

Graduate Studies Handbook

University of Notre Dame
Department of Aerospace and Mechanical Engineering

2018 – 2019 Academic Year



Available online at <http://ame.nd.edu/graduate-programs/graduate-handbook>

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I. INTRODUCTION

This handbook describes the policies and procedures for graduate studies in the Department of Aerospace and Mechanical Engineering (AME) of the University of Notre Dame. It emphasizes issues that are particular to the AME Department. It provides details on various general topics that are described in other sources. The most important of these other information sources is the University of Notre Dame Graduate School's annual *Bulletin of Information*¹, which is the primary source of policies pertaining to all graduate students at the University. Graduate students are expected to familiarize themselves with these policies. Nothing herein, in previous handbooks or online, is to be interpreted as contrary to the regulations of the Graduate School.

An additional source of information is the *du Lac Handbook*,² as it provides information on student services, student life, and student government. In particular, students should review this document and be aware of the policies regarding discriminatory and sexual harassment as they will be serving at times in positions of teaching authority during their graduate program. All students were provided a copy of this *Handbook* upon admission.

At the departmental level, all policy-making and administrative authority on graduate studies resides in the Graduate Studies Committee, composed of the Department Chair, the Director of Graduate Studies, and elected department faculty members. The student's primary contact for all graduate school matters is a faculty member who serves as the student's research advisor. Any policy question or administrative matter that cannot be resolved by the student and advisor should be referred in writing to the Graduate Studies Committee via the Director of Graduate

Studies. During the 2018-2019 academic year, Prof. David Go³ will serve as the Director of Graduate Studies (DGS).

These policies apply to all students enrolled during the 2018-2019 academic year. *Note that these policies may be different from policies published in previous years.* An electronic version of this handbook is available online on the AME website.⁴ More general information about the graduate program in AME and the AME Department in general, can be found online.⁵

Topics covered in this handbook include the basic responsibilities of graduate students, requirements for the M.S. and Ph.D. programs, and items related to selected facilities and services available in the Department and University. A number of other important documents and directives are listed in the Table of Contents in the form of URLs, and each student is encouraged to review these documents. Often, answers to questions regarding the graduate program can be found by contacting the DGS or the AME graduate program administrative assistant (Ms. Nancy Davis⁶).

This handbook is intended to provide general guidelines for AME graduate students, and it is recognized that exceptions will occur. All students are expected to have read these guidelines. If under any circumstances a student wishes to take exception to or deviate from these guidelines, they should secure prior written approval from the DGS and ensure that the approval is recorded in their permanent file. It is much safer and wiser to secure approval *prior* to taking exception to a directive than after.

Appeals and Grievances

Appeals of decisions related to academic matters, grievances of course grades or

¹ <https://graduateschool.nd.edu/about-the-graduate-school/print-materials/>

² <https://dulac.nd.edu/>

³ dgo@nd.edu

⁴ <https://ame.nd.edu/graduate-programs/graduate-handbook>

⁵ <https://ame.nd.edu/graduate-programs>

⁶ ndavis@nd.edu

conduct, conflicts between students and advisors, or other issues that affect a student's degree progress will be addressed by the DGS under consultation with the Graduate Studies Committee. Students wishing to file a formal grievance or appeal should do so in writing to the Director of Graduate Studies *or* to the Department Chair. The student should indicate the nature of the problem, the date(s) the problem occurred, the grounds upon which the appeal is based, background information that the student considers important, and the relief requested. The matter will be considered by the DGS and Department Chair in consultation with the Graduate Studies Committee, and acted on in no more than 15 working days. If the student feels the resolution is inadequate, they may appeal the decision to the Graduate School by following the formal procedures.⁷

II. BASIC RESPONSIBILITIES

Most full-time students receive a monthly stipend from the department. Funds for these stipends typically come from the externally funded grants and contracts of the student's advisor or from internal sources through the Graduate School. It is expected that full-time students receiving financial support from the University devote their entire professional efforts to research, teaching, and course work within the University.

Those students who are receiving stipend support in any form from the University must receive approval from their advisor, the DGS, and the Graduate School prior to pursuing any employment outside the Department that will be in conjunction and simultaneous to their graduate studies. Students who are funded by external fellowships, such as the National Science Foundation Graduate Research Fellowship, are expected to follow the

guidelines and requirements of the fellowship program.

Any extracurricular activities that require a significant time commitment, including: ND marching band, intramural coaching or refereeing, or any form of instruction (other than assigned TA responsibilities), must be approved by the student's advisor.

Students are allowed the following University holidays: the Wednesday before Thanksgiving, Thanksgiving and the following Friday, Christmas Eve through New Year's Day, Good Friday and Easter Monday, Memorial Day, and Independence Day. Students are expected to be present during Fall Break, Spring Break, and breaks before each semester as well as during the summer session. Any extra vacation time during periods in which the student is receiving financial support must be approved by the student's advisor.

Students receiving University support as a Teaching Assistant (TA) must be available throughout the semester, and three days beyond the end of final exams, to support the courses for which they have responsibility. Any absence from campus by a TA during the semester must be approved in writing by the student's research advisor, the instructor in the course for which the student is serving as a TA, and the Department Chair.

Registration and enrollment

All graduate degree programs in AME have a set number of credit-hour requirements (see pg. 6) and these include both courses and research credit. All students therefore, are required to both register and enroll before each Spring and Fall semester to maintain student status; otherwise they have to apply for re-admission. The only exception is for officially approved leaves of absence.

First year, full-time graduate students are required to register for 12 credit hours each Fall and Spring semester during their

⁷http://graduateschool.nd.edu/assets/9047/info_appeal_procedure.pdf

first year in residence. These 12 credits may be coursework or a mix of coursework and research credits, dependent upon the advisor's discretion.

Once a student has passed beyond their first year of study, a minimum of 9 credit hours must be taken each Fall and Spring semester until all course and research credit requirements are met for their degree, and students are ready for graduation.

All students are required to register and enroll for the zero-credit course AME 67890 during each Summer Session. However, those expecting to obtain terminal degrees in August must register for zero credit hours of research under their advisor unless additional credit hours are needed to fulfill degree requirements. More information regarding this policy can be found in the Graduate School's *Bulletin of Information*.

For entering students, registration and enrollment is done two days prior to the beginning of classes. For continuing students, registration is in the middle of the prior semester, with the subsequent enrollment the day before classes begin. Students beyond the first year are required to register for research credits in AME68691 (M.S.) and AME98991 (Ph.D.). Course selections should be made during registration after consultation with the student's advisor.

Graduate students are allowed to audit graduate courses, and to do so they must first register for the course, then complete the online audit form accessed through the Graduate School's student website under the Forms, Policies and Handbook section.⁸ This course, with an audit designation, does appear on the student's official transcript; thus, if a student registers in a course with the audit status but does not regularly attend the course, the faculty teaching the course is instructed to remove the student from the official course roster. If a student enrolls as an auditor in a course, the

student must actually audit the course for it to appear on the student's transcript. Additional information on auditing courses can be found on the Registrar's website.⁹

On occasion, students spend part of their graduate program in a non-resident status. A student should carefully discuss all aspects of such an arrangement with their research advisor prior to departure. Students who leave prior to completing their degree program and graduating must realize that in order to eventually receive their degree they must be registered as a student in the semester prior to the graduation. If they are in a non-resident status and wish to complete their program and graduate, they will be responsible for the tuition costs associated with that registration.

Satisfactory progress toward degree

Each student's progress toward their degree will be reviewed annually by the student's advisor in conjunction with the Graduate Studies Committee. Continued financial support, both stipend and tuition, is dependent upon successful performance in research, course work, assistance in teaching, as well as the availability of funds. While the department will endeavor to maintain or increase the stipend level, it cannot be guaranteed that the level of support will remain constant or increase.

One means for assessment of the student's academic progress is through grades assigned in course work. The Graduate School grading system is on a four-point basis. Grades recorded for graduate courses are: A (4.0); A- (3.667); B+ (3.333); B (3.0); B- (2.667); C+ (2.333); C (2.0); C- (1.667); D (1.000); and F (0.0). **Note that a grade of C is the lowest acceptable passing grade for graduate students;** the grades of C- and D are used to calculate both semester and cumulative GPAs, but are not counted as course credits toward the student's degree. The Graduate School requires

⁸ <http://graduateschool.nd.edu/resources-for-current-students/> ⁹ <http://registrar.nd.edu/students/audit.php>

that a student maintain a cumulative GPA of 3.0; any student whose cumulative GPA is below 3.0 or whose GPA in any given semester is below 2.5 may be subject to loss of financial support and/or dismissal. In order to take the AME Ph.D. Qualifying Examination, a student must be in good standing, meeting all GPA requirements of the Graduate School.

Students should complete the work of graduate level courses during the regular academic term in which they are taken, and a grade of Incomplete (I) will be given only under *exceptional* circumstances. If a student receives an Incomplete, they have 30 days from when the grades were due (the semester in which the (I) was given) to complete the coursework for a grade. If the coursework is not completed by this date, the (I) will be changed permanently to a grade of F. Any extensions for Incompletes require a formal approval from the Associate Dean for Academic Affairs in the Graduate School.

Academic service

All graduate students are expected to, as part of their professional development, contribute to the academic mission of the Department during the time they are on-campus students. This typically involves working with a faculty member to aid in teaching a course. The graduate student may conduct labs or recitation sessions, grade homework or exams, help develop new learning activities, or hold office hours to provide assistance to students.

Students currently or previously supported by Department funds, external grants/contracts, or University positions must contribute approximately 70 hours of work per semester (minimum of 60 hours and maximum of 80 hours) as a teaching assistant is part of the academic requirements for a graduate degree in the Department. The number of hours in a given week is typically 4 hours and will not exceed 18 hours. Students holding external

fellowships may be exempt from this requirement.

Second year and later students who receive stipend support from University sources, depending upon the level and type of that support, will also be designated as Teaching Assistants, and their total commitment is nominally 16 hours per week.

The exceptions are:

1. Ph.D. students at or near the end of their program can petition for a single semester of dissertation writing status (ABD). For a graduate student on dissertation writing status whose full stipend support comes from external sources, the commitment is waived for one semester. If that student remains on campus in the Ph.D. program after the dissertation semester, they will once again be expected to participate each remaining semester at a level dependent upon the source of their stipend.
2. Ph.D. students who receive full or partial stipend support from University sources can also request dissertation writing status but they will be expected to nominally be engaged for 8 hours each week in activities as a Teaching Assistant during their ABD semester.

Professional Development and Career Planning

Preparation for a career beyond graduate school is an important part of the AME graduate program. This includes not only career guidance but a holistic development of the student to be conversant across a breadth of topics in aerospace and mechanical engineering. To facilitate this, students must also meet the following requirements:

- a) Graduate Seminar: Students must enroll in AME 63999 Graduate Seminar every Fall and Spring semester. The guidelines for participation in the Graduate Seminar are distributed at the beginning of each semester.

- b) All first-year students must register for GRED 60501 Teaching Engineering Tutorials and Laboratories, which is offered by the Kaneb Center only during the summer. The course addresses aspects of professionalism, learning styles, classroom procedures, characteristics of Notre Dame undergraduate students, sensitivity to diversity, etc. It is the student's responsibility to determine the scheduling for this special course and to arrange any personal activities or vacation in a way that will allow attendance during the summer between their first and second year. This course is subject to summer tuition and students must request a tuition scholarship through the Summer Session's online form accessible to students in late March/early April. Failure to request a summer tuition scholarship may result in the student being responsible for the cost of summer tuition.
- c) Career Planning: The Graduate Career Center resources are focused on graduate student success —helping you to be the best prepared in order to obtain strong career outcomes after your time at Notre Dame. All first-year students intending to obtain a Ph.D. are required to schedule a one-on-one sit down session with a Graduate Career¹⁰ counselor during their first year of study, preferably in the spring semester, and again sometime within their third year of the program. The purpose of the requirement is to assist the student in understanding and navigating their career options while taking the steps necessary to achieve their career goals.

Safety Regulations for Office and Laboratory Facilities

The Department supports a number of office complexes and research laboratories. Students are responsible for acquainting themselves with and following the proper safety procedures for the laboratories they use.

Safety training is managed online by ComplyND¹¹, and all graduate students are required to take the Basic Safety Training and Fire Extinguisher Training as part of their teaching assistant duties. All students are automatically signed up for these online courses and directly emailed information on how to complete them. (Note that this information is sent to the Notre Dame email account.) Additional training may be required depending on research duties, and students should discuss these requirements with their advisor. Questions about safety training and ComplyND should be directed to the AME safety coordinator Nancy O'Connor in the Department office.¹²

All users of Department offices and laboratories are to observe the following general safety and security procedures:

- a) Graduate students with a need for routine access into any of the laboratories will be issued a key or passcode or given contactless card access from the faculty member responsible for the laboratory or the Department office. Keys and passcodes may not be traded among, loaned to, or passed on to other students and must be returned as soon as the need for regular access has passed.
- b) Users of a laboratory share in maintaining its security and orderly appearance. Laboratory doors are not to be propped open or left unlocked when the laboratory is unattended, and must be locked at the end of the working day. The equipment inside a

¹⁰<https://gradcareers.nd.edu/>

¹¹ <https://comply.nd.edu/>

¹² nmcc@nd.edu

laboratory is not, in general, insured against theft or damage.

- c) Unauthorized users are not allowed into a laboratory.
- d) Guests may be invited into a laboratory, but may not be left unsupervised. The host is responsible for the guests' safety.
- e) Equipment or tools may not be removed from a laboratory without express permission for the faculty or staff member in charge of the laboratory.
- f) Each student using a laboratory must be acquainted with all the special safety procedures and safety equipment in the laboratory. These include the locations of emergency controls and the locations and use of all safety equipment and first aid supplies. It is essential that students not create hazards for themselves or their co-workers and that all laboratory personnel are able to take prompt, knowledgeable action if a hazardous situation does arise.
- g) Graduate students who supervise undergraduate laboratories assume primary responsibility for safety procedures. If additional safety supplies (such as hard hats or safety glasses) are required, Nancy O'Connor in the Department office should be notified.
- h) Any graduate student developing a new experiment or acquiring new equipment will also be responsible for developing and recording the proper safety procedures associated with the new equipment.
- i) Observed inadequacy of laboratory safety procedures or equipment must be reported immediately to a faculty member or the Department Chair so that the situation may be corrected.
- j) Violations of safety procedures or the creation of unsafe or unhealthy conditions must be reported to the responsible faculty and Department Chair. Failure to work safely or to maintain orderly, professional working environments may result in the forfeiture of office or laboratory privileges.

III. DEGREE PROGRAMS

This section describes the Department's requirements for the M.S. (thesis), M.S. (non-thesis), and Ph.D. degrees. Additional details of University requirements, including residency and degree eligibility requirements, are in the *Bulletin of Information*. Appendix C shows a short summary of requirements for each degree along with tables outlining 'typical' degree programs.

Advising

One of the most important matters for graduate students is the choice of a faculty advisor. This choice can have a great effect on both the student's time in graduate school and long-term career path. Upon entry, graduate students are temporarily advised by their admission advisor. Students are encouraged to speak with the faculty members in the area of their expressed interest during their first semester. Students will be asked to submit a ranked list of their preferences for potential advisors to the DGS at the beginning of the Spring semester. In most cases, individual students and faculty members make this arrangement without external intervention.

If a student has not identified and has not been accepted by a research advisor by the end of the second semester in the program, they will be dismissed from the program.

General Course Guidelines

Only graduate courses offered by departments in the Colleges of Engineering or Science can be applied to degree requirements. Introductory graduate-level courses are numbered 6XXXX, special graduate courses are numbered 7XXXX, and advanced graduate courses are 9XXXX. In general, students will register for both formal course work and either dissertation or thesis research to fulfill the 9-credit hour requirement to maintain full-time status.

With the prior written approval (*i.e.*, prior to taking the course) of the DGS, credit can be

received for up 40000 or 50000 level courses offered in the Colleges of Engineering and Science as follows:

- A maximum of 6 credit hours (2 courses) for both the M.S. (thesis) and the Ph.D. degrees.
- A maximum of 9 credit hours (3 courses) for the M.S. (non-thesis) degree

Such credit will not be given for work that is considered remedial.

Graduate students who completed undergraduate degrees at Notre Dame, and took graduate level (50000 level or higher) courses that were not used to satisfy undergraduate degree requirements, can request up to 6 credit hours of qualified courses to satisfy graduate degree requirements.

A. Master's Degree (Plan I – Thesis)

This section details the requirements for the M.S. (thesis) degree. A minimum of 30 credit hours must be successfully completed, of which at least 18 must be course work and up to up 12 may be research credits (*i.e.*, thesis research credits).

Course Requirements for the M.S. Degree (thesis)

A total of 18 credit hours (6 classes) of course work is required for the M.S. degree with thesis. The department has established a single core-course requirement that all M.S. (thesis) students must pass or have passed an equivalent course at another institution. The DGS in consultation with the Graduate Studies Committee will judge whether or not courses at other institutions are equivalent. Students must complete and pass one of the following mathematical methods courses in their first year of study:

- AME 60611 Mathematical Methods I (fall semester annually) or
- CBE 60542 Mathematical Methods in Engineering I (fall semester annually)

¹³ <https://graduateschool.nd.edu/resources-for-current-students/>

Both courses are foundational for graduate studies in engineering with AME60611 being a more advanced course. Appendix C shows a table that illustrates a “typical” program for an M.S.-Thesis student.

Thesis Preparation

All M.S. (thesis) students must write a thesis that is generally completed during the third or fourth semesters. The final version of the thesis must conform to the requirements as outlined by the Graduate School.¹³ All theses *must* be checked by the Graduate School for conformity to the guidelines before final submission. Any questions should be submitted to Shari Hill Sweet¹⁴ in the Graduate School.

When the thesis is complete, the student's advisor signs it to indicate final approval and its readiness for the committee of readers. The readers are selected by the student in conjunction with their advisor and submitted for approval to the DGS in consultation with the Graduate Studies Committee. There must be at least two readers, besides the advisor, who are members of the AME Graduate Faculty (see Appendix B). Additional readers, including those outside the AME Graduate Faculty are allowed, but the DGS in consultation with the Graduate Studies Committee must approve readers who are not on the Department's faculty. To be accepted, the thesis must be approved by at least two readers. The advisor may not be one of the official readers. The readers report their decision on the appropriate form to the Graduate School.

Final Examination and Degree Candidacy

Application to degree candidacy for the M.S. (thesis) degree is completed at the same time the M.S. (thesis) oral examination is conducted.

The final comprehensive examination for the M.S. (thesis) degree is an oral examination and covers the area of the thesis. It is scheduled

¹⁴ shill2@nd.edu

upon the request of the student, but will not be given less than one week from the time that the completed thesis is made available to the examining committee. This committee will consist of a minimum of three faculty members, normally the thesis advisor plus the two readers.

The examination begins with a thirty to forty-minute presentation by the candidate. This presentation is open to the public. The presentation should review the major elements of the thesis and should be primarily directed to the thesis readers. After the presentation, the thesis advisor calls for questions from members of the committee as well as the general audience. Additional questioning by the committee may be conducted in private after excusing the public audience. After the examination, the thesis advisor may excuse the candidate and call for discussion followed by a vote of committee members. A candidate passes upon either the unanimous consent or the consent of all except one member of the committee.

Publication of the Thesis

The Master's thesis serves as the scholarly record of the student's research, and should be published and disseminated. After the oral examination and approval of the thesis format by the Graduate School, the Department requires the student to upload a clear, print-quality PDF version of the complete thesis to the Library's electronic master's theses and doctoral dissertations (ETDs) repository.¹⁵ The Library system allows students to have control over the electronic release of their thesis to protect their intellectual property where appropriate. This policy allows all AME M.S. theses to be available online.

The Graduate School currently requires that students submit one clear print-quality PDF document. The AME policy satisfies the Graduate School policy at no cost to the

student. This policy provides for the greatest exposure and accessibility for the AME archive of theses. (Note: the AME Department does not require that students submit any print copies for binding.) It is the responsibility of the individual graduate student and/or their research advisor to support the cost to produce and distribute any bound or reader's copies of the student's thesis. Any questions regarding Graduate School thesis rules should be submitted to Shari Hill Sweet¹⁶ in the Graduate School.

B. Master's Degree (Plan II – Non-thesis)

This section gives the specific requirements for the M.S. (non-thesis) degree. The M.S. (non-thesis) degree is generally not an option for students receiving financial support from the department. Students receiving financial support from the department must obtain the approval of their advisor and the Department Chair prior to matriculating in the M.S. (non-thesis) program.

Credit Hour Requirements for the M.S. Degree (non-thesis)

A minimum of 30 credit hours must be completed to receive this degree. Of these, up to 6 credit hours may be taken as non-thesis research (i.e. AME687XX) or if the student began working on a thesis and a decision is made to terminate their program with a non-thesis MS degree, they can also use thesis research credits (AME68691) to satisfy this 6-hour requirement at the discretion DGS in consultation with the Department Chair and the Graduate Studies Committee. At least 24 credit hours (8 classes) must be course work.

Degree Candidacy and Final Examination

Application to degree candidacy for the M.S. (non-thesis) degree is completed at the same time the M.S. (non-thesis) oral examination is conducted.

¹⁵ <https://deposit.library.nd.edu/areas/etd>

¹⁶ shill2@nd.edu

The final comprehensive examination for the M.S. (non-thesis) degree is an oral examination by a committee of Department faculty. The student should coordinate scheduling this with Nancy Davis, and must be at least a week in advance of the intended date. This committee consists of a minimum of three faculty members, normally the faculty advisor plus the two other members of the AME Graduate Faculty (see Appendix B). Permission to include others on the committee must be granted by the DGS in consultation with the Graduate Studies Committee.

The examination begins with a presentation of thirty to forty minutes by the candidate. The presentation topic/focus will be decided upon by the student and their advisor. After the presentation, the faculty advisor calls for questions from members of the committee. After the examination, the faculty advisor may excuse the candidate and call for discussion followed by a vote of committee members. A candidate passes upon either the unanimous consent or the consent of all except one member.

C. Master of Engineering in Mechanical Engineering

This degree is intended for students who are interested in engineering management, and combines courses from the Mendoza College of Business with traditional engineering courses. A total of 24 credits of course work (8 classes) is required. Details on the program are provided in a separate handbook. Specific information about the MEME degree requirements can be found online at <http://ame.nd.edu/graduate-programs/MEMEProgram.pdf>

D. Doctor of Philosophy

This section describes the requirements for the doctoral degree. Students entering with an M.S. degree should note some deviations from this program given on page 14. The M.S. degree is not a prerequisite for the Ph.D. program.

A total of 60 credit hours are required for the Ph.D. degree of which at least 39 must be course work and up to up 21 may be research credits (*i.e.*, thesis research credits). Students are expected to complete all degree requirements in approximately five years, although the exact time will vary depending on research progress.

Note that **each first year graduate student must register for 12 credit hours both semesters**. First year students supported in full by external funding can take fewer course credits, and more research credits, with the approval of their research advisor.

Course Requirements for the Ph.D. Degree

The student must complete a minimum of 39 credit hours (13 classes) of course work, which include 9 credit hours from the core courses and 18 credit hours in a **major area** defined by the advisor and student. At least 9 credits must be in a **second, coherent area of study** different from the major area of study. At least 6 credit hours must be from courses **outside the AME Department**. An individual course can be used to satisfy both the out-of-department requirement and a core course or secondary area course requirement. In addition, the student should take any other courses deemed necessary by their advisor. The final program of courses must be approved by the advisor and the DGS prior to taking the candidacy exam (see appendix F).

First year students should meet with their admission advisor at the beginning of their first semester to prepare an individual course of study for the first semester. A permanent research advisor is assigned during the second semester as described on pg. 6. The research advisor will then work with the student to plan the remainder of their program.

The Department has established core course requirements that each Ph.D. student must complete and pass as follows.

1. Mathematical Methods I

Students must complete and pass one of the following Mathematical Methods courses:

- AME 60611 Mathematical Methods I (Fall semester annually)
- CBE 60542 Mathematical Methods in Engineering I (Fall semester annually)

2. Mathematical Methods Elective

Students must complete and pass a second 3-credit course in mathematics. Students whose studies are concentrated in the aerodynamics, heat transfer, or fluid mechanics fields are advised to complete AME 60612 Mathematical Methods II in their second semester of study. Students in other research areas should consult with their advisor to determine the most appropriate course for their field of study. Candidate courses that satisfy the mathematics elective requirement include:

- AME 60612 Mathematical Methods II (Spring semester annually).
- 60000 level or higher courses in the Department of Mathematics or the Department of Applied and Computational Mathematics and Statistics (ACMS); see Appendix E for the approved list of courses.
- 60000 level or higher applied mathematics courses in the College of Engineering; requires prior approval of DGS in consultation with the Graduate Studies Committee.

3. Numerical Methods

Students must complete and pass a 3-credit course in numerical methods. Candidate AME and non-AME courses that satisfy the numerical methods elective requirement include:

AME

- AME 60614 Numerical Methods - *ODE and PDE techniques*

- AME 60613 Finite Elements in Engineering - *a finite element methods course*
- AME 60644 Finite Elements in Structural Mechanics - *a finite element methods course*

Non-AME

- CSE 60113 Numerical Methods and Computation
- ACMS 60690 or MATH 60690 Numerical Analysis I
- CE 60130 Finite Elements in Engineering
- PHYS 50051/ACMS 50051 Numerical PDE Techniques for Scientists and Engineers

Other courses may be approved by the DGS in consultation with the Graduate Studies Committee. If a student wishes to take another course to satisfy this core requirement, they should submit a request in writing to the DGS prior to taking the course.

Ph.D. Qualifying Examination

The Ph.D. Qualifying Examination (QE) is a combination of a written document and oral exam whose purpose is to

- evaluate a student's readiness to pursue a Ph.D.;
- provide formative feedback to the student.

Upon completion of the QE, the student is formally admitted to the AME Ph.D. program.

A student may take the QE during one of three triannual windows: (a) the week immediately prior to the spring semester, (b) the week immediately after spring semester finals week, or (c) the week immediately prior to the fall semester. **The exam must be completed before the beginning of the student's 4th semester.**

A typical student, entering during the fall semester will take the QE either immediately following finals week of their spring (2nd) semester *or* at the end of that first summer

during the week immediately prior to the fall semester. A student entering during the spring semester will generally take the QE at the completion of the summer following their 1st semester, during the week immediately prior to the fall semester, or after their fall (2nd) semester, in the week immediately preceding the start of spring semester. The scheduling of the exam will be coordinated by the individual AME graduate student with his/her approved examination committee, and when a date/time has been selected, exam room scheduling will be coordinated with the AME graduate program administrative assistant (Ms. Nancy Davis¹⁷).

In order to be eligible to take the QE, the student must have completed a minimum of four (6XXXX or higher) courses¹⁸ that satisfy degree requirements and maintained a minimum cumulative GPA of 3.0 across all completed 6XXXX or higher courses.¹⁹ The GPA is calculated based only on courses taken in the graduate program at Notre Dame. Students who do not meet the GPA requirement by the time of the latest window when they are eligible (immediately prior to the beginning of their fourth semester) are ineligible to remain in the PhD program.

The student, in consultation with their advisor, will recommend a committee of three members from the AME Graduate Faculty (see Appendix B), including the advisor, and submit these to the DGS for approval 4 weeks prior to their selected exam window. The advisor and one committee member must be within the broad subject area of the student's research topic and the final member must be outside of the student's area and provide breadth of expertise. The student and advisor are encouraged to determine if committee

members will agree to serve prior to submitting their recommendation, but are also asked to submit alternative options if those recommended members are unavailable. It is important to note that the student's QE committee is independent of (and therefore may be different from) their committees at their candidacy examination or dissertation defense.

Two weeks prior to the selected exam window, the student must submit a 5-7 page document that demonstrates an understanding of the fundamental science underlying the content in one of two options:

- (a) ongoing research, including the motivation, methods, and results;
- (b) literature review of subject area(s) chosen by the student's advisor, which may include key papers specified by the advisor.

The student is encouraged to discuss the document and its content with their advisor. It is also recommended that the student make their committee aware of the document's content in advance. A soft copy of this must also be submitted to the AME graduate program administrative assistant (Ms. Nancy Davis) at the time it is delivered to the committee.

During a scheduled exam time, the student will present the content of the QE document (~20 minutes) followed by an oral exam with the committee, such that the overall length of the presentation and oral exam is no more than 60 minutes total. Questions posed to the student by the committee will focus on the student's readiness for Ph.D. research, including gaps in understanding of the fundamental science underlying the content presented. Each committee member will provide their feedback directly to the student and advisor regarding the

¹⁷ ndavis@nd.edu.

¹⁸ These courses must be taken at the University of Notre Dame and must be 3 credits or greater; AME63999 Graduate Seminar may not be counted.

¹⁹ Students that have entered the Ph.D. program with an M.S. degree and have had transfer credits for four (or more) courses

approved are only required to take one (6XXXX or higher) course. Students that transfer credits for fewer than four courses must make up the difference with 6XXXX or higher courses at Notre Dame.

student's readiness for Ph.D. research, which may include recommendations for research direction, further preparation, and planned academic coursework. This feedback will be both verbal at the end of the exam and in written form by each committee member. **The entire exam – presentation and examination by the committee – is closed to the public.**

Admission to the Doctoral Program

The student's advisor in consultation with their QE committee, the DGS, and the Graduate Studies Committee will make the decision to accept the student into the doctoral program after reviewing the student's academic record and QE performance. Admission to the degree program does not constitute admission to degree candidacy for which additional requirements are described below.

Ph.D. Candidacy Examination

The Ph.D. Candidacy Examination is a combination of a written document and oral exam where the student proposes and defends a line of research that will lead to the completion of the Ph.D.

The Ph.D. Candidacy Examination *must* be completed by the end of the eighth semester (4th year), or the student will be placed on probation by the Graduate School and forfeit their academic and financial eligibility. This may include the obligation for the student to pay for some or all of their credit hours for semesters beyond the eight semester, *regardless if the student is supported by a Fellowship or research grant*. Typically, the Candidacy Examination should be successfully completed near the end of their sixth semester (3rd year) in residence for students entering with their B.S. degree and prior to the fifth semester for students entering with their M.S. degree.

This examination is administered by the Candidacy Committee, which consists of 1) the student's advisor(s), 2) and at least three other faculty members, who will also serve as

dissertation readers, selected by the student with the approval of the advisor(s). Unless special circumstances warrant, at least two of the three readers on the candidacy committee should be members of the AME Graduate Faculty (see Appendix B).

To initiate the Candidacy process, the student should consult with their advisor(s) to select members of a Candidacy Committee. The student then downloads the Ph.D. Committee Formation form from the department's resource/forms webpage²⁰ and completes it with the names and signatures of the committee members. Care should be exercised in the selection of the voting members, as they, along with the advisor(s), will also serve as the voting members in the Ph.D. Dissertation Defense.

If a student wishes to include someone from outside of the University on their Committee, they should see the graduate program administrative assistant as it requires approval of the DGS in consultation with the Graduate Studies Committee. In general, individuals from outside the University should be on the faculty at another university or otherwise have a record of scholarly activity. Company/corporate individuals involved in a student's research may be added as additional committee members, but only after approval from the DGS.

The Candidacy Examination itself consists of both written and oral parts. It is the student's responsibility to schedule both. The oral examination is scheduled only after passage of the written portion. In addition, the student will be required to complete and have approved the Course Approval Form, also available for download on the resource/forms webpage. Once all exams and forms have been completed, returned and approved, students will supply to the graduate administrative assistant Nancy Davis via email the following

²⁰ <http://ame.nd.edu/resources/forms>

information **at least 5 business days prior to the scheduling of the oral examination date:**

- Name and ID number (#900)
- Date, time, and place of the exam (please contact Nancy Davis for room scheduling assistance).
- Advisor(s) name.
- All committee members and their department/company affiliations.

The Reporting Form for the oral candidacy examination will be completed and distributed to the student before the exam by the graduate administrative assistant. An overview of the examination procedures will be included in a notification email sent to the advisor(s), committee members and the Graduate School and cc'd to the student as soon as scheduling of the exam is complete. All committee members, including the advisor(s), must sign the Reporting Form and indicate their vote. Official notification of the results of the examination will be sent to the student and their advisor(s) from the Graduate School. (See Appendix I for more detailed information.)

The purpose of the written examination is to verify the student's capability of conducting Ph.D. level research within his or her area of specialization. In nearly all cases, the written portion consists of a dissertation proposal that discusses and outlines a line of research to complete the student's Ph.D. Under some special circumstances, the Committee may request that the student complete a problem or project in lieu of a written dissertation proposal.

Typically, the dissertation proposal consists of about twenty pages of text, wherein the dissertation topic, research accomplishments to date, plan of research, and significance of expected original contributions of the research are summarized. The written prospectus should be limited to 8000 words, excluding the title page, table of contents, lists of figures/tables, figure/table captions,

acknowledgements, and references; written in a 12-point font, and double spaced. Any deviation from this requirement should be approved by the thesis advisor.

The dissertation proposal should be submitted to each member of the Candidacy Examination committee at least two weeks prior to the oral examination. Each member of the Committee will report the results (*i.e.*, pass or fail) of the written portion of the examination on the Written Exam Approval form, which can be downloaded from the department's resource/forms webpage. Only when this form has been signed by all the Committee members and returned to the Department can the oral part of the examination be scheduled.

The oral examination explores the feasibility, originality, and significance of the proposed Ph.D. dissertation topic. The oral examination covers material in the written dissertation proposal and in the areas general area of research. The examination begins with an approximately 45-minute presentation by the student directed primarily to the Committee members. This presentation is open to the public. After the presentation, the thesis advisor calls for questions from members of the Committee as well as the general audience followed by the dismissal of the general audience. The Committee then conducts a series of questions on both the presentation and material in the written proposal and which can include questions that are generally relevant to the student's area of research, but not covered in the presentation or proposal. After the examination, the thesis advisor will excuse the student and call for discussion by the Committee members.

Both portions of the Candidacy Examination are passed or failed by a vote of the Candidacy Examination Committee. To pass, the student must receive the support of at least all members except one. That is, on a Committee of three, two votes in favor are required to pass, on a Committee of four, three

votes are required to pass, and similarly on a committee of five, four votes are required to pass. In the case of a failure, the student may be allowed one re-examination by the Department Chair upon recommendation of a majority of the Candidacy Examination Committee members and the approval of the Graduate School.

Master's Degree Option

A doctoral student who has successfully completed all parts of the doctoral Candidacy Examination may receive a non-thesis Master's degree upon the student's request and the recommendation of the student's advisor, the DGS, and the Department Chair. Note that it is the policy of the University to not award duplicate degrees. A student who has a Master's degree in aerospace *or* mechanical engineering, whether from Notre Dame or another institution, *will not* be awarded a Master's degree on completion of the Candidacy examination.

Students entering with an M.S. Degree

There are some modifications which apply only to those students with either an M.S. degree from another University, or who hold an M.S. degree from Notre Dame but are coming back after an absence from the University.

A request to the Graduate Studies Committee for transfer of up to 24 credits from a master's degree obtained within a period no longer than five years prior to admission to Notre Dame may be made. To receive credit for a graduate course taken elsewhere, the course must be a graded, graduate-level, academic course in engineering or science that would normally be considered as part of AME graduate academic course requirements. The student must have achieved a grade of a B or better. Pass/fail courses, research credits, M.S. thesis writing credits, or other credits not related to formal course work cannot be transferred. The DGS in consultation with the Graduate Studies Committee will make a

determination if any of these credits can additionally satisfy the mathematics, numerical methods, or out-of-department course requirements. A maximum of 6 hours of graduate course credit may be accepted from graduate courses completed elsewhere if no graduate degree was earned.

For those students entering with M.S. degrees, the Qualifying Examination should be taken at the earliest opportunity. If a student has not completed the QE prior to the start of their fourth semester, they will be dismissed from the program. In terms of eligibility to take the QE, students that have entered the Ph.D. program with an M.S. degree and have had transfer credits for four (or more) courses approved are only required to take one (6XXXX or higher) course. Students that transfer credits for fewer than four courses must make up the difference with 6XXXX or higher courses at Notre Dame.

The Candidacy Examination should be taken prior to the fifth semester, and as with all students, *must* be passed no later than the eighth semester, or the student will be placed on probation by the Graduate School and forfeit academic and financial eligibility. It is expected that the student will finish the requirements for the Ph.D. in approximately three years.

Preparation of Dissertation

After successfully completing the Qualifying Examination and Candidacy Examination and the completion of research, the student will prepare a written dissertation. The dissertation is a comprehensive report on the student's research, including the motivation and purpose, background and relevant prior work by others (literature), the methodology used in the research, results and findings (with suitable discussion), and conclusions. The dissertation should clearly demonstrate the student's original contribution to their research community. The dissertation typically is written in book-style, consisting of multiple

chapters. It is important to note that the dissertation should outline a coherent line of research inquiry and not only collect papers the student has published. The student should work closely with their advisor on the format and content of their dissertation.

The final version of the dissertation must conform to the requirements as outlined on the Graduate School's webpage.²¹ Dissertations must be checked for conformity to the formatting standards before final submission (see Shari Hill Sweet in the Graduate School²²). To avoid problems, students should use the Microsoft Word® document templates or LaTeX class files supplied by the Graduate School.

As with the Candidacy Examination, the dissertation will be submitted to a Defense Examination Committee that also act as readers of the dissertation. In nearly all cases, the Committee will consist of the same members from the student's Candidacy Examination and the same requirements for the composition of Committee apply (see pg. 12). A candidate may petition the DGS and Graduate Studies Committee for any change in the composition of the Committee after the Candidacy Examination. Only in extraordinary circumstances will the DGS and Graduate Studies Committee approve a change. Examples of circumstances under which a change would likely be approved include serious illness or permanent departure from the University. An extended leave by a member of the Committee will only be accepted as a need for a change if evidence is given that an acceptable communication link cannot be established for the examination to take place.

When the dissertation advisor(s) is satisfied that the dissertation is in suitable form, the advisor(s) will sign a distribution form, available from the AME's resource/forms webpage²³, releasing the dissertation for

distribution to the dissertation Committee, who serve as readers. The Ph.D. candidate will deliver this signed form to the department's graduate administrative assistant Nancy Davis, who will then issue the Ph.D. reader's reports to the candidate. It is the responsibility of the candidate to deliver the required copies of the dissertation along with the appropriate reader's card to their readers.

The dissertation defense may not be scheduled sooner than four weeks from the date the graduate administrative assistant receives the dissertation distribution form. It is expected that during this time, each reader will carefully read the dissertation, then meet individually with the candidate and discuss suggested or necessary changes to be made before the oral defense. The oral examination will not be scheduled until all the Ph.D. reader's cards have been signed and returned to the graduate studies administrative assistant. It is expected that all members of the Committee will have met with the candidate at least two weeks prior to the scheduled date of the oral defense and have reported their approval or disapproval at least one week prior to the scheduled date of oral defense. Reader approval of the dissertation for defense does not imply reader agreement or support; it implies reader acknowledgment that the dissertation is an academically sound and defensible scholarly product. Only a dissertation unanimously and unconditionally approved by all Committee members may be defended.

Defense of Dissertation

The purpose of the Ph.D. dissertation defense is to explore the originality and significance of the candidate's dissertation and for the candidate to support its claims, procedures, and results. It is the candidate's responsibility to determine a mutually agreeable time for the defense. The defense is

²¹ <https://graduateschool.nd.edu/resources-for-current-students/>

²² shill2@nd.edu

²³ <http://ame.nd.edu/resources/forms>

open to the public and fellow graduate students are encouraged to attend.

Once all reader's reports have been signed and returned, the candidate will supply to the graduate administrative assistant Nancy Davis via email the following information **at least 5 business days prior to the scheduling of the PhD defense date**:

- Name and ID number (#900)
- Date, time, and place of the exam (please contact **Nancy Davis** for room scheduling assistance).
- Advisor(s) name.
- All committee members and their department/company affiliation.
- A copy of the dissertation abstract in pdf form for posting.

The Reporting Form for the PhD defense will be completed and distributed to the student before the exam by the graduate administrative assistant. An overview of the defense procedures will be included in a notification email sent to the advisor(s), committee members, the Graduate School and cc'd to the student as soon as scheduling of the oral defense is complete. All committee members, including the advisor(s), must sign the Reporting Form and indicate their vote. Official notification of the results of the PhD dissertation defense will be sent to the student and their advisor(s) from the Graduate School. (See Appendix I for more detailed information.)

The examination begins with a summary presentation of thirty to forty minutes by the candidate. The presentation should review the major elements of the dissertation. After the presentation, the chair calls for questions from members of the general audience. Final questioning by the Committee will be conducted in private upon excusing the public audience. After the examination is completed,

the chair will excuse the candidate and call for discussion followed by a vote of Committee members. A candidate passes when at least all except one Committee member approves the defense of the work. That is, on a Committee of three, two votes in favor are required to pass, on a Committee of four, three votes are required to pass, and similarly on a committee of five, four votes are required to pass.

Failure of the defense does not necessarily require rewriting the dissertation. In the case of a failure, the student may be allowed a second opportunity to present a defense of their work based upon the recommendation of a majority of the Defense Examination Committee members, the Department Chair, and the approval of the Graduate School. Failure in the second defense terminates the candidate's eligibility for a doctorate at the University.

Publication of the Dissertation

The dissertation serves as the scholarly record of the student's doctoral research, and should be published and disseminated. After the oral defense and approval by the Graduate School the Department requires that the student uploads a clear, print-quality PDF version of the complete dissertation to the Library's electronic submission website.²⁴ The Library system allows students to have control over the electronic release of their dissertation so as to protect their intellectual property where appropriate. This policy allows all AME Ph.D. dissertations to be available on-line.

The Graduate School currently requires that students submit one clear print-quality PDF document. The Department policy satisfies the Graduate School policy at no cost to the student. This policy provides for the greatest exposure and accessibility for the Department archive of Ph.D. dissertations. If bound copies of the dissertation are desired, it is the responsibility of the individual advisors and graduate students to support the cost,

²⁴ <https://deposit.library.nd.edu/areas/etd>

produce and distribute them. Any questions regarding Graduate School dissertation rules should be submitted to Shari Hill Sweet in the Graduate School.

IV. FACILITIES AND SERVICES

A. Library

The University Library system consists of a number of libraries. Circulation policies and operating hours are available at each of the libraries. Students should make themselves aware of the resources the libraries provide and become more familiar with them by visiting the University library web site, <http://library.nd.edu/>.

B. Computing Facilities

The Office of Information Technologies (OIT) oversees a variety of computers, workstation clusters, and personal computer facilities throughout campus. Some are open year-round, twenty-four hours a day. The University is fully networked and has a wide range of software and printing services available for the use of all students. For a complete current listing of University facilities, which change often, students should visit their web page located at <http://oit.nd.edu>.

The Center for Research Computing (CRC) provides a number of services for those in need of computing resources for research purposes, including access to high performance computing resources, access to large amounts of data storage, and support for software development, visualization, and systems design/acquisition. Students that require these resources should consult the CRC website at <https://crc.nd.edu/>.

The Department maintains a number of computers and printers for research, data acquisition, and report preparation. Please see you advisor to determine what resources will be available for you use.

C. Laboratory Facilities

A variety of research and instructional laboratories exist in the department. These are located primarily on the third floor of Fitzpatrick Hall and Cushing Hall, throughout the lower levels of Fitzpatrick Hall, in the Hessert Laboratory for Aerospace Research,

White Field Laboratory, and in the Multidisciplinary Research Building (MRB) and Stinson-Remick Hall.

D. Office Facilities

All full-time graduate students have twenty-four hour access to personal office space in Cushing Hall, Fitzpatrick Hall, the Hessert Laboratory, MRB, or White Field. Offices are typically shared with other students. Each student will also have a mailbox located in or near the main administrative office in the building to which they have been assigned. Students are encouraged to use their office as a base for carrying out day-to-day academic activities. Students are expected to maintain professional office environments. If this is not the case, based upon the decision of the Department Chair, a student may lose the opportunity to have an on-campus office.

E. Copying Facilities

There are a number of copying facilities on campus, with services available at a charge. Many small machines are located in Hesburgh Library and each branch library. The Departmental copy machines are located in each of the Department buildings and policies associated with the use of the copy machines are established in each facility.

F. Student Government Service

Graduate students are responsible for the activities of the Graduate Student Union (GSU). Through a council of elected officers, appointed officers, and representatives from the departments of its constituent colleges, the GSU provides a variety of services and represents its membership on various University councils and committees. It publishes the bimonthly GSU newsletter, conducts a graduate orientation program, and sponsors workshops, travel grants, and various social and cultural activities. The GSU is the graduate students' official liaison with University administration, the Student Activities Office, and the Library

Administration. The GSU finances operations through a yearly fee assessed on all graduate students. The GSU maintains offices in W206A Duncan Student Center; their website is <http://www.gsu.nd.edu/>.

G. AME Graduate Student Department Organization (GSDO)

The AME Graduate Student Department Organization (GSDO) encompasses all graduate students in the AME Department. The mission of the AME GSDO is to organize and facilitate social events for AME graduate students, provide a forum for the expression of AME graduate student opinions and concerns, as well as aiding in the orientation of new incoming students. All graduate students in the AME department are automatically members of the AME GSDO.

H. Graduate Student Life

A unit within the Division of Student Affairs and in cooperation with the Graduate School, Graduate Student Life (<http://gradlife.nd.edu/>) is committed to enhancing the educational experience and quality of life for Notre Dame students pursuing advanced degrees. The Graduate Student Life website contains reference links for special events and programs, family resources and information regarding campus life in general. A helpful Q&A weblog to answer your questions is also featured.

I. Health, Counseling, Career and Placement, International, and Religious Services

There are many additional services available to graduate students. Most are described in detail in the *Bulletin of Information* or on the web at <http://graduateschool.nd.edu/resources-for-current-students/>.

University Health Services located in Saint Liam Hall (<http://uhs.nd.edu/>, 631-7497), provides immediate, follow-up, and ongoing health care. The services provided include outpatient clinics, dispensing medication,

administering allergy injections, laboratory and x-ray facilities, and a twenty-five-bed inpatient unit. Health insurance is required of all international and full-time students. The University offers a plan for all students. The student's spouse and children have the option of purchasing health insurance through this plan. More information can be obtained by calling 631-7497.

The University Counseling Center, located within the University Health Center (<http://ucc.nd.edu/>, 631-7336), offers professional services to all graduate students and their families.

The University has several excellent athletic facilities (<https://recsports.nd.edu/>), most of which are available free of charge.

The University's Graduate Career Services (<https://gradcareers.nd.edu/>) provides assistance with post-graduate placement and professional development through online services and the guidance of graduate career consultants. (See Section II. Basic Responsibilities, page 4, for additional information).

The University supports International Student and Scholars Affairs (ISSA) (<https://international.nd.edu/issa/>, 631-1138) aids in immigration matters, serves as a liaison with sponsoring agencies and governments, and promotes interaction within the University. The Student Activities Office (SAO) (<http://sao.nd.edu/>), maintains a list of clubs for interested students.

Campus Ministry, 114 Coleman-Morse Center (<http://campusministry.nd.edu/>, 631-7800), offers many programs to serve students' spiritual needs. In keeping with the character of the University, most programs are oriented with the Catholic faith; students of other religious traditions are welcome to participate in any of the programs.

APPENDIX A: ACADEMIC INTEGRITY

In questions involving academic integrity the student is referred to the general policy found in the Graduate School *Bulletin of Information*.

The Department expects all students to maintain and promote the highest standards of personal honesty and professional integrity. These standards apply to examinations, assigned papers, projects and preparation of the thesis or dissertation. Violation of these standards, which includes, but is not limited to cheating in examinations, plagiarism and fraudulent practices in conducting research or reporting the results of such research, may result in suspension or dismissal.

Within the Department, primary authority for judgment and decision on matters of academic integrity lies with the course instructor for issues, which arise in the classroom, or the faculty research advisor for issues that arise in research. Unsettled disputes should be referred first to the Director of Graduate Studies and next to the Department Chair each of whom can serve as arbiters at the department level. Any further appeal should be directed to the Graduate School.

APPENDIX B: FACULTY**AEROSPACE AND MECHANICAL ENGINEERING GRADUATE FACULTY (2018-2019)*****Full Professors***

<i>Faculty Member</i>	<i>PhD Institution</i>	<i>Year of Ph.D.</i>	<i>Research Area</i>	<i>Faculty Office Bldg.</i>
Robert Bernhard	Iowa State Univ.	1982	Engineering Mechanics	(NA)
Hsueh-Chia Chang*	Princeton Univ.	1980	Microfluids	(Fitz)
Kenneth Christensen	Univ. Illinois	2001	Fluid Mechanics	(Fitz)
Dipankar Choudhury**	Univ. Minnesota	1987	Comp. Fluid Mechanics	(NA)
Thomas C. Corke	Illinois Inst. Tech.	1981	Fluid Mechanics	(Hess)
Joseph Fernando*	Johns Hopkins Univ.	1983	Fluid Mechanics	(Cush)
J. William Goodwine	Cal Tech	1998	Robotics	(Fitz)
Eric J. Jumper	Air Force Inst. Tech.	1975	Aerodynamics	(Cush)
Scott C. Morris	Michigan State Univ.	2002	Aero Fluids	(Hess)
Glen L. Niebur	Univ. California	2000	Biomedical/Mechanics	(MRB)
Timothy Ovaert	Northwestern Univ.	1989	Solid Mechanics/Tribology	(MRB)
Joseph M. Powers	Univ. Illinois	1988	Combustion	(Fitz)
Matthew Ravosa*	Northwestern Univ.	1989	Biomechanics	(Galvin)
Ryan K. Roeder	Purdue Univ.	1999	Biomedical/Materials	(MRB)
Yiming Rong**	Univ. of Kentucky	1989	ME Design/Automation	(NA)
Steven R. Schmid	Northwestern Univ.	1993	Tribology	(MRB)
James P. Schmiedeler	Ohio State Univ.	2001	Robotics	(Fitz)
Flint O. Thomas	Purdue Univ.	1983	Fluid Mechanics	(Hess)
Gretar Tryggvason**	Brown Univ.	1985	Comp. Fluid Mechanics	(NA)
Meng Wang	Univ. Colorado	1989	Fluid Mechanics	(Hess)
Joannes Westerink*	M.I.T.	1984	Civil Engineering	(Fitz)
Nicholas Zabaraz	Cornell Univ.	1987	Comp. Math & Science	(Cush)

Associate Professors

<i>Faculty Member</i>	<i>PhD Institution</i>	<i>Year of Ph.D.</i>	<i>Research Area</i>	<i>Faculty Office Bldg.</i>
David Go	Purdue Univ.	2008	Thermal Sciences	(McCrtny)
Stanislav Gordeyev	Univ. of Notre Dame	1999	Aerodynamics	(Hess)
Andrew Kennedy*	Monash Univ.	1998	Civil, Environmental, Earth Sc.	(Fitz)
Edward C. Kinzel	Purdue Univ.	2010	Manufacturing/Thermal	(Fitz)
Tengfei Luo	Michigan State Univ.	2009	Thermal Sciences	(Fitz)
Karel Matous	Czech Tech Univ.	2000	Comp. Science & Engr.	(Fitz)
Ryan McClarren	Univ. of Michigan	2007	Nucl.Eng/Radiological Sci	(Fitz)
Svetlana Neretina	McMaster Univ.	2007	Material Sci/Nanomanuf	(Fitz)
Hirotaaka Sakaue	Purdue Univ.	2003	Fluid Flow	(Hess)
Michael M. Stanisic	Purdue Univ.	1986	Machine Kinematics	(Fitz)
Alexandros Taflanidis*	Cal. Inst. Tech.	2007	Computational Mechanics	(Fitz)
Pinar Zorlutuna	Middle East Tech	2005	Biotechnology/Biomedical	(MRB)

*Concurrent professor; **Adjunct professor

APPENDIX B: FACULTY (CONTINUED)**AEROSPACE AND MECHANICAL ENGINEERING GRADUATE FACULTY (2018-2019)*****Assistant Professors***

<i>Faculty Member</i>	<i>PhD Institution</i>	<i>Year of Ph.D.</i>	<i>Research Area</i>	<i>Faculty Office Bldg.</i>
Joel Boerckel**	Georgia Tech	2011	Biomechanics	(NA)
Donny Hanjaya-Putra	Johns Hopkins Univ.	2012	Biomedical/Biomaterials	(MRB)
Maria Holland	Stanford Univ.	2017	Biomech/Computations	(MRB)
Seong-Kyun Im	Stanford Univ.	2013	Exper. Fluid Dynamics	(Hess)
Thomas Juliano	Purdue Univ.	2010	Hypersonic Flows	(Hess)
Zhangli Peng	Univ. of California	2011	Multi- scale/physics Mdlng	(Fitz)
Mark Plecnik	Univ. of California	2015	Robotics/Controls	(Fitz)
David Richter*	Stanford Univ.	2011	Turbulence	(Cush)
Tracy Vargo-Gogola**	Vanderbilt Univ.	2002	Biochemistry/Biomedical	(RC)
Jian-Xun Wang	Virginia Tech	2017	Fluid Mechanics	(Fitz)
Patrick Wensing	Ohio State Univ.	2014	Dynamic Systems/Controls	(Fitz)
Sangpil Yoon	Univ. Texas	2012	Acoustics/Biomedical	(MRB)
Matthew Zahr	Stanford Univ.	2016	Comp. Sci. & Engr	(Fitz)
Yanliang Zhang	Rensselaer Polytech Inst.	2011	Thermal Science/Energy	(Fitz)

Research Professors

<i>Faculty Member</i>	<i>PhD Institution</i>	<i>Year of Ph.D.</i>	<i>Research Area</i>	<i>Faculty Office Bldg.</i>
Sergey Leonov	Baltic State Univ.	1990	Mech of Fluids/Plasma	(Hess)

Research Associate Professors

<i>Faculty Member</i>	<i>PhD Institution</i>	<i>Year of Ph.D.</i>	<i>Research Area</i>	<i>Faculty Office Bldg.</i>
Robert Hughes	McMaster Univ.	1992	Physics	(Cush)
R. Mark Rennie	Univ.of Notre Dame	1996	Aerodynamics	(Hess)

Research Assistant Professors

<i>Faculty Member</i>	<i>PhD Institution</i>	<i>Year of Ph.D.</i>	<i>Research Area</i>	<i>Faculty Office Bldg.</i>
Gianluca Blois	Polytech Univ Milan	2007	Fluids	(Hess)
Joshua Cameron	Univ.Notre Dame	2007	Aero Fluids	(NA)
Aleksandar Jemcov	Univ.Belgrade	2004	Aero Fluids	(Hess)
Eric Matlis	Univ.Notre Dame	2004	Fluid Mechanics	(Hess)
Prakash Nallathamby	Old Dominion	2010	Nanotechnology	(MR)
Kan Wang	Univ.Notre Dame	2012	Aerodyn/Turbulence	(Hess)

Special Professional Faculty

<i>Faculty Member</i>	<i>Institution/Degr</i>	<i>Year of Degree</i>	<i>Research Area</i>	<i>Faculty Office Bldg.</i>
Michael Seelinger	Univ. Notre Dame, PhD	1999	Robotics/ME Systems	(Fitz)

*Concurrent professor; **Adjunct professor

APPENDIX B: FACULTY (CONTINUED)

Associate Special Professional Faculty

<i>Faculty Member</i>	<i>Institution/Degr</i>	<i>Year of Degree</i>	<i>Research Area</i>	<i>Faculty Office Bldg.</i>
John Ott	Univ. Notre Dame, MS	1998		(Fitz)
Richard Strebinger	RPI, M.S.	1983		(Fitz)

Assistant Special Professional Faculty

<i>Faculty Member</i>	<i>Institution/Degr</i>	<i>Year of Degree</i>	<i>Research Area</i>	<i>Faculty Office Bldg.</i>
Paul Rumbach	Univ. Notre Dame, PhD	2016		(Fitz)
Jing Wang	RPI, M.S.	2011		(Fitz)

Department Chairman: Dr. Kenneth Christensen

Associate Department Chairman: Dr. James Schmiedeler;

Director of Hessert Laboratory: Dr. Thomas C. Corke

Director of Graduate Studies: Dr. David Go

Director of Undergraduate Studies: Dr. J. William Goodwine, Jr.

Faculty Office Locations: (Cush) - Cushing; (Fitz) - Fitzpatrick Hall; (Hess) - Hessert Laboratory; (MRB) - Multidisciplinary Research Building; (McCrtny) – McCourtney Hall; (RC) - Racklin-Carmichael; (WF) - White Field

**Concurrent professor; **Adjunct professor*

APPENDIX C: OVERVIEW OF REQUIREMENTS FOR EACH DEGREE PROGRAM AND TYPICAL DEGREE OUTLINE

CREDIT REQUIREMENTS FOR EACH GRADUATE PROGRAM

Required for all students:

- AME63999 Graduate Seminar (every semester)
- GRED 60501 Teaching Engineering Tutorials and Laboratories (summer after 1st year)
- AME67890 zero-credit summer course (every summer)

	M.S. (non-thesis)	M.S. (thesis)	Ph.D.*
Total Credits	30	30	60
<i>course work (minimum)</i>	24 (8 classes) **	18 (6 classes)**	39 (13 classes) ***
<i>research (nominal)</i>	6	12	21
Notes		<ul style="list-style-type: none"> • AME63999 Math Methods I or CBE60542 Math Methods required 	<ul style="list-style-type: none"> • 9 core credits (AME63999 Math Methods I, 2nd math, numerical methods) • 18 credits in major area** • 9 credits in second area • 6 credits outside AME

* Ph.D. students must also complete career counseling in Years 1 and 3

** Up to 6 credits in (non-remedial) undergraduate (40000 or 50000 level) courses may be taken for M.S. (thesis) and Ph.D.; up to 9 credits may be taken for M.S. (non-thesis). These courses require **prior** approval by the DGS.

*** Students entering with an M.S. degree may transfer up to 24 credits, such that they require only 15 credits (5 classes) to complete their Ph.D.

TYPICAL MASTER'S PROGRAM (Thesis)

Year 1	Fall	Courses: 9 hrs (3 classes) Research: 3 hrs
	Spring	Courses: 9 hrs (3 classes) Research: 3 hrs
	Summer	Research: 6 <i>if August graduate</i> GRED 60501 AME 67890
Year 2	Fall	Research: 9 <i>M.S. Thesis Defense</i>

TYPICAL DOCTORAL PROGRAM

		Students entering with B.S.	Students entering with M.S. (assuming 24 credits transfer)
Year 1	Fall	Courses: 9 hrs (3 classes) Research: 3 hrs	Courses: 9 hrs (3 classes) Research: 3 hrs
	Spring	Courses: 9 hrs (3 classes) Research: 3 hrs <i>Qualifying Exam</i>	Courses: 6 hrs (2 classes) Research: 3 hrs <i>Qualifying Exam</i>
	Summer	GRED 60501 Research AME 67890	GRED 60501 Research AME 67890
Year 2	Fall	Courses: 6 hrs (2 classes) Research: 3 hrs	Research: 9 hrs
	Spring	Courses: 6 hrs (2 classes) Research: 3 hrs	Research: 9 hrs <i>Candidacy Exam</i>
	Summer	Research AME 67890	Research AME 67890
Year 3	Fall	Courses: 6 hrs (2 classes) Research: 3 hrs	Research: 9 hrs
	Spring	Courses: 3 hrs (1 class) Research: 6 hrs <i>Candidacy Exam</i>	Research: 9 hrs
	Summer	Research AME 67890	Research AME 67890 <i>Ph.D. Defense</i>
Year 4	Fall	Research: 9 hrs	
	Spring	Research: 9 hrs	
	Summer	Research AME 67890	
Year 5	Fall	Research: 9 hrs	
	Spring	Research: 9 hrs <i>Ph.D. Defense</i>	
	Summer		

APPENDIX D: 2018-2019 GRADUATE COURSE OFFERINGS²⁵

Course	Title	Instructor	Semester Offered
AME 60611	Mathematical Methods I	McClarren, Ryan	Fall 2018
AME 60631	Exp Methods Fluid Dynamics	Gordeyev, Stanislav	Fall 2018
AME 60632	Physical Gas Dynamics	Jumper, Eric	Fall 2018
AME 60634	Intermediate Heat Transfer	Zhang, Yanliang	Fall 2018
AME 60635	Intermediate Fluid Mechanics	Juliano, Thomas	Fall 2018
AME 60672	Cell Mechanics	Niebur, Glen	Fall 2018
AME 60678	Biomedical Imaging Modalities	TBA	Fall 2018
AME 60741	Comp. Nonlinear Solid Mechanics	Matous, Karel	Fall 2018
AME70779	Stat Comp Method for Sci & Engr	Zabaras, Nicholas	Fall 2018
AME 60614	Numerical Methods	Peng, Zhangli	Spring 2019
AME 60623	Analytical Dynamics	Plecnik, Mark	Spring 2019
AME 60637	Ionization & Ion Transport	Go, David	Spring 2019
AME 60638	Turbine Engine Components	Morris, Scott	Spring 2019
AME 60654	Advanced Kinematics	Stanisic, Michael	Spring 2019
AME 77104	Aeroacoustics: Theory/Comput.	Wang, Meng	Spring 2019
AME 90931	Viscous Flow	Christensen, Ken	Spring 2019
AME 90935	Turbulence	Thomas, Flint	Spring 2019
AME 90937	Hydrodynamic Stability	Corke, Thomas	Spring 2019
AME 90951	Nonlinear Controls	Goodwine, John	Spring 2019
AME 90991	Probabilistic Graphical Methods	Zabaras, Nicholas	Spring 2019
AME TBD	Surface Flow Measurement	Sakaue, Hirotaka	Spring 2019
AME TBD	Advanced Compressible Flow	Im, Seong-Kyun	Spring 2019

²⁵ Proposed as of August 2018. **Course offerings are subject to change** due to low enrollment or other circumstances.

APPENDIX E: MEDICAL SEPARATION FROM ACADEMIC DUTIES FOR STUDENTS IN THE GRADUATE SCHOOL

Students enrolled in the Notre Dame Graduate School who wish to temporarily interrupt their programs for medical reasons must apply to the Graduate School. Information can be found in the Forms, Policies, and Handbooks section in the Academic Code of the Graduate School:

<https://graduateschool.nd.edu/resources-for-current-students/>

APPENDIX F: MATHEMATICS ELECTIVE COURSES

The following courses are accepted to meet the Mathematical Elective Requirement for the Ph.D. degree. No other Notre Dame courses will be accepted. Mathematics courses taken at another University as part of an awarded M.S. degree and transferred to Notre Dame may fulfill the mathematics elective requirement.

Department of Aerospace and Mechanical Engineering

AME 60612 Mathematical Methods II
AME 60624 Continuum Mechanics

Department of Mathematics

MATH 60210 Basic Algebra I
MATH 60620 Basic Algebra II
MATH 60350 Real Analysis I
MATH 60360 Real Analysis II
MATH 60370 Basic Complex Analysis I
MATH 60380 Basis Complex Analysis II
MATH 60430 Basic Topology I
MATH 60440 Basic Topology II
MATH 60510 Basic Modern Logic I
MATH 60520 Basic Modern Logic II
MATH 60610 Discrete Mathematics
MATH 60620 Optimization
MATH 60630 Geometric Methods for Dynamical Systems
MATH 60650 Basic Partial Differential Equations I
MATH 60660 Differential Manifolds
MATH 60690 Numerical Analysis I
MATH 60790 Numerical Analysis II
MATH 60850 Probability
MATH 60860 Stochastic Modeling
MATH 60920 Probabalistic Aspects of Linear Control and Optimization
MATH 60950 Topics in Applied Partial Differential Equations

Department of Applied and Computational Mathematics and Statistics

ACMS 50051 Numerical PDE Techniques for Scientists and Engineers
ACMS 60395 Numerical Linear Algebra
ACMS 60590 Finite Elements in Engineering
ACMS 60630 Nonlinear Dynamical Systems
ACMS 60650 Applied Partial Diff Equations
ACMS 60690 Numerical Analysis I
ACMS 60786 Applied Linear Models
ACMS 60790 Numerical Analysis II
ACMS 60852 Statistical Methods in the Biological and Health Sciences
ACMS 60885 Bayesian Statistics

Department of Civil & Environmental Engineering & Earth Sciences
CE 60123 Probabilistic Methods for Engineers and Scientists
CE 60130 Finite Elements in Engineering
CE 60140 Applied/Computational Probability for Engineers

APPENDIX G: COURSE CHECKLIST FOR CANDIDACY EXAMINATIONS

Student: _____
Last Name
First Name
MI
NDID#

Advisor: _____ Co-Advisor: _____
Print Name
(If applicable)
Print Name

Date of Candidacy Exam: _____

Instructions: Complete this form and submit to Nancy Davis at the time your candidacy exam is scheduled. Descriptions of the course requirements can be found in the Graduate Studies Handbook.

Core Courses (Math I, advanced mathematics, numerical methods)

Course #	Term and Year*	Grade
AME 60611		

Secondary area courses (at least 3):

Course #	Term and Year*	Grade

Major area: _____

Secondary area: _____

Major area courses (at least 6):

Course #	Term and Year*	Grade

Out of department courses (at least 2) †

Course #	Term and Year*	Grade

* Enter planned completion date if not yet taken. Note that any proposed courses listed on this form must be taken prior to graduation, or an amended form must be submitted and approved by the director of graduate studies.

† Courses used to satisfy the core requirements and secondary area of study may be used to satisfy the requirements for out-of-department courses. Out-of-department courses must not be cross-listed as AME courses.

Student: _____ Date: _____
Signature

Advisor: _____ Date: _____
Signature

Co-Advisor: _____ Date: _____
(If applicable)
Signature

Approval: _____ Date: _____
Director of Graduate Studies Signature

**A fillable/savable version of this form can be downloaded at: <http://ame.nd.edu/resources/forms>

APPENDIX H: REQUEST TO TRANSFER COURSES (REVISED 8/2013)²⁶

Student: _____
Last Name
First Name
MI
NDID#

Advisor: _____ Co-Advisor: _____
Print Name
(If applicable)
Print Name

Instructions: Complete this form and submit to Nancy Davis before the completion of your first academic year of study. Attach a copy of your academic transcripts, and a syllabus for each course. If you believe the course satisfies the mathematics, numerical methods or out-of-department requirements, indicate so in the *Requirement* column.

*Note: Form data is savable using Reader 8.0 or higher.

Is this transfer request for credits from a previously completed and awarded master's degree? Yes No

Institution	Course #	Course Name	Term/Year	Grade	Requirement

Student: _____ Date: _____
Signature

Advisor: _____ Date: _____
Signature

Co-Advisor: _____ Date: _____
(If applicable) Signature

Approval: _____ Date: _____
Director of Graduate Studies Signature

Additional Comments:

²⁶ **A fillable/savable version of this form can be downloaded at: <http://ame.nd.edu/resources/forms>

APPENDIX I: DEPARTMENT CALENDAR

Fall Semester 2018

AME New graduate student orientation	August 20
First day of class	August 21
Last day for course changes	August 28
Last day for course discontinuance	October 26
Department deadline to submit dissertation to readers*	October 23
Preliminary Format Check (mandatory)	November 05
Last day for Ph.D. dissertation defense for (January Graduation)	November 19
Last day for Master's thesis defense	November 19
Submission of completed theses/dissertations to Graduate School	November 26

Spring Semester 2019

Qualifying examination (first-year students)	January 7-11
First day of class	January 15
Last day for course changes	January 22
Last day for course discontinuance	March 22
Department deadline to submit dissertation to readers*	March 06
Preliminary Format Check (mandatory)	March 04
Last day for Ph.D. dissertation defense (May graduation)	April 01
Last day for Master's thesis defense	April 01
Submission of completed theses/dissertations to Graduate School	April 08

Summer 2019

Qualifying examination (first-year students)	May 13-17
GRED 60501 (required for first year students)	See http://kaneb.nd.edu/
Department deadline to submit dissertation to readers*	June 04
Preliminary Format Check (mandatory)	June 10
Last day for Ph.D. dissertation defense (August graduation)	July 01
Last day for Master's thesis defense	July 01
Submission of completed theses/dissertations to Graduate School	July 08

*PhD committee members must be allowed up to a maximum of 4 weeks to read and approve the dissertation before the oral defense can be scheduled. Once all signed readers reports have been received, the dissertation can officially be defended.

APPENDIX J: SCHEDULING PROCEDURES FOR ORAL CANDIDACY EXAMINATIONS AND DISSERTATION DEFENSES

Procedures for the formation of the PhD committee, the taking of the oral candidacy examination, the distribution and defense of the dissertation can be found within the Graduate Handbook. Necessary forms are available for downloading at <http://ame.nd.edu/resources/forms>. **This outline pertains only to the scheduling of the oral candidacy exam or PhD defense.** *Unless otherwise noted*, all forms are to be returned to Nancy Davis, 153 Multidisciplinary Research Building.

1. For oral candidacy examinations, the Committee Formation Form, Course Approval Form and Written Exam Approval Form must all be returned no later than **5 business days prior to the scheduled exam**. *No exceptions!* (<http://ame.nd.edu/resources/forms>)
2. For PhD dissertation defenses, all signed readers reports must be returned to the graduate administrative assistant no later than **5 business days prior to the scheduled defense**. *No exceptions!* (Readers reports are obtained through the graduate administrative assistant.)
3. Students will supply the graduate administrative assistant via email (ndavis@nd.edu) the following information **no later than 5 business days prior to the scheduling of the exam/defense date**:
 - a. Name and ID number (#900)
 - b. Date, time, and place of the exam (please contact **Nancy Davis** for room scheduling assistance).
 - c. Advisor(s) name.
 - d. All committee members and their department/company affiliation.
 - e. A copy of the dissertation abstract in pdf form for posting (PhD dissertation defense only)
4. **Committee members are allowed up to 4 weeks to read and approve the dissertation.** The Reporting Form for both the oral candidacy exams and dissertation defenses will be completed and distributed to the student before the exam/defense by the graduate administrative assistant. A notification email will be sent to the advisor(s), committee members, and cc'd to the student as soon as scheduling of the exam/defense is complete, along with an overview of the exam/defense procedures. **All committee members, including the advisor(s), must sign the Reporting Form and indicate their vote.**
5. The Reporting Form should be returned *immediately* after the defense to the graduate administrative assistant, 153 Multidisciplinary Research Building.
6. If a member of the committee is off-campus and unable to physically sign the form, an email should be sent *immediately* after the defense to Nancy Davis (ndavis@nd.edu) indicating their vote.