



2019-2020

Engineering Mechanics Graduate Manual

Virginia Polytechnic Institute
& State University

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Engineering Mechanics Graduate Regulations Manual

Virginia Tech

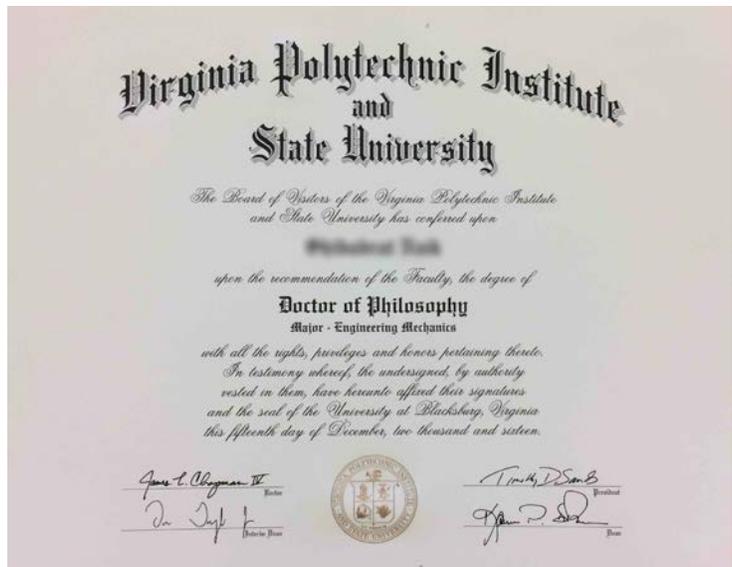
I. Introduction

This manual is a guide for students who are planning their graduate studies in Engineering Mechanics at Virginia Tech. This guide is intended to supplement, not to replace, the [Graduate Catalog](#) published by the Graduate School of Virginia Tech.

All references to credit hours in this manual are based on the semester system.

II. General Information

Administratively, the Engineering Mechanics Graduate Program (hereafter the “EM Program”) is contained within the *Department of Biomedical Engineering and Mechanics* (BEAM) at Virginia Tech. Prior to 2014, the EM Program was administered by the *Department of Engineering Science and Mechanics* (ESM), and Virginia Tech offers a Bachelor Degree in ESM. Informally, the graduate degrees and program are sometimes referred to as *ESM*, and all courses offered directly by the EM Program are labeled as “ESM XXXX”. Academically, the EM Program involves faculty in six different departments from two different colleges at Virginia Tech, and a number of the ESM graduate courses are cross-listed with other graduate programs. Regardless of an advising faculty member’s primary academic department, all graduate degrees earned by students in the EM Program are designated as *Degrees in Engineering Mechanics*; see the example diploma to the right. The cover pages of theses and dissertations must state that the degree is in *Engineering Mechanics*.



A. Graduate Student Orientation

Each fall, the EM Program conducts a mandatory orientation session for all graduate students. The orientation provides information on EM requirements, procedures for fulfilling those requirements, and other topics of importance to new students. Additional departmental and university training may be required.

B. Continuous Enrollment

Graduate students in the EM Program must be registered *continuously* at Virginia Tech during the academic year (fall and spring semesters) and pay the prescribed tuition and fees (or have these costs covered by an assistantship). Except for the options listed below, enrollment must be continuous from the time of first enrollment until earning a degree. Graduate students who need a break from continuous enrollment can do so by applying for a [*leave of absence*](#) or by participating in programs and activities approved by the Graduate School that require absence from the University (*in absentia status*). Students who fail to follow this process will be resigned from the university by the Graduate School and will then need to apply for readmission in order to continue their studies. Readmission requires a positive recommendation from the EM Program and is not guaranteed.

C. Minimum Hours of Registration

Full-time enrollment for Virginia Tech graduate students, for purposes of tuition and fees, consists of a minimum of 9 credit hours during academic year semesters. However, the Commonwealth of Virginia does not count students as full time unless they are enrolled for at least 12 credits. Students being supported on an assistantship, fellowship recipients, and scholarship recipients must therefore register for at least 12 credit hours each semester of the academic year.

The minimum enrollment requirement is 3 credit hours at Virginia Tech during each semester of the academic year, except in the case of a student who qualifies for a *Start of Semester Defense Exception* ([see Section II. K](#)).

Summer school enrollment is optional. Students should consult with their faculty advisor before registering for summer session courses.

Enrollment credits may consist of any combination of course credits, dissertation credits (5994, 7994), independent study credits (5974, 6974), or special study credits (5984, 6984). Students registered for 5994 and 7994 are expected to devote time to research in proportion to the numbers of credit hours registered. Degree requirements for course enrollment are described in [Section III](#) (for MS degrees) and [Section IV](#) (for PhD degrees).

D. Residency Requirement

Students enrolled in the EM Program are expected to be residents of the Blacksburg area (or nearby areas such as Roanoke) so that they can participate regularly and consistently in the many academic, research, and professional development activities on the Blacksburg campus of Virginia Tech. Exceptions to this requirement must be approved by the student's faculty advisor and the GPD.

E. Academic Advising and Plan of Study

Students must select a faculty advisor (also known as the academic advisor, committee chair, chairperson, major professor, or faculty mentor), form an advisory committee, and complete a Plan of Study. Selecting

an advisor and committee must be done with the consent of the faculty involved. The Plan of Study must be approved by the faculty advisor and the student's advisory committee before being submitted to the EM Program GPD and GC. Once a Plan of Study is approved by the EM Program, it is submitted by the GPD to the Graduate School for approval. Modifications to the Plan of Study, such as changing listed courses or changing advisory committee members, can be made by submitting the appropriate paperwork to the Graduate School: [Change of Committee/Advisor form](#), [Change in the Plan of Study form](#).

Students are expected to submit the Plan of Study prior to completing 12 credit hours of coursework; the Plan of Study must be submitted no later than the end of the 2nd semester of enrollment for MS students and by the end of the 3rd semester for PhD student. Students who have not determined their advisory committee before completing 12 credit hours of coursework must submit a draft Plan of Study to the Graduate Coordinator (GC). Failure to submit the Plan of Study in a timely fashion may result in a loss of credits and the inability to hold an assistantship. An approved Plan of Study must be on file with the Graduate School in order to schedule an exam requiring Graduate School approval (such as the Preliminary Exam).

F. Evaluation of Progress

The Graduate School requires that each department conduct an annual performance and progress evaluation for its graduate students. Each spring, EM students are required to submit a *Progress to Degree Report* to the department. Students will be evaluated on their academic and research progress using the contents of their progress report. The report must include an evaluation by their faculty advisor (see IIE). Both the faculty advisor and the student must sign the report prior to submission to the department.

G. Academic Probation

Students whose cumulative GPA falls below a "B" (3.00 GPA) are placed on probation by the Graduate School. Enrollment for one semester under academic probation is permitted to remedy an unsatisfactory GPA. If the student does not achieve a 3.0 GPA within one semester after being placed on probation, the student will be dismissed from the Graduate School.

If a student placed on academic probation does not achieve a 3.0 GPA within one semester, an appeal for additional time can be submitted by the GPD to the Graduate School. In order for an appeal to be submitted, the student must work with their faculty advisor to develop a remediation plan that details steps to be taken to raise the student's GPA to 3.0 or higher, including (i) the courses to be taken, (ii) the corrective action(s) to be taken, and (iii) the amount of time requested for the extension. If the remediation plan is approved by the student, the faculty advisor, and the GPD, then an appeal (including the remediation plan) will be submitted to the Graduate School. If extra time is granted by the Graduate School, the student will be informed in writing of the amount of additional time allowed for achieving a 3.0 GPA. If the EM Program does not support a time extension, or if the extension request is denied by the Graduate School, the student will be dismissed from the Graduate School. If the student does receive a time extension, and then does not achieve a 3.0 GPA within the time specified by the Graduate School, the student will be dismissed from the Graduate School.

H. Scholarly Ethics and Integrity Requirement

All graduate students are expected to uphold the [Virginia Tech Principles of Community](#) and the [Graduate School's Expectations for Graduate Education](#) as well as the scholarly integrity and research ethics standards for engineering mechanics.

Students are expected to complete the requirements of the *Engineering Mechanics Scholarly Ethics and Integrity Plan* (see [Appendix A](#)) within 12 months of enrolling as a graduate student in engineering mechanics. Plans of Study will not be approved by the department until the program's *Scholarly Ethics and Integrity* requirements are completed.

Failure to complete the *Scholarly Ethics and Integrity* requirements within 12 months of enrollment will affect eligibility for financial support on assistantships and scholarship awards.

I. Diversity & Inclusion Requirement

In April 2018, The Commission on Graduate Studies and Policies (CGS&P) approved a new requirement for graduate students: an inclusion and diversity component (CGS&P Resolution 2017-18A). This requirement aligns with the Graduate School's goal of providing all students with an affirming, inclusive, and diverse education program that helps prepare students to face the complex challenges they will meet in their post-graduation careers. Engineering Mechanics graduate students entering the program in 2019-20 satisfy this requirement by successfully completing *ENGE 5984: Graduate Student Success in Multicultural Environments (1 credit)* within the first two semesters of enrollment. For additional information on this Graduate School requirement, see <https://graduateschool.vt.edu/faculty-and-staff-resources/inclusion-diversity-requirement.html>.

J. Financial Support

There are two general categories of appointment for graduate students: Graduate Teaching Assistant (GTA) and Graduate Research Assistant (GRA). Both will be referred to as [Graduate Assistants \(GAs\)](#) unless specific information pertaining to one of them is involved. GAs must maintain an overall GPA of 3.00 or above.

Work periods for GAs are normally based on the following semester or summer session periods:

- Fall semester: August 10 to December 24
- Spring semester: December 25 to May 9
- Summer I: May 10 to June 24
- Summer II: June 25 to August 9

GAs are required to work between the dates stated on their appointment letter.

Students on a 100% assistantship are expected to work an average of 20 hours per week during the appointment period. For the fall and spring academic appointment periods, students cannot be required to perform more than 390 total hours of work (average of 20 hours per week for 19.5 weeks). For the summer sessions, students cannot be required to perform more than 130 total hours of work. Fractional appointments

scale as expected. These hours can be distributed by the GA supervisor throughout the appointment period as needed to support the assigned research (GRA) or teaching (GTA) activities. Students are asked to report to the GPD or GC any discrepancies they experience between these expectations and the actual GA effort. Hours worked in support of a GRA appointment are in addition to time spent conducting research for 5994 and 7994 credit hours.

GAs will be evaluated continuously by the faculty member supervising their work and formally reviewed at the end of each semester. If their work is not satisfactory or if they are not making satisfactory progress towards their EM degree, their financial support may not be renewed, and in extreme cases may be discontinued.

Financial support may be extended on a semester-to-semester basis, within the guidelines of the Virginia Tech Graduate School and with the mutual agreement of the student, their faculty advisor, the GPD, and the BEAM department head. All GAs must sign an *Assistantship Agreement* form for the period of their appointment. Because GRA appointments are subject to the availability of external funding and GTA appointments are subject to the availability of university funding, the EM Program cannot guarantee the continuity of these appointments. GTAs are arranged on the student's behalf by their faculty advisor; students are not to request a GTA from the EM Program on their own.

K. Vacation Policy

Students appointed on any Graduate Assistantship (GTA or GRA) are considered employees of the Commonwealth of Virginia (COV). As such, Graduate Assistants (GAs) are given the same holidays as faculty. [Human Resources](#) has the current listing of these holidays (note that GAs do not receive the staff-only holidays). With the exception of these dates, GAs are expected to be working in support of assigned teaching or research duties for the full appointment period ([see Section II. D.](#)). Approval for any additional vacation time must be preapproved by the faculty advisor (for GRAs) or the course supervisor (for GTAs). Note that class breaks (fall break, spring break, etc.) are not vacation days unless they correspond with official university holidays.

L. Start of Semester Defense Exception

Start of Semester Defense Exception (SSDE) is a special enrollment category that allows enrollment for one (1) credit if students have fulfilled all requirements, *including advisory committee review and agreement that the thesis or dissertation is ready to be defended*, and are registering only to take the final examination. To qualify for SSDE, students must meet all of the criteria established by the Graduate School and complete the [Start of Semester Defense Exception Request](#).

M. Graduate Honor Code

The [Graduate Honor Code](#) establishes academic integrity among graduate students. All incoming graduate students are notified of the honor code upon application to Virginia Tech. By accepting admission, you agree to comply with the Graduate Honor Code, which requires honesty and ethical behavior in all academic pursuits. The Graduate Honor System (GHS) upholds and enforces the Graduate Honor Code. The GHS

exists to educate students and faculty about the Graduate Honor Code, to investigate and hear all cases that are referred to the GHS, and to impose a penalty when a student is found guilty. You can find additional information about the GHS by reviewing the Constitution of the Graduate Honor System, which details GHS procedures, rights of accused students, and rights of referrers. The procedures in the Constitution are strictly adhered to in all GHS matters. The Constitution is found online in the Graduate Honor Code web site.

N. Student Health Care

All full-time graduate students are required to pay a health-service fee. [The Schiffert Health Center](#) provides limited medical care for all students when the university is in session and for those students who are required to work between terms. Schiffert lacks operating facilities, extensive equipment, and medical specialists. Thus, they provide services only for minor medical ailments and sicknesses. Persons are not eligible for health services when they are not registered. The fee does not provide health services for the student's family.

International students are required to have insurance on themselves and all family members. The insurance policy can be obtained through the university (information can be found [here](#)) or through private U.S. and foreign insurance companies. Students who maintain 50-100% assistantship appointments and who have purchased the university-sponsored health care plan are eligible to receive a contribution towards their health insurance premiums.

O. Language Requirement

There is no departmental language requirement. However, foreign languages or other requirements are optional at the discretion of the student's advisory committee. Any language courses taken do not count towards the hours on your Plan of Study. There are a number of campus and community resources to help with English conversation skills. They include:

English practice groups through the [Virginia Tech Writing Center](#)
YMCA [conversation groups](#)

P. Justification of Courses

Academic work, including transfer credit, must meet the time limits specified below. Requests for revalidation of out-of-date courses must be submitted by the student and include signatures of all members of the student's advisory committee and the GPD. Revalidations are normally for a period of one year unless otherwise noted.

Course work more than five years old at the time of submission of the Plan of Study must be revalidated to count toward the master's or doctorate by completing the [Course Justification Request](#) through the Graduate School.

III. Requirements for the Engineering Mechanics Degrees of Master of Science and Master of Engineering

A. Degree Options

The Engineering Mechanics Program offers the Master of Science (MS, thesis and non-thesis) and Master of Engineering (MEng) degrees. Each degree requires completion of a minimum of 30 credit hours with a minimum overall GPA of 3.0.

1. Master of Science (MS) thesis option

Students pursuing the MS thesis degree option must complete at least 30 credit hours, including at least 21 graded course credit hours (see Plan of Study below), and satisfactorily prepare and defend a master's thesis (see Final Examination below).

The final transcript will designate the degree as thesis.

2. Master of Science (MS) non-thesis option

Students pursuing the MS non-thesis degree option must complete at least 30 graded course credit hours (see Plan of Study below), and satisfactorily pass a comprehensive oral examination (see Final Examination below). This option must be declared at the time the Plan of Study is submitted to the Graduate School.

The final transcript will designate the degree as non-thesis.

3. Master of Engineering (MEng)

This program is oriented toward engineering practice instead of fundamental research, teaching or further study. (Recipients of this degree are not barred, however, from pursuing more advanced degrees.) This degree is intended to increase the competence of students who are interested in design, development, operation, and engineering practice.

Students pursuing the MEng degree option must complete at least 30 credit hours, including at least 27 graded course credit hours (see [Plan of Study below](#)), and satisfactorily prepare and defend an engineering project report (see [Final Examination below](#)). The purpose of the project report is to develop and demonstrate the candidate's ability to plan and execute projects relating to the practice of engineering.

B. Plan of Study

The student's Plan of Study must include the courses described below.

1. Master of Science (MS) thesis option

The MS thesis option Plan of Study must include at least 30 credit hours that satisfy the following requirements:

- ESM 5994 Research and Thesis (*at least 6 credits*)
- ESM 5014 Introduction to Continuum Mechanics (*3 credits*)
- One ESM 5xxx/6xxx course in two of the following three areas: dynamics, solid mechanics, or fluid mechanics; [see Appendix B](#) (*3 credits in each area, for a total of 6 credits*)
- One course satisfying the mathematics requirement, [see Appendix B](#) (*3 credits*)
- Graded elective courses (*at least 9 credits*)

MS students must also satisfactorily complete *ENGE 5984: Graduate Student Success in Multicultural Environments* (1 credit) within the first two semesters of enrollment. This course satisfies the Graduate School's *Diversity and Inclusion Requirement* (see Section II.I.). This course credit is not included in the Plan of Study.

MS students must also register for one credit hour of 5944 Seminar for at least two semesters. These seminar credits are not included on the Plan of Study.

The MS Plan of Study may contain a combination of 5xxx and 6xxx-level courses and a maximum of six (6) hours of approved 4xxx-level courses (for approved 4xxx-level courses, [see Appendix B](#)).

A minimum of 12 course credits must be labeled ESM (not including 5944 or 5994).

A maximum of six (6) credit hours of independent study (IS) or special study (SS) courses can be used to complete the Plan of Study, with the total for both IS and SS courses not exceeding six (6) hours.

2. Master of Science (MS) non-thesis option

The MS non-thesis option Plan of Study must include at least 30 credit hours that satisfy the following requirements:

- ESM 5014 Introduction to Continuum Mechanics (*3 credits*)
- One ESM 5xxx/6xxx courses in two of the following areas: dynamics, solid mechanics, or fluid mechanics; [see Appendix B](#) (*3 credits in each area, for a total of 6 credits*)
- One course satisfying the mathematics requirement, [see Appendix B](#) (*3 credits*)
- Graded elective courses (*at least 18 credits*)

MS students must also satisfactorily complete *ENGE 5984: Graduate Student Success in Multicultural Environments* (1 credit) within the first two semesters of enrollment. This course satisfies the Graduate

School's *Diversity and Inclusion Requirement* (see Section II.I.). This course credit is not included in the Plan of Study.

MS students must also register for one credit hour of 5944 Seminar for at least two semesters. These seminar credits are not included on the Plan of Study.

The MS Plan of Study may contain a combination of 5xxx and 6xxx-level courses and a maximum of six (6) hours of approved 4xxx-level courses (for approved 4xxx-level courses, [see Appendix B](#)).

A minimum of 12 course credits must be labeled ESM (not including 5944 or 5994).

A maximum of nine (9) credit hours of independent study (IS) or special study (SS) courses can be used to complete the Plan of Study, with the total for both IS and SS courses not exceeding nine (9) hours.

3. Master of Engineering (MEng) option

The MEng option Plan of Study must include at least 30 credit hours that satisfy the following requirements:

- ESM 5904 Project and Report (*3 credits*)
- ESM 5014 Introduction to Continuum Mechanics (*3 credits*)
- One ESM 5xxx/6xxx course in two of the following areas: dynamics, solid mechanics, or fluid mechanics; [see Appendix B](#) (*3 credits in each area, for a total of 6 credits*)
- One course satisfying the mathematics requirement, [see Appendix B](#) (*3 credits*)
- Graded elective courses (*at least 15 credits*)

MEng students must also satisfactorily complete *ENGE 5984: Graduate Student Success in Multicultural Environments* (*1 credit*) within the first two semesters of enrollment. This course satisfies the Graduate School's *Diversity and Inclusion Requirement* (see Section II.I.). This course credit is not included in the Plan of Study.

MEng students must also register for one credit hour of 5944 Seminar for at least two semesters. These seminar credits are not included on the Plan of Study.

The MEng Plan of Study may contain a combination of 5xxx and 6xxx-level courses and a maximum of six (6) hours of approved 4xxx-level courses (for approved 4xxx-level courses, [see Appendix B](#)).

A minimum of 12 course credits must be labeled ESM (not including 5944 or 5994).

A maximum of six (6) credit hours of independent study (IS) or special study (SS) courses can be used to complete the Plan of Study, with the total for both IS and SS courses not exceeding six (6) hours.

C. Advisory Committee

Each graduate student must have an advisory committee, which approves the Plan of Study and evaluates the student's academic work. The committee must be selected prior to the submission of a Plan of Study.

1. Master of Science, Thesis Option

The MS thesis option advisory committee is to be composed of the faculty advisor (acting as the chair of the committee) and a minimum of two other faculty members. The faculty advisor and at least one of the committee members must be from the [Graduate Catalog's approved list of Engineering Mechanics faculty](#) (i.e., either a BEAM faculty member or an official program affiliate). The third member must be approved by the Graduate School to serve on a graduate committee. All committee members must be approved by the GPD and the Dean of the Graduate School.

The Committee's function is to advise and aid students in completing the Plan of Study, to advise them in their research, to evaluate their progress, and to conduct the final examination. Students are encouraged to confer with a broad spectrum of the faculty and select those (willing) faculty members who best support their research activities.

2. Master of Science, Non-thesis Option

The MS non-thesis option advisory committee is to be composed of the faculty advisor (acting as the chair of the committee) and a minimum of two other faculty members. The faculty advisor and at least one of the committee members must be from the [Graduate Catalog's approved list of Engineering Mechanics faculty](#) (i.e., either a BEAM faculty member or an official program affiliate). The third member must be approved by the Graduate School to serve on a graduate committee. All committee members must be approved by the GPD and the Dean of the Graduate School.

The Committee's function is to advise and aid students in completing the Plan of Study, to evaluate their progress, and to conduct the final examination. Students are encouraged to confer with a broad spectrum of the faculty and select those (willing) faculty members who best support their academic interests.

3. Master of Engineering

Master of Engineering students should follow the procedures outlined for students pursuing the Master of Science Degree (thesis option) in selecting their advisory committee. The student's advisory committee must approve the subject and outline of the final project.

D. Final Examination

All MS and MEng students must pass an oral examination upon completion of the degree requirements. The [Request to Admit Candidate to Final Exam form](#) must be received by the Graduate School two weeks before the desired date. The student should work in consultation with the EM Program to

schedule the examination and the candidate must be registered for a minimum of three credit hours or have the [*Start of Semester Defense Exception \(SSDE\)*](#).

The examination is to be administered by the advisory committee, with additional members as needed to cover the examination material. The examination is expected to cover all mechanics course work as well as the research (for MS thesis) or project (for MEng) completed by the student. The GPD and the Graduate School must approve the examining committee.

In order to pass the final examination, a candidate is allowed at most one negative vote from the examining committee. If a student fails the final examination, there must be a lapse of one full semester (a minimum of 15 weeks) before rescheduling the examination. The student is allowed no more than two opportunities to pass the final examination.

E. Thesis

The thesis should be a scholarly discourse on a topic approved by the student's advisory committee. It should demonstrate the student's ability to perform independent research of professional quality. The thesis is expected to be well organized and written clearly. Detailed guidelines for publication of the thesis are specified in the [Graduate Catalog](#).

The title of the degree, which appears on the cover page, is *Engineering Mechanics*. An example graduate diploma is shown in [Section II](#).

IV. Requirements for the Engineering Mechanics Degree of Doctor of Philosophy

A. Overview of Doctoral Degree Requirements

Students must satisfy the following requirements to earn a doctoral degree in engineering mechanics:

1. Satisfy the *Scholarly Ethics and Integrity Requirement* (see [Section II.H](#))
2. Satisfy the *Diversity and Inclusion Requirement* (see [Section II.I](#))
3. Complete[†] a minimum of 90 credits that can be included on the Plan of Study (see [Section IV.B](#)).
 - a. Complete[†] a minimum of 35 credits of graded coursework, including the 5 core courses (see [Section IV.B.2](#)).
 - b. Complete[†] a minimum of 4 credits of ESM 5944 Seminar.
 - c. Complete[†] a minimum of 30 credits of ESM 7994 Doctoral Research.
4. Pass the program's *Qualifying Examination* (see [Section IV.C](#)).
5. Pass the program's *Preliminary Examination* (see [Section IV.E](#)).
6. Prepare a *Dissertation* (see [Section IV.F](#)) and pass the *Final Examination* (see [Section IV.G](#)).

B. Credit Hour Requirements for a PhD in Engineering Mechanics

To earn a doctoral degree in engineering mechanics, students must complete[†] a minimum of 90 credits that satisfy the following requirements:

- At least thirty-five (35) credits of coursework are required according to the program specifications listed [in Section IV. B.1](#), and fourteen (14) of these credits must consist of the core coursework in [Section IV.B.2](#).
- At least four (4) credits of ESM 5944 Seminar are required as described in [Section IV.B.3](#).
- At least thirty (30) credits of ESM 7994 Doctoral Research are required as described in [Section IV.B.4](#).
- The content of the remaining twenty-two (21) credits must be agreed upon by the student and their Advisory Committee.

Students must also comply with all requirements of the Graduate School.

[†] In this document, “completing” a course includes the requirement that the resulting grade be a C– or better for graded courses, a P for pass/fail courses, or an EQ for research or project/report credits. This is to comply with a VT Graduate School requirement as listed in the [Graduate Catalog](#): ‘Courses on the Plan of Study with grades below "C-" must be repeated.’

1. General Coursework Requirements

Students pursuing a doctoral degree in engineering mechanics are required to complete[†] a minimum of 35 credits of coursework that satisfies each of the following requirements. All of these courses must be taken for a letter grade (except for courses that are only offered on a pass/fail basis). The courses used to satisfy these requirements must be approved by the student's Advisory Committee and the GPD through submission of the Plan of Study.

1. Fourteen (14) credits of graded core coursework ([see Section IV.B.2](#)).
2. At least three (3) credits of additional graduate-level coursework in mathematics; see [Appendix B](#).
3. At least six (6) credits of additional ESM-designated graded coursework.
4. At least twelve (12) credits of additional graduate-level graded coursework in support of the chosen area of doctoral research.

Restrictions:

- No more than 3 credits of 4xxx-level coursework can be counted toward the required minimum 35 credits of coursework.
- No more than 3 credits of Independent Study (5974 or 6974) can be counted toward the required minimum 35 credits of coursework.
- A maximum of 15 credits of transfer coursework can be counted toward the required minimum 35 credits of coursework.

Students are expected to enter the doctoral program with a math background that includes the equivalent to the following two courses:

1. MATH 4564 Operational Methods (3 credits)
2. MATH 4574 Vector and Complex Analysis for Engineers (3 credits)

If the EM Program determines that a student does not have this background, the student is required to complete[†] these two courses prior to taking (or being exempted from) the *Qualifying Examination*; students are encouraged to complete these courses as early as possible. The above two MATH courses are *not* counted toward the minimum 35 credits of coursework required for a doctoral degree in engineering mechanics.

2. Core Coursework Requirements

Engineering mechanics doctoral students must complete[†] each of the following five (5) core courses prior to taking the *Qualifying Examination*:

1. ESM 5014 Introduction to Continuum Mechanics (3 credits)
2. ESM 5314 Intermediate Dynamics (3 credits)
3. ESM 5024 Introduction to Solid Mechanics (3 credits)
4. ESM 5054 Introduction to Fluid Mechanics (3 credits)
5. ESM 5004 Communicating Engineering Mechanics (2 credits)

Students are expected to complete all of the above core coursework requirements by the end of their fourth (4th) semester of enrollment in the engineering mechanics program.

Students may substitute one or more graduate course(s) taken at another institution for any of these core courses. To substitute, (1) the previous course must be successfully transferred to Virginia Tech for credit toward the doctoral degree, and (2) the GPD and the student's Advisory Committee must approve the substitution. (Not all courses will qualify for approval, despite course name or content, or the grade received. Multiple transfer courses may be required to substitute for a single core course.) Transferred courses are *not* included in the calculation of the cumulative core-course GPA, which is used in determining exemption from the *Qualifying Examination*. Transfer courses may be substituted for a maximum of 6 credits of core coursework.

3. Seminar Requirement

Students pursuing a doctoral degree in engineering mechanics are required to complete[†] a minimum of 4 credits of ESM 5944 Seminar.

- Students are required to enroll in ESM 5944 during their first two semesters in the EM doctoral program. Requests for waivers of this requirement (in order to accommodate conflict with a course or a teaching assignment, for example) are to be submitted in writing to the EM Program no later than the *Course/Add* date for the semester in question.
- Any additional credits of ESM 5944 required by the student's Advisory Committee will be listed as *Supporting Courses* on the Plan of Study.

4. Research Credit Requirements

Students pursuing a doctoral degree in engineering mechanics are required to complete[†] a minimum of 30 credits of ESM 7994 Doctoral Research.

C. Qualifying Examination

Students pursuing a doctoral degree in engineering mechanics are required to pass the *Qualifying Examination* before taking the *Preliminary Examination*.

1. Format

The *Qualifying Examination* consists of one or more written and/or oral examinations based on the material covered by the core coursework described in Section B. Examination contents will be tailored to address any deficiencies identified by each student's performance in the core coursework. Exam content and grading will be overseen by an ad hoc *Engineering Mechanics Qualifying Examination Committee*.

2. Timing and retesting

- A student is eligible to take the *Qualifying Exam* after completing the core coursework described in Section B. Note that this means the student must have received a C- or higher in all the core coursework before taking the *Qualifying Exam*. If a grade of less than C- is obtained in any core course, that course must be repeated until a grade of C- or higher is obtained.
- The *Qualifying Examination* must be taken prior to starting the fifth (5th) semester of doctoral study in the engineering mechanics doctoral program. Students entering the program with an MS degree are strongly encouraged to take the examination prior to starting the third (3rd) semester of doctoral study in engineering mechanics.
- The *Qualifying Examination* must be successfully passed before starting the seventh (7th) semester of doctoral study in the engineering mechanics doctoral program. Students entering the program with an MS degree are encouraged to have passed the examination prior to starting the fifth (5th) semester of doctoral study in engineering mechanics.
- Each student is allowed a total of two attempts to pass the *Qualifying Examination*. A student who fails the first attempt at the exam must retake it no later than 12 months after the first attempt. A student who fails the *Qualifying Examination* twice is not allowed to continue in the engineering mechanics doctoral program.

3. Exemptions

Students satisfying *both* of the following criteria are exempted from taking the *Qualifying Examination*:

- earn a B– or better in each of the core courses (see [Section III B.1](#)) that are taken at Virginia Tech, *and*
- attain a cumulative GPA of 3.2 or higher in the core courses (see [Section III.B.2](#)) that are taken at Virginia Tech.

D. Advisory Committee

Each graduate student must have an advisory committee, which approves the Plan of Study and evaluates the student's academic work. The committee must be selected prior to the submission of a Plan of Study.

The PhD advisory committee is to be composed of the faculty advisor (acting as the chair of the committee) and a minimum of four (4) other faculty members. The faculty advisor and at least two of the other committee members must be from the [Graduate Catalog's approved list of Engineering Mechanics faculty](#) (i.e., either a BEAM faculty member or an official program affiliate). At least one committee member must be from outside the Engineering Mechanics Program. All members must be approved by the Graduate School to serve on a graduate committee. All committee members must be approved by the GPD and the Dean of the Graduate School.

The Committee's function is to advise and aid students in completing the Plan of Study, to advise them in their research, to evaluate their progress, to conduct the Preliminary Examination, and to conduct the

Final Examination. Students are encouraged to confer with a broad spectrum of the faculty and select those (willing) faculty members who best support their research activities.

E. Preliminary Examination

Students pursuing a doctoral degree in engineering mechanics are expected to take the *Preliminary Exam* not more than 12–18 months after passing the *Qualifying Exam*. A student's Plan of Study must be approved by the department and the Graduate School before the *Preliminary Examination* can be scheduled. Students are required by the Graduate School to pass the *Preliminary Examination* at least 6 months before taking their *Final Examination*.

The *Preliminary Examination* will consist of at least the three following components:

- a written dissertation proposal
- a public presentation of the proposed research
- a private oral examination by the student's Advisory Committee

Any additional expectations by the Advisory Committee must be communicated to the student in writing prior to the scheduling of the exam, and preferably at least 6 months prior to the exam.

1. Format

- The proposal is intended to be a plan of research for the student's doctoral dissertation. As such, the proposal should clearly document the individual studies that the student will conduct, their motivation, and their potential significance. The inclusion of preliminary data is encouraged, but not required. The length and format of the document will be specified by the student's Advisory Committee, but a concise document (e.g., NSF-style) is encouraged.
- Because the *Preliminary Examination* is expected to occur before the majority of the research is conducted, the proposal is not a contract *per se*, and some changes to the plan may arise in the course of conducting the research. Such changes should be clearly communicated with the student's Advisory Committee.
- The format of the public presentation will be specified by the student's Advisory Committee; a concise presentation is encouraged.
- The private questioning session immediately follows the public presentation. The questioning session is intended to provide sufficient basis for evaluating the student's ability to complete the doctoral degree requirements and succeed as an independent researcher. Therefore, questions by the committee members are expected to focus on the written document and the presentation, but they are not limited in any way.

2. Timing and retesting

- Students are eligible to take the *Preliminary Exam* after passing or being exempted from the *Qualifying Exam* described in Section IV.C.

- The written proposal should be submitted to the student's Advisory Committee at least two (2) weeks in advance of the public presentation and oral examination; exceptions to this timing must be approved by the student's Advisory Committee.
- Each student is allowed a total of two attempts to pass the *Preliminary Examination*. A student who fails the *Preliminary Examination* on their second attempt will be dismissed from the Graduate School upon completion of the current academic term.
- A student planning to retake the *Preliminary Exam* is expected to work with their Advisory Committee to (1) justify a second attempt at the exam and (2) develop a remediation plan that addresses the steps needed to prepare for that second attempt.
- A student is allowed to retake the *Preliminary Exam* no sooner than one semester (15 weeks) and no later than 12 months after the first attempt.

F. Dissertation

The dissertation should be an original contribution to the literature in the field of mechanics. Style and organization requirements are described in the Graduate Catalog. The dissertation must be *completed by the student and read by the advisory committee* prior to scheduling the final examination. The style, organization, and standards of the dissertation shall be consistent with those for papers in the Journal of Applied Mechanics.

The title of the degree, which appears on the cover page, is *Engineering Mechanics*. An example graduate diploma is shown in [Section II](#).

G. Final Examination

All PhD students must pass an oral examination upon completion of the degree requirements. All final examinations must be scheduled with [the Graduate School](#) at least two weeks before it is held and cannot be scheduled any sooner than six months after the acceptance of the proposal. The candidate must be registered for a minimum of three credit hours or have [the Start of Semester Defense Exception \(SSDE\)](#) at the time of the examination.

The examination is to be administered by the student's Advisory Committee, with additional members as deemed necessary. The GPD and the Graduate School must approve the examining committee. The examination is expected to consist primarily of a defense of the dissertation. The dissertation must be *completed by the student and read by the advisory committee* prior to scheduling the final examination.

In order to pass the final examination, a candidate is allowed at most one negative vote from the examining committee. If a student fails the final examination, there must be a lapse of one full semester (a minimum of 15 weeks) before rescheduling the examination. The student is allowed no more than two opportunities to pass the final examination. A student who fails the *Final Examination* on their second attempt will be dismissed from the Graduate School upon completion of the current academic term. More information about this policy can be found in the [Graduate Catalog](#).

Appendix A

Scholarly Ethics and Integrity Requirement

Beginning in Fall 2014, all Virginia Tech graduate students are required to satisfy the *Resolution to Include a Scholarly Ethics and Integrity Component in Graduate Education* (CGS&P Resolution 2012-13B). Students in the EM Program satisfy the *Scholarly Ethics and Integrity Requirement* by completing the following two **mandatory** activities:

1. **Attend the EM program orientation.** Attendance is taken at this orientation and will be recorded in each student's record. During orientation, the Engineering Mechanics Ethics and Integrity Requirements are presented, and students are informed of the timeline for satisfying these requirements. Orientation includes presentations/discussions on EM and Graduate School policies and procedures, introduction to the Virginia Tech Graduate Honor System, and campus resources for assessing conduct and reporting misconduct. Students are expected to complete this requirement prior to the first semester of enrollment. Students who enroll late or are otherwise unable to attend the EM orientation prior to the first semester of enrollment are required to attend orientation before their third semester of enrollment.
2. **Complete the NSF Responsible Conduct of Research (RCR) requirement as implemented at Virginia Tech.** Completing the on-line course created and maintained by the Collaborative Institutional Training Initiative (CITI) satisfies this requirement. On completion of this course, students are awarded a certificate of completion. This certification must be submitted to the GC within the first month of graduate enrollment; the certificate will be recorded in the student's record.

The completion of the *Scholarly Ethics and Integrity Requirement* will be noted in the Plan of Study submitted for EM Program and Graduate School approval.

Failure to complete the *Scholarly Ethics and Integrity Requirement* within 12 months of enrollment will affect eligibility for financial support on assistantships and scholarship awards.

The proposed procedure for the EM *Scholarly Ethics and Integrity Requirement* satisfies the four required topics enumerated in the Appendix to CGS&P Resolution 2012-13B in the following specific ways:

Required Topic 1: Plagiarism and other violations of the Graduate Honor Code

The definition of plagiarism and responsibilities of graduate students as research participants is covered in the module of the CITI online course entitled "Introduction to Responsible Conduct of Research." Specific examples and information on best practices are given within the following modules: "Research Misconduct," "Publication Practices and Responsible Authorship," and "Data Acquisition, Management, Sharing and Ownership." In addition, the EM program orientation introduces students to Virginia Tech resources on plagiarism and other violations of the Graduate Honor Code; specifically those resources at the [Graduate Honor System](#) and the Virginia Tech Library System's "Outline of Plagiarism and how to avoid it" (<https://guides.lib.vt.edu/c.php?g=658932&p=4625922>).

Required Topic 2. Proper use of professional conventions in citation of existing research and scholarship, accurate reporting and ownership of findings, and acknowledgement of contributions to the work

This required topic is covered in the module of the CITI on-line course entitled “Publication Practices and Responsible Authorship.” In addition, the EM program orientation introduces students to Virginia Tech resources on proper citations of existing research, the reporting and ownership of findings, and the acknowledgement of contributions of work. These resources include those available at the [Graduate Honor System](#), the [“Information Appropriately” module](#) from VT Libraries, and the [“Research Integrity”](#) available from the Virginia Tech Research Office.

Required Topic 3. Ethical standards in teaching, mentoring, and professional activities

This required topic is covered in the CITI on-line course modules entitled “Conflicts of Interest and Commitment,” “Mentor/Trainee Responsibilities,” “Peer Review,” and “Collaborative Research.” In addition, the EM program orientation introduces students to Virginia Tech resources on ethical standards in teaching, mentoring, and professional activities. In particular, Virginia Tech courses on training on research misconduct are provided through the Office of the Vice [President](#) for Research and Innovation. The [CITI program](#) provides information on the procedures and approval requirements for the use of human subjects in research. Finally, Research and Innovation provides [conflict of interest training and resources](#).

Required Topic 4. Available avenues for reporting alleged misconduct

The available avenues for EM graduate students to report alleged misconduct are presented at the required EM program orientation. The particular avenues available to students include the [Graduate Honor System](#) and the [Committee on Faculty Ethics](#). Both are presented and described. Examples of how these resources can be used are provided based on situations that have previously arisen in the EM graduate program.

Optional Topics

In addition to the required topics detailed above, the CGS&P resolution also includes a number of optional topics that may be covered by the EM Ethics and Integrity Requirement. The EM program orientation addresses intellectual property issues and the use of [VTIP](#), guidelines for determination of authorship, proper purchasing procedures, and appropriate use of university facilities and equipment (including computing resources). Individual laboratory procedures and documentation policies, including IRB approval, varies by research group, and will be handled by the student’s faculty advisor or laboratory supervisor.

Appendix B

Preapproved Engineering Mechanics Courses

Further descriptions are available on the [Engineering Mechanics course listing in the graduate catalog](#)

A. Mathematics Courses

All MATH 5xxx and 6xxx courses	ESM 5754 Introduction to Perturbation Methods
ESM 5734 Introduction to the Finite Element Method	ESM 6314 Advanced Dynamics
ESM 5744 Energy and Variational Methods in Applied Mechanics	ESM 6714 Applied Tensor Analysis
	ESM 6734 Finite Element Analysis

B. Dynamics Courses

ESM 4114 Nonlinear Dynamics and Chaos	ESM 5314 Intermediate Dynamics
ESM 4444 (AOE 4054, CEE 4444) Stability of Structures	ESM 5344 Wave Propagation in Solids
ESM (AOE) 5304 Mechanical and Structural Vibrations	ESM 5414 Nonlinear Systems
	ESM 6314 Advanced Dynamics

C. Fluid Mechanics Courses

ESM 5054 Introduction to Fluid Mechanics	ESM 5554 Turbulence and Turbulent Flows
ESM 5504 Introduction to Ideal Flow	ESM 6514 Computational Methods for Viscous Flows
ESM 5514 Viscous Flow	
ESM 5524 Compressible Flow I	

D. Solid Mechanics Courses

ESM 4024 Advanced Mechanical Behavior of Materials	ESM 5144 (MSE) Deformation and Fracture of Materials
ESM 4154 Nondestructive Evaluation of Materials	ESM 5174 (CHEM) Polymer Viscoelasticity
ESM 5024 Introduction to Solid Mechanics	ESM 5264 Mechanics of Adhesive Bonding and Interfaces
ESM 5044G Advanced Mechanics of Composite Materials	ESM 5454 Elastic Stability
ESM 5074 Mechanics of Laminated Composite Structures	ESM 6014 Nonlinear Elasticity
ESM 5124 Theory of Elasticity	ESM 6044 Theory of Plates and Shells
ESM 5134 Advanced Mechanics of Materials	ESM 6054 Fracture Mechanics
	ESM 6104 Mechanics of Composite Strength and Life
	ESM 6154 Analysis of Composite Materials

E. Biomechanics Courses

ESM 4105, 4106 Engineering Analysis of Physiologic Systems	ESM 5305, 5306 Biomechanics of the Cardiovascular System
ESM 5224 (BMES 5124) Advanced Musculoskeletal Biomechanics	ESM 5405, 5406 Clinical Internship in Biomedical Engineering
ESM 5245G, 5246G Mechanics of Animal Locomotion	