

MECHANICAL AND NUCLEAR ENGINEERING, DOCTOR OF PHILOSOPHY (PH.D.)

Program mission

The Ph.D. curriculum will provide graduate-level training in both mechanical and nuclear engineering. Graduates of the program will be prepared for research and teaching careers in areas such as energy production, nuclear waste transport, storage and disposal, and the development of new mechanical devices for use in nuclear medicine. Technical electives in both mechanical and nuclear engineering will allow students to pursue in-depth study relevant to their selected research topics. Dissertation topics pursued as directed research credit hours will be devoted to open-ended research projects at the intersection of mechanical and nuclear engineering.

1. **Advanced technical skills:** To produce graduates who possess the necessary advanced analytical and technical skills in engineering and sciences – responds directly to the higher goals of fulfilling the needs of industry for effective, productive engineers and of providing economic development for the region, state and nation
2. **Communication:** To produce graduates who possess a facility with both written and oral communications – emanates from the requirement that engineers must be able to interact and share ideas with others in the work environment, and at a higher level, be capable of creative self-expression and leadership
3. **Advanced problem-solving:** To produce graduates who demonstrate creativity and innovation in solving technological problems – stems from the realization that new knowledge and new solutions to existing problems are necessary to meet the needs of our changing society and to advance the quality of human life

Student learning outcomes

1. **Apply advanced knowledge of mathematics, science or engineering:** Graduates will demonstrate an ability to apply advanced knowledge of mathematics, science or engineering.
2. **Communicate effectively:** Graduates will demonstrate an ability to communicate effectively.
3. **Identify, formulate and solve engineering problems:** Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

VCU Graduate Bulletin, VCU Graduate School and general academic policies and regulations for all graduate students in all graduate programs

The VCU Graduate Bulletin website documents the official admission and academic rules and regulations that govern graduate education for all graduate programs at the university. These policies are established by the graduate faculty of the university through their elected representatives to the University Graduate Council.

It is the responsibility of all graduate students, both on- and off-campus, to be familiar with the VCU Graduate Bulletin as well as the Graduate School website (<http://www.graduate.vcu.edu/>) and academic regulations in individual school and department publications and

on program websites. However, in all cases, the official policies and procedures of the University Graduate Council, as published on the VCU Graduate Bulletin and Graduate School websites, take precedence over individual program policies and guidelines.

Visit the **academic regulations section for additional information on academic regulations for graduate students.** (<http://bulletin.vcu.edu/academic-regs/>)

Degree candidacy requirements

A graduate student admitted to a program or concentration requiring a final research project, work of art, thesis or dissertation, must qualify for continuing master's or doctoral status according to the degree candidacy requirements of the student's graduate program. Admission to degree candidacy, if applicable, is a formal statement by the graduate student's faculty regarding the student's academic achievements and the student's readiness to proceed to the final research phase of the degree program.

Graduate students and program directors should refer to the following degree candidacy policy as published in the VCU Graduate Bulletin for complete information and instructions.

Visit the **academic regulations section for additional information on degree candidacy requirements.** (<http://bulletin.vcu.edu/academic-regs/grad/candidacy/>)

Graduation requirements

As graduate students approach the end of their academic programs and the final semester of matriculation, they must make formal application to graduate. No degrees will be conferred until the application to graduate has been finalized.

Graduate students and program directors should refer to the following graduation requirements as published in the Graduate Bulletin for a complete list of instructions and a graduation checklist.

Visit the **academic regulations section for additional information on graduation requirements.** (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info/>)

Other information

Student handbook (<http://www.egr.vcu.edu/current-students/graduate-student-services/resources-forms/>) is available on the College of Engineering website.

Apply online today. (<https://www.vcu.edu/admissions/apply/graduate/>)

Admission requirements

Degree:	Semester(s) of entry:	Deadline dates:	Test requirements:
Ph.D.	Fall	Jan 15	GRE-General
	Spring	Oct 1	TOEFL required for international students

In addition to the general admission requirements of the VCU Graduate School (<http://bulletin.vcu.edu/graduate/study/admission-graduate-study/admission-requirements/>), the following comprise the admissions requirements for the mechanical and nuclear engineering Ph.D. program:

1. Proof of graduation from an accredited college or university with either a bachelor's or a master's degree in mechanical engineering,

nuclear engineering or a related discipline with a minimum grade point average of 3.0

2. Demonstration of proficiency in spoken and written English
3. Submission of results of the Graduate Record Examination (minimum score for admission to be established annually by the MNE graduate committee)
4. Submission of at least three letters of recommendation from former instructors or other individuals qualified to evaluate the applicant's ability to engage in graduate study in mechanical and nuclear engineering
5. Submission of a written statement of purpose that clearly demonstrates commitment to a career in mechanical and nuclear engineering

The MNE graduate committee may admit students unconditionally or provisionally. Provisional admission may be granted when deficiencies are identified; these deficiencies should be remedied by the time specified by the admissions committee. At the end of the provisional period, the student's progress is evaluated. Failure to meet the goals set forth by the MNE graduate committee at the time of admission results in a show-cause notice. A response to this notice that is deemed unsatisfactory results in a recommendation for dismissal. The student has the right to appeal the recommendation for dismissal following procedures set forth by the College of Engineering and the VCU Graduate School. Remedial courses, or those designed to remove deficiencies, will not be accepted for credit hours toward the fulfillment of the course requirements for the Ph.D.

Degree requirements

In addition to the VCU Graduate School graduation requirements (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info/>), the Ph.D. degree will require a minimum of 68 credit hours beyond the B.S. degree or a minimum of 36 credit hours beyond the M.S. degree. Students may enter the Ph.D. program with either a B.S. or M.S. degree.

Transfer policy

Transfer courses must be approved by the MNE graduate committee and must fulfill all requirements of the VCU Graduate School as described in the student handbook. For students entering with a B.S. degree, a maximum of nine credit hours of technical electives may be transferred from another VCU program or outside institution and, if not applied previously toward another degree, may be applied toward the Ph.D.

Doctoral comprehensive oral examination guidelines

Goals

A comprehensive oral examination is used to determine admission of graduate students to Ph.D. candidacy in the Department of Mechanical and Nuclear Engineering. The CO exam is administered by the graduate examination committee (a standing committee of four MNE faculty members with rotating one year terms selected by the graduate program committee) with the goals of:

1. Assessing the student's understanding of MNE foundational material at the Ph.D. level
2. Evaluating the student's critical-thinking and problem-solving skills
3. Determining the student's ability to communicate ideas clearly and effectively

Format

The CO will be administered by the graduate examination committee, which is organized by the MNE graduate program committee as outlined in the graduate student handbook. The format of the CO is as follows:

- The student provides a brief presentation (~five slides). The student should provide a copy of his or her presentation to the committee at least one week prior to the CO exam detailing:
 - His or her academic background
 - Courses taken in graduate school at VCU (including a printed copy of the VCU transcript made available to committee members)
 - The remaining planned course of study
- The student then provides a brief presentation (~two to three slides) describing:
 - The expected dissertation research area
 - The proposed methods for addressing the research topic
- The GEC then presents questions in an oral format to the student.
- The question-and-answer session of the CO should not exceed 1 hour.
- After the question-and-answer component of the CO, the GEC meets in closed session to discuss their assessment of the candidate's responses and vote on admission to Ph.D. candidacy.

Assessment

The purpose of the CO is to assess items 1-3 provided under "Goals" in order to determine if the student should be admitted to Ph.D. candidacy. The committee will discuss the responses, including strengths and weaknesses observed. Correct answers are not required for a certain percentage of questions. Instead, the committee is to deliberate on the potential of the candidate to successfully complete the Ph.D. degree and become a successful professional. The committee then grades the student as pass or fail in each area of the goals. The committee also votes "yes" or "no" on admission to Ph.D. candidacy. A majority vote for promotion to candidacy is required for successful completion of the CO.

At least three (of the four GEC) voting committee members must be present in the CO exam and vote.

Preparation

To prepare for the CO exam, the student should review course work completed in the first year of graduate study as a Ph.D. student and foundational MNE undergraduate courses.

Scheduling

It is anticipated that the student will have completed two full semesters of courses in graduate school at VCU at the time of the CO exam and have a firm understanding of undergraduate concepts. The student must pass the CO before the end of their fourth semester (excluding summer sessions) as a Ph.D. student at VCU. The primary CO will be administered during the second week of the fall semester. The graduate coordinator will provide a sign-up list of available times to graduate students. A secondary CO will be offered in the second week of the spring semester of each year for students who started in the spring semester of the previous year and for second chance exams.

Successful completion of the CO

Upon successful completion of the CO, the student works with his or her adviser to develop the dissertation proposal document for presentation to the committee at the proposal presentation. The proposal presentation will focus on the research topic an emphasis on objectives (or hypotheses) and a discussion of completed and future work.

Unsuccessful CO

In the event of an unsuccessful CO, the student may retake the exam once. The adviser is expected to work with the student on weaknesses identified by the committee. The CO is then re-administered and must be completed successfully within the first four semesters as a Ph.D. student at VCU. Failure to successfully complete the CO within the first four semesters is grounds for dismissal from the program. Special circumstances in scheduling within the four-semester timeline can be accommodated with written approval from the MNE graduate program director and approval from the student's primary adviser.

Benefits of the CO format

The CO is intended to benefit the student, primary adviser and department by:

- Providing feedback to the student at an early stage regarding admission to Ph.D. candidacy
- Critically evaluate Ph.D. candidates by committee consensus at an early stage
- Continue the development of well-trained successful Ph.D. applicants and professionals

For more information, contact the graduate program director.

Research adviser and graduate dissertation committee

Students will be expected to select a research adviser and dissertation committee within 12 months of enrollment in the Ph.D. program. The dissertation committee will consist of five faculty members, including the primary research adviser and at least two other faculty members from the mechanical and nuclear engineering graduate program. This committee reviews and votes to approve or disapprove the student's dissertation research proposal, oral candidacy exam, and the final Ph.D. dissertation and oral defense. This committee also makes the final recommendation to award the Ph.D. degree. All voting members of the committee must be members of the graduate faculty. Additional, nonvoting members may serve on the committee with the approval of the MNE graduate program director.

Proposal presentation exam

Within nine months after passing the qualifying examination the student will submit one copy of an original dissertation research proposal based upon their proposed research project to each member of his or her dissertation committee. The proposal consists of the research topic and proposed research plan. The proposal should include a thorough literature review of the topic and contain information sufficient to judge the feasibility, scope and potential impact of the research. The dissertation committee will then administer an exam based on the material submitted in the dissertation research proposal. The format of the exam is an oral presentation by the candidate with questions by the dissertation committee members. A favorable decision by the dissertation committee with no more than one negative vote (all members are required to vote) shall be required to pass the exam. If a student fails the exam, one re-examination may be given with the consent of the dissertation committee. Failure to pass the second exam will result in dismissal from the program.

Publication requirement

A Ph.D. student appearing for the final defense in the Department of Mechanical and Nuclear Engineering must provide evidence of a minimum of two manuscripts accepted for publication in peer-reviewed archival journals recognized by the ISI Web of Science at the time of defense. These publications should be based on the student's

dissertation research and must also be acceptable to the student's dissertation committee. The student is expected to have served as the first author in one or more of the papers. Specific publication requirements are available on the department's website as well as in the College of Engineering graduate handbook.

Dissertation defense

No earlier than six months after passing the oral candidacy examination, the student will defend the dissertation in an open forum administered by the dissertation committee. At least two weeks prior to the defense, the candidate will submit a written copy of the dissertation to each committee member and schedule a date for the defense. The defense will be advertised and faculty and student colleagues will be invited to attend. During the defense, the student will present a detailed summary of their research project, which should be the original problem presented and approved during the proposal presentation exam. If a solution of the original problem proves elusive for reasons beyond the student's control, the student may be allowed to redirect the research with permission from the dissertation committee and find an alternate pathway to the solution of a redefined problem. The format of the dissertation defense will be a presentation by the student followed by questions from the dissertation committee and other attendees. After the first round of questions are completed, the non-committee members in attendance will be asked to leave and the dissertation committee members will hold a second round of questions in closed session. After the second round of questions is completed the student will be asked to leave and the committee members will deliberate privately. The problem presented and solved must be of sufficient importance and interest to warrant publication in a peer reviewed journal in the student's area of specialization. A favorable decision by the dissertation committee with no more than one negative vote (all members are required to vote) shall be required to pass the dissertation defense. If a student fails the dissertation defense, one re-examination may be given. Failure to pass the second dissertation defense will result in dismissal from the program.

Students entering with a B.S. degree who are terminated from the Ph.D. program because of a failure to pass the QE, proposal presentation exam or dissertation defense (but not for other reasons such as academic dishonesty) will have the option to continue toward the M.S. in Mechanical and Nuclear Engineering.

Time limit

It is anticipated that students entering with a B.S. will complete the program in four years from the time the student passes the qualifying examination. Students must be continuously enrolled in the program (minimum of one credit hour per semester). All requirements for the Ph.D. degree must be completed within six years of passing the qualifying examination.

It is anticipated that students entering with an M.S. degree will complete the program in three years from the time the student passes the qualifying examination. Students must be continuously enrolled in the program (minimum of 1 credit hour per semester). All requirements for the Ph.D. must be completed within five years of passing the qualifying examination.

Any student may request a one-year extension of the maximum time for extenuating circumstances such as a medical situation. The graduate program committee will review and approve or deny all such requests. The maximum time cannot be extended longer than one year. Students

who do not satisfy the degree requirements within the maximum time will be dismissed from the program.

Because of the maximum time limits imposed on students in the Ph.D. program, the program does not accept part-time students.

Preparing Future Faculty Program

Students enrolled in the program will have the option and are strongly encouraged to participate in the Preparing Future Faculty Program. The VCU Graduate School provides graduate students with ongoing opportunities for academic and professional development. The PFFP at VCU offers a series of short courses and professional development opportunities for graduate students interested in pursuing careers in higher education. The series is modeled on the national PFFP created by the Association of American Colleges and Universities. PFFP courses introduce graduate students to the roles and responsibilities of higher education; address teaching, learning and technology issues in the college classroom; and incorporate material on the academic job search and continued professional development. For those students who complete all course requirements, the capstone course is an internship/externship experience during which the student is mentored by a senior faculty member. The program offers access to resources and activities and service-learning experiences while providing networking opportunities with students and faculty from a wide range of disciplines as well as discipline-specific areas of study. Since most courses are one or two credit hours, students are able to add them easily into their academic program schedules.

Curriculum requirements

Requirements for students entering with a B.S. degree

Course	Title	Hours
Core courses		
EGMN 604	Mechanical and Nuclear Engineering Materials	3
EGMN 605	Mechanical and Nuclear Engineering Analysis	3
EGMN 606	Mechanical and Nuclear Engineering Continuum Mechanics	3
EGMN 607	Heat and Mass Transfer Theory and Applications	3
EGMN 610	Topics in Nuclear Engineering	3

Technical elective component

With the approval of your adviser or program director, select 21 credit hours of courses with the following rubrics: EGMN, EGRM, ENGR, EGRN, EGRB, EGRE, CLSE, CMSC, PHYS, MATH, NANO, CHEM, BIOL, GRAD, LFSC, OVPR. 21

Directed research component

This component consists of dissertation research directed toward completion of Ph.D. degree requirements under the direction of a dissertation adviser and dissertation committee. Students can register for 1 to 15 credit hours of directed research in mechanical and nuclear engineering. 24

EGMN 697	Directed Research in Mechanical and Nuclear Engineering
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Seminar component

EGMN 690	Mechanical and Nuclear Engineering Seminar	8
Total Hours		68

Notes:

1. A total of 21 credit hours from the core courses, technical electives or seminar (not including directed research credit hours) must be at the 600 level or higher.
2. In certain cases, independent study courses (EGMN 691) are offered by individual faculty members. Up to three credit hours of EGMN 691 may be taken as a technical elective course.
3. EGMN 610 is not required for students entering with a B.S. in Nuclear Engineering. A replacement course approved by the MNE graduate program director must be taken and will count toward the required 15 credits of core courses.

For these students, the minimum total of graduate credit hours required for this degree is 68.

Requirements for students entering with an M.S. degree

Course	Title	Hours
Core courses		
EGMN 604	Mechanical and Nuclear Engineering Materials ¹	3
EGMN 607	Heat and Mass Transfer Theory and Applications	3
EGMN 610	Topics in Nuclear Engineering	3
Directed research component		
This component consists of dissertation research directed toward completion of Ph.D. degree requirements under the direction of a dissertation adviser and dissertation committee.		24
EGMN 697	Directed Research in Mechanical and Nuclear Engineering	
Seminar component		
EGMN 690	Mechanical and Nuclear Engineering Seminar	3
Total Hours		36

Notes:

1. A total of nine credit hours of core courses and seminar but not including directed research credit hours must be at the 600 level or higher.
2. Students entering with an M.S. will follow the same curriculum as the students entering with a B.S. with the above noted reduction in required credit hours.
3. EGMN 610 is not required for students entering with a B.S. in Nuclear Engineering. A replacement course approved by the MNE graduate program director must be taken and will count toward the required 9 credits of core courses.

For these students, the minimum total of graduate credit hours required for this degree is 36.

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Program website: mechanical-and-nuclear.egr.vcu.edu/academics/graduate (<https://egr.vcu.edu/departments/mechanical/academics/graduate/>)