

HANDBOOK FOR GRADUATE STUDENTS

in

MECHANICAL ENGINEERING

College of Engineering

Wayne State University

Detroit, Michigan

<https://engineering.wayne.edu/me/index.php>

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I. Introduction

The primary source of information about graduate programs at Wayne State University is the Graduate School web page <https://gradschool.wayne.edu/>. All applications to the MSME and Ph.D. programs must be submitted online through <https://wayne.edu/apply#fndtn-graduate>.

This handbook has been developed to provide you with an understanding of the policies and regulations governing admission, academic standards and student obligations within the M.S. and Ph.D. programs in Mechanical Engineering (ME), focusing on College and Departmental requirements that are in addition to the general requirements listed by the Wayne State Graduate School. This handbook is divided into two main sections, the first deals with the MSME degree and the second with the Ph.D. degree.

At regular intervals you should carefully review the Graduate School web page and this document to ensure that you are in compliance with specific requirements of the University, the College of Engineering, and the Department of Mechanical Engineering (ME). Should you have any questions regarding your graduate program, contact the ME Director of Graduate Studies, Prof. Leela Mohana Reddy Arava (larava@wayne.edu). In particular, Prof. Arava's signature is needed on any document requiring formal approval from the ME Graduate Program Committee. Newly admitted graduate students will be advised by the ME Department Chair Dr. Nabil Chalhoub until they select a permanent advisor.

II. Master of Science in Mechanical Engineering (MSME)

1. Admission

Applicants must apply for admission into the MSME program online at: <https://wayne.edu/apply#fndtn-graduate>. The applicant must have a bachelor's degree from an ABET accredited institution in the United States or a comparable degree from an officially recognized institution outside the United States to apply for graduate admission. He/she must have adequate preparation and discernable ability to pursue graduate study in the selected major field.

All applicants for the MSME program whose B.S. degree is not from an ABET-accredited university are required to submit his/her scores of the Graduate Record Examination (GRE). International applicants are required to submit a WES Evaluation for their transcripts. Note that the official transcript evaluation must be transmitted directly from WES to the Office of Graduate Admissions. Along with the application, the applicant must upload an official transcript from every college and/or university attended. All students who have earned degrees from a country where English is not the native language must have a minimum score of 79 on the internet-based TOEFL (iBT) or 550 from a paper-based TOEFL (pBT) or IELTS score of 6.5.

To be admitted into the ME graduate programs, an applicant must satisfy all Graduate School requirements that are listed at <https://wayne.edu/admissions/graduate/admission-requirements/>. In addition, a regular admission for Master's degree may be authorized if the applicant's grade point average (GPA) is 3.0/4.0 or better and if he/she holds a degree from an ABET accredited or equivalent institution. Students with an overall GPA between 2.8 and 3.0 out of 4.0 in their BSME degree program will be considered on a case-by-case basis.

Students with degrees in fields other than Mechanical Engineering or degrees from non-accredited institutions may be admitted to the post-bachelor program where students will be expected to complete a set of assigned courses with a grade B or better in each course. The set of assigned courses will be selected from the following list of courses based on the student's field of interest:

- ME 2200 - Thermodynamics
- ME 2410 - Statics
- ME 2420 - Elementary Mechanics of Materials
- ME 3300 - Fluid Mechanics: Theory & Laboratory
- ME 3400 - Dynamics
- ME 4210 - Heat Transfer: Theory & Laboratory
- ME 4300 - Thermal Fluid Systems Design
- ME 4150 - Design of Machine Elements
- ME 4500 - Mechanical Engineering Design II

A successful completion of all post-bachelor program requirements will earn the student a regular admission to the Master's degree program in Mechanical Engineering.

All applicants must pay the \$50 Application Fee. Note that your application will not be assessed until all necessary items are submitted via our online application at <https://wayne.edu/apply#fndtn-graduate>. For questions about your application or requirements, please contact Mr. Rob Carlson, Academic Services Officer, at rcarlson@wayne.edu and include your Access ID or Application ID. For additional questions, please contact Professor and Chair Dr. Nabil Chalhoub at ab9714@wayne.edu.

2. Time Limitations

Students have a six-year time limit to complete all requirements for the Master's degree. The six-year period starts at the beginning of the semester during which the student has taken work that applies toward meeting the requirements of the degree. The College of Engineering reserves the right of revalidation of over-age credits. In revalidation cases the advisor and the student must set a terminal date for completion of all degree requirements, including such additional requirements as may be prescribed to revalidate the over-age credits. Time extensions beyond these conditions are authorized only for conditions clearly beyond the student's control.

In work counted toward a Master's degree, no credit may be more than six years old at the time all requirements are completed. A time extension may be authorized by the Associate Dean for Academic Affairs of the College of Engineering with the approval of the ME Department Chairman, but only for conditions which are clearly beyond the control of the student. Upon recommendation of the advisor and approval of the Associate Dean for Academic Affairs of the College of Engineering, a student may arrange for revalidation of over-age credits which are between six and ten years old and which represent courses completed at Wayne State University. Credits from other institutions may not be revalidated. A special examination fee is charged for course revalidations.

3. Transfer of Graduate Credits

Credits from a graduate school at another institution may be transferred provided they are:

- (a) certified as graduate-level on an official transcript of the original institution;
- (b) applicable to the degree program of the student;
- (c) not used toward the requirements of another degree; and
- (d) certified with a grade B or better (B minus credit is not acceptable for transfer).

A maximum of eight credit hours may be transferred towards the MSME. A student wishing to transfer graduate credits should file a petition requesting such transfer, approved by his/her advisor and the ME Director of Graduate Studies.

4. Residence Requirements

An MSME student must complete at least twenty-four credit hours of graduate work at Wayne State University.

5. Advisors

Students enrolled in the Master's degree program (thesis option) are expected to select a permanent advisor prior to completion of their second semester of course work at WSU. The permanent advisor will assist in the preparation of the student's Plan of Work. The student's choice of a permanent advisor should be solely governed by his/her field of interest.

If a student wishes to change advisors, he/she should discuss the proposed change with his/her current advisor. A departmental form for change of advisor must be completed, and signed by the current advisor, departmental Director of Graduate Studies and department Chair.

6. MS Thesis Committee

The Master's Thesis Committee will consist of three graduate faculty members from the Department of Mechanical Engineering, including the advisor. Upon approval by the ME Director of Graduate Studies, one graduate faculty member of the Department of Mechanical Engineering may be replaced by a member from another department.

The Master's Thesis Committee will administer the final oral examination.

7. Candidacy

Students enrolled in Master's degree program must file a Plan of Work before registering for any graduate courses. In addition, MS thesis students must file a thesis outline form by the time the equivalent of eight graduate credits have been earned. Both the thesis outline and Master's Plan of Work must be approved by the Director of Graduate Studies.

8. Course Requirements

Three plans are offered by the Department of Mechanical Engineering leading to the Master of Science degree:

i) **Plan A: Thesis Option**

This program requires a minimum of 32 semester credits that can be selected as follows

- ME 8999 - *MS Thesis* (8 Cr.)
- A minimum of 8 credits (2 courses) should be taken at the 7000-level. Directed study and directed research courses (ME 7990 and ME 7996) cannot be used to satisfy this requirement.
- ME 5000 - *Engineering Analysis I* (4 Cr.) is a required core course
- A maximum of 4 credits may be taken in Directed Studies (ME 5990)
- A minimum of 4 courses (16 Cr.) should be taken from one of the three thrust areas of the ME Department.
- All credits required by the MSME program should be selected from the ME curriculum.

ii) Plan C: Course Work Option

This program requires a minimum of 32 semester credits that can be selected as follows

- A minimum of 12 credits should be taken at the 7000-level. Directed study and directed research courses (ME 7990 and ME 7996) cannot be used to satisfy this requirement.
- ME 5000 - Engineering Analysis I (4 Cr.) is a required core course
- A maximum of 4 credits may be taken in Directed Studies (ME 5990)
- A minimum of 4 courses (16 Cr.) should be taken from one of the three thrust areas of the ME Department.
- All credits required by the MSME program should be selected from the ME curriculum.

iii) Plan D: Internship In Industry

This plan requires a minimum of 33 credits of course work including 1 credit of ME 6991 - *Internship in Industry*. Students can choose up to three semesters of internship with the permission of both the ME Graduate Program Director and the Office of International Students and Scholars (OISS). The permission of OISS is required for international students only. ME 6991 credits must be taken in addition to the minimum 32 credits required for the MSME under either plan A or plan C. The student is responsible for arranging the internship in the industry. Students are eligible to enroll in ME 6991 after successfully completing 16 credits in their graduate program.

Note

- A grade of B or better must be earned for the core course ME 5000 – *Engineering Analysis I*.
- The Graduate GPA will be calculated using all graduate courses taken at Wayne State University. It must always be maintained at 3.0/4.0 or better; otherwise, the student will be placed under academic probation.
- Students on academic probation have one semester to raise their GPA to at least 3.0/4.0. Failure to do so will result in the student being excluded from the ME graduate program.

9. Course Group Requirements

The Department of Mechanical Engineering has three research thrust areas, namely the "*Noise and Vibration Control*", the "*Advanced Materials and Manufacturing*", and the "*Advanced Propulsion and Energy Systems*". In addition, many *Biomedical Engineering courses* are cross listed with ME courses and are available for ME Graduate students to take and be considered towards their degree. Graduate students must select a field of study in one of the three thrust areas of the ME Department.

All MSME students must select at least four courses from one of the three thrust areas listed above. The core course (ME 5000) is considered to be one of the four courses required from the selected thrust area.

Courses offered in the **Noise and Vibration Control** Thrust area are:

- ME 5000 Engineering Analysis I (Core Course)
- EVE 5110 Fundamentals of Electric-drive Vehicle Engineering
- ME 5400 Dynamics II
- ME 5410 Vibrations II
- ME 5425 Analysis of Vibration Measurements and Instrumentation

- ME 5440 Industrial Noise Control
- ME 5460 Fundamentals in Acoustics and Noise Control
- ME 5990 Directed Study (limited to 4 Cr.)
- ME 5995 Special Topics in Mechanical Engineering I
- ME 6550 Modeling and Control of Dynamic Systems
- ME 7400 Advanced Dynamics
- ME 7410 Vibrations of Continuous Systems
- ME 7420 Random Vibrations
- ME 7440 Signal Processing Technologies and Their Applications
- ME 7460 Advanced Acoustics and Noise Control
- ME 7480 Nonlinear Vibration
- ME 7550 Control of Dynamic Systems
- ME 7590/ECE 7420 Nonlinear Control Systems
- ME 8999 Master's Thesis Research and Direction

Courses offered in the **Advanced Materials and Manufacturing** Thrust area are:

- ME 5000 Engineering Analysis I (Core Course)
- ME 5040 Finite Element Methods I
- ME 5453 Automotive Manufacturing System and Processes
- ME 5580 Computer-Aided Mechanical Design
- ME 5620 Fracture Mechanics in Engineering Design
- ME 5700 Fundamentals of Mechanics
- ME 5720 Mechanics of Composite Materials
- ME 5990 Directed Study (limited to 4 Cr.)
- ME 5995 Special Topics in Mechanical Engineering I
- ME 7020 Finite Element Methods II
- ME 7451 Advanced Manufacturing II: Material Forming
- ME 7610 Theory of Elasticity
- ME 7680 Manufacturing Processing Mechanics
- ME 7720 Advanced Mechanics of Composite Materials
- ME 7820 Engineering Non-Destructive Evaluation (NDE) Methods and Industrial Applications
- ME 8020 Crashworthiness and Occupant Protection in Transportation Systems I
- ME 8030 Crashworthiness and Occupant Protection in Transportation Systems II
- ME 8999 Master's Thesis Research and Direction

Courses offered in the **Advanced Propulsion and Energy Systems** Thrust area are:

- ME 5000 Engineering Analysis I (Core Course)
- ME 5110/EVE 5130 Fundamental Fuel Cell Systems
- ME 5210 Convective and Radiative Heat Transfer
- ME 5215/EVE 5120 Fundamentals of Battery Systems for Electric and Hybrid Vehicles
- ME 5300 Intermediate Fluid Mechanics
- ME 5700 Fundamentals of Mechanics
- ME 5800 Combustion Engines

- ME 5810 Combustion and Emissions
- ME 5820 Thermal Environmental Engineering
- ME 5990 Directed Study (limited to 4 Cr.)
- ME 5995 Special Topics in Mechanical Engineering I
- ME 7260 Heat and Mass Transfer
- ME 7290 Advanced Combustion and Emissions
- ME 7300 Advanced Fluid Mechanics
- ME 7310 Computational Fluid Mechanics and Heat Transfer
- ME 8290 Advanced Combustion and Emissions II
- ME 8999 Master's Thesis Research and Direction

Cross-listed courses with ***Biomedical Engineering*** are:

- ME 5100/BME 5010 Engineering Physiology
- ME 5160/BME 5210 Musculoskeletal Biomechanics
- ME 5170/BME 5570 Design of Human Rehabilitation Systems
- ME 5180/BME 5370 Introduction to Biomaterials
- ME 6180/BME 6480 Biomedical Instrumentation
- ME 7100/BME 7100 Mathematical Modeling in Impact Biomechanics
- ME 7160/BME 7160 Impact Biomechanics
- ME 7180/BME 7300 Advanced Topics in Biomaterials and Tissue Biomechanics
- ME 7195/BME 7210 Tissue Biomechanics

10. Student Performance Requirements

The overall GPA for completing MSME Degree is 3.0/4.0 or higher (i.e, “B” grade or better) with no more than two courses with grades below C and no more than two courses can be repeated throughout the MSME program. A passing grade for any course is “B-” or better with the exception of the core course (ME 5000), which must be passed with a grade of “B”. Thesis credit requirements are met by satisfactory completion of ME 8999. Note that three "C+" or lower grades will result in termination of the student from the ME graduate program. All course work must be completed in accordance with the regulations of the Graduate School and the College governing graduate scholarship and degrees.

Graduate students may register for a maximum of 8 credits per semester unless they have permission from the ME Director of Graduate Studies.

11. Examinations

A public final oral examination based on the MS thesis is required. The examination will be administered by the advisor and two other graduate faculty members from the Department of Mechanical Engineering. One ME member of the thesis committee may be replaced by a non-ME graduate faculty, if the thesis topic is multi-disciplinary, with the approval of the ME Director of Graduate Studies. Passing of the examination requires a majority vote of the committee.

12. Graduation

Each degree candidate must file an Application for Degree at the beginning of the semester in which he/she plans to complete degree requirements at <https://reg.wayne.edu/students/degrees>. The candidate should consult the academic calendar of the Graduate Division Bulletin. If an

application for a degree was filed for a previous semester in which the student did not graduate, a new application is necessary.

III. Doctor of Philosophy in Mechanical Engineering (Ph.D.)

From the Graduate School web page <https://gradschool.wayne.edu/phd/forms>, you can download Ph.D. forms, including Plan of Work, Individual Development Plan, Transfer of Credits, Candidacy, Oral Examinations, and get updated information about the Annual Ph.D. Student Review process.

1. Admission

Applicants must apply for admission to the Ph.D. program online at: <https://wayne.edu/apply#fndtn-graduate>. Along with the application, the applicant must upload an official transcript from every college and/or university attended. All students who have earned degrees from a country where English is not the native language must have a minimum score of 79 on the internet-based TOEFL (iBT) or 550 from a paper-based TOEFL (pBT) or IELTS score of 6.5. Deadline dates for filing an Application for Admission are published by the Office of Graduate Admission at <http://www.gradschool.wayne.edu/>.

Doctoral applicants must present higher entrance qualifications than those required of Master's degree applicants. To be admitted into the ME Ph.D. program, an applicant must satisfy all Graduate School requirements that are listed at <https://wayne.edu/admissions/graduate/admission-requirements/>. The applicant must have a grade point average (GPA) of at least 3.5/4.0 in a master's degree program in mechanical engineering (MSME) and must have completed a bachelor's degree from an ABET accredited institution in the United States or a comparable degree from an officially recognized institution outside the United States. The applicant must have adequate preparation and discernable ability to pursue graduate study in the major field he/she elects.

Applications to the Ph.D. program can also be submitted by students who have completed a bachelor's degree from an ABET accredited institution in the United States or a comparable degree from an officially recognized institution outside the United States with a GPA of at least 3.6/4.0. Students with an undergraduate GPA less than 3.6/4.0 must complete a master's degree in mechanical engineering prior to consideration for admission to the Ph.D. program.

Admission to the Ph.D. program is contingent upon satisfying the following requirements:

- All students must have an MS in Mechanical Engineering or a very similar field. Applicants without an MS degree in Mechanical Engineering are considered on a case-by-case basis.
- All applicants are encouraged to submit Graduate Record Examination (GRE) scores. This requirement is optional.
- International applicants are required to submit a WES Evaluation for their transcripts. Note that the official transcript evaluation must be transmitted directly from WES to the Office of Graduate Admissions.
- The admission to the Ph.D. program is contingent upon the approval of an ME graduate faculty to serve as the permanent Ph.D. advisor for the applicant.

All applicants must pay the \$50 Application Fee. Note that your application will not be assessed until all necessary items are submitted via our online application at <https://wayne.edu/apply#fndtn-graduate>. For questions about your application or requirements, please contact Mr. Rob Carlson, Academic Services Officer, at rcarlson@wayne.edu and include your Access ID or Application ID. For additional questions, please contact Professor and Chair Dr. Nabil Chalhoub at ab9714@wayne.edu.

2. Time Limitations

Students have a seven-year time limit to complete all requirements of the Ph.D. degree. The seven-year period starts at the beginning of the semester during which the student was admitted to doctoral study and was taking work toward meeting the requirements for the degree. Up to thirty-two graduate credit hours with a grade B or better earned prior to the student's admission as a doctoral applicant may be applied toward the degree without regard to lapse of time. Credits earned beyond these thirty-two semester hours will not be counted towards the Ph.D. degree at the time of admission to the Ph.D. program. Credits earned after acceptance as a Ph.D. applicant may not be over seven years old at the time the degree is conferred, except when, on the recommendation of the advisor, up to ten semester hours of credit previously earned at Wayne State University may be specified for revalidation by examination. In the event that any courses have been previously revalidated in connection with the earning of the Master's degree, these shall be counted as a part of the total ten. Time extensions beyond these limitations can only be approved by the Graduate School on a yearly basis. The extension requests should reflect conditions that are clearly beyond the student's control.

3. Transfer of Graduate Credits

Credits from a graduate school at another institutions may be transferred provided they are:

- (a) certified as graduate-level on an official transcript of the original institution;
- (b) applicable to the degree program of the doctoral Applicant;
- (c) not used toward the requirements of another degree; and
- (d) certified with grade B or better (B minus credit is not acceptable for transfer).

All transfer credits requests must be approved by the Chairman of the student's Doctoral Committee, the ME Director of Graduate Studies and the Office for Graduate Studies. Such a request is granted only when it is deemed to improve the student's program of study and, at the same time, comply with time limitations. Transfer credits cannot be used to meet the residence requirement.

4. Residence Requirements

The requirement of one year of residence for the Ph.D. is normally met by completion of 6 credit hours of course work, exclusive of dissertation, in each of two successive semesters after admission as a Ph.D. applicant.

5. Advisors

All Ph.D. students are required to have a permanent advisor upon their admission into the Ph.D. program. The permanent advisor will assist in the preparation of the Plan of Work. The student's choice of a permanent advisor should be governed by his/her field of interest. If a student wishes to change advisors, he/she should discuss the proposed change with his/her current advisor. A departmental form for change of advisor must be filled, and signed by the current advisor, departmental Director of Graduate Studies, and department Chairperson.

6. Dissertation Committee

At the time the doctoral plan of work is being prepared, the Doctoral Committee which serves as both the Final Qualifying Examination Committee and the Dissertation Committee for each Ph.D. student should be formed. The permanent advisor of the student will serve as chairman of

the Doctoral Committee. The Committee will be made up of at least three graduate faculty members from Mechanical Engineering and one graduate faculty member from outside the department. The other members will be selected by the student's permanent advisor subject to approval by the ME Director of Graduate Studies and the Office for Graduate Studies. The Doctoral Committee will administer the Final Written and Oral Qualifying Examinations and the Dissertation Public Lecture Presentation-Defense. Upon approval by the ME Director of Graduate Studies and the Graduate School Ph.D. Office, a graduate faculty member of the Department of Mechanical Engineering may be replaced by a member from another department as long as the committee meets the minimum Graduate School requirement.

A "Doctoral Dissertation Outline" form, approved by all members of the Doctoral Committee and the Director of Graduate Studies, should be filed with the Graduate School Ph.D. office at or near the beginning of the student's dissertation work.

7. Candidacy

A Ph.D. Plan of Work must be filed with the Office for Graduate Studies and approved within one semester after passing the preliminary qualifying examination (PQE). A student can be admitted to the status of doctoral candidate by fulfilling the following requirements:

- Successful completion of at least 50 credit hours of didactic coursework
- Passed the written preliminary qualifying examination (PQE)
- Formed a dissertation advisory committee
- Submitted the Recommendation for Candidate Status form with the Office for Graduate Studies.

Note that changes in the Plan of Work must be approved by the advisor, the ME Director of Graduate Studies and the Office for Graduate Studies.

8. Course Requirements

A minimum of ninety credits beyond the baccalaureate degree must be earned in the Ph.D. program. These credits are distributed in the following way:

- a. Thirty credits dissertation requirements are fulfilled by successfully completing ME 9991, 9992, 9993, and 9994 (*Doctoral Candidate Status: Dissertation Research and Direction I, II, III, and IV*, respectively). All Ph.D. students must have achieved the status of doctoral candidate before they will be allowed to register for dissertation credits. They are required to register for thesis or dissertation credits in 4 consecutive academic year semesters without any interruption (7.5 credits per semester). If a student has registered for all Doctoral Dissertation Research credits but has not completed dissertation requirements then he/she may register in ME 9995 - *Candidate Maintenance Status* until the requirements are completed, the time limit for degree is reached, or the student withdraws from the program.
- b. A minimum of 30 credits must be earned in formal lecture credits.
- c. At least 30 credits of course work beyond the Bachelor's degree must be in courses open only to graduate students (i.e., courses at 7000-level or higher).
- d. At least half of all course work exclusive of dissertation credits must be earned in the Mechanical Engineering Department.
- e. All Ph.D. students are required to take the core course ME 5000 – *Engineering Analysis I*

- f. All Ph.D. students are required to select a minor field and complete at least 8 credit hours in courses numbered 5000 or above in the selected field.
- g. A maximum of 30 credits may be earned in Special Topics courses.
- h. A maximum of 8 credits may be earned in ME 7990 - *Directed Study*.
- i. A maximum of 8 credits may be earned in ME 7996 - *Research*.
- j. All course work must be completed in accordance with the regulations of the Graduate School and the College governing graduate scholarship and degrees.

Note

- A grade of B or better must be earned in all ME courses.
- A grade of B⁻ or better must be earned in all non-ME courses (Minor).
- The Graduate GPA will be calculated using all graduate courses taken at Wayne State University.

The Mechanical Engineering Department has three research thrust areas, namely the "*Noise and Vibration Control*", the "*Advanced Materials and Manufacturing*", and the "*Advanced Propulsion and Energy Systems*". In addition, many *Biomedical Engineering courses* are cross listed with ME courses and are available for ME Graduate students to take and be considered towards their degree. Graduate students must select a field of study in one of the three thrust areas of the ME Department.

Courses offered in the **Noise and Vibration Control** Thrust area are:

- ME 5000 Engineering Analysis I (Core Course)
- EVE 5110 Fundamentals of Electric-drive Vehicle Engineering
- ME 5400 Dynamics II
- ME 5410 Vibrations II
- ME 5425 Analysis of Vibration Measurements and Instrumentation
- ME 5440 Industrial Noise Control
- ME 5460 Fundamentals in Acoustics and Noise Control
- ME 5990 Directed Study (limited to 4 Cr.)
- ME 5995 Special Topics in Mechanical Engineering I
- ME 6550 Modeling and Control of Dynamic Systems
- ME 7400 Advanced Dynamics
- ME 7410 Vibrations of Continuous Systems
- ME 7420 Random Vibrations
- ME 7440 Signal Processing Technologies and Their Applications
- ME 7460 Advanced Acoustics and Noise Control
- ME 7480 Nonlinear Vibration
- ME 7550 Control of Dynamic Systems
- ME 7590/ECE 7420 Nonlinear Control Systems
- ME 7990 Directed Study (limited to 8 Cr.)
- ME 7995 Special Topics in Mechanical Engineering II
- ME 7996 Research (Limited to 8 Cr.)
- ME 9990 Pre-Doctoral Candidacy Research
- ME 9991 Doctoral Candidate Status I: Dissertation Research and Direction
- ME 9992 Doctoral Candidate Status II: Dissertation Research and Direction
- ME 9993 Doctoral Candidate Status III: Dissertation Research and Direction
- ME 9994 Doctoral Candidate Status IV: Dissertation Research and Direction

- ME 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction

Courses offered in the **Advanced Materials and Manufacturing** Thrust area are:

- ME 5000 Engineering Analysis I (Core Course)
- ME 5040 Finite Element Methods I
- ME 5453 Automotive Manufacturing System and Processes
- ME 5580 Computer-Aided Mechanical Design
- ME 5620 Fracture Mechanics in Engineering Design
- ME 5700 Fundamentals of Mechanics
- ME 5720 Mechanics of Composite Materials
- ME 5990 Directed Study (limited to 4 Cr.)
- ME 5995 Special Topics in Mechanical Engineering I
- ME 7020 Finite Element Methods II
- ME 7451 Advanced Manufacturing II: Material Forming
- ME 7610 Theory of Elasticity
- ME 7680 Manufacturing Processing Mechanics
- ME 7720 Advanced Mechanics of Composite Materials
- ME 7820 Engineering Non-Destructive Evaluation (NDE) Methods and Industrial Applications
- ME 7990 Directed Study (limited to 8 Cr.)
- ME 7995 Special Topics in Mechanical Engineering II
- ME 7996 Research (Limited to 8 Cr.)
- ME 8020 Crashworthiness and Occupant Protection in Transportation Systems I
- ME 8030 Crashworthiness and Occupant Protection in Transportation Systems II
- ME 9990 Pre-Doctoral Candidacy Research
- ME 9991 Doctoral Candidate Status I: Dissertation Research and Direction
- ME 9992 Doctoral Candidate Status II: Dissertation Research and Direction
- ME 9993 Doctoral Candidate Status III: Dissertation Research and Direction
- ME 9994 Doctoral Candidate Status IV: Dissertation Research and Direction
- ME 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction

Direction Courses offered in the **Advanced Propulsion and Energy Systems** Thrust area are:

- ME 5000 Engineering Analysis I (Core Course)
- ME 5110/EVE 5130 Fundamental Fuel Cell Systems
- ME 5210 Convective and Radiative Heat Transfer
- ME 5215/EVE 5120 Fundamentals of Battery Systems for Electric and Hybrid Vehicles
- ME 5300 Intermediate Fluid Mechanics
- ME 5700 Fundamentals of Mechanics
- ME 5800 Combustion Engines
- ME 5810 Combustion and Emissions
- ME 5820 Thermal Environmental Engineering
- ME 5990 Directed Study (limited to 4 Cr.)

- ME 5995 Special Topics in Mechanical Engineering
- ME 7260 Heat and Mass Transfer
- ME 7290 Advanced Combustion and Emissions
- ME 7300 Advanced Fluid Mechanics
- ME 7310 Computational Fluid Mechanics and Heat Transfer
- ME 7990 Directed Study (limited to 8 Cr.)
- ME 7995 Special Topics in Mechanical Engineering II
- ME 7996 Research (Limited to 8 Cr.)
- ME 8290 Advanced Combustion and Emissions II
- ME 9990 Pre-Doctoral Candidacy Research
- ME 9991 Doctoral Candidate Status I: Dissertation Research and Direction
- ME 9992 Doctoral Candidate Status II: Dissertation Research and Direction
- ME 9993 Doctoral Candidate Status III: Dissertation Research and Direction
- ME 9994 Doctoral Candidate Status IV: Dissertation Research and Direction
- ME 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction

Cross-listed courses with ***Biomedical Engineering*** are:

- ME 5100/BME 5010 Engineering Physiology
- ME 5160/BME 5210 Musculoskeletal Biomechanics
- ME 5170/BME 5570 Design of Human Rehabilitation Systems
- ME 5180/BME 5370 Introduction to Biomaterials
- ME 6180/BME 6480 Biomedical Instrumentation
- ME 7100/BME 7100 Mathematical Modeling in Impact Biomechanics
- ME 7160/BME 7160 Impact Biomechanics
- ME 7180/BME 7300 Advanced Topics in Biomaterials and Tissue Biomechanics
- ME 7195/BME 7210 Tissue Biomechanics

9. Ph.D. Degree Requirements

(a) Preliminary Qualifying Examination: This is a three-part written examination administered twice per year by the ME Graduate Program Committee during the third week of the months of September and January. All Ph.D. applicants must pass this examination within their first year after joining the Ph.D. program at WSU. Students must fill out the "PQE Registration Form" that can be downloaded from the ME website and submit it to the ME Graduate Program Director or at the ME front desk no later than one week prior to the exam date.

(b) Final Qualifying Examination: This examination consists of written and oral parts covering the student's major and minor areas and other related fields. The oral part of the examination shall include a presentation of the proposal for the dissertation research. The Final Qualifying Examination is administered by the student's Doctoral Committee. The student is expected to take this examination before registering for ME 9991 - *Doctoral Candidate Status I: Dissertation Research and Direction*.

Under ordinary circumstances, the committee members may not be changed before the Qualifying Examination (written and oral) have been passed. Under extraordinary

circumstances the Office for Graduate Studies may approve a committee change, but such change shall require written justification and approval in advance of the examination.

If the student fails the final qualifying examination, he/she must be re-examined before the end of the semester that follows the one in which the failure occurred. The student is allowed only one re-examination. Successive failure of the examination will result in dismissal.

The student passes the final qualifying examination upon the recommendation of his/her Ph.D. Committee with no more than one dissenting vote.

- (c) **An approved Plan of Work** should be filed with the Office for Graduate Studies. The Plan of Work form can be downloaded from the Graduate School web site at <https://gradschool.wayne.edu/phd/forms>.
- (d) **A Doctoral Dissertation Outline**, approved by all members of the Doctoral Committee and the Departmental Graduate Program Committee, should be filed by the student immediately after completing the oral part of the Final Qualifying Examination.
- (e) The **Conflict of Interest Form** must be turned in twice, once with the Prospectus and again with the pre-defense paperwork (Final Report Form). The Conflict of Interest Form can be downloaded from the Graduate School web site at <https://gradschool.wayne.edu/phd/forms>.
- (f) A **Unicheck certification** must be turned in three weeks prior to the Dissertation Defense. The Unicheck certification form can be downloaded from the Graduate School website at https://engineering.wayne.edu/pdfs/phd_unicheck.pdf

10. Milestones of the Ph.D. Program

Year 1 Milestones: Identify Advisor & File Plan of Work		
Fall / Winter / Spring 10cr / 10cr / 2cr Core and Elective Courses Mandatory RCR Course	Confirm Faculty Advisor File Plan of Work Qualification Exams	Annual Review Individual Development Plan
Year 2 Milestones: Prospectus and Candidacy		
Fall / Winter / Spring 10cr / 10cr / 2cr Core and Elective Courses	Form Dissertation Committee Prospectus and Candidacy	Annual Review Individual Development Plan
Year 3 Milestones: Present at Conference and Publish in Academic Journal		
Fall / Winter / Spring 10.5cr / 10.5cr / 2cr 9991/9992	Dissertation Committee Meeting Present at Conference Publish in Journal	Annual Review Individual Development Plan
Year 4 Milestone: Dissertation Defense		
Fall / Winter / Spring 10.5cr / 10.5cr / 2cr 9993/9994	Register for Dissertation Defense Dissertation Defense Submission of Dissertation	Annual Review Individual Development Plan
Years 5-6 Maintenance Credits and Dissertation Defense		
0cr Maintenance Credits (9995)	Dissertation Defense 7 Year Time Limit	Annual Review Individual Development Plan
Year 7 Maintenance Credits and Dissertation Defense		
0cr Maintenance Credits (9995)	Dissertation Defense File Extension Request	Annual Review Individual Development Plan

11. Preliminary Qualifying Examination (PQE) Guidelines

These guidelines are intended to assist the mechanical engineering graduate students in preparing for the Ph.D. Preliminary Qualifying Examination, which is a requirement of all Ph.D. applicants in the Department of Mechanical Engineering.

All students must pass the three PQE exams during their first year in the Ph.D. program. They will only have two chances to pass the examination. Students joining the Ph.D. program in the fall semester must take the PQE exams in September. Those who fail will have another chance to retake the exams in January of the same academic year. As for those who join the program in the winter semester, they have to take the PQE exams in January. If they do not pass then they have to retake the exams in September of the following academic year. **All PQE requirements must be fulfilled within the first year after the student joins the Ph.D. program.** Failure to meet this requirement within the specified time limit will result in the dismissal from the Ph.D. Program.

MSME students who have completed 20 graduate credits at WSU with a GPA of 3.5/4.0 or better will be eligible to one free chance to take the Ph.D. Preliminary Qualifying Examination. The results of such an examination would only count if the student passes. Failing grades would not count. Irrespective of the result of such an examination, the student has to go through the regular application process to be considered for admission to the Ph.D. program. These students would still be eligible for the two trials to pass the PQE exams after being admitted to the Ph.D. program.

The PQE exams are administered by the ME Graduate Program Committee and are offered twice a year during the third week of September and the third week of January of each academic year.

The Preliminary Qualifying Examination consists of a compulsory math exam in addition to two other exams that can be selected from topics in thermodynamics, mechanics of materials or dynamics. The passing guidelines for these exams will be set by the faculty. Each of these exams will involve four problems and the students are required to solve three out of the four problems in a two-hour period. The examination will be **closed book, closed notes**.

The exam papers will be graded within two weeks after the exam date and the results will be approved by the faculty at the first faculty meeting following the PQE exam. The results will then be communicated to students through the ME Graduate Program Director. Within one week from receiving the examination results, students can appeal their results by stating all their questions and concerns in a formal written request addressed to the ME Graduate Program Director. Students must refrain from discussing exam issues with the examiners after the exam is over.

Registration for the Preliminary Qualifying Exam: Students must fill out the "PQE Registration Form" that can be downloaded from the ME website and submit it to the ME Graduate Program Director or at the ME front desk no later than one week prior to the exam date. During their first attempt, students must take all three exams of the PQE. In their second attempt, students would only have to retake the exam(s) of the PQE that they were not able to pass during their first attempt. **Absenteeism for any exam, without an advanced written notice to the ME Graduate Program Director, will result in a failing grade for the exam.**

Under extreme circumstances such as illness or other emergency situations, the student will be allowed to postpone the examination, but only one such postponement will be allowed. The student must inform the ME Graduate Program Director of such situation on or before the examination date and present the supporting official documents thereafter.

- Medical Excuse: A signed letter from a physician from the day of the examination indicating that the student had a valid medical reason for missing the exam. This letter must be on the physician's letterhead and the name and phone number of the physician must be legible. For cases of extended medical treatment, the letter can be dated prior to the examination, if the physician's recommendation for leave extends beyond the examination date.
- Death in the Family or Family Illness: A copy of the death certificate or obituary for the family member who has died. For illness of a family member for whom a student is the primary care-giver, a signed letter from the family member's physician for the day of the examination.

Scope of the Preliminary Qualifying Examination: The PQE consists of the following three exams:

1. Math exam (compulsory)
2. Select two exams from the following list:
 - a. Dynamics Exam
 - b. Mechanics of Materials exam
 - c. Thermodynamics exam

The scope of the exams will be based on the topics listed below for each area. All exams will be **closed book, closed notes**.

Mathematics: Based on course contents of MAT 2030 – Calculus III, MAT 2150 – Differential Equations and Matrix Algebra, and ME 5000 – Engineering Analysis I

- Ordinary differential equations: Initial and boundary value problems, 1st order differential equations and applications, linear 2nd order differential equations, structure of general solution, method of undetermined coefficients and parameter variations, particular solutions of non-homogeneous equations using Fourier series, Laplace transforms, and power series solutions.
- Systems of linear differential equations with constant coefficients: Matrix representation, determinants, eigenvalues and eigenvectors, general solutions, determining types of stationary (equilibrium) points on the phase plane, criteria of stability and instability of critical points based on roots of characteristic equations.

Dynamics: Based on course content of ME 3400

- Kinematics of a particle: Rectilinear motion, curvilinear motion (Rectangular coordinates, normal tangential coordinates, and polar coordinates), constraint motion, relative motion in pure translation
- Kinetics of a particle: Newton's second law and free-body diagram (rectangular coordinates, normal tangential coordinates and polar coordinates), work and energy method, linear momentum, linear impulse, angular momentum, angular impulse and impact
- Kinematics of rigid bodies in plane motion: Instantaneous center, relative motion in rotating coordinates (Coriolis acceleration)
- Kinetics of rigid bodies in plane motion: Mass moment of inertia (parallel axes theorem), first moment of mass (Center of mass), Newton's second law and free-body diagram (pure translation, rotation about a fixed axis, center of percussion concept, general plane motion),

Work and energy, linear momentum and linear impulse, angular momentum and angular impulse, and impact

Mechanics of Materials: Based on course content of ME 2420

- *Axial loads*: Elastic deformation of axially loaded member, principle of superposition for total effect of different loading cases and applying compatibility principles to solve statically indeterminate structures.
- *Torsion*: Shear stresses in a circular shaft due to torsion, angle of twist and analyze statically indeterminate torque-loaded members
- *Bending*: Determine the internal moment at a section of a beam, determine the stress in a beam member caused by bending and application of flexural formula
- *Transverse shear*: Shear stress in a prismatic beam, shear flow in a built-up and thin-walled beams
- *Combined loading*: Determine stresses developed in thin-walled pressure vessels, determine stresses developed in a member's cross section when axial load, torsion, bending and shear occur simultaneously
- *Stress transformation*: Navigate between rectilinear co-ordinate systems for stress components, determine principal stresses and maximum in-plane shear stress, determine the absolute maximum shear stress in 2-D and 3-D cases
- *Deflections of beams*: Determine the deflection and slope at specific points on beams and shafts, using various analytical methods including the integration method, the use of discontinuity functions and the method of superposition

Thermodynamics: Based on course content of ME 2200

- *First Law of Thermodynamics*: Energy balance of open and closed systems, conservation of mass, uniform flow, flow rates, flow work, boundary work, energy conversion efficiencies
- *Properties of Pure Substances*: Property tables, phase change process, P-v and T-v diagrams, ideal gas equation of state, compressibility factor, specific heats, internal energy, enthalpy, incompressible substances
- *Second Law of Thermodynamics*: Heat engines, refrigerators, heat pumps, reversible and irreversible processes, entropy, isentropic processes, entropy change, reversible work, compressor work, isentropic efficiencies, entropy balance
- *Cycles*: Gas power cycles, Carnot cycle, Otto cycle, diesel cycle, Brayton cycle, gas turbines, vapor cycle, Rankin cycle

12. Additional Requirements for the Ph.D. Degree

- (a) **Pre-Defense Presentation:** At least four weeks before the planned Dissertation Public Lecture Presentation-Defense, the student will present a preliminary dissertation defense lecture to the members of his/her Ph.D. Committee, who will provide a feedback to the student within two weeks for the purpose of incorporating any changes/corrections in the dissertation.
- (b) Before graduation, each Ph.D. student is expected to have one journal paper accepted.
- (c) **Dissertation Public Lecture Presentation-Defense:** The dissertation format and appearance must be approved by the Office for Graduate Studies before the Dissertation

Public Lecture Presentation-Defense is to be arranged. Additionally, each committee member must have certified, in writing (using the Dissertation Public Lecture Presentation-Defense form), that the dissertation has been read and approved for a Public Lecture Presentation-Defense. 21

The final lecture is to be publicized by public notice to the academic community. This responsibility rests with the student's advisor. At this final lecture, the candidate will outline his/her methodology, research and the results of the investigation. Members of the committee will lead the discussion following the presentation.

At the conclusion of the oral defense of the dissertation, the Graduate Examiner shall poll the Dissertation Committee and report in writing to the Office for Graduate Studies. The Graduate Examiner is the presiding officer at the Defense and is responsible for its conduct. The role of the Graduate Examiner may be assumed by the dissertation advisor or an external member of the committee.

13. Graduation

Each degree candidate must file an Application for Degree at the beginning of the semester in which he/she plans to complete degree requirements at <https://reg.wayne.edu/students/degrees>. The candidate should consult the academic calendar of the Graduate Division Bulletin. If an application for a degree was filed for a previous semester in which the student did not graduate, a new application is necessary. Note that the student is only required to register in the semester he/she plans to defend and not necessarily in the semester he/she files an Application for Degree.