

University of Delaware
Department of Civil and Environmental Engineering
Graduate Program Policies and Requirements
2014 Revision

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. The department also issues a Graduate Student Handbook that offers supplemental information to help graduate students with the day-to-day logistics of graduate student life in the department.

I. Degrees 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 **Master of Civil Engineering (MCE)** degree is awarded only to individuals who, upon admission, have an undergraduate degree in engineering, preferably in civil or environmental engineering. The student pursuing the MCE degree may choose a traditional thesis program or a non-thesis option. The courses for the non-thesis option correspond to the course requirements for the traditional thesis master's degree program. The core requirements for both master's degrees are the same.

The **Master of Applied Science (MAS)** degree is awarded to students who, upon admission, have a non-engineering undergraduate degree. The student pursuing the MAS degree may choose a traditional thesis program or a non-thesis option. The courses for the non-thesis option correspond to the course requirements for the traditional master's degree program.

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 are given in Section III.

The **Ph.D. in Civil Engineering** is offered in the major areas of Civil Infrastructure Systems, Coastal Engineering, Environmental Engineering, Structural Engineering, Geotechnical Engineering, Transportation Engineering, and Water Resources Engineering.

Concentrations

The Department of Civil & Environmental Engineering offers the following seven areas of concentration:

- Civil Infrastructure Systems—asset management, natural disaster risk analysis, and infrastructure vulnerability
- Coastal Engineering—coastal engineering, wave mechanics and fluid mechanics.
- Environmental Engineering—water and wastewater treatment, environmental chemistry and remediation, solid and hazardous 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—urban transportation, traffic engineering, systems engineering, logistics engineering, and engineering management.
- 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. All students must meet the concentration requirements detailed in Section X, in addition to meeting the general master's or Ph.D degree requirements. The concentration will be denoted on the student's transcript.

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.

II. Admission Requirements

Civil and Environmental 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 3.5 (out of a possible 4.0) for Ph.D. applicants; GRE scores (verbal and quantitative combined) of at least 300 (or 1050 in old scoring system); and a TOEFL score (for international students) of at least 79 (IBT).

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.

The Master of Science in Ocean Engineering is not available in a non-thesis option.

III. Academic Requirements

A. Master's Degree Requirements (Civil Engineering)

Master's Degrees Thesis Option

The master's program with thesis requires 30 credit hours including 24 graduate course credits and 6 credits for the master's thesis. The Department Graduate Committee must approve each student's program.

The 24-credit course program of each student must include the following:

- At least one course each in mathematics and in engineering sciences.
- At least 9 credits of courses in the chosen concentration (required courses for each concentration area are listed below).

The student should consult his/her advisor in selecting courses to fit these requirements. Petitions for required course substitutions may be made via the Department Graduate Program Director. A maximum of 9 credits is transferable to the University of Delaware toward any master's degree.

Seminars

All thesis 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.

Master's Degrees Non-Thesis Option

Within the MCE and MAS degree programs, non-thesis options are available for students concentrating their studies in the areas of Civil Infrastructure Systems, Coastal Engineering, Environmental Engineering, Structural Engineering, Geotechnical Engineering, Transportation Engineering, and Water Resources Engineering. 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 master's degree with thesis. 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.

The non-thesis programs are designed for students with relevant experience in industry, whose employment precludes them from doing a thesis master's degree. Students originally enrolled in the thesis master's degree program may not transfer to the non-thesis option except under special conditions and with the approval of the faculty (thesis) advisor and the Graduate Committee. Students selecting the non-thesis option are not eligible for financial support from the University.

B. Master's Degree Requirements (Ocean Engineering)

The Master of Ocean Engineering degree program requires a minimum of 30 credit hours. This includes a thesis describing independent research. Students may earn up to six credits for the thesis.

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.

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 may be fulfilled in the fall and spring semesters but not 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 taken into account in the design of the doctoral program. All courses in the program are selected with the approval of the student's dissertation advisor. The Ph.D. coursework typically include at least 3 credits at the 800 level. The program requirements are shown in the following table.

Beyond the Bachelor of Science Degree:

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

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 |
| TOTAL Ph.D. PROGRAM | 72 |

Mathematics and Engineering Sciences: The purpose is to provide an adequate basis for original work in the field of study and, within the limits of available time, to extend the student's knowledge outside that field. Typically one course must be taken from each of the Mathematics and Engineering Sciences course lists.

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.

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 then forwards a recommendation for the composition of the committee via the Department Chairperson to the Office of Graduate and Professional Education. Changes in the composition of the committee to reflect the student's interests may be made following the same procedure.

Qualifying Examination

The Qualifying Examination is usually taken near the completion of 36 credits of course work beyond the bachelor's degree. The Qualifying Exam consists of a comprehensive written and oral exam. It is usually administered in two sections, a week or so apart, to test the student's preparation and the aptness of the proposed research. It is not open to the public. The advisor, as the Examination Committee Chairperson, administers the written exam and chairs the oral exam. 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 completion of the Exam. At the conclusion of the Qualifying Exam, the committee members signify agreement by signing the [Recommendation for Candidacy Form](#).

The Qualifying Exam (written and oral) may result in one of the following actions for a student:

- a. Passed; candidacy form signed by all committee members.
- b. Passed, but additional work required (self-study or formal course); form signed by all committee members. 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 to the Office of Graduate and Professional Education. If unsuccessful a second time, the student will not be permitted a third attempt, and matriculation in the program will be ended. The form must be signed by all committee members.
- d. Failed, no re-examination; form signed by all committee members and matriculation in the program will be ended.

Dissertation Defense

The procedure for departmental presentation of the Ph.D. dissertation is as follows: 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 Office of Graduate and Professional Education. 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 Final Oral Examination is as follows:

- a. The candidate gives a presentation of approximately 30 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. In the case where 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 terminated 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 |
| TOTAL Ph.D. PROGRAM | 72 |

Required courses include courses in mathematics and engineering sciences designed to insure 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 if their course of study included equivalent courses.

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; candidacy form signed by all committee members.
- b. Passed, but additional work required (self-study or formal course); 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 Office of Graduate and Professional Education. If unsuccessful a second time, the student will not be permitted a third attempt, and matriculation in the program will be terminated. The form signed by all committee members.
- d. Failed, no re-examination; form signed by all committee members and matriculation in the program will be ended.

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 Office of Graduate and Professional Education through the respective college deans.

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

IV. Statutes of Limitation

A Ph.D. student entering with a master’s degree must finish within 5 years. A Ph.D. student entering without a master’s degree must finish within 7 years. 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 Office of Graduate and Professional Education 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 his/her past performance. Incoming international students may find it necessary to begin with 3 to 6 fewer credits than normal for the first one or two semesters. Any courses prescribed to correct deficiencies in academic or language backgrounds will be taken into account 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 | Normal |
|---------------------|--|--------|
| 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 Sessions

During winter session, no registration is required. 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 868-800 (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. Unfunded students must register for summer session if they will be awarded their degrees at the conclusion of the Summer Session, although the University will not pay their tuition. All students may use the laboratories, library, and computers for study and research without registration and without paying for such use.

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.)

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. (Sustaining registration is not required for summer session unless the degree is to be awarded at the conclusion of the summer session. Sustaining registration is never required for winter session, as graduate degrees are not awarded at the conclusion of winter session.)

VI. Petition

Exceptional circumstances may justify petition for relief of certain requirements. A student may petition the Departmental Graduate Committee through the advisor, who will attach an appropriate recommendation. The Departmental 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 Office of Graduate and Professional Education.

VII. Grade Requirements and Evaluation of Progress

The Department has the following requirements in addition to those of the Office of Graduate and Professional Education, stated in the University Graduate Catalog. Failure to meet the standards listed below may result in termination of funding.

Academic Progress: Grades

The academic records of students are reviewed at the end of each semester. Special attention is given to students who earn less than a B (3.0) average in any semester or those whose cumulative average is less than B. Graduate student's overall grade point average must be at least B (3.0) 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/Dissertation Progress

During the first year, students should select a thesis/dissertation topic and an advisor. During the second year, students should have their research underway.

VIII. Thesis/Dissertation Preparation

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 Office of Graduate and Professional Education.

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

IX. Graduate Assistantships/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. Master's degree candidates are typically supported for a maximum of two years (Students selecting a non-thesis master's degree option are not eligible for financial support. Students originally enrolled in the thesis master's degree program may not transfer to the non-thesis option except under special 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.

Master's and Ph.D. candidates are also both eligible for Research Assistantships (excluding non-thesis master's students). 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 a 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.

X. Concentrations

Concentrations are available in Civil Infrastructure Systems, Coastal Engineering, Environmental Engineering, Geotechnical Engineering, Structural Engineering, Transportation 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.

Civil Infrastructure Systems

Civil infrastructure systems involves the design, analysis, and management of infrastructure supporting human activities, including, for example, 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.

MCE/MAS Course Requirements

In addition, the Master's degree in Civil Engineering or Applied Science in the field of Civil Infrastructure Systems requires three core course and five electives taken from a variety of fields. Electives should be selected based on approval from your advisor.

Core Courses:

- CIEG 655 – Civil Infrastructure Systems
- CIEG 641 – Risk Analysis
- APEC 601 – Survey of Operations Research I or CIEG 667 - Optimal Design

Suggested electives include:

Civil Infrastructure Systems

- CIEG 650 – Urban Transportation Systems
- CIEG 611 – Structural Dynamics Design
- CIEG 667 – Resilience Engineering
- CIEG 667 – Sensors
- CIEG 811 – Advanced Structural Dynamics Design

Modeling

- MAST 663 – Decision Tools for Policy Analysis
- BUAD 836 – Problem Structuring and Analysis for Decision Making
- GEOG 670 – Geographic Information Systems
- GEOG 671 – Advanced Geographic Information Systems
- GEOG 677 – Spatial Analysis
- APEC 602 – Survey of Operations Research II
- APEC 603 – Simulation Modeling and Analysis
- STAT 601 – Probability Theory for Operations Research and Statistics
- STAT 602 – Mathematical Statistics

APEC 608 – Statistical Research Methods
STAT 609 - Regression and Experimental Design
STAT 611 – Regression Analysis
UAPP 704 – Statistics for Policy Analysis
Social Science and Policy Analysis
DISA 650 – Overview of Disaster Science and Management
SOCIO 640 – Social Issues in Disaster Research
SOCIO 643 – Society and Risk
MAST 672 – Applied Policy Analysis
ECON 801 – Microeconomics
ECON 802 – Macroeconomics

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.

General Requirements

Students must also complete the general degree requirements as detailed in the Civil and Environmental Engineering Graduate Handbook and University Catalog. These requirements include credit requirements and - for Ph.D. and thesis option Master's students - the carrying out of research and completion of dissertation/thesis.

Coastal Engineering

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) is responding to this demand through the development of science and engineering methodologies to support design strategies for the coastal and offshore industry.

MCE/MAS Course Requirements

The Master's degree in Civil Engineering or Applied Science in the field of Coastal Engineering requires three core course and five electives taken from a variety of fields for the thesis option. Students electing to receive the non-thesis degree must take 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
- CIEG684 Numerical Methods for Coastal Modeling
- CIEG865 Civil Engineering Seminar (Ocean)
- CIEG870 Offshore Design
- CIEG871 Coastal Structures
- CIEG872 Advanced Water Wave Mechanics
- MAST681 Remote Sensing of Environment
- MAST693 Waves in Marine Environment
- MAST806 Geophysical Fluid Dynamics
- MAST808 Coastal/Estuarine Physical Dynamics
- GEOG670 Geographic Information Systems and Science

General Requirements

Students must also complete the general degree requirements as detailed in the Civil and Environmental Engineering Graduate Handbook and University Catalog. These requirements include credit requirements and for Ph.D. and thesis option Master's students - the carrying out of research and completion of dissertation/thesis.

Environmental Engineering

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
- Environmental Chemistry and Nanotechnology
- Green, Sustainable, and Global Environmental Technologies
- Solid Waste and Hazardous Waste Management
- Water Quality and Wastewater Engineering

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

MCE/MAS Course Requirements

The Master's degree in Civil Engineering or Applied Science in the field of Environmental Engineering requires three core courses and five electives taken from a variety of fields for the thesis option. Students electing to receive the non-thesis degree must take 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 - Contaminant Transport and Separation in Environmental Systems
- CIEG 636 - Biological Processes in Environmental Systems
- CIEG 644 – Microbiology of Engineered Systems

Suggested electives include:

- 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.

General Requirements

Students must also complete the general degree requirements as detailed in the Civil and Environmental Engineering Graduate Handbook and University Catalog. These requirements include credit requirements and - for Ph.D. and thesis option Master's students - the carrying out of research and completion of dissertation/thesis.

Geotechnical Engineering

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.

MCE/MAS Course Requirements

The Master's degree in Civil Engineering or Applied Science in the field of Geotechnical Engineering requires a total of three core course and five electives taken from a variety of fields for the thesis option. Students electing to receive the non-thesis degree must take 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
- CIEG620 Soil Mechanics II
- CIEG621 Foundation Engineering
- CIEG623 Soil Mechanics Lab
- CIEG625 Geo-Environmental Engineering
- CIEG627 Deep Foundations

- CIEG628 Ground Improvement Methods
- CIEG667 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)
- GEOG667 Geographic Information Systems
- GEOG671 Advanced Geographic Information Systems
- GEOG677 Spatial Data Analysis
- 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 Seminar courses are frequently offered by the professors in the geotechnical engineering group, and will be accepted for elective credit.

General Requirements

Students must also complete the general degree requirements as detailed in the Civil and Environmental Engineering Graduate Handbook and University Catalog. These requirements include credit requirements and - for Ph.D. and thesis option Master's students - the carrying out of research and completion of dissertation/thesis.

Structural Engineering

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.

MCE/MAS Course Requirements

The Master's degree in Civil Engineering or Applied Science in the field of Structural Engineering requires three core courses in two different topic areas (as detailed below) and a minimum five electives taken from a variety of fields for the thesis option. Students electing to receive the non-thesis degree must take 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:

Group 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
CIEG 817 – Stability of Structures

Group 2 (3 credits required, 1 course from the following list)

CIEG 604 – Prestressed Concrete Design
CIEG 802 – Advanced Steel Design

Suggested 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 619 – Mechanical Behavior of Materials and Structures
CIEG 621 – Foundation Engineering
CIEG 667 – Non-Destructive Testing for Civil Engineers
CIEG 667 – Structural Design for Extreme Events
CIEG 675 – Matlab for Engineering Analysis
CIEG 801 – Advanced Topics in Finite Element Analysis
CIEG 811 – Advanced Structural Dynamics Design
CIEG 817 – Stability of Structures
MEEG 618 – Fracture of Solids
MEEG 690 – Intermediate Engineering Math
MEEG 813 – Theory of Elasticity
MEEG 814 – Theory of Plasticity
MEEG 816 – Advanced Continuum Mechanics
MEEG 817 – Composite Materials

General Requirements

Students must also complete the general degree requirements as detailed in the Civil and Environmental Engineering Graduate Handbook and the University Catalog. These requirements include credit requirements and, for Ph.D. and thesis option Master's students, the carrying out of research and completion of a dissertation/thesis.

Transportation Engineering

The transportation engineering program offers opportunities for study and research in the planning, design, construction, operation, and management of transportation facilities and services. We emphasize systems approach to understand the interactions among transportation services, demand, mobility, socio-economic activities, environment, energy, and the quality of life. We use a variety of techniques, from mathematical modeling, global positioning and geographic information systems, to artificial intelligence, to solve problems in:

- Transportation demand forecasting
- Traffic engineering, controls and safety
- Construction methods and management
- Logistics and freight transportation
- Pavement design and performance
- Intermodal urban transportation systems
- Asset management

The education program maintains close links with the Delaware Center for Transportation and the University Transportation Centers.

MCE/MAS Course Requirements

The Master's degree in Civil Engineering or Applied Science in the field of Transportation with thesis requires four core courses and four electives taken from a variety of fields. For the non-thesis option, the four core courses should be supplemented with six electives. Electives should be selected based on approval from your advisor.

Core Courses:

CIEG 652 Transportation Facilities Planning & Design
CIEG 653 Roadway Geometric Design
CIEG 654 Transportation Planning
CIEG 667 Traffic Engineering

Suggested Electives:

- APEC 601, 602 Survey of Operations Research
- APEC 603 Simulation Modeling & Analysis
- BUAD 836 Problem Structuring and Analysis for Decision Making
- CIEG 618 Introduction to Railroad Engineering
- CIEG 621 Soil Mechanics
- CIEG 641 Risk Analysis
- CIEG 650 Urban Transportation Systems
- CIEG 655 Civil Infrastructure Systems
- CIEG 658 Pavement Analysis & Design
- CIEG 686 Engineering Project Management
- ECON 801 Microeconomics
- ECON 802 Macroeconomics
- GEOG 670 Geographic Information Systems
- GEOG 671 Advanced Geographic Information Systems
- GEOG 677 Spatial Data Analysis
- MAST 663 Decision Tools for Policy Analysis
- MAST 672 Applied Policy 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 601 Measure and Define Planning Problems (1 credit)
- UAPP 602 Introduction to Comprehensive Planning (1 credit)
- UAPP 603 Introduction to Zoning and Land Use Controls (1 credit)

In addition other CIEG 667 Seminar courses are frequently offered covering contemporary topics in transportation. Each semester students are also expected to register for CIEG865 - Civil Engineering

General Requirements

Students must also complete the general degree requirements as detailed in the Civil and Environmental Engineering Graduate Handbook and University Catalog. These requirements include credit requirements and - for Ph.D. and thesis option Master's students - the conduct of research and completion of dissertation/thesis.

Water Resources Engineering

Water resources engineering involves the control of supply of surface and subsurface water to the public; control hazards associated with water, e.g., flooding; and maintain 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:

- Hydrology of Landfills
- Watershed Hydrochemistry
- Water Quality Modeling
- Groundwater Hydrology
- Contaminant Movement in Soil and Groundwater

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.

MCE/MAS Requirements

The Master's degree in Civil Engineering or Applied Science in the field of Water Resources Engineering requires four core courses and four electives taken from a variety of fields for the thesis option. Students electing to receive the non-thesis degree must take 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
MATH/STAT – An approved 600-level course in Mathematics or Statistics

Suggested electives include:

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
GEOG 667 – Watershed Hydro-Ecology
PLSC 603 – Soil Physics
PLSC 621 – Nonpoint Source Pollution
PLSC 667 – Watershed Hydrochemistry
UAPP 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.

General Requirements

Students must also complete the general degree requirements as detailed in the Civil and Environmental Engineering Graduate Handbook and University Catalog. These requirements include credit requirements and - for Ph.D. and thesis option Master's students - the conduct of research and completion of a dissertation/thesis.

XI. 4+1 Bachelor's/Master's Degree Programs

The Bachelor's degree in Civil or Environmental Engineering is the minimum requirement for practicing in these professions today. It is also one of the key requirements for becoming a licensed professional engineer. More than ever before, the industry is demanding graduates to seek advanced training and education in order to handle the complex problems we currently face with our deteriorating infrastructure and ever changing environment. Through this program, qualified UD undergraduate students pursuing the Bachelor of Civil Engineering (BCE) degree or the Bachelor of Environmental Engineering (BENV) degree may begin work toward their Masters degree in Civil Engineering as a senior, and complete the Masters degree in as little as one year.

Eligibility:

The program is limited to UD undergraduates pursuing the BCE or BENV 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. 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; however, students are not required to take the GRE to gain admission to this program.

Program Requirements:

- Students must fulfill all of the requirements for the Master of Civil Engineering degree.
- Students may choose the non-thesis or the thesis option (the thesis option may require more time).
- 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.

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.