



Academic
Year
2022–23

Engineering Mechanics Graduate Manual

Program Contacts

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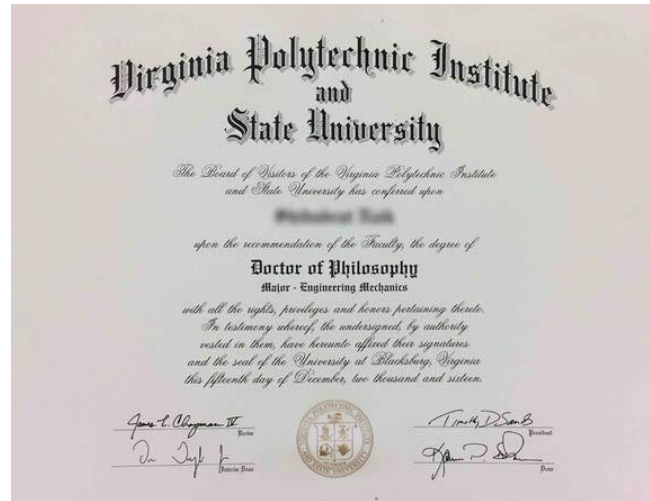
I. Introduction

This manual is a guide for students who are planning or pursuing 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. BEAM also offers an undergraduate minor in *Engineering Science and Mechanics (ESM)*, and the graduate degrees and program may also be referred to as ESM. All courses offered directly by BEAM for the EM Program are labeled as “*ESM XXXX*”. Academically, the EM Program involves faculty from multiple departments across different colleges at Virginia Tech, and a number of the ESM graduate courses are cross-listed with other graduate programs, making the EM Program a highly interdisciplinary collection of students and faculty. 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. New Graduate Student Orientation

Each fall, the EM Program conducts a mandatory orientation session for all new graduate students. The orientation provides information on EM requirements, procedures for fulfilling those requirements, and other topics of importance to new students. Attendance at the new graduate student orientation is one component of completing the requirements of the [Engineering Mechanics Scholarly Ethics and Integrity Plan](#). Additional departmental and university training may be required, particularly for students being supported on a Graduate Teaching Assistantship (GTA).

B. 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 System web site](#).

C. Residency Expectation

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 EM GPD. All students are required to satisfy the [residency guidelines established by the Graduate School](#).

D. Continuous Enrollment and Leaves of Absence

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 to continue their studies. Readmission requires approval from the EM Program and is not guaranteed.

E. Minimum Hours of Registration and the Start of Semester Defense Exception (SSDE)

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 (fall and spring) semesters. However, the Commonwealth of Virginia does not count students as full time unless they are enrolled for at least 12 credits. Therefore, students being supported on an assistantship, fellowship recipients, and scholarship recipients must register for at least twelve (12) credit hours each semester of the academic year.

The minimum enrollment requirement is three (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*.

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 of the thesis or dissertation document and committee 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 submit the [Start of Semester Defense Exception Request](#).

Summer session enrollment is optional. Students should consult with their faculty advisor before registering for summer session courses. Students must be registered in order to schedule a Graduate School approved examination during the summer.

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). [Audited courses](#) do not count toward full-time enrollment. Students registered for 5994 and 7994 are expected to devote time to research in proportion to the numbers of credit hours registered.

F. 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. Students are encouraged to confer with a broad spectrum of the faculty and select those (willing) faculty members who best support their academic interests and/or research activities (as appropriate). Students may be co-advised by two (or more) faculty advisors who cooperate in supervision of the student; in these cases, one of the faculty advisors is designated as the *lead advisor* who takes primary administrative responsibility for the student, including chairing the advisory committee, and co-advisors must be members of the advisory committee. In this document, “the advisor” refers to the lead advisor.

The Plan of Study must be approved by the faculty advisor and the student’s advisory committee before being submitted to the EM GC. Once a Plan of Study is approved by the EM Program, it is submitted by the EM GC to the Graduate School for approval. 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 students. 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 before scheduling any exam requiring Graduate School approval (such as the Preliminary Exam or a Final Exam). 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 EM GC: see the [Change of Committee and/or Advisor form](#) and the [Plan of Study Change Request form](#).

G. Course Completion

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 definition of completion is to comply with the VT Graduate School requirement listed in the [Graduate Catalog](#): “Courses on the Plan of Study with grades below ‘C-‘ must be repeated.”

H. Educational Background

Students are expected to enter an Engineering Mechanics graduate program with an educational

background that includes the equivalent to the following Virginia Tech undergraduate courses:

- ESM 2204 Mechanics of Deformable Bodies
Concepts of stress, strain, and deformation. Factor of safety. Stress-strain relationships and material properties. Stress concentrations. Area moments of inertia. Axially loaded members, torsionally loaded members, bending of beams. Shear and moment diagrams. Stresses due to combined loading. Thin-walled pressure vessels. Transformation of stress including Mohr's circle. Beam deflections and buckling stability.
- ESM 2304 Dynamics
Vector treatment of the kinematics and kinetics of particles and rigid bodies, Newton's laws, work and energy, impulse and momentum, impact, mass moments of inertia, rotating axes.
- ESM 3024 Introduction to Fluid Mechanics
Fluid properties. Hydrostatics. Derivation and application of the mass, momentum, and energy conservation equations. Dimensional analysis and similitude. Introduction to analyses of pipe flows and piping systems, open channel flows, and fluid forces on solid bodies.
- MATH 4564 Operational Methods for Engineers
Laplace transformations, Fourier series, partial differential equations and separation of variables, boundary value problems, and Sturm-Liouville theory.
- MATH 4574 Vector and Complex Analysis for Engineers
Vector Analysis: Green's theorem, potential theory, divergence, and Stokes theorem. Complex Analysis: Analyticity, complex integration, Taylor series, residues, conformal mapping, applications.

The required prerequisites for these courses are also expected background; these prerequisites include:

- ESM 2104 Statics
- MATH 2114 Introduction to Linear Algebra
- MATH 2204 Introduction to Multivariable Calculus
- MATH 2214 Introduction to Differential Equations

In some cases, admission to the program is allowed without prior formal education in all of these subjects, or significant time may have passed since learning this material. Acquiring sufficient background can be achieved through self-study or completing these courses at Virginia Tech. Students with questions about background preparation are encouraged to consult with their faculty advisor and/or the GPD. Note that lower-level undergraduate courses (below 4000) are not allowed on any graduate Plan of Study, and MATH 4564 and MATH 4574 cannot be counted toward the minimum 35 credits of coursework required for an EM PhD.

I. Language Requirement

University business and all instruction are conducted in English. 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](#)

There is no foreign language requirement for the EM Program. However, foreign language requirements are optional at the discretion of the student's advisory committee. Any language courses taken do not count towards the required program hours on the Plan of Study.

J. 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](#) 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.

K. Diversity and Inclusion Requirement

In April 2018, The Commission on Graduate Studies and Policies (CGS&P) approved an [inclusion and diversity education requirement](#) for graduate students (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 starting in 2019-20 are expected to satisfy this requirement by successfully completing *ENGE 5304: Graduate Student Success in Multicultural Environments (1 credit)* within the first two semesters of enrollment. This 1 credit course is not included on the Plan of Study but is required for approval of the Plan of Study.

L. Transfer Credit

In general, transfer credits are formally reviewed/approved at the time the Plan of Study is submitted. Credits may be transferred from a regionally accredited university. All such credits must have earned grades of "B" or better, have been earned while in good standing in graduate status, and must have been graduate courses at the institution where the student took the course. Grades of "S" or "P" are not acceptable for transfer credit. All transfer courses must be reviewed and acceptable to the student's Advisory Committee and the GPD. Official transcripts are required before transfer course work can be approved for the Plan of Study. Transferred courses count as credit hours but are not included in the calculation of the Virginia Tech GPA (i.e., the grade does not transfer). For transfer course work more than five years old, a Justification of "old" course work form must be filed with the Plan of Study (see [Justification of Courses](#)).

The number of course credits transferred from another institution cannot exceed the number of course credits taken at Virginia Tech. Limits on the number of transfer credits allowed for an Engineering Mechanics degree are listed under each degree description.

Research, Project and Report, Practicum or Internship credit hours may not be transferred from another university to meet Virginia Tech graduate degree requirements (i.e., they cannot be included on the Plan of Study). Credits taken while in undergraduate status or for an undergraduate degree cannot be used as transfer credit for a graduate degree, with the exception of Virginia Tech students enrolled in the Accelerated Undergraduate/Graduate (UG/G) program who have received pre-approval for this credit through submission of the UG/G paperwork.

Substitution of transfer coursework for any of the EM core courses (see below) requires pre-approval by the GPD and the student's academic advisor. Submission of the pre-approval form must be accompanied by detailed information regarding the course(s) taken at the other university, including required textbook information, a list of the assigned homework problem statements, and copies of the administered test questions (only the assignment/test questions are needed, not the corresponding work). This pre-approval process is required only if direct substitution on the Plan of Study is being requested for the following core courses:

- ESM 5004 Communicating Engineering Mechanics
- ESM 5014 Introduction to Continuum Mechanics
- ESM 5024 Introduction to Solid Mechanics
- ESM 5054 Introduction to Fluid Mechanics
- ESM 5314 Intermediate Dynamics

M. Justification of Courses

Academic work, including transfer credits, must meet the time limits specified by the Graduate School. 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. 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.

N. 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 will receive via email and are required to submit a *Progress to Degree Report* to the EM GC. 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 [Academic Advising](#)). Both the faculty advisor and the student must sign the report prior to submission to the EM GC.

O. Academic Probation

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

semester, an appeal for additional time can be submitted by the EM GPD to the Graduate School. For an appeal to be submitted, the student must work with their faculty advisor and the EM GPD to develop a remediation plan that details steps to be taken to raise the student's cumulative 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 EM 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 cumulative 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 cumulative 3.0 GPA within the time specified by the Graduate School, the student will be dismissed from the Graduate School.

P. Theses and Graphical Abstracts

Within two (2) weeks of a scheduled MS thesis or PhD dissertation defense, it is required to submit a completed [Thesis and Dissertation Approval Form](#), upload the (draft) [Electronic Thesis and Dissertation \(ETD\)](#) and *graphical abstract*, and submit applicable supporting documentation.

Beginning in the Fall 2021 semester, graphical abstracts are required with every Engineering Mechanics ETD. These graphical abstracts will be used to promote each student's work and celebrate their degree completion through social media and the program's website. This submission is intended to complement, not replace, the traditional text abstract by providing a 'representative graphic' for the work. Many leading journals are moving to the use of a graphical abstract, so this requirement for EM students is consistent with emerging publication practices; it is likely that most students will have already prepared a graphical abstract for a journal submission.

The [Physical Review Fluids website](#) provides good examples of a 'minimalistic' graphical abstract approach. Elsevier provides [instructions and multiple examples](#) of a more complex approach to the graphical abstract. Either style can be accepted as an EM graphical abstract.

Q. 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 are expected to perform 390 total hours of work (average of 20 hours per week for 19.5 weeks). For each of the

summer sessions, students are expected to perform 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 cannot be required to work for more hours than designated by their appointment. Students are asked to report to the EM 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 unless specified in a written offer. GTAs are arranged on the student's behalf by their faculty advisor; students are not allowed to request a GTA from the EM program on their own.

R. 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 [Financial Support II.Q](#)). Approval for any additional vacation time must be preapproved by the faculty advisor (for GRAs) or the course supervisor or GDP (for GTAs). Note that class breaks (fall break, spring break, etc.) are not vacation days unless they correspond with official university holidays.

S. 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.

III. Requirements for the Accelerated Undergraduate/Graduate (UG/G) Program

The EM Program invites applications to the Accelerated Undergraduate/Graduate (UG/G) Degree Program for highly qualified VT undergraduate students from any major. Students may apply for admission to an M.S. or direct Ph.D. degree as a part of this program. If admitted, they are then able to double-count up to 12 credit hours toward both their undergraduate and graduate degree programs. Application to this program is available to VT students who have an overall undergraduate GPA of 3.3 or higher; GRE scores are not required. Students must submit a degree application (MS or direct PhD) through the Graduate School. The *degree admission term* is for the first semester after the bachelor's degree is to be awarded. For example, if a student expects to finish the bachelor's degree in Spring 2023, they will apply for admission for Fall 2023. Double-counting of courses would begin in their senior year of undergraduate studies. Students must be accepted into a graduate degree program and approved for Accelerated UG/G *prior to* the first day of classes in the term that the double-counted courses will begin.

A. Double-Counting Courses

Acceptance into the program allows the student to 'double-count' up to 12 hours of coursework, which is chosen in advance and taken during the senior year. Six of the 12 hours can be at the 4000 level, with the other 6 hours being at the 5000 level. Courses included on a UG/G student's list of proposed coursework must be consistent with the course requirements for the appropriate graduate degree.

B. Application Instructions

The UG/G application consists of two steps: (1) applying to the Graduate School for admission to an EM graduate program and (2) submitting the [UG/G Degree and Course Designation Request](#).

Graduate School admission is applied for through the normal VT online application process. Deadlines for applying to the Graduate School are January 1 for spring admission and August 1 for fall admission. Students will choose either the M.S. or the Ph.D. degree in Engineering Mechanics and then indicate in the application that they are pursuing the UG/G (checkbox option after application is started), and the effective term will be the semester in which the student becomes a full-time graduate student (*not* the beginning term of the senior year).

The [UG/G Degree and Course Designation Request](#) form should be submitted to the EM GC *after* applying to the Graduate School as described above; this form is due no later than two weeks before the start of classes for the semester in which courses are to be double counted. The student should confer with the EM GC as well as the undergraduate advisor in their 'home' undergraduate program in order to choose the courses that will be double counted.

For more information from the Graduate School about the UG/G application process, visit the [Graduate School Admissions website](#).

IV. Requirements for the Engineering Mechanics Degrees of *Master of Science (MS)* and *Master of Engineering (MEng)*

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, and satisfactorily prepare and defend a master's thesis.

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 and satisfactorily pass a final examination. 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 toward 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, and satisfactorily prepare and defend an engineering project report. 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. Coursework and Plan of Study

The MS or 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 (see the GC for information regarding approved 4xxx-level courses).

A minimum of 12 course credits must be labeled ESM (not including 5894, 5904, 5944, or 5994).

MS and MEng students must satisfactorily complete *ENGE 5304: 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. This course credit is not included on the Plan of Study.

MS and MEng students must register for one (1) credit hour of *ESM 5944 Seminar* for at least two (2) semesters. These two seminar credits are not included on the 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 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 (*3 credits in each area, for a total of 6 credits*); see the GC for a current list of approved courses
- One course satisfying the mathematics requirement (*3 credits*); see the GC for a current list of approved courses
- Graded elective courses (*at least 9 credits*)
- ESM 5994 Research and Thesis (*at least 6 credits*)

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 (*3 credits in each area, for a total of 6 credits*); see the GC for a current list of approved courses
- One course satisfying the mathematics requirement (*3 credits*); see the GC for a current list of approved courses
- Graded elective courses (*at least 18 credits*)

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)

The MEng 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 course in two of the following areas: dynamics, solid mechanics, or

fluid mechanics (*3 credits in each area, for a total of 6 credits*); see the GC for a current list of approved courses

- One course satisfying the mathematics requirement (*3 credits*); see the GC for a current list of approved courses
- Graded elective courses (*at least 15 credits*)
- ESM 5904 Project and Report (*3 credits*)

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 a [faculty advisor and an advisory committee](#), which guides and approves the Plan of Study, evaluates the student's academic progress, advises the student on their research (when applicable), and conducts the final examination.

The MS or MEng advisory committee is to be composed of a minimum of three (3) faculty: the faculty advisor, who serves as the chair of the committee, and a minimum of two other faculty members. The faculty advisor and at least one of the other committee members must be from the [Graduate Catalog's approved list of Engineering Mechanics faculty](#). The third member must be approved by the Graduate School to serve on a graduate committee.

D. Final Examination

All MS and MEng students must pass a final 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 and their advisory committee to schedule the examination and the candidate must be registered for a minimum of three credit hours or have an approved [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. Students are encouraged to confer with their committee members prior to the final examination time for guidance regarding the expected scope and format of the examination.

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. MS Thesis

The thesis must be a scholarly discourse on a topic determined in consultation with the student's faculty advisor and approved by the student's advisory committee. It should demonstrate the

student's ability to perform independent research of professional quality on a topic in mechanics. 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*.

MS thesis students are required to submit a [graphical abstract](#) along with their ETD. Scheduling of the Final Examination will not be approved by the GPD without submission of an acceptable (draft) graphical abstract. A final version of the graphical abstract can be submitted with the final ETD.

F. Continuing to the PhD

Some students may elect to continue to the PhD after earning their MS degree. Students may do this by either (1) submitting a new [Graduate School application](#) for admittance to the PhD program or (2) submitting a [change of degree program form](#). The change of degree program form, which requires approval of the academic advisor and the GDP, allows the student to continue in the program without reapplying. Students should talk with their advisor and/or the GPD for advisement on which option to pursue.

Graded coursework taken toward the MS at Virginia Tech also counts toward the PhD. If earning a thesis MS, please note that ESM 5994 (master's level research hours) cannot count toward your PhD dissertation research hours. The appropriate number of credit hours of ESM 7994 (doctoral level research hours) must be listed on the Plan of Study. Please consult the PhD degree requirements for more information.

A PhD Plan of Study, qualifying exam, preliminary exam, and PhD final exam are required.

Any transfer courses that are used to fulfill the MS requirements cannot be counted toward the PhD requirements, with the exception of double-counted Virginia Tech courses taken by Virginia Tech students who are enrolled in the Accelerated Undergraduate/Graduate (UG/G) program. Please see the transfer credit section for more information.

V. Requirements for the Engineering Mechanics Degree of Doctor of Philosophy (PhD)

A. Overview of PhD Requirements

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

- Satisfy the [Scholarly Ethics and Integrity Requirement](#)
- Satisfy the [Diversity and Inclusion Requirement](#)
- Complete a minimum of [90 credit hours](#) that can be included on the Plan of Study
- Pass the program's [Qualifying Examination](#)
- Pass the program's [Preliminary Examination](#)
- Prepare a [Dissertation](#) and pass the [Final Examination](#)

B. Credit Hour Requirements

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 [below](#), and fourteen (14) of these credits must consist of the [core coursework](#).
- At least four (4) credits of [ESM 5944 Seminar](#) are required.
- At least thirty (30) credits of [ESM 7994 Doctoral Research](#) are required.
- The content of the remaining twenty-one (21) credits must be agreed upon by the student and their Advisory Committee.

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

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.

- Fourteen (14) credits of graded core coursework.
- At least three (3) credits of additional graduate-level coursework in mathematics; see the GC for a current list of approved courses.
- At least six (6) credits of additional ESM-designated graded coursework.
- At least twelve (12) credits of additional graduate-level graded coursework in support of the chosen area of doctoral research.

Restrictions:

- No more than three (3) credits of 4xxx-level coursework can be counted toward the required minimum 35 credits of coursework.
- No more than three (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.
- A maximum of 6 credits of transfer coursework can be counted toward the required 14 credits of core coursework.

2. Core Coursework Requirements

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

- ESM 5014 Introduction to Continuum Mechanics (3 credits)

- ESM 5314 Intermediate Dynamics (3 credits)
- ESM 5024 Introduction to Solid Mechanics (3 credits)
- ESM 5054 Introduction to Fluid Mechanics (3 credits)
- 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 EM PhD program.

Students may substitute one or more graduate course(s) taken at another institution for any of these core courses; see [Transfer Credit](#). Transfer courses may be substituted for a maximum of six (6) credits of core coursework. The GPD and the student's Advisory Committee must approve any core course substitutions. Not all transfer 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.

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 (e.g., to accommodate conflict with a course or a teaching assignment) are to be submitted in writing (email is acceptable) to the EM Program no later than the *Course/Add* date for the semester in question. Students receiving this exemption are still required to fulfill the minimum requirement of 4 credit hours of ESM 5944.
- 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. There is a maximum number of credits of ESM 7994 that can be included on the Plan of Study; check with the GC.

C. Qualifying Examination

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

1. Exam Format

The Engineering Mechanics PhD Qualifying Examination (QE) consists of one or more written and/or oral examinations based on the material covered by the core coursework described in the [Core Coursework Requirements](#). Examination content 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 Examination after successfully completing the core coursework requirements. 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 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.

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. Examination Exemptions

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

- earn a B– or better in each of the required core courses that are taken at Virginia Tech, and
- attain a cumulative GPA of 3.2 or higher in the required core courses that are taken at Virginia Tech.

D. Advisory Committee

Each graduate student must have a faculty advisor and an advisory committee, which guides and approves the Plan of Study, evaluates the student's academic progress, advises the student on their research, and conducts the preliminary and final examinations.

The PhD advisory committee is to be composed of a minimum of four (4) faculty: the faculty advisor, who serves as the chair of the committee, and a minimum of three 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. The fourth member must be approved by the Graduate School to serve on a graduate committee.

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 program 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. Exam Format

The dissertation *proposal* is intended to be a plan of research for the student's doctoral dissertation. As such, the proposal should clearly document the research studies that the student will conduct, their motivation, and the potential significance of the expected findings. 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., an NSF-style 15-page proposal) is recommended.

Because the Preliminary Examination is expected to occur before much of the dissertation research is conducted, the proposal is not a contract *per se*, and some changes to the plan are likely to arise. 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 conducted by the Advisory Committee immediately follows the public presentation. This questioning session is intended to provide sufficient basis for evaluating

- the student's competency in mechanics as it relates to their research,
- their ability to complete the doctoral degree requirements, and
- their potential for success as an independent researcher.

Questions by the committee members are expected to focus primarily on the written dissertation proposal and the presentation, but they are not limited in any way.

2. Timing and Retesting

A student is eligible to take the Preliminary Exam after passing or being exempted from the [Qualifying Examination](#).

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 planning for a second attempt at 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. This justification and remediation plan must be submitted to the GPD as a written document. 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. 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.

F. Candidacy Status

Doctoral students who have passed their preliminary exam, have completed all required coursework on their Plan of Study, and satisfy all additional [requirements established by the Graduate School](#) are eligible to apply for candidacy status. Students granted candidacy status receive a discount on tuition charges for that semester. Doctoral candidates must submit the [Graduate Candidacy Status Tuition Reduction Request Form](#) to the Graduate School in *each* semester they wish to utilize the discounted tuition rate. Applications are due by the last day to add course registration for the semester. Candidacy status tuition reduction can be received in *no more than* four (4) academic semesters (fall or spring, not necessarily consecutive) within a *maximum period* of three (3) academic years.

G. Dissertation and Graphical Abstract

The dissertation must be an original contribution to the literature in the field of mechanics. General style and organization requirements established by the Graduate School are described in the [Virginia Tech ETD Guide](#). As a supplement to the ETD Guide, the presentation style, logical organization, and scholarly standards of the dissertation are expected to be consistent with papers in, for example, the *Journal of Applied Mechanics*. The title of the degree, which appears on the cover page, is *Engineering Mechanics*.

Engineering Mechanics PhD candidates are required to submit a [graphical abstract](#) along with their ETD. Scheduling of the Final Examination will not be approved by the GPD without submission of an acceptable (draft) graphical abstract. A final version of the graphical abstract can be submitted with the final ETD.

The dissertation and graphical abstract must be completed by the student and reviewed by the advisory committee prior to scheduling the Final Examination with the Graduate School.

H. Final Examination

All PhD students must pass an oral examination upon completion of the degree requirements. A Final Examination 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 passing the [Preliminary Examination](#). At the time of the Final Examination, the candidate must be registered for a minimum of three (3) credit hours or have an approved [Start of Semester Defense Exception \(SSDE\)](#).

The Final Examination is to be administered by the student's Advisory Committee, with additional members added 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.

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 (2) 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](#).

I. Earning an EM MS “along the way”

EM PhD students have the option (but not the obligation) of obtaining an EM MS “along the way” as they complete the coursework requirement of the EM PhD (irrespective of whether they entered with or without an MS degree from elsewhere).

PhD students can choose to earn either a non-thesis MS or a thesis MS “along the way”. In general, courses taken at Virginia Tech toward the EM PhD can also count toward an EM MS degree. However, if choosing the thesis MS option, ESM 7994 (doctoral level research hours) cannot count toward MS research hours, and the appropriate number of ESM 5994 (master’s level research hours) must be on the MS Plan of Study; consult the [MS degree requirements](#) for more information. Furthermore, the contents of the MS thesis *must be distinct from* the contents of the PhD dissertation. Therefore, it is typically the non-thesis EM MS degree that is earned “along the way”.

Any [transfer courses](#) that are used to fulfill the EM MS requirements cannot be counted toward the EM PhD requirements (and vice versa), except for Virginia Tech students enrolled in the Accelerated Undergraduate/Graduate (UG/G) program who have pre-approved transfer coursework from their undergraduate degree at Virginia Tech.

EM PhD students may wish to earn an MS degree from another program (e.g., mathematics) while simultaneously working on their EM PhD requirements. Earning two simultaneous degrees from separate programs is not the same as earning the MS “along the way” in the same program. In particular, there are strict limits regarding the number of courses that can be counted toward both degrees. EM PhD students interested in earning an MS degree from a non-EM program are encouraged to consult with the GPD as early as possible.

Appendices

VI. Scholarly Ethics and Integrity Requirement

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:

- **Attend the EM Program’s new graduate student 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 a presentation and 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.
- **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. Information regarding completion of the CTTI is distributed to new students prior to orientation, and submission of the certificate of completion at orientation is encouraged. The 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 on the Plan of Study and is required for EM Program and Graduate School approval of the Plan of Study. 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](#)".

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 [Virginia Tech Libraries](#), and the [Virginia Tech Research Integrity 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. 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 several 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.