

## Requirements for the M.S. degree in Environmental Engineering

The M.S. degree in environmental engineering requires completion of 30 hours of graduate credit (5000-level or higher) beyond the bachelor's degree. The M.S. degree may be earned through: (1) 24 hours of didactic graduate coursework, including at least 15 hours of graduate level courses at Vanderbilt in the major area (i.e., within Environmental Engineering graduate program) and a research thesis of at least 6 semester hours - *Thesis M.S. Degree* or (2) 30 hours of didactic graduate coursework, including at least 15 hours of graduate level courses at Vanderbilt in the major area (i.e., within Environmental Engineering graduate program) and a substantive report of 3 semester hours of independent study - *Non-Thesis M.S. Degree*. For the thesis M.S. option, each degree candidate conducts research under the supervision of a faculty advisor, prepares a written thesis for faculty approval, and presents it orally to the faculty. For the non-thesis M.S. option, each degree candidate conducts an independent study that results in a written report of a literature centric evaluation of an engineering problem or topic (i.e., review) under the supervision of a graduate faculty member. The specifics of the requirements for the M.S. degree in environmental engineering are listed below.

1. **Courses.** As part of the required 24 hours (*thesis M.S. degree*) or 30 hours (*non-thesis M.S. degree*) of didactic graduate coursework, students must demonstrate competency in four areas – (i) *quantitative mechanisms and theory*; (ii) *experimental methods*; (iii) *data analysis techniques*; and (iv) *computation, simulation, and applied mathematics* – by taking at least one course in each of the four areas selected from the following approved list.

***Quantitative mechanisms and theory:*** ENVE 5605 Environmental Thermodynamics, Kinetics and Mass Transfer; ENVE 5625 Environmental Separations Processes; ENVE 5705. Physical Hydrology; CHBE 5200. Phase Equilibria and Stage-based Separations; CHBE 5300. Fluid Mechanics and Heat Transfer; CHBE 6200. Transport Phenomena; CHBE 6220. Surfaces and Adsorption; EES 5550. Transport Processes in Earth and Environmental Systems; EES 5650. Physics of the Climate System.

***Experimental methods:*** ENVE 5620 Environmental Characterization and Analysis; CHEM 5040. Nanoparticles; EES 5250. Earth Materials; EES 5600. Geochemistry; EES 7300. Isotopes and the Environment; MSE 6343. Intro. To Electron Microscopy; PHYS 8159. Experimental Nanoscale Fabrications and Characterization.

***Data analysis techniques:*** CE 6300. Probabilistic Methods in Engineering Design; CE 6310. Uncertainty Quantification;

***Computation, simulation, and applied mathematics.*** CE 6210. Finite Element Analysis; CE 6212. Adv. Computational Mechanics; CE 6313. Multiscale Modeling; CHBE 6100. Applied Mathematics in Chemical Eng; CHEM 5410. Molecular

Modeling Techniques; EES 5760. Agent- and Individual-Based Computational Modeling; ME 5263. Computational Fluid Dynamics & Multiphys. Modeling.

In addition, as part of the 24 hours (*thesis M.S. degree*) or 30 hours (*non-thesis M.S. degree*) course requirements, students must complete 15 hours of didactic graduate coursework at Vanderbilt within the Environmental Engineering graduate program (i.e., ENVE listed courses). This requirement can be met in part through the selection of courses to fulfill the requirement of four specific areas indicated above.

2. **Thesis M.S. Degree**. The thesis M.S. degree is for students who wish to gain research experience but are not yet committed to the extended level of research required for a Ph.D. A key requirement is that a faculty member is interested and has a funded research project that fits the time scale of the Master's degree. Thesis M.S. students are required during their first semester of studies to enroll in a 1-hour, zero credit seminar course. This seminar provides guiding principles for selecting a research topic of interest, methods to conduct a critical literature review, and how to prepare research proposals.

**Research Advisor.** Students are not assigned to a faculty member; instead, students interested in pursuing a thesis M.S. degree must take the initiative to contact a faculty member working in their area of interest and discuss their interests and research possibilities. Students must have selected a research advisor prior to the end of the first semester in the program upon mutual agreement with the prospective advisor. The selection of the research advisor is formalized by completing an advisor selection form that indicates the student, the faculty advisor, and sets the objectives and time line for the proposed research as well as the source of financial support for the research. The form should be signed by both the student and the faculty member and approved by the Director of Graduate Studies (DGS) and Department Chair if department funds are the planned source of financial support for the research. In the event that a student does not have a thesis research advisor by the end of the first semester in the program, the student will then be considered a non-thesis M.S. student and will be expected to complete the requirements under the non-thesis M.S. degree option.

**Thesis Committee.** The DGS in consultation with the research advisor and the student will appoint a thesis committee by the end of the first semester in the program. The thesis committee should be comprised of the research advisor and at least one additional Environmental Engineering graduate faculty member, including one tenured faculty member from the department. The thesis committee will be responsible for guiding the student in the production of a thesis, monitoring the student's progress in completing the requirements toward the degree, and ensuring the quality of graduate

work. The student will consult with the thesis committee regarding course selection. The thesis committee will meet formally with the student once each semester.

**Thesis.** A written thesis is required to obtain the thesis M.S. degree. The thesis must have a substantial research component and must be written under the guidance of an Environmental Engineering graduate program faculty research advisor. The thesis gives the student an opportunity to demonstrate expertise in the chosen research area. The organization of the thesis should follow the guidelines provided by the Graduate School (<http://gradschool.vanderbilt.edu/academics/theses/>). By the end of the first semester, the students should write a short proposal (absolute max of 5 pages single-spaced total, including figures and tables; reference list can appear on additional pages) that identifies a suitable problem and shows that the student is able to come up with adequate methods to tackle the problem and is capable of articulating ideas in writing. The proposal is initially reviewed by the advisor and then by the other thesis committee member(s). A goal should be that the research culminates in a manuscript submitted for publication in a peer-reviewed journal. The thesis needs to be approved for content and clarity by the thesis research advisor and a second Environmental Engineering graduate faculty reader from the thesis committee. Signatures by both are required for formal submission of the thesis to the Graduate School.

**Thesis Presentation.** Students are required to give an oral presentation (~30 minutes) of their research to the department. The thesis presentation should be made at least two weeks prior to formal submission of the thesis to the Graduate School so that suggestions/modifications received during the presentation can be incorporated. The thesis committee will ensure that the oral presentation is of high quality. When students pass the oral defense, most typically the thesis committee will request that the student make changes to the written thesis to reflect suggestions made during the presentation.

**Support.** Students pursuing this degree option are not eligible for assistantship support or tuition remission from the department. Any financial support for a thesis M.S. student will depend on the availability of research funds of the advisor.

**Transfer of Credits.** No more than 6 credit hours from a previously earned degree may be transferred. All transferred credits must be approved by the ENVE Oversight and Management Policy committee and must be finalized by the end of the second semester in the program.

**Time-to-Degree.** Students can complete an M.S. in one year and are strongly encouraged to complete their degree requirements, including thesis, in no more than two (2) years, i.e., by the end of the fourth semester in the program. The maximum time allowed for completing the thesis M.S. degree is three (3) years from the time of admission to the M.S. program (i.e., 6 semesters).

**Switching Degree.** Change from the thesis M.S. option to the non-thesis M.S. option should be made by mutual agreement of the student and the research advisor. A request form (available from the DGS) for thesis M.S. option change that includes the reason for the requested change and plan of study should be submitted to the DGS. If the change occurs after one or more semesters of research, the student should write up a research paper that documents his/her results and this should serve as the 3 credit independent study for non-thesis students (see non-thesis M.S. degree requirements).

3. **Non-Thesis M.S. Degree.** The non-thesis M.S. degree is designed for students seeking additional expertise and training in environmental engineering without the emphasis placed on in-depth research training associated with the thesis M.S. degree.

**Plan of Study.** As early as possible during the first few months in the program and no later than the end of the first semester, the student is responsible for developing a plan of study in consultation with the DGS. The Plan of Study identifies: (i) courses the student intends to transfer from another institutions and (ii) coursework to be completed to fulfill the degree requirements.

**Independent Study.** Non-thesis students are required to complete a minimum of 3 credit hour independent study under the supervision of an Environmental Engineering graduate faculty member. The independent study should result in a substantial project report consisting of a literature centric evaluation of an engineering problem or topic (i.e., review). A list of independent studies with corresponding supervising faculty will be made available prior to the start of each semester for students to select (one student per independent study).

**Support.** Students pursuing this degree option are not eligible for assistantship support or tuition remission from the department. Students should thus expect to pay their tuition through other means throughout their studies in the program.

**Transfer of Credits.** No more than 6 credit hours from a previously earned degree may be transferred. All transferred credits must be approved by the ENVE Oversight and Management Policy Committee and must be finalized by the end of the second semester in the program.

**Time-to-Degree.** Students are expected to complete their degree requirements within 2 years; i.e., by the end of the fourth semester of study in the program.

4. **Criteria for Adequate Progress.** Students (thesis and non-thesis) must maintain a 3.00 grade point average in ENVE courses and a 3.00 GPA in all graduate coursework as required by the Graduate School. In addition, students must meet deadlines and make progress on the thesis (thesis M.S. option) or project report (non-thesis M.S. option) in order to stay on track for timely completion. Students that fail to make adequate

progress toward the degree and/or who's GPA falls below 3.00 for two consecutive semesters will be dismissed from the program.

5. **Transition to the Ph.D. Program.** M.S. students (both thesis and non-thesis) interested in transitioning to the Environmental Engineering Ph.D. Program should apply for admission to the Ph.D. program through the standard application process via the Graduate School (deadline of January 15) during the Fall semester prior to the anticipated completion of the M.S. degree. It is critical that students discuss their plan with the DGS, and if applicable, potential research advisor prior to applying. Students will be considered with the general pool of applicants, and if admitted, will begin the Ph.D. program the following fall semester.