Structural Analysis
Ph.D. Oral Qualifying Examination in System Dynamics and Control Theory

Background
The system dynamics and control theory exam covers modeling, analysis and design as detailed below. Background for the system dynamics and control theory exam is contained in standard courses on system dynamics and control theory found in virtually all Department of Mechanical Engineerings. References below are to texts that cover the expected background.

Topics that may be covered
- Formulation of models of mechanical, electrical, fluid, thermal and mixed energy domain systems.
- Identification of energy sources, energy storage elements, energy dissipative elements and energy transforming elements. Model simplifications including lumping, linearizing nonlinear elements and neglecting small effects. Models in state-variable or input-output form.
- Design of SISO (single input, single output) feedback control system for a linear time-invariant system.
- Transient response specifications such as rise time, settling time and peak overshoot. PID (proportional plus integral plus derivative) control. Lead-lag and lag-lead control. System “type.” Final value theorem to find steady-state errors to standard (step, ramp, etc.) inputs in command and disturbance. Controller design using root locus. Stability analysis using the Routh-Hurwitz method. Design of a control system using frequency response. Gain margin, phase margin and bandwidth.

Relevant courses (at the University of Minnesota)
- ME 3281, System Dynamics and Control
- ME 5281, Analog and Digital Control

Suggested references
Cannon, Jr. R. H., Dynamics of Physical Systems
Close C.M., Frederick D.K. and Newell J. C., Modeling and Analysis of Dynamic Systems
Dorf R. C. and Bishop R. H., Modern Control Systems
Franklin G.F., Powell J.D. and Emami-Naeini A., Feedback Control of Dynamic Systems
Ogata K., Modern Control Engineering
Ogata K., System Dynamics
Ph.D. Oral Qualifying Examination in Thermodynamics

Background
The qualifying examination in thermodynamics will be used to assess the candidate’s understanding of thermodynamics at an advanced undergraduate level. The successful student will demonstrate a working knowledge of conservation of mass, the first and second laws of thermodynamics, and property relationships of single and two-phase fluids. The exam will assess the knowledge of these topics in the context of engineering systems, such as pumps, compressors, turbines, nozzles, mixing chambers and valves, using open and closed thermodynamic systems.

Topics covered
- Concept of system, system boundaries, mass and energy transfer across system boundaries, and other
- Interactions of system with surroundings
- Conservation of mass and energy
- Thermodynamic properties (density, p-v-T relations, specific heats, internal energy, enthalpy, entropy)
- Ideal gases
- Second law of thermodynamics and its consequences: concept of efficiency, Carnot efficiency, irreversibility,
- Definition of entropy, entropy balance, isentropic and non-isentropic processes
- Analysis of power and refrigeration cycles
- Gas vapor mixtures: Dalton’s law, mixture specific heats, psychrometrics, mixture properties
- Thermodynamics of reacting flows: combustion, adiabatic flame temperature, enthalpy of combustion,
- Enthalpy of formation, chemical equilibrium

Relevant courses (at the University of Minnesota)
- ME 3331: Thermodynamics I (essential)
- ME 5103, Thermal Environmental Engineering (beneficial)
- ME 5446: Introduction to Combustion (beneficial)
- ME 5462: Gas Turbines (beneficial)

Suggested references
Written Preliminary Examination

The Ph.D. Written Preliminary Examination is a research proposal prepared by each Ph.D. student that provides suitable motivation for the proposed doctoral research, a summary of accomplishments, and a detailed research plan of thesis research.

Timing

Each Ph.D. student should make an effort to complete the Written Preliminary Examination within 12 months of passing the oral qualifying examination. Each PhD student is strongly encouraged submit the written document to the examination committee by the 8th week of the semester when they plan on completing the oral preliminary examination. The written examination must be passed at least one week prior to scheduling the Oral Preliminary Examination, and the examination committee must have at least 3 weeks to review the Written Preliminary Examination.

Examination Committee

The examination committee for the Written Preliminary Examination consists of the student’s adviser(s) and at least two additional members of the Mechanical Engineering Graduate Faculty (members or senior members). Selection of the examination committee is at the discretion of the student with approval of the adviser(s). Members of the Written Preliminary Examination committee will also serve on the oral examination committee.

Evaluation

The Written Preliminary Examination will be evaluated on the basis of the scientific and technical comprehension, the quality of the research plan, and the ability to communicate clearly and effectively.

A three-week reading period is required for evaluation of the Written Preliminary Examination. The committee members must indicate their assessment of the examination at the conclusion of the two week reading period on the Written Preliminary Examination assessment form at: http://me.umn.edu/education/graduate/current/pdf/writtenexamform.pdf

Scoring options are pass, revise, or fail.

If one or more members of the committee score “revise” or “fail,” the examination committee must meet within two weeks to decide what revisions are required. The adviser(s) must summarize the deficiencies of the examination and provide requirements for revision to the student in writing within one week of the meeting of the examination committee.

If revisions are required, the student must submit a revised thesis proposal to the committee within one semester, or an earlier date if specified by the committee. A two-week reading period is required for reevaluation of the revised written proposal. A “pass” of the revised written preliminary examination by two of the three members of the examination committee constitutes a passing grade. (If there are four committee members, three of four must approve the revision.) Students who do not receive a passing grade after revision will be terminated from the Ph.D. program.

Format

Students are expected to write the thesis proposal independently in consultation with the faculty adviser(s). The research adviser(s) should be consulted during the process of formulating and preparing the research proposal.
The proposal must be legible, and conform to the following requirements:

- The font size should be easy to read. Please use Times New Roman or a Computer Modern Family Font at 11 point font or larger, Arial, Courier New, Calibri, or Palatino Linotype at a font size of 10 point or larger.
- A font size of 10 point or less may be used for mathematical formulas or equations, figure, table or diagram captions and when using a Symbol font to insert Greek letters or special characters. Please note, however, that the text must still be readable at 100% size. Figure captions can have a different font style, such as Arial, to help offset them from the main text.
- All margins must be at least an inch.
- Page limits and line spacing requirements apply. See below.

Failure to follow these formatting guidelines will be grounds for the student’s committee to request a revision of the proposal.

**Content**

The proposal must contain the following sections:

- **Cover Page.** The Cover Page must contain the title of the proposal, student name, adviser(s)’s name, and the names of the student’s committee members, including which ones will serve as readers. The submission date should also be included.
- **Project Summary.** The Project Summary is a one page, single-spaced summary of the proposed activity. The Project Summary should be a self-contained description of the proposed research. It should include a statement of objectives and methods to be employed. It must address the scientific and/or technical merit of the project, for example, the influence that the results might have on the direction, progress and thinking in relevant scientific or engineering fields. It must also address the appropriateness of the proposed methods, and the logic and feasibility of the research approach. The Project Summary should be informative to persons working in the same or related fields and, insofar as possible, understandable to a scientifically or technically literate lay reader.
- **Project Description.** The Project Description is a 30 page (maximum), double-spaced proposal that describes the thesis project. It should include background & motivation, objectives, proposed research, preliminary results, and conclusion. Multiple proposed research and preliminary results sections may be used if the proposed research is best divided up into sub-topics. The precise organization of these sections is up to the student, in consultation with the adviser(s). Figures and tables (with captions) are included in the 30 page limit.
  - The **background & motivation** section should include a critical review of the relevant literature. It should indicate the current state of understanding of the proposed research topic. The review should emphasize how the prior work relates to the proposed study. It should address the significance and limitations of the cited work. If any figures are taken from another publication or a website, they must be referenced explicitly in the caption.
  - The **objectives** section should provide a context for the proposed work as well as specific objectives and expected significance of the Ph.D. dissertation. It should contain a brief overview of the proposed work in relation to the present state of knowledge in the field and to work in progress by others.
- The **proposed research** section (or sections) is the key element of the proposal and should comprise no less than half the page limit set for the project description. This section should outline the plan of work, including the activities to be undertaken, and a description of experimental and/or computational methods and procedures. It should address what will be done, how it will achieve the proposed objectives, and should contain justification for the approach proposed. The proposed research section should complete the arguments developed earlier and present initial ideas on how to solve the problems posed. Strong proposals avoid repetition and digression. This section (or sections) should relate the proposed activities to the project objectives and provide expected outcomes, including how the proposed research, if successful, will contribute to a greater understanding of the topical area. An assessment of risk should be provided with the proposed research as well as a contingency plan in case a particular research avenue proves inexpedient in some manner. It should present a reasoned path from where the student begins to where they want to be at the end of the research.

- The **preliminary results** section (or sections) should provide an overview of completed work including its significance.

- The **conclusion** section should provide a concise summary of what will be known when the research has been completed that is not known. It must present the scientific and/or technical merit of the project.

- **References.** Reference information is required. Each reference must include the names of all authors (in the same sequence in which they appear in the publication), the article and journal title, book title, volume number, page numbers, and year of publication. Students must be especially careful to follow accepted scholarly practices in providing citations for source materials, including websites, relied upon when preparing any section of the research proposal. There is no page limitation for the references, but this section must include cited references only. References should be single-spaced, but a blank line between each individual reference is preferred.

- **Biosketch.** A biosketch of not more than 1 page, single-spaced, should be provided. The biosketch should be written in a narrative format and it should include a summary of previous education, including institutions attended, and research experiences.

- A copy of the approved Graduate Degree Plan.
Oral Preliminary Examination

The Oral Preliminary Examination consists of a seminar presented by the student on proposed research, followed by questions from the examining committee concerning the proposed research and related material.

Timing

The oral preliminary exam should be taken as soon as possible after the student has passed the written preliminary exam, preferably the same semester. Once a date is set, the examination MUST be scheduled with the Graduate School; the oral exam cannot be formally held without scheduling this exam (via an online approval process) in advance with the exam committee approved by the Director of Graduate Studies and the Graduate School.

https://onestop.umn.edu/academics/doctoral-oral-exam-scheduling

Examining committee

The examining committee will be the same as for the Written Preliminary Examination, with the addition of a tenured/tenure-track faculty member at the University of Minnesota who is a Senior Member (not affiliate senior member) of a Graduate Program outside mechanical engineering. If the student has a minor, the additional member must be from the minor’s program.

Form of the examination

The examination consists of an oral presentation by the student on the proposed research, and of questioning by the committee about the proposed research. The length of the presentation should be approximately 30-40 minutes, if it were not interrupted by questioning. The total length of the exam should not exceed two hours.

The exam emphasizes the following:

- an understanding of research topic(s) proposed
- the ability to formulate a hypothesis or research plan
- demonstration of independence and creativity in solving problems
- the ability to think logically
- the ability to communicate
- the ability to adequately respond to critical questioning by faculty
- demonstration of fluency with the basic concepts that apply to the selected research area

Contents of visual aids used in any presentation, including slides, overheads, etc., must be the student’s work, or must be appropriately cited. The adviser(s) cannot take any role in presenting the material to the rest of the committee or interpreting and responding to questions. This examination is closed to the public; only committee members can attend. The examination is immediately followed by a deliberation of the committee on whether the student passed, passed with reservations, or failed. Voting complies with Graduate School policies:

“The outcome of the examination, with all committee members present and voting, is recorded in one of three ways: pass, pass with reservations, or fail. The voting proportions necessary for these decisions are as follows: if the committee consists of four members, a favorable verdict for passing consists of either a unanimous vote or 3-1; if the committee consists of five members, a favorable verdict for passing consists
of either a unanimous vote or a vote of 4-1; if the committee consists of six members, a unanimous vote or a vote of 5-1 or 4-2 is needed. Candidates who do not earn committee votes in these proportions fail the examination. If, in order to achieve the minimum number of votes to reach a verdict of pass, any vote of pass with reservations is included, then the outcome will be recorded as pass with reservations. A vote to pass the student with reservations still constitutes a passing vote.”

The following procedure applies if the committee decides that the student has PASSED THE EXAMINATION WITH RESERVATIONS:

“..the student is informed immediately, but the committee is permitted one week in which to convey its reservations to the student in writing, informing the student of the steps that must be taken to remove them. A copy of this letter must be sent to the Graduate School. When the student has satisfied the committee’s reservations, a second letter informing the student and the Graduate School that the reservations have been removed and that the student may proceed toward the degree is also required. Both letters should be written by the committee chair. The final oral examination may not be scheduled until the Graduate School has received a copy of the letter indicating that the reservations have been removed.”

“If the committee members disagree as to whether the reservations have been satisfactorily removed, the committee chair asks for another vote, the results of which are subject to the same voting proportions as the initial vote. If the student is unable to satisfy the committee’s reservations, his or her doctoral candidacy and graduate student status may be terminated.”

It is within the prerogative of the preliminary oral examining committee to decide on additional steps required to remove those reservations. If the committee so chooses, the student can retake part(s) of the oral preliminary exam, but only one repetition is allowed. The committee will specify the format and the date for that exam. This examination will be held as soon as possible.
**Final Thesis Examining Committee**

The final thesis examining committee should be assigned within three months after the successful completion of the Doctoral Preliminary Exams. To assign one’s committee for final exam please submit selected committee members with the Graduate School at the following link:

[https://onestop.umn.edu/examination-committees](https://onestop.umn.edu/examination-committees)

The committee will normally consist of faculty members who served on the Oral Preliminary Examination committee, but this is not required. The final oral examining committee requires at least four members: the adviser(s) and at least two other members of the mechanical engineering graduate faculty, and at least one member with graduate faculty membership in the minor or supporting program. Adviser(s) cannot chair the final defense committee.
V. FINANCIAL SUPPORT

Financial support opportunities available to students include:

- Fellowships
- Research Assistantships
- Teaching Assistantships

In general these forms of support provide a regular stipend, waiver of all or part of tuition and fees, and a health insurance and benefit package.

**Fellowships**

All Ph.D. applicants who apply for admission to the Department of Mechanical Engineering by the December 15 deadline will automatically be considered, on a competitive basis, for pre-awards (i.e., awards offered in advance of a student's enrollment) of financial support, often through a combination of fellowships and/or assistantships. While MSME students will occasionally be considered for pre-awards, the vast majority of pre-awards are reserved for Ph.D students (this is limited by the availability of department funds). Students who enroll are eligible for research and/or teaching assistantships, which can be obtained at any time during one's academic program. International students should contact the International Student and Scholar Services (ISSS) office for counseling, advising, financial aid, career and immigration status services. Fellowships are offered on a competitive basis and require excellent academic records for consideration. Fellowships may also be terminated at any time by the Director of Graduate Studies.

For current graduate students, a number of external fellowships are available on a competitive basis each year the Graduate Program will host a Fellowship Information Session. The Graduate School online may also be consulted for opportunities at the University of Minnesota and external Fellowships at:

http://www.grad.umn.edu/funding-tuition/fellowshipsandgrants

This booklet does not present the full range of Fellowship opportunities available at the University of Minnesota.

**Research Assistantships**

Research Assistantships (RA) are appointments from faculty members who hold research contracts and grants. These appointments usually materialize through direct discussions with individual faculty. Please see individual faculty web pages for more information on research topics. The faculty member providing support will typically serve as a student’s academic adviser. Appointments vary, depending on the availability of funds and the academic progress of the student. Research appointments are made at any time in the calendar year depending on funding and other factors. Teaching and Research Assistantships may be held concurrently. Stipend rates are set by the Mechanical Engineering Graduate Faculty. Ph.D. candidates will receive an increase in their stipend once they pass their preliminary oral examination and complete 24 credits of thesis registration. The stipend is increased by 10%, or up to the maximum rate the University may set, whichever is lower. As RA appointments are made by individual faculty members, the faculty member providing the funds for the RA has the right to terminate the RA
appointment in the event that funds are no longer available or because of unsatisfactory performance by the student. However, appointment termination can only take place following University employment procedures. Students are encouraged to familiarize themselves with these procedures:

https://policy.umn.edu/hr/gradstudentemployment

Teaching Assistantships

Teaching Assistantships (TA) are available each academic semester for graduate students to assist in departmental course instruction. The assignments naturally require demonstrated expertise in the course subject matter to which the student is assigned. Teaching assistant responsibilities vary with course assignments and may involve grading, recitation lecture, laboratory, homework problem solution, office hour consultation, or a mix of these duties. The teaching assistant is not ultimately responsible for course grades; final grades are a faculty responsibility.

The TA Appointment Process

Teaching Assistant appointments are made several weeks prior to the onset of a new semester. The department administrators (Head, Associate Head, and Director of Graduate Studies) consult with course instructors for recommendations when assigning teaching assistantships. Students must register as a full-time student in the semester in which they hold teaching assistantships (except during summer sessions providing they were registered the preceding spring semester). Teaching appointments hold no guarantee for continuation beyond one academic semester. Students cannot be enrolled in Curricular Practical Training (CPT) or Optional Practical Training (OPT) while holding a TA appointment. Incoming and current graduate students interested in teaching assistantships are advised to contact individual course instructors to discuss specific TA responsibilities and qualifications.

TA Application

TA applications are accepted June - September for the Fall semester and November - December for the Spring semester. The application process is online at:

http://www.me.umn.edu/education/graduate/ta/index.shtml

Appointment Scope

The number of teaching and research assistantships fluctuates with enrollment and availability of funds. M.S. students at any time are unlikely to obtain assistantships during every semester of study, and hence should have a plan to support their own education. Ph.D. students should expect to maintain full (50%) assistantship or fellowship support throughout their studies, and are strongly advised to consider the possibility of stable RA support when selecting their adviser. There is no strict deadline for incoming students to accept admission for RA and TA positions; however, for incoming students it is advisable to apply for admission to the Graduate School early as TA offers are made only to those students who have received admission and agreed to matriculate to the University.

Whereas teaching assistantship appointments are typically one semester in duration, after which a new assignment can be made, it is possible to hold simultaneous teaching and research assistantships within any academic semester. If simultaneous appointments are made, then each is typically a 25% appointment. Appointments are occasionally combined at other than 25% levels to total 50% overall. Maximum appointments for teaching assistantship and/or research assistantship positions are 50%, except in unusual cases where graduate students who have qualified for doctoral candidacy may receive 75% appointments if a distinct service need exists.

Teaching and Research Assistantships are financial aid academic appointments reserved for graduate students. If accepting an offer of financial aid, it is being entered into a contract, which cannot be terminated unless both parties consent, in writing, to terminate the contract.
VI. REGISTRATION

Registration Steps—New Students

_____ 1. Obtain a UMN student I.D. card by visiting the UCard Office located in Coffman Union.

_____ 2. All new international students, check in with the International Student & Scholar Services (ISSS) Office, at 190 Hubert H. Humphrey Center located on the West Bank Campus.

_____ 3. Consult with the Director of Graduate Studies or provisional advisers to determine first semester’s courses. It is strongly encouraged to examine to select an area of specialization and take classes based upon the suggested courses for first year students.

_____ 4. Follow the registration procedures on One Stop:
https://onestop.umn.edu/how-guides#accord-1

Registration Steps—Current Students

Register at One Stop in the Bruininks Hall building or online through the Student Access System (onestop.umn.edu), according to the registration queue published in the Class Schedule.

- Students are charged a late fee if they register after classes begin and may only register after the first week of the semester with special permission.
- Students must register every Fall and Spring term to maintain active graduate status. If a student has not registered, they must apply for readmission and must register before they can resume work on a master or doctoral thesis or on a master Plan B paper, take written or oral examinations, or file for graduation. The Department of Mechanical Engineering reserves the right to reject a readmission application based on academic performance and other factors.
- The University requires that graduate students holding appointments such as teaching assistants, research assistants, and administrative fellows register for at least 6 credits during each term in which they hold an appointment of greater than or equal to 12.5%. (This rule does not apply to summer terms if registered in the preceding spring quarter.) Each student should check to make sure to satisfy other criteria for full-time status (i.e., some student loan deferrals may require 7-credit registration) that may apply to financial aid.
- Doctoral students must register for 24 doctoral thesis credits (ME 8888) at the University of Minnesota beginning in the semester they have passed the preliminary oral examination. The requirement of 24 doctoral thesis credits cannot be reduced by transfer of master’s thesis credits, or thesis credits taken at another institution.
- Students are permitted to register for doctoral thesis credits during the current semester if they have passed the preliminary oral examination.
Registration- Special Categories

- **Curricular Practical Training (CPT)**
  Curricular Practical Training (CPT) is work authorization that allows a student to work in a job related to their field. Students are not allowed to hold a TA or RA position while in CPT status. To sign up for CPT students need to first pick up a CPT Student Request and Academic Adviser Verification form from ISSS. Students must register for ME 8990 the same semester they sign up for CPT. In order to register for ME 8990 students will need a permission number which will be issued after all paperwork is completed and signed by the adviser, and pending Director of Graduate Studies approval. CPT can only be taken once, should preferably be taken during the summer and should not hinder the student’s ability of continued progress towards degree. If the student is nearing completion of their degree the student should not apply for CPT, but rather OPT (see ISSS website). If a student applies for CPT near the end of his/her degree or multiple times it may not be approved by the Director of Graduate Studies.

- **GRAD 0999**
  GRAD 0999 is a zero credit/no fee class that will maintain a student’s active status with the Graduate School. However, it will not maintain fulltime status for anything else such as a paid appointment (RA or TA), visa status, or deferred student loans. International students can get a waiver from ISSS to register for GRAD 0999, but must check with ISSS before registering. Once all degree requirements have been completed, but active status needs to be maintained to graduate, then registration for GRAD 0999 will be allowed can be registered for. After a student’s second registration for GRAD 0999 a hold will be placed on their record. If a student is making continuous progress towards their degree a permission number may be granted for additional registrations of GRAD 0999. If continuous progress in not being made, a Leave of Absence should be considered.

- **Leave of Absence (LOA)**
  Graduate students are expected to maintain active status through continuous registration from the time they matriculate until their graduation. Students who are not able to maintain active status are strongly encouraged to consult with the DGS, their adviser, and student advising office to determine whether requesting a Leave of Absence is the most appropriate course of action. In order to apply for a Leave of Absence a student must complete the LOA form and have it signed by their adviser. Then, submit the completed form to the Student Advising Office for the signature of the DGS. A student may request a leave for up to 2 academic years. Once the student returns from the LOA they need to contact the Student Advising Office (1120 ME) for matriculating back into the Graduate Program. It is necessary that the student returns by the date specified on the LOA form, or earlier. Once the student matriculates back into the program, it will be recognized they never left and there is no readmission fee necessary.
VII. CHANGE OF STATUS

A Change of Status form must be filed with the Graduate School, if one or more of the following Criteria are met:

- A student has completed M.S. and has interest in pursuing a Ph.D. This particular change of status requires submission of documents similar to a new graduate application.
- A student would like to change majors or add a second major. This also involves a new graduate application-like form.
- A student has not registered in the Graduate School within the past fall or spring term.
- A student is changing status from the Ph.D. to the M.S. program.

Please note that the ME program does not allow Express Readmits.

Additional Information: https://grad.umn.edu/change-add

VIII. MAIL, MAILBOXES

Each full-time graduate student who is on appointment (Fellowship, RA, or TA appointment) by the Department of Mechanical Engineering is given a mailbox upon check-in. Postings are distributed through mailboxes and electronic mailboxes. The department supplies room keys by having the faculty member responsible for the laboratory area contact meaccess@umn.edu. Requested keys can be picked up in Mechanical Engineering 1120, once the faculty members request has been approved.

IX. STUDENT MACHINE SHOP

http://www.me.umn.edu/intranet/studentshop.shtml

X. COMPUTING FACILITIES

Two major computer facilities are available for graduate students within the Department of Mechanical Engineering:

- The College of Science and Engineering Instructional Computing Labs (CSEICC)
- The Department of Mechanical Engineering Computing Labs.

There is a main departmental computing lab which are accessible to graduate students - ME 10. Accounts for these facilities are requested by printing out a New Account Request Form from www.enet.umn.edu and submitting it to the ENet Office in ME 376.

All workstations and personal computers are networked into the campus-wide network. From the network, the workstations have access to other computing resources, such as the supercomputer
facilities of the Minnesota Supercomputing Institute. (www.msi.umn.edu) Access the ME Webpage for an up-to-date list of accessible facilities. Graduate students obtain accounts for using the labs of the College of Science and Engineering Instructional Computing Committee (CSEICC) by paying the semester CSEICC computing fee. The fee-payment procedure is described in the Class Schedule. All software available in the Mechanical Engineering and CSEICC labs is strictly limited to academic use only. The software may be used for coursework and research directly attributed to the graduate program only. The software cannot be used for consulting under any circumstances. No licensed software may be copied or removed from the labs.
Sample Graduate Degree Plan

UNIVERSITY OF MINNESOTA

Graduate Degree Plan

DIRECTIONS
Use this form to declare your degree plan. Review your major field's student handbook and confer with your faculty advisor and director of graduate studies (DGS) to ensure your plan fulfills minimum graduate education and program requirements. Obtain original signatures from your faculty advisor, co-advisor (if applicable), major field DGS, and minor field DGS (if applicable) indicating their approval. Email to gsp@umn.edu or drop off in person at Graduate Student Services and Progress office (333 Bruninrks Hall).

Part 1. Student Information
Student name (Last, first, middle)  University ID  University email

Part 2. Degree Information
Degree sought  Major
Track (if applicable)  Minor (if declared)  Language requirement (if required)
Degree type (check one)
- Master's Plan A - 12 core course credits
- Master's Plan B - 20 core course credits
- Master's Plan C - 20 core course credits
- Doctoral (24 thesis credits) - 12 core course credits

Number of thesis credits (check if applicable)
- 10 Master's Plan A thesis credits (8777)
- 24 Doctoral thesis credits (6880)
- 12 Doctoral thesis credits (8866) - Ed.D. only
- 4 Doctoral thesis credits (8888) - D.M.A. only

Part 3. Transfer coursework from other institutions
List all coursework from other institutions in chronological order. You must attach official transcripts unless you previously submitted them with your application for admission.
*Note: Course type “outside” refers to a minor field and/or outside of your major coursework. A course cannot be used to meet both “major” and “outside” course requirements. Choose only one.

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<th>Term and year</th>
<th>Course type* (choose one)</th>
<th>Department and course number</th>
<th>Course title</th>
<th>Number of semester credits</th>
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<th>Institution</th>
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Graduate program/college office use only

☐ All international coursework was reviewed by the Graduate Admissions office

To request copies of this form in an alternative format, call Disabilities Resource Center at 612-626-3333. The University of Minnesota is an equal opportunity employer and educator. This form is printed on paper made from no less than 20 percent post-consumer waste. Please recycle.

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**University of Minnesota**

**Part 4. University of Minnesota core coursework**

List University of Minnesota coursework taken while enrolled in your current graduate program. These credits may not be applied to any other requirements from another degree. List in chronological order, beginning with earliest term and year. Do not include the following: xxxx-5777, xxxx-9888, xxxx-8886, GRAD 999, xxxx-8333, xxxx-8444, or coursework not applied to this degree. *Note: Course type “outside” refers to a minor field and/or outside of your major coursework. A course cannot be used to meet both “major” and “outside” course requirements. Choose only one.*

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<th>Term and year</th>
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**PART 5. Other University of Minnesota coursework**

List University of Minnesota coursework taken as non-degree, before the award of an undergraduate degree, or that is being applied to another graduate degree. This section may also be used to list additional University of Minnesota core coursework if needed. *Note: Course type “outside” refers to a minor field and/or outside of your major coursework. A course cannot be used to meet both “major” and “outside” course requirements. Choose only one.*

<table>
<thead>
<tr>
<th>Term and year</th>
<th>Course type* (choose one)</th>
<th>Department and course number</th>
<th>Course title</th>
<th>Number of semester credits</th>
<th>Grade</th>
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<tbody>
<tr>
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<td>Major</td>
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</table>

**PART 6. Course totals**

<table>
<thead>
<tr>
<th>Core credit total</th>
<th>Transfer and other UMN credit total</th>
<th>Total course credit total</th>
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</thead>
</table>

**PART 7. Approvals**

<table>
<thead>
<tr>
<th>Advisor signature</th>
<th>Date</th>
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<tbody>
<tr>
<td>Co-advisor signature</td>
<td>Date</td>
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<tr>
<td>DGS (major field) signature</td>
<td>Date</td>
</tr>
<tr>
<td>DGS (minor field) signature</td>
<td>Date</td>
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<tr>
<td>College signature</td>
<td>Date</td>
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Departmental Check Out Sheet

All masters and doctoral degree students are required to submit this sheet to the Student Advising Office, 1120 M.E., after all degree requirements are complete. (This includes students completing residual work subsequent to degree completion or in transition to the doctorate.)

Name: ________________________________

Degree ________________________________
(Please Print)(If M.S. indicate thesis plan, project plan, or course plan)

I.D. ________________________________

I attest that, to the best of my knowledge, I have returned all books, papers, equipment, etc. belonging to the Dept. or its personnel.

Student Signature ________________________________

Adviser Signature ________________________________

Payroll –1100D ME Signature ________________________________
Margaux Lassegard

Department Office –1100 ME ________________________________
Sarah Chapman (Keys, access card)

Graduate Program Coordinator-1120 ME ________________________________
John Gardner

E-mail Address: ________________________________

Professional Position taken: ________________________________