

# University of Delaware

## Department of Civil and Environmental Engineering

### *Graduate Program Policies and Requirements 2021 Revision*

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## Introduction

The University's most current [Undergraduate and Graduate Catalog](#) is the basic document describing overall requirements for all degrees, course offerings, and library, laboratory and computer facilities. It includes the general requirements for graduate degrees in the Department of Civil and Environmental Engineering as well.

The present document provides more specific requirements of the Department of Civil and Environmental Engineering for its graduate degrees and additional academic and procedural information.

## I. Degrees, Concentrations, and Certificates Offered

The Department of Civil and Environmental Engineering offers five graduate degrees. These include three Master's degrees—the Master of Civil Engineering (MCE), the Master of Applied Science (MAS), and the Master of Science in Ocean Engineering (MS)—and Ph.D. degrees in Civil Engineering and Ocean Engineering. The degrees in Civil and Environmental Engineering are available in the six concentrations listed in Section I.B and detailed in Section X. A Graduate Certificate in Railroad Engineering is also offered.

### A. Degrees

The **Master of Civil Engineering (MCE)** degree is awarded only to individuals who, upon admission, have an undergraduate degree in engineering. Students pursuing the MCE degree choose between thesis or non-thesis tracks and declare a concentration in coastal, environmental, geotechnical, structural, transportation and civil infrastructure systems, or water resources engineering. General degree requirements are given in Section III.A and concentration-specific requirements are given in Section IX.

The **Master of Applied Science (MAS)** degree is awarded to students who, upon admission, have a non-engineering undergraduate degree. Students pursuing the MAS degree complete a thesis and declare a concentration in coastal, environmental, geotechnical, structural, transportation and civil infrastructure systems, or water resources engineering. General degree requirements are given in Section III.A and concentration-specific requirements are given in Section IX.

The **Master of Science in Ocean Engineering** is offered jointly with the Physical Ocean Science and Engineering Program (POSE) in the College of Earth, Ocean and Environment. Students may matriculate through either the College of Engineering or the College of Earth, Ocean and Environment and may choose a thesis advisor from either program. Degree requirements are the same for either College and requires a thesis. Additional degree requirements are given in Section III.B.

The **Ph.D. in Civil Engineering** is offered in the concentration areas of coastal, environmental, geotechnical, structural, transportation and civil infrastructure systems, and water resources engineering. Degree requirements are given in Section III.C.

The **Ph.D. in Ocean Engineering** is offered jointly with the Physical Ocean Science and Engineering Program (POSE) in the College of Earth Ocean and Environment. Students may matriculate through either the College of Engineering or the College of Earth, Ocean and Environment and may choose a thesis advisor from either program. Degree requirements are given in Section III.D.

## **B. Civil Engineering Concentrations**

The Department of Civil & Environmental Engineering offers the following six areas of concentration for the MCE, MAS, and Ph.D. degrees:

- Coastal Engineering - coastal engineering, wave mechanics and fluid mechanics.
- Environmental Engineering - water and wastewater treatment, environmental chemistry and microbiology, soil remediation, and waste management.
- Geotechnical Engineering - computational geomechanics, soil mechanics, foundation engineering, earth structures engineering.
- Structural Engineering - structural mechanics, dynamics, analysis and design of structures, bridge engineering, computational mechanics, and structural engineering materials.
- Transportation Engineering and Civil Infrastructure Systems - urban transportation, traffic engineering, systems engineering, railway engineering, logistics engineering, engineering management, asset management, natural disaster risk analysis and infrastructure vulnerability.
- Water Resources Engineering - groundwater hydraulics, groundwater contamination, watershed management, hydrology, and water quality control.

Concentrations are selected through the graduate application process. Study in two or more related concentrations is allowed with the approval of your academic advisor. The concentration will be denoted on the student's transcript.

## **C. Graduate Certificate**

A Graduate Certificate in Railroad Engineering is offered. This Certificate can be obtained as part of an ongoing Graduate Degree program or as a stand-alone University Certificate. The Certificate requirements are 9 credit hours of course work, as outlined in Section XII.

## **II. Admission Requirements**

**Civil Engineering:** The minimum requirements for admission to a master's or doctoral degree program are:

- an undergraduate grade point average of at least 3.0 (out of a possible 4.0) for master's applicants or an undergraduate or graduate grade point average of at least 3.5 (out of a possible 4.0) for Ph.D. applicants, and
- for international students, a TOEFL score of at least 79 (IBT) with a minimum SPEAK score of 18 or higher or an IELTS overall score of at least 6.5, with no individual sub-score below 6.0.

Although it is possible for students to study toward a Ph.D. directly upon entering graduate school, most students choose to obtain the MCE or MAS first. Students considering doctoral study typically must have completed any previous graduate study with at least a 3.5 grade point average and have

clearly demonstrated a capacity for independent work. If a master's thesis or other comprehensive work was written at another institution, a copy must be provided to the advisor soon after the student enrolls at the University of Delaware.

**Ocean Engineering:** The minimum requirements for admission to a master's or doctoral degree program are as follows: a Bachelor of Science in Engineering, an undergraduate grade point average of at least 3.0 (out of a possible 4.0) for Masters applicants, or 3.5 (out of a possible 4.0) for Ph.D. applicants, GRE scores (verbal and quantitative combined) of at least 308 (or 1200 in old scoring system), and a TOEFL score (for international students) of at least 100 (IBT). The POSE Graduate committee may increase these minimum requirements.

### **III. Academic Requirements**

#### **A. Master's Degree Requirements, Civil Engineering)**

##### ***Thesis Track Master's Degrees (MCE or MAS)***

##### **Course Requirements**

The thesis track MCE and MAS programs require 30 credit hours including 24 graduate course credits meeting the requirements of one of the concentrations, listed in Section X, and 6 credits for the master's thesis. The student should consult their advisor in selecting courses to fulfill these requirements and choose electives that complement research and career aspirations. Prior approval from one's advisor, via the Graduate Student Advisement Form, is required for enrolling in electives each semester. The Department's Director of Graduate Studies, who is appointed by the Department's Chair, will review the composition of coursework of each student prior to their graduation to ensure that the stated requirements have been fulfilled. The grade requirements in Section VII also apply.

Petitions for course substitutions may be made to the Department Director of Graduate Studies. A maximum of 9 credits is transferable to the University of Delaware toward any master's degree.

##### **Thesis Committee**

The thesis committee must consist of at least three faculty members. The committee is chaired by the student's research advisor and must include at least one additional faculty member from the Department who represents the student's major field of interest. The selection of prospective members of the thesis committee should be discussed and agreed upon by the student and their advisor. The committee members shall be listed on the Thesis Approval Form, which is discussed in the following section. Later changes in the membership of the committee may be made if agreed upon by both the student and research advisor.

##### **Thesis Plan**

Within 10 months of matriculation, a thesis plan shall be submitted to the student's thesis committee. The thesis plan is intended to ensure that all committee members agree with the research direction at an early stage such that feedback can be implemented without undue burden on the student. Plans submitted in advance of the 10-month deadline are thus highly encouraged. The plan is limited to a maximum of 500 words and should include objectives of the study, current state of knowledge/practice, hypothesis or problem statement, proposed methodology, expected outcomes, and

projected timeline. The thesis committee shall provide feedback on the plan and render one of the following judgments:

- a. The plan is approved, meaning that the committee members agree that the plan has the minimum criteria necessary towards completing a thesis.
- b. The plan needs revision. If revisions are required, the committee will provide clear feedback on the modifications needed in order for the plan to be approved. The student may resubmit the plan after the revisions are implemented. A revised version must be ultimately approved by the committee.

The student must have an approved research plan within 12 months of matriculation as a master's student to remain actively enrolled in the degree program and document this approval through completing the Thesis Plan Approval Form. Students originally enrolled in a thesis track master's degree program may not transfer to the non-thesis track, except under rare and unforeseen conditions and with the approval of the faculty (thesis) advisor and the Graduate Committee.

## Thesis Defense

After the student has obtained the approval of the research advisor regarding the completed thesis, the written thesis must be distributed to the committee members for review no less than two weeks prior to the scheduled defense. The distributed version of the thesis must be prepared in accordance with the rules of the Graduate College. The defense shall be open and an announcement of the time, place, student's name, and the title of the thesis shall be made available to the University community at least one week prior to the defense.

The procedure for the thesis defense is as follows:

- a. The candidate gives a presentation of approximately 30 minutes on the thesis research and findings.
- b. Following the presentation, the audience and committee members will question the student. The questioning may cover topics including, but not limited to, framing of the research question, methodology, data analysis and interpretation, soundness of conclusions, and implications of findings on future studies or related fields. After the questioning is completed, the meeting is closed to everyone except the committee members, who may ask additional questions and then render their vote.
- c. Upon passing the defense and completing necessary revisions to the thesis, the candidate will be certified by the thesis committee as having satisfied their thesis requirements through completing and submitting the Thesis Approval Form.
- d. If the thesis defense is not passed, the student will be allowed a second attempt after the lapse of at least three months. If unsuccessful in a second attempt, the student will not be granted the degree.

## Seminars

All thesis track graduate students are required to attend departmental or college seminars each semester in their fields of study. Students are expected to register for CIEG865 (0 credits) each

semester. Students will also make presentations at these seminars. Students are also encouraged to attend other University seminars that may be of interest to them.

### ***Non-Thesis Track Master's Degree (MCE only)***

#### **Objective**

The objective of the non-thesis master's programs is to provide an opportunity for students who do not have the need to develop research skills to obtain a non-thesis degree with a quality and depth of study comparable to the thesis track master's degree. Through coursework (minimum of 30 credits), students develop their engineering skills and obtain a state-of-the-art background within the chosen area of study.

Students originally enrolled in the thesis track master's degree program may not transfer to the non-thesis option except under rare and unforeseen conditions and with the approval of the faculty (thesis) advisor and the Graduate Committee. Students selecting the non-thesis track are not eligible for financial support from the University.

#### **Course Requirements**

The non-thesis track MCE program requires 30 graduate course credits meeting the requirements of one of the concentrations, listed in Section X. The student should consult their advisor in selecting courses to fulfill these requirements and choose electives that complement their career aspirations. Prior approval from one's advisor, via the Graduate Student Advisement Form, is required for enrolling in electives each semester. The Department's Director of Graduate Studies, who is appointed by the Department's Chair, will review the composition of coursework of each student prior to their graduation to ensure that the stated requirements have been fulfilled. The grade requirements in Section VII also apply.

Petitions for course substitutions may be made to the Department Director of Graduate Studies. A maximum of 9 credits is transferable to the University of Delaware toward any master's degree.

### **B. Master's Degree Requirements, Ocean Engineering**

#### **Course Requirements**

The Master of Ocean Engineering degree program requires a minimum of 30 credit hours. This includes a thesis describing independent research. Students are required to earn six credits for the thesis and 24 course credits.

Required courses are as follows:

- MAST691 (Fluid Dynamics in Marine Systems) or CIEG639 (Ocean Fluid Dynamics)
- MAST882 (Physical Ocean Science and Engineering Seminar) or CIEG865 (Civil Engineering Seminar)
- MEEG690 (Intermediate Engineering Mathematics)
- MAST693 (Waves in the Marine Environment) or CIEG672 (Water Wave Mechanics)

Additional courses typically include at least 6 credits at the 800 level and at least 9 credits of graduate courses. The student's advisor approves the course curriculum. Petitions for required course substitutions may be made via the advisor to the program director. A maximum of 9 graduate course

credits from other universities may be applied toward the Master's degree. The grade requirements in Section VII also apply.

## Seminars

All full-time graduate students in Ocean Engineering are required to attend departmental or college seminars in their fields of study. Students are expected to register for CIEG865 or MAST882 (0 credits) each semester. Students will also make presentations at these seminars. Students are also encouraged to attend other University seminars that may be of interest to them.

## C. Ph.D. Degree Requirements, Civil Engineering

The Ph.D. program is aimed at training the graduate student to achieve the highest degree in research within a chosen topic. Mathematics, fundamental sciences, and engineering sciences are combined to provide a personalized program of study and research. All graduate students work in close cooperation with the faculty in the chosen area. Although it is possible for students to study toward a Ph.D. directly upon entering graduate school, most students choose to obtain the MCE or MAS first.

### ***Residency Requirement***

The student must meet a campus residency requirement of at least one continuous academic year devoted exclusively to full-time study in the major field at the University of Delaware. The residency requirement must be fulfilled in the fall and spring semesters, but registration is not required in the summer or winter sessions. If a student has earned a master's degree at the University of Delaware, this can be used to fulfill the residency requirement.

### ***Course Requirements***

A student's doctoral program, comprising 72 credits beyond the bachelor's degree (including doctoral dissertation), is planned around a central objective in applied science and mathematics. If a student who already holds a master's degree in the specific field of study is accepted directly into the Ph.D. program, the coursework from the master's degree will be considered in the design of the doctoral program. All courses in the program are selected with the approval of the student's dissertation advisor. The program requirements are shown in the following table. The grade requirements in Section VII also apply.

Beyond the Bachelor's Degree:

TOTAL COURSE REQUIREMENTS	CREDITS
Graduate Program Courses	36
Ph.D. DISSERTATION	9
RESEARCH (minimum)	9
Additional research and/or courses	18
<b>TOTAL Ph.D. PROGRAM</b>	<b>72</b>

Beyond the Master's Degree:

TOTAL COURSE REQUIREMENTS	CREDITS
MASTER'S DEGREE	30

Graduate Program Courses	12
Ph.D. DISSERTATION	9
RESEARCH (minimum)	9
Additional research and/or courses	12
<b>TOTAL Ph.D. PROGRAM</b>	<b>72</b>

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### ***Seminars***

All doctoral students are required to attend departmental or college seminars each semester in their fields of study. Students are expected to register for CIEG865 (0 credits) each semester. Students will also make presentations at these seminars. Students and are also encouraged to attend other University seminars that may be of interest to them.

### ***Preliminary Qualifying Examination***

The Preliminary Qualifying Exam consists of a written and/or oral exam as determined by the Doctoral Committee. The purpose of the Preliminary Qualifying Exam, commonly referred to as "prelims," is to test the student's working knowledge of basic fundamentals in their subject area and qualify them to advance (pass) to the next level, which is the "Qualifying Examination and Dissertation Proposal," within the doctoral program. The exam questions will be generated by a committee of at least three faculty in the student's area of concentration, who should strive to achieve consensus concerning the student's performance and quality of work. In the case of dissenting votes, a majority vote in favor is needed for a successful completion of the Exam. The Exam should be taken within 12 months of entering the degree program. If the student does not pass the Preliminary Qualifying Exam, a second attempt is allowed. The Exam shall be passed within 15 months of entering the degree program and successful completion of the exam will be indicated by all Committee members signing the Preliminary Qualifying Exam Certification. Only two attempts are allowed; if a student does not pass on the second attempt, then the student will be presented with the option of receiving a terminal master's degree.

### ***Doctoral Committee***

The Ph.D. committee must consist of at least four individuals. The committee is chaired by the student's research advisor and must include at least one additional faculty member from the Department that represents the major field of interest. Moreover, the committee must have an external examiner from a different academic unit or from outside the University. The selection of prospective members of the Doctoral Committee is discussed by the student and his advisor, who should strive for agreement on the Committee membership. Changes in the composition of the committee to reflect the student's interests may be made following the same procedure.

### ***Qualifying Examination***

The Qualifying Exam must consist of written and oral components that test the student's preparation and aptness of the proposed research. A written Dissertation Proposal that is orally presented and defended is required. The student's doctoral committee shall determine whether the written and oral dissertation proposal, combined with previous performance on the Preliminary Qualifying Exam, is sufficient to assess the student's preparation and aptness for the proposed research or if additional components of the qualifying exam are appropriate. If additional components will be included in the qualifying exam, this shall be communicated to the student at least three months prior to the start of the qualifying exam.

The Dissertation Proposal consists of a written and oral presentation of the proposed research. The Dissertation Proposal is intended to assist the student with formulating their research, to provide a formal mechanism for receiving feedback on their plans, and to assess the student's ability to formulate and communicate research plans. The maximum length of the Dissertation Proposal is 15 single-spaced pages, unless approval is received from all committee members. Supplementary material may be included in appendices. The oral presentation should not exceed 30 minutes, excluding time for answering questions from committee members. The Dissertation Proposal may be submitted as early as the completion of 36 credits of coursework beyond the bachelor's degree but no later than 24 months after entering the degree program.

Additional components may include additional written or oral questions that relate to the student's coursework or research. If such written and oral questions are included, these two components are administered separately from each other, at least one week and up to one month apart, but the oral component may occur concurrently with the proposal defense.

The advisor, as the Examination Committee Chairperson, administers any written exam and chairs the oral defense, and exam if applicable. No component of the qualifying exam is open to the public.

The Doctoral Committee should strive to achieve consensus concerning the student's performance and quality of work. In the case of dissenting votes, a majority vote in favor is needed for a successful completion of the Exam. The Qualifying Exam may result in one of the following actions for a student:

- a. Passed; [Recommendation for Candidacy Form](#) is signed by all committee members and the student is admitted to doctoral candidacy.
- b. Passed, but additional work required (self-study or formal course); Recommendation for Candidacy form is signed by all committee members. If the Committee recommends passing but with additional study or course work, the Committee Chairperson will ensure that the student meets these recommendations promptly. The student is admitted to doctoral candidacy.
- c. Failed, but to be offered a second complete exam after, in most cases, one semester of additional preparation; memo of record from advisor via the Department Chairperson to the Graduate College. If unsuccessful a second time, the student will not be permitted a third attempt, and matriculation in the program will be ended.
- d. Failed, no re-examination; the Examination Committee Chairperson submits a memo signed by all committee members recommending dismissal from the program to the Graduate College. The student will be presented with the option of receiving a terminal master's degree.

### ***Dissertation Defense***

After the student has obtained the approval of the advisor regarding the contents of the dissertation, it must be prepared in accordance with the rules of the Graduate College. The written dissertation must be distributed to the committee members for review no less than two weeks prior to the scheduled final oral examination. University policy requires that "all Ph.D. dissertation defenses be open and that an announcement of the time, place, subject, candidate's name, and the title of the dissertation be made available to the University community at least one week prior to the defense."



In the Department of Civil and Environmental Engineering, the procedure for the dissertation defense is as follows:

- a. The candidate gives a presentation of approximately 30 to 45 minutes on the dissertation research and findings.
- b. An intensive questioning by the Doctoral Committee and all others present takes place after the presentation. The examination is not merely a defense by the student of the dissertation but may also include a review of the student's competence and comprehension in related fields. After the questioning is completed, the meeting is closed to everyone except the committee members, who render their vote.
- c. Upon successful completion of this examination and compliance with any necessary revisions of the dissertation, the candidate will be certified by the Doctoral Committee for conferral of the degree by completion of the [Certification of Doctoral Dissertation Defense](#) form
- d. If the Final Oral Examination is not passed by the student, the applicant will be allowed to appear for a second trial after the lapse of at least six months. If unsuccessful in a second trial, the student will not be permitted to take a further examination and will be recommended for termination from the program.

#### **D. Ph.D. Degree Requirements, Ocean Engineering**

The Ph.D. in Ocean Engineering program is aimed at training graduate students to achieve the highest level of proficiency in research. Mathematics, fundamental sciences, ocean sciences and engineering sciences are combined to provide a personalized program of study and research. All graduate students work in close cooperation with the faculty on their dissertation area.

##### ***Residency Requirement***

The student must meet a campus residency requirement of at least one continuous academic year. If a student has earned a master's degree at the University of Delaware, this can be used to fulfill the residency requirement.

##### ***Course Requirements***

A student's doctoral program, comprising 72 credits (including doctoral dissertation) beyond the bachelor's degree, is planned around a central engineering objective. For students holding a master's degree in an appropriate field of study, the coursework from the master's degree will be taken into account in the design of the doctoral program. All courses in the program are selected with the approval of the student's advisor.

The program requirements are shown in the following table.

Beyond the Bachelor of Science Degree:

TOTAL COURSE REQUIREMENTS	CREDITS
Graduate Courses Beyond the Bachelor of Science Degree	36

The purpose of the course work is to provide a solid foundation for original research in the field of study and, within the limits of available time, to extend the student's knowledge outside that field. At least 6 of the required credits should be taken outside of the Program of Ocean Science and Engineering and may include significant components from other departments.

Ph.D. DISSERTATION	9
RESEARCH (minimum)	9
MASTER'S THESIS (if applicable)	6
Additional research and/or courses	12
<b>TOTAL Ph.D. PROGRAM</b>	<b>72</b>

Required courses include courses in mathematics and engineering sciences designed to ensure that Ph.D. candidates have the basic skills in Physical Ocean Science and Engineering needed to conduct dissertation research.

Required courses beyond the Bachelor of Science:

- CIEG639 Ocean Fluid Dynamics or MAST691 Fluid Dynamics in Marine Systems
- CIEG672 Water Wave Mechanics
- MEEG690 Intermediate Engineering Mathematics
- MEEG691 Advanced Engineering Mathematics
- MAST693 Waves in the Marine Environment
- MAST882 Physical Ocean Science and Engineering Seminar
- CIEG865 Civil Engineering Seminar

Students matriculating from other universities may petition to have these courses waived or substituted if their course of study included equivalent courses.

### ***Seminars***

All full-time graduate students in Ocean Engineering are required to attend departmental or college seminars in their fields of study. Students are expected to register for CIEG865 or MAST882 (0 credits) each semester. Students will also make presentations at these seminars. Students are also encouraged to attend other University seminars that may be of interest to them.

### ***Doctoral Committee***

Each Doctoral Committee shall consist of no fewer than four or more than six members. The selection of members of the Doctoral Committee is made by the student and advisor. This is forwarded via the Department Chairperson or a program director and respective college deans to the University Coordinator of Graduate Studies. A Doctoral Committee in the Ocean Engineering program is required to have at least four members. This is composed of the student's advisor, who is also the chair of the committee, at least one member each from CEOE and CIEG faculties, and one member from an outside academic unit. At least two committee members, one of whom is the committee chairperson, represent the major field of interest.

### ***Qualifying Examination***

Doctoral students must demonstrate to their advisory committee that they have acquired a comprehensive grasp of their field of study through a Qualifying Examination (written and oral) before they are admitted to formal candidacy.

The examination process begins when the student submits a dissertation proposal to his/her committee at least six weeks before the written and oral examination. Then the student consults each member of the Doctoral Committee for advice on any specific preparation that the committee members suggest. Any committee member who is not fully satisfied with a student's preparation for the formal exam will advise the Doctoral Committee chairperson promptly.

The Qualifying Examination is a comprehensive written and oral exam. It is administered in two sections approximately a week apart. This examination is designed to test the student's preparation and the aptness of the proposed research. It measures the student's preparation, including knowledge about the area of Physical Ocean Science and Engineering, the student's capability to apply knowledge gained in courses, and the student's qualifications in written and oral communication. Qualifying exams are not open to the public. The advisor, as Exam Committee Chairperson, administers the written exam and chairs the oral exam. The written exam usually consists of one independent exam of at least two hours duration set by each of the committee members and administered over two or more consecutive days. At the oral exam, the student gives a brief review of the research plan and then answers questions from each committee member related to the dissertation proposal or to the student's coursework. In general, the Doctoral Committee should strive to achieve consensus concerning the student's performance and quality of work. In the case of dissenting votes, the majority opinion rules and a majority vote in favor is needed for a successful defense. Upon successful completion of the Qualifying Exam, the committee members signify agreement by signing the [Recommendation for Candidacy Form](#).

- a. Passed; Recommendation for Candidacy form is signed by all committee members.
- b. Passed, but additional work required (self-study or formal course); Recommendation for Candidacy form signed. If the Qualifying Exam Committee recommends passing but with additional study or course work, the Committee Chairperson will ensure that the student meets these recommendations promptly.
- c. Failed, but to be offered a second complete exam after, in most cases, one semester of additional preparation; memo of record from advisor via the Department Chairperson or College Dean to the Graduate College. If unsuccessful a second time, the student will not be permitted a third attempt, and matriculation in the program will be terminated.

Failed, no re-examination; the Examination Committee Chairperson submits a memo signed by all committee members recommending dismissal from the program to the Graduate College.

### ***Dissertation Defense***

Upon completion of the dissertation, a final oral examination must be passed, consisting of a defense of the dissertation and a test of the candidate's mastery of the fields covered in the program. The final oral examination is open. It is conducted by the student's Doctoral Committee and chaired by the student's advisor. To permit adequate time for the committee to review the dissertation, all copies of the tentatively completed dissertation (subject to revisions required by the examining committee) must be deposited with the program director and the respective college offices at least two weeks before the date of the final oral examination. The advisor shall submit certification of a successful defense to the Graduate College through the respective college deans.

## IV. Statutes of Limitation

A Ph.D. student entering with a master's degree must finish within 5 years and meet all other timeline requirements outlined in Section III.C or III.D, depending on their degree program. A Ph.D. student entering without a master's degree must finish within 7 years and meet all other timeline requirements outlined in Section III.C or III.D, depending on their degree program. Expiration of the limit without an extension results in automatic dismissal from the Graduate Program. Requests for extensions must be made in writing by the student and be approved by the student's advisor and the Chair of the Department before they are sent to the Graduate College for approval.

## V. Academic Load

### ***Fall and Spring Semesters***

Credits to be taken per semester depend upon the student's needs, the nature of employment or appointment, and the student's past performance. Incoming international students may find it necessary to begin with the minimum number of credits listed in the table below for the first one or two semesters. Any courses prescribed to correct deficiencies in academic or language backgrounds will be considered by the student and advisor in establishing maximum academic load for any term. Credits shown in the following table are graduate semester credits, taken for grade.

Status	Fall or Spring Term Minimum Requirement	Typical
Graduate Students		
Part-time	3	3-6
Full-time	9	9-12
Teaching Assistants	6	9
Research Assistants	6	9
Graduate Assistants	6	9
Fellows	9	9-12

Required minimum figures include only courses for which graduate credit is given. Additional credits, up to the maximum, may be used for courses in which enrollment is required to remove a deficiency or to achieve competence in English. Registration for ongoing students must be completed during early registration period.

Fellows and Assistants must be full-time graduate students during the period of their contract and, therefore, must register for the minimum graduate credits shown in the preceding table or register in sustaining status.

### ***Winter and Summer Registration***

During winter session, no registration is required unless the degree is to be awarded in winter.

All funded students are required to be registered in at least three credits during the 7-1/2 week summer session. Students may register in 868-000 (research), 869 (thesis), 964 (pre-candidacy study), 969 (dissertation), sustaining, or a regular graduate course needed for the degree and offered in the 7-1/2 week summer session. Tuition coverage for winter or summer (except for the aforementioned 3-credit course) is not part of a student's contract.

Self-funded students must register for summer session (courses or sustaining) if they will be awarded their degrees at the conclusion of the Summer Session. All students may use the laboratories, library, and computers for study and research without registration and without paying for such use in winter and summer.

### ***Registration Prior to Doctoral Candidacy (G1 Status)***

Once a student has completed all course requirements in a program of study but has not yet met all of the stipulations for passing into candidacy, the student must maintain registration during the fall and spring semesters in course(s) or in 3-12 credits of Pre-candidacy Study, CIEG964, which is graded pass/fail. If the student registered in Pre-candidacy Study is admitted to candidacy before the end of the free drop/add period of the next semester, the registration in Pre-candidacy Study for the preceding semester may be changed to the course Doctoral Dissertation, CIEG969. Students classified as G1 and holding graduate assistantships or tuition scholarships must register for a minimum of six graduate credits, and those holding fellowships must register for a minimum of nine graduate credits.

### ***Sustaining Status Registration***

Sustaining Status University policy states that students may not register for Doctoral Dissertation (CIEG969) until admitted to candidacy (G2 status). In addition, once a graduate student who is completing a thesis or dissertation option has completed all required course credits needed for the degree (including six credits of Master's Thesis (CIEG869) or nine credits of Dissertation (CIEG969)), except the submission of thesis or dissertation, the student is required to maintain his/her matriculation in the degree program during the fall and spring semesters by registering for either Master's Sustaining Thesis (UNIV 899) or Doctoral Sustaining (UNIV 999). All students, including sustaining students, are required to be registered in the semester in which the degree is officially awarded. For winter and summer registration requirements, please see the appropriate section above.

## **VI. Petition**

Exceptional circumstances may justify petition for relief of certain requirements. A student may petition the Department Graduate Committee through the advisor, who will attach an appropriate recommendation. The Department Graduate Committee may act upon certain petitions. In other matters, it may be necessary to refer such a petition, along with a committee recommendation, to the Department Chairperson and possibly to the Dean of the Engineering College or to the Graduate College.

## **VII. Grade Requirements for All Degrees**

The academic records of students are reviewed at the end of each semester. A graduate student's overall grade point average must be at least B (3.0 out of a possible 4.0) in order to be eligible for the degree. **A student who receives a grade below B (3.0) in a core course is required to retake the course.** Credit hours and courses for which the grade is below C- do not count toward the degree,

even though the grade is applied to the cumulative grade point average.

## Thesis and Dissertation Preparation

Students should select a thesis or dissertation topic and an advisor as soon as possible, but no later than the end of their first year. Students should have their research underway no later than the start of their second year.

The thesis or dissertation must show that the candidate has technical mastery and is capable of independent research. It must enlarge or modify what was previously known or present a significant interpretation of its subject. The dissertation must be prepared in accordance with the rules of the Graduate College.

A copy of the [Thesis/Dissertation Manual](#) is available electronically on the web site for the Graduate College. The written dissertation must be distributed to the committee members for review no less than two weeks prior to the scheduled final oral examination.

## VIII. Graduate Assistantships and Fellowships

A number of research assistantships, graduate/teaching assistantships, and fellowships, are awarded on a competitive basis each year to full-time graduate students in the Department. Both entering and continuing graduate students are eligible for these types of financial support. Selections among continuing students are based on graduate academic and work performance to date. Thesis track master's degree candidates are typically supported for a maximum of two years. Non-thesis track students are not eligible for financial support.

Students originally enrolled in a thesis track master's degree program may not transfer to a non-thesis track option except under rare and unforeseen conditions and with the approval of the thesis advisor and the Graduate Committee.) For Ph.D. candidates, a maximum of three years support by graduate assistantship will be provided beyond the master's level.

Thesis track master's and Ph.D. candidates are both eligible for Research Assistantships. Research Assistantships are offered by the Department on the recommendation of individual faculty having research funds. No long-term support is assured for any graduate student; awards are typically committed on a semester or yearly basis with further support based on the student's satisfactory performance and the availability of research funding.

Students who hold appointments in the Department of Civil & Environmental Engineering are not permitted to accept other employment (inside or outside the University) during the period of appointment. Students who do not hold appointments, but who accept employment elsewhere are requested to keep the advisor informed of these circumstances. The Civil & Environmental Engineering Chairperson must sign any contract issued by another department for a graduate student in this department. International graduate student may not work for more than 20 hours per week and still be considered a full-time graduate student (thus entitled to FICA tax-exempt status) by the IRS.

The following types of support are available:

Type	Expected Weekly Performance
Graduate Assistantships: Teaching*	20 hours (maximum): paper grading, proctoring, teaching, running labs, etc.

Graduate Assistantships: Non-teaching	20 hours (maximum): assisting a faculty member
Research Assistantships	20 hours (maximum): research: assisting a faculty member

\*International graduate students who have been offered a Teaching Graduate Assistantship and whose native language is not English must participate, prior to the teaching assignment, in the International Teaching Assistant Training Course offered by the English Language Institute, University of Delaware.

## **IX. Concentration-Specific Course Requirements for MCE and MAS Degrees**

Concentrations are available in, Coastal Engineering, Environmental Engineering, Geotechnical Engineering, Structural Engineering, Transportation & Civil Infrastructure Systems Engineering, and Water Resources Engineering. Students must meet the concentration requirements detailed in the following sections, in addition to meeting their general degree requirements (Section III-A). Study in two or more related concentrations is allowed.

### **Coastal Engineering**

#### ***Overview***

A broad engineering knowledge is required for the construction, protection, and maintenance of coastal communities and harbors, the development of offshore resources, and the preservation of estuarine and coastal areas. Generic engineering knowledge is crucial, despite the fact that construction of coastal and offshore facilities is highly dependent upon unique site-specific characteristics, such as local bathymetry, coastal topography and the offshore wave climate. Coastal engineers who work on the nearshore region face a wide variety of problems, including the following:

- Prediction of long-term shoreline changes due to beach nourishment or presence of structures;
- Prediction of the forces a marine structure, including a levee, experiences over its lifetime;
- Prediction of wave-induced forces and currents on sediment redistribution and morphological change.
- Determination of the influence of sea level rise on coastal erosion and infrastructure;
- Determination of shallow water directional spectra and storm surge;
- Determination of correct breakwater design, including composition, shape, and orientation;
- Calculation of estuarine and harbor hydrodynamics and pollution transport;
- Wave breaking and air bubbles.

Because of shoreline erosion from major storms and increasing sea level rise, pollution of estuaries, and the high cost of constructing and maintaining navigable channels and harbors, the demand for coastal research expertise is strong. The Center for Applied Coastal Research ([www.coastal.udel.edu](http://www.coastal.udel.edu)) is responding to this demand through the development of science and engineering methodologies to support design strategies for the coastal and offshore industry.

#### ***Course Requirements, Thesis and Non-Thesis Track***

Thesis track Master of Civil Engineering and Master of Applied Sciences in the field of Coastal Engineering degrees require three core courses, five electives taken from a variety of fields, six thesis credits and the completion of a thesis. Students enrolled in these degree programs are also required to enroll in the CIEG865: Seminar (Coastal/Ocean) each semester.

The Non-thesis track Master of Civil Engineering degree requires a total of 30-credits of course work, which typically translates to seven electives beyond the three core courses. Electives should be selected based on approval from your advisor.

### Core Courses

- CIEG639 Ocean Fluid Dynamics or MAST691 Fluid Dynamics in Marine Systems
- CIEG672 Water Wave Mechanics
- MEEG690 Intermediate Engineering Mathematics

### Suggested Electives

- CIEG670 Physics of Cohesive Sediment
- CIEG675 MATLAB for Engineering Analysis
- CIEG678 Transport and Mixing Processes
- CIEG679 Sediment Transport Mechanics
- CIEG680 Coastal Processes
- CIEG681 Water Wave Spectra
- CIEG682 Nearshore Hydrodynamics
- CIEG870 Offshore Design
- CIEG871 Coastal Structures
- CIEG872 Advanced Water Wave Mechanics
- MAST681 Remote Sensing of Environment
- MAST693 Waves in Marine Environment
- GEOG670 Geographic Information Systems and Science

## Environmental Engineering

### **Overview**

The field of environmental engineering deals with environmental issues from the nanoscale to the global scale. Contamination caused by the activities and waste products of our modern society affect the water, air, soil, and ecosystems around us in complex ways that must be clearly understood if we are to successfully address these problems. In recognition of the interdisciplinary nature of these issues, our program provides students with a broad foundation in the fundamentals of physical, chemical, and biological processes. Advanced coursework and research in our graduate program is focused on the following areas:

- Contaminant Fate and Treatment in Soil and Groundwater
- Environmental Biotechnology and Chemistry
- Water Quality Modeling Green and Sustainable Environmental Technologies
- Solid Waste and Hazardous Waste Management
- Stormwater Treatment and Wastewater Engineering



The environmental engineering program is designed for those with undergraduate degrees not only in Civil, Environmental or other engineering disciplines, but also related non-engineering fields such as Chemistry, Environmental Science, Geology, and many others.

### ***Course Requirements, Thesis and Non-Thesis Track***

Thesis track Master of Civil Engineering and Master of Applied Sciences in the field of Environmental Engineering degrees require three core courses, five electives taken from a variety of fields, six thesis credits and the completion of a thesis. Students enrolled in the thesis track are also required to enroll in the CIEG865: Seminar (Environ.) each semester.

The non-thesis track Master of Civil Engineering requires a total of 30-credits of course work, which typically translates to seven electives beyond the three core courses. Electives should be selected based on approval from your advisor.

#### **Core Courses**

9 credits from the following core courses:

- CIEG 632 - Chemical Aspects of Environmental Engineering
- CIEG 634 - Physical Aspects of Environmental Engineering
- CIEG 636 - Biological Processes in Environmental Systems
- CIEG 644 – Microbiology of Engineered Systems
- CIEG 640 – Organic Chemical Partitioning in Environmental Media

#### **Suggested Electives**

- CIEG 615 – Air Pollution Meteorology
- CIEG 630 - Water Quality Modeling
- CIEG 633 – Hazardous Waste Management
- CIEG 645 - Industrial Ecology – The Science of Environmental Sustainability
- CIEG 668 - Principles of Water Quality Criteria
- CIEG 678 - Transport and Mixing Processes
- CIEG 679 - Sediment Transport Mechanics
- CIEG 698 - Groundwater Flow and Contaminant Transport
- CIEG 833 - Fate of Organic Pollutants in the Environment

In addition, classes from other departments can be selected in consultation with the advisor. These include graduate-level courses offered by, Mathematics, Mechanical Engineering, Marine Studies, Geography, Urban Affairs and Public Policy, or Plant and Soil Sciences.

## **Geotechnical Engineering**

### ***Overview***

Civil engineering is the professional engineering discipline that deals with the design, construction, and maintenance of public and private infrastructure within the natural environment. Geotechnical

engineering is a discipline within Civil Engineering that focuses on the behavior of natural geological materials in engineered systems. Geotechnical engineers recognize that soil and rock are the cheapest and most abundant building materials on earth, and consequently play a major role in the construction and performance of every type of civil engineering structure.

To be successful in the field of geotechnical engineering, students should have a broad exposure to Civil Engineering, with advanced knowledge and coursework in geology, soil and rock mechanics, slope stability, foundation engineering, and computational mechanics.

The Geotechnical Engineering program at the University of Delaware offers opportunities for advanced study and research in the following areas:

- Soil and rock mechanics
- Soil-structure interaction
- Constitutive modeling
- Computational geomechanics
- Foundation and earth structures engineering
- Ground improvement
- Slope stability and landslide stabilization
- Liquefaction of soils and earthquake engineering
- Laboratory characterization of geomaterials and soil reinforcement
- Environmental geotechnics

Given the strong need for improvement to our nation's infrastructure, there is currently a high demand for geotechnical engineers within the civil engineering profession. Sustainable stewardship of our built environment is dependent on successful training of the future generation of civil engineers, both as researchers that are capable of advancing the state of the art, and as practitioners that have the ability to implement effective design solutions to real-world problems. A graduate degree in geotechnical engineering will give you the skills you need to succeed in both of these highly challenging environments.

### ***Course Requirements, Thesis and Non-Thesis Track***

Thesis track Master of Civil Engineering and Master of Applied Sciences in the field of Geotechnical Engineering degrees require three core course, five electives taken from a variety of fields, six thesis credits and the completion of a thesis. Students enrolled in a thesis program are also required to enroll in the CIEG865: Seminar each semester.

the non-thesis track Master of Civil Engineering requires a total of 30-credits of course work, which typically translates to seven electives beyond the three core courses. Electives should be selected based on approval from your advisor.

#### **Core Courses**

- CIEG601 Introduction to the Finite Element Method
- CIEG622 Earth Structures Engineering
- CIEG626 Soil Behavior

#### **Suggested CIEG Electives**

- CIEG605 Intermediate Topics in Finite Element Analysis

- CIEG621 Foundation Engineering
- CIEG623 Soil Mechanics Lab
- CIEG625 Unsaturated Soil Mechanics
- CIEG627 Deep Foundations
- CIEG628 Ground Improvement Methods
- CIEG658 Pavement Analysis and Design
- CIEG675 MATLAB for Engineering Analysis
- CIEG698 Groundwater Flow and Contaminant Transport
- CIEG801 Advanced Topics in Finite Element Analysis
- CIEG820 Inelastic Behavior of Geomaterials
- CIEG867 Computational Geomechanics

### Other Suggested Courses

- CIEG606 Ocean and Atmosphere Remote Sensing (MAST606)
- GEOG670 Geographic Information Systems & Science
- GEOG671 Advanced Geographic Information Systems
- MAST681 Remote Sensing of Environment
- MEEG690 Intermediate Engineering Mathematics
- STAT601 Probability Theory for Operations Research and Statistics
- STAT602 Mathematical Statistics
- STAT608 Statistical Research Methods
- STAT609 Regression and Experimental Design

In addition to the courses listed above, a variety of CIEG667 courses are frequently offered by the professors in the geotechnical engineering group and will be accepted for elective credit.

## Structural Engineering

### ***Overview***

The structural engineering program offers opportunities for graduate study and research in many subject areas related to the analysis and design of civil structures. Emphasis areas of the program include bridge engineering, building engineering, structural health monitoring, structural mechanics, structural dynamics, computational structural analysis, and structural engineering materials.

### ***Course Requirements, Thesis Track***

Thesis track Master of Civil Engineering and Master of Applied Sciences in the field of Structural Engineering degrees require three core courses in two different topic areas (as detailed below), a minimum of five electives taken from a variety of fields, six thesis credits and the completion of a thesis. Students enrolled in the thesis track are also required to enroll in the CIEG865: Seminar (Structures) each semester. Electives should be selected based on approval from your advisor.

### Core Courses

*Topic 1 (6 credits required, 2 courses from the following list):*

CIEG 601 – Introduction to Finite Element Method

CIEG 611 – Structural Dynamics Design  
CIEG 612 – Advanced Mechanics of Materials

*Topic 2 (3 credits required, 1 course from the following list):*

CIEG 604 – Prestressed Concrete Design  
CIEG 602 – Advanced Steel Design

### Possible Electives

Additional courses in Groups 1 and 2 above  
CIEG 605 – Intermediate Topics in Finite Element Analysis  
CIEG 608 – Introduction to Bridge Design  
CIEG 610 – Experimental Mechanics of Composite Materials  
CIEG 617 – Railroad Safety and Derailment Engineering  
CIEG 618 – Introduction to Railroad Engineering\*  
CIEG 619 – Concrete Materials  
CIEG 621 – Foundation Engineering  
CIEG 641 – Risk Analysis  
CIEG 642 – Advanced Data Analysis  
CIEG 662 – Transportation Sustainability  
CIEG 675 – MATLAB for Engineering Analysis  
CIEG 801 – Advanced Topics in Finite Element Analysis  
CIEG 811 – Advanced Structural Dynamics Design  
MEEG 610 – Intermediate Solid Mechanics  
MEEG 616 – Composite Material Structures  
MEEG 621 – Linear Systems  
MEEG 690 – Intermediate Engineering Math  
MEEG 816 – Advanced Continuum Mechanics  
MEEG 617 – Composite Materials

### **Course Requirements, Non-Thesis Track**

The Master of Civil Engineering (non-thesis) degree in the field of Structural Engineering requires six core courses, one materials elective, and a minimum of three additional electives, totaling a minimum of 30 credit hours of course work. The three additional electives shall be selected based on the student's interests and career goals with prior approval from the student's advisor using the Graduate Student Advisement Form. Electives shall be 600 or 800 level and may come from civil or other engineering disciplines or from outside of the College.

### Required Courses

18 credit hours:  
CIEG 601 – Introduction to Finite Element Method  
CIEG 604 – Prestressed Concrete Design  
CIEG 608 – Highway Bridge Engineering  
CIEG 611 – Structural Dynamics Design  
CIEG 612 – Advanced Mechanics of Materials  
CIEG 602 – Advanced Steel Design

Materials Elective, one required from the following list, 3 credit hours:  
CIEG 619 – Concrete Materials

MEEG 617 – Composite Materials  
MEEG 813 – Fracture of Complex Material Systems  
MEEG 613 – Nanomaterials and Nanotechnology  
MSEG 606 – Corrosion and Protection  
MSEG 608 – Structure and Properties of Materials I

3 Electives (9 credit hours):

Any University of Delaware 600 or 800 level course approved by advisor

## **Transportation Engineering and Civil Infrastructure Systems**

### ***Overview***

Civil infrastructure systems involve the design, analysis, and management of infrastructure supporting human activities, including, electric power, oil and gas, water and wastewater, communications, transportation, and the collections of buildings that make up urban and rural communities. These networks deliver essential services, provide shelter, and support social interactions and economic development. They are society's lifelines.

The field of civil infrastructure systems builds on and extends traditional civil engineering areas. Rather than focus on individual structural components or structures, civil infrastructure systems emphasizes how different structures behave together as a system that serves a community's needs. Problems in this field typically involve a great deal of uncertainty, multiple and competing objectives, and sometimes numerous and conflicting constituencies. They are often spatial and dynamic. The technical aspects of infrastructure engineering must be understood in the social, economic, political, and cultural context in which they exist, and must be considered over a long-time horizon that includes not just design and construction, but maintenance, operations, performance in natural disasters and other extreme events, and destruction as well.

The transportation engineering program offers opportunities for study and research in the planning, design, operation, maintenance and management of transportation facilities and services. We emphasize a systems approach to understanding the interactions among transportation demand, mobility, socio-economic activities, environment, energy, and the quality of life. A variety of techniques and data are used including mathematical modeling and simulation, as well as many of the software tools currently used in the practice. Students take courses in travel demand forecasting; traffic engineering and modeling; logistics and freight transportation, intermodal urban transportation systems, asset management and rail systems.

### ***Course Requirements, Thesis and Non-Thesis Tracks***

Thesis track Master of Civil Engineering and Master of Applied Sciences in the field of Transportation Engineering and Civil Infrastructure Systems degrees require three core courses in one of the three topic areas listed below, five electives, six thesis credits and the completion of a thesis. Students in a thesis program are also required to enroll in the CIEG865: Seminar (Transp/CIS) each semester.

The non-thesis track Master of Civil Engineering degree in the field of Transportation Engineering and Civil Infrastructure Systems requires three core courses in one of the three topic areas listed below and an additional 21 credit hours of course work, which typically translates to seven electives beyond the three core courses. Electives should be selected based on approval from your advisor.

## Core Courses

<i>Topic Area</i>	<i>Modeling Infrastructure Systems (3 of the 4 listed)</i>	<i>Physical Infrastructure Systems</i>	<i>Transportation (3 of the 4 listed)</i>
Core Courses	CIEG 641 – Risk Analysis	CIEG 601 – Introduction to Finite Element Method*	CIEG 652 Transportation Facilities Planning & Design
	CIEG 642 – Advanced Data Analysis	Two classes from Physical Infrastructure Systems suggested electives.	CIEG 653 Roadway Geometric Design
	CIEG 655 – Civil Infrastructure Systems*		CIEG 654 Urban Transportation Planning
	CIEG 659 - Optimization in Design and Construction or CIEG 646 Convex Optimization or CIEG 647 Network Optimization		CIEG 663 Traffic Engineering & Modeling

## Suggested Electives

Students pursuing any of the three topic areas of the Transportation Engineering and Civil Infrastructure Systems master's degrees may choose from any of the four categories of electives listed below. Electives are categorized into groups for informational purposes only.

### *Physical Infrastructure Systems*

CIEG 601 Introduction to Finite Element Method\*  
 CIEG 608 Introduction to Bridge Design  
 CIEG 611 Structural Dynamics Design  
 CIEG 612 Advanced Mechanics of Materials  
 CIEG 614 Railroad Geotechnical Engineering  
 CIEG 617 Railroad Safety and Derailment Engineering  
 CIEG 618 Introduction to Railroad Engineering\*  
 CIEG 621 Foundation Engineering  
 CIEG 642 Advanced Data Analysis  
 CIEG 652 Transportation Facilities Planning & Design  
 CIEG 653 Roadway Geometric Design\*\*  
 CIEG 654 Urban Transportation Planning\*\*  
 CIEG 655 Civil Infrastructure Systems  
 CIEG 658 Pavement Analysis & Design  
 CIEG 662: Transportation Sustainability\*\*  
 CIEG 663 Traffic Engineering & Modeling\*\*  
 CIEG 686 Engineering Project Management  
 UAPP 611 Regional Watershed Management

### *Modeling and Tools*

CIEG642 – Advance Data Analysis  
 CIEG 675 – MATLAB for Engineering Analysis  
 MAST 663 – Decision Tools for Policy Analysis  
 BUAD 621 – Decision Analytics and Visualization\*  
 GEOG 670 – Geographic Information Systems\*\*  
 GEOG 671 – Advanced Geographic Information Systems  
 STAT 601 – Probability Theory for Operations Research

STAT 602 – Mathematical Statistics  
STAT 608 – Statistical Research Methods\*  
STAT 609 - Regression and Experimental Design  
STAT 611 – Regression Analysis\*  
UAPP 691 - Quantitative Analysis in Public and Nonprofit Sectors\*\*

*Social Science and Policy Analysis*

DISA 650 – Overview of Disaster Science and Management  
DISA 670 - Issues in Disaster Response  
ECON 811 – Microeconomic Theory I  
ECON 812 – Macroeconomic Theory I  
MAST 672 –Benefit Cost Analysis  
UAPP 701 – Public Policy  
UAPP 707 – Public Policy Analysis

*Transportation*

CIEG 617 Railroad Safety and Derailment Engineering  
CIEG 618 Introduction to Railroad Engineering  
CIEG 621 Foundation Engineering  
CIEG 641 Risk Analysis  
CIEG642 Advance Data Analysis  
CIEG 646 Convex Optimization  
CIEG 647 Network Optimization  
CIEG 655 Civil Infrastructure Systems  
CIEG657 Contemporary Topics in Transportation  
CIEG 658 Pavement Analysis & Design  
CIEG 659 Optimization in Design and Construction  
CIEG 686 Engineering Project Management  
ECON 811 – Microeconomic Theory I  
ECON 812 – Macroeconomic Theory I  
GEOG 670 Geographic Information Systems  
GEOG 671 Advanced Geographic Information Systems  
MAST 663 Decision Tools for Policy Analysis  
MAST 672 Cost Benefit Analysis  
STAT 601 Probability Theory for Operations Research and Statistics  
STAT 602 Mathematical Statistics  
STAT 608 Statistical Research Methods  
STAT 609 Regression and Experimental Design  
UAPP 701 Public Policy  
UAPP 707 Public Policy Analysis

**Note:** \*Online, \*\*Evening

Additional Courses

Students without any computer programming or Computer Science background should take CISC 106, CISC 181 or CISC 220. The College of Engineering also periodically offers courses in technical writing for graduate students. Students should strongly consider these courses when announcements are posted.

## **Water Resources Engineering**

### **Overview**

Water resources engineering involves the supply of surface and subsurface water to the public; control of hazards associated with water, e.g., flooding; and maintenance of the health of ecological systems. Because water pollution is often the primary driving force for the engineered control of water resources, graduate students typically take courses and conduct research within groups that also include environmental engineering students. Graduate course work and research in the water resources engineering program is focused on the following areas:

- Groundwater Hydraulics
- Contaminant Movement in Soil and Groundwater
- Watershed Management
- Hydrology
- Water Quality Control

The water resources engineering program is designed not only for those with undergraduate degrees in Bioresources, Civil, Environmental, or Chemical Engineering, but also related non-engineering fields such as Geology, Environmental Science, and Soil Science.

### **Course Requirements, Thesis and Non-Thesis Tracks**

Thesis track Master of Civil Engineering and Master of Applied Sciences in the field of Water Resources Engineering degrees require three core courses, one approved 600-level Math or Statistics course, four electives taken from a variety of fields, six thesis credits and the completion of a thesis.. Students in a thesis program are also required to enroll in the CIEG865: Seminar each semester.

The non-thesis track Master of Civil Engineering requires a total of 30-credits of course work, which typically translates to six electives beyond the four core courses. Electives should be selected based on approval from your advisor.

#### **Core Courses**

CIEG 630 – Water Quality Modeling  
CIEG 698 – Groundwater Flow and Contaminant Transport or GEOL 628 - Hydrogeology  
GEOG 632 – Environmental Hydrology

#### **Other Required Courses**

MATH/STAT – An approved 600-level course in Mathematics or Statistics

#### **Suggested Electives**

CIEG 645 - Industrial Ecology – The Science of Environmental Sustainability  
CIEG 667 – Research Methods and Topics in Soil/Water Systems: Science and Policy  
CIEG 668 - Principles of Water Quality Criteria  
CIEG 678 - Transport and Mixing Processes  
CIEG 679 - Sediment Transport Mechanics



CIEG 833 - Fate of Organic Pollutants in the Environment  
APEC 682 – Spatial Analysis of Natural Resources  
GEOG 656 – Hydroclimatology  
GEOG 657 – Climate Dynamics  
PLSC/BREG 603 – Soil Physics  
PLSC 621 – Nonpoint Source Pollution  
PLSC 643 – Watershed Hydrochemistry  
UAPP/APEC 611 – Regional Watershed Management  
UAPP 628 – Issues in Land Use & Environmental Planning

In addition, classes from other departments can be selected in consultation with your advisor. These include graduate-level courses offered by Geography, Geology, Mathematics, Mechanical Engineering, Marine Studies, Plant and Soil Sciences, or Urban Affairs and Public Policy.

## **X. 4+1 Bachelor's/Master's Degree Programs (BCE/MCE, BENE/MCE)**

### Eligibility

The program is limited to UD undergraduates pursuing the BCE or BENE degree, with a minimum cumulative grade point average of 3.25 at the time of application. Students must have completed at least 90 credits toward the undergraduate degree before they can be enrolled in the program. As a result, it is typical that students begin working towards their Master's degree as a senior and complete both the bachelor's and master's degrees in five years. Only full-time students are eligible.

### Admission Requirements

Students apply to the program in the spring semester of their junior year, or when they have completed 75 credits toward the undergraduate degree. Students must meet all of the requirements for admission to the regular graduate program.

### Program Requirements

- Students must fulfill all of the requirements for the Master of Civil Engineering degree.
- Students may choose the thesis or non-thesis track, although it is more typical that students will pursue and receive a non-thesis track degree. Thesis-track degrees will likely require more time to complete due to the thesis requirements.
- Up to 6 credits of graduate course work (600 level and above) taken while a senior, may be "dual-counted" towards the Bachelor's and the Master's degrees. The dual-counted courses must be established classes in civil or environmental engineering. Independent study or research cannot be dual-counted. The dual-counted courses must be taken as technical electives for the undergraduate degree.
- Additional graduate-level courses taken while a senior beyond the two dual-counted courses may be transferred toward the master's degree as long as it is not used toward the completion of the undergraduate degree

Before enrolling in any graduate-level courses, students must meet with their academic advisor for course approval and to complete the Graduate Course Approval Form.

## **XI. Graduate Certificate Requirements**

In addition to the above degree programs, the Department offers the following Graduate Certificate Program:

## **Graduate Certificate in Railroad Engineering**

Requirements for Admission:

Certificates are available to matriculated and non-matriculated students. Matriculated graduate students in civil or mechanical engineering are eligible to pursue the Graduate Certificate in Railroad Engineering. Interested students should discuss this option with their faculty advisor.

Admissions and enrollment in railroad engineering certificate program courses by those who are not already matriculated in a graduate engineering degree program are managed through the Professional Engineering Outreach Program. GREs are not required for certificate program admission. The prospective student is required to submit a copy of his/her undergraduate transcript for review to ensure the necessary technical course background for success in the graduate railroad engineering courses. Those who hold an undergraduate degree in civil or mechanical engineering should meet the criteria.

Course Requirements: 3 courses with a total of 9 credits.

**Required Core Courses:** Two courses, selected from the following:

- [CIEG 614 - Railroad Geotechnical Engineering \(3cr.\)](#)
- [CIEG 617 - Introduction to Railroad Safety and Derailment Engineering \(3cr.\)](#)
- [CIEG 618 - Railroad Engineering \(3cr.\)](#)

Note: Any of the courses currently listed or added later to the list of core course options, that are not used to fulfill the required core may be used as an elective course.

**Elective Options:** One course from the following CIEG courses. Also see the note above.

- [CIEG 608 - Introduction to Bridge Design \(3cr.\)](#)
- [CIEG 626 - Soil Behavior \(3cr.\)](#)

Note: Additional course options may be added as approved by the CIEG graduate committee.

## Appendix 1. Plan of Study Templates

Table A1.1 provides possible timelines for the completion of each degree program. These are offered as examples for schedules complying with necessary degree requirements, but individual circumstances may result in differing timelines. For example, it is common for MS and MAS students to graduate in the summer of their second year.

**Table A1.1: Plan of Study Templates**

		Degree Program			
		MEng.	MS and MAS	Ph.D. Students w/ BS Only	Ph.D. Students w/ BS and Master's Degrees
Timeline	Prior to matriculation			Choose advisor and research topic	Choose advisor and research topic
	Fall - Year 1	2-3 courses	2-3 courses  Begin research  Choose advisor Choose research topic Complete Responsible Conduct of Research Workshop	Course work  Begin research  Complete Responsible Conduct of Research Workshop	Course work  Begin research  Complete Responsible Conduct of Research Workshop
	Spring - Year 1	2-3 courses	2-3 courses Determine thesis committee Continue research	Course work Form doctoral committee	Course work Form doctoral committee
	Summer - Year 1		Complete Thesis Plan Receive approval of Thesis Plan Continue research	Complete preliminary qualifying exam Continue research	Complete preliminary qualifying exam Continue research
	Fall - Year 2	2-3 courses	1-2 courses	Course work	Course work
	Fall / Winter - Year 2		Continue research		Complete qualifying exam
	Spring - Year 2	2-3 courses	0-1 courses	Course work	Course work
	Spring / Summer - Year 2		Complete research Complete thesis Defend thesis	Complete qualifying exam	
	Years 3+			Annual meetings w/ committee Complete dissertation Defend dissertation	Annual meetings w/ committee Complete dissertation Defend dissertation

## Appendix 2. Expected Research Skills for Graduate Students

A critical component for students completing MS, MAS, and Ph.D. degrees is the completion of a thesis or dissertation, which requires conducting high-quality, independent research. The table below is offered as a guideline for characteristics that graduate student researchers should aim to develop and perfect.

**Table A2.1: Characteristics and Expectations of Successful Graduate Research Assistants**

Characteristic	Expectation
Work habits	Works the expected number of hours and uses this time efficiently, while ensuring work is performed to the highest standards. Meets and sets reasonable timelines. Is on time for all professional activities (e.g., meetings with faculty, staff, and peers; classes and seminars; teaching assistant responsibilities such as office hours). Is willing to work non-standard hours when necessary to complete urgent requirements. Demonstrates attention to detail in research and in the documentation of it. Consistently works on research. Keeps research tasks and output well organized. Acts as the project manager for their research and takes ownership of their research.
Engagement	Actively and continuously performs literature searches to independently locate journal articles. Participates in department/professional activities that build awareness of ongoing research and methods, research needs, etc. Is fully engaged during professional activities and limits distractions (e.g., cell phones, laptops used for purposes other than recording or sharing information).
Research hypothesis	Independently and continuously assesses research data, both from the student's project and that from other researchers, and formulates hypotheses describing observed phenomena.
Lab notebooks	Provides detailed descriptions of work done in the laboratory or field. Step-by-step descriptions and observations are recorded so that anyone using the notebook can completely understand what was done.
Writing	Continually writes, including maintaining updated literature review of pertinent topics, writing journal publications and reports, and developing research protocols and sensor "cheat sheets".
Publication	Realizes that publication of research results is paramount and focuses considerable effort in developing and writing manuscripts. Continuously develops new publication ideas and proactively approaches advisor with potential manuscript topics.
Problem solving	Looks at research problems as an opportunity to grow and learn. Independently advances research by developing potential solutions to problems and discusses them with advisor. Avoids returning to advisor for future direction after trying a singular solution or small incremental steps.
Teamwork	Understands that the collective output of the research team is a key component of the student's own success. Willingly assists others in the lab or field with projects and lab/field chores (even mundane ones).
Improvement	Solicits and implements constructive feedback.
Initiative	Proactively initiates and explores research ideas. Proposes innovative research approaches and perspectives.

<sup>1</sup>Adapted from a memo by Dr. R. Hughes, UMI, to his graduate students, dated 16 December 2003; text from Dr. Derick G. Brown, Leigh University; and text from UD CIEG faculty.