DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

The Department of Civil Engineering offers the Master of Civil Engineering degree, the Master of Science degree in Civil Engineering, the Doctor of Philosophy degree in Civil Engineering, and the Doctor of Philosophy degree in Environmental Science and Engineering.

- M.S. in Civil Engineering (p. 1)
- Master of Civil Engineering (p. 1)
- Ph.D. in Civil Engineering (p. 2)
- Ph.D. in Environmental Science and Engineering (p. 3)

Master of Science Degree in Civil Engineering

The Master of Science degree in Civil Engineering is designed to provide specialized knowledge in selected technical areas of Civil Engineering. The educational objective of this program is to produce graduates who are capable of research and professional practice in a specialized area of Civil Engineering, namely environmental engineering, geoenvironmental engineering, geotechnical engineering, structural engineering, transportation engineering, and water resources engineering. This program involves both coursework and a thesis, and it is designed to provide exposure to research that could possibly lead to subsequent doctoral study.

Admission Requirements

For unconditional admission, applicants must satisfy the following requirements, in addition to the University-wide graduate admission requirements (refer to Student Policies, Admission Policies):

- An undergraduate degree in Civil Engineering or a closely related field from an accredited institution of higher education, or proof of equivalent training at a foreign institution
- A satisfactory score, as evaluated by the Civil Engineering Graduate Studies Committee, on the Graduate Record Examination (GRE)
- Test of English as a Foreign Language (TOEFL) minimum scores of 79 or 60 for Internet or paper versions, respectively
- A statement of research/specialization interest
- A favorable recommendation by the Civil Engineering Graduate Studies Committee

Degree Requirements

The minimum number of semester credit hours required for the degree is 30. At least 24 semester credit hours must be taken at UTSA. Elective courses may be chosen from 5000-7000 level courses offered in Civil and Environmental Engineering (CEE) or outside the department, with approval from the Graduate Advisor of Record. Any grade lower than “B” in a graduate course cannot be counted toward the coursework requirement. Each candidate is required to pass a comprehensive examination during their thesis defense administered by his or her advisory committee.

Advisory Committee

Students must choose an Advisory Committee consisting of a chair and at least two additional graduate faculty members. Students must submit the names of their Advisory Committee to the CEE Graduate Studies Committee by the end of their first semester of study.

Program of Study

A. Electives (24 semester credit hours):

These can be selected from 5000-7000 level courses offered in Civil and Environmental Engineering, or other departments with the approval of the Graduate Research Advisor. The objective of these courses is to provide advanced training in areas considered to form the foundation for the disciplines of Civil Engineering, namely structures, geotechnical, transportation and water resources. Students in consultation with a faculty advisor will develop a plan of study based on their career goals.

B. Master’s Thesis (6 semester credit hours):

Includes comprehensive examination/thesis defense/seminar presentation

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CE 5981</td>
<td>Master’s Thesis</td>
</tr>
<tr>
<td>or CE 5982</td>
<td>Master’s Thesis</td>
</tr>
<tr>
<td>or CE 5983</td>
<td>Master’s Thesis</td>
</tr>
</tbody>
</table>

Total Credit Hours: 30

Master of Civil Engineering Degree

The Master of Civil Engineering degree is designed to provide specialized knowledge in selected technical areas of Civil Engineering. The educational objective of this program is to produce graduates who are capable of professional practice in a specialized area of Civil Engineering, namely environmental engineering, geoenvironmental engineering, geotechnical engineering, structural engineering, transportation engineering, and water resources engineering. It involves courses only and a seminar. It does not normally lead to subsequent doctoral study.

Admission Requirements

For unconditional admission, applicants must satisfy the following requirements, in addition to the University-wide graduate admission requirements (refer to Student Policies, Admission Policies):

- An undergraduate degree in Civil Engineering or a closely related field from an accredited institution of higher education, or proof of equivalent training at a foreign institution
- A satisfactory score, as evaluated by the Civil Engineering Graduate Studies Committee, on the Graduate Record Examination (GRE)
- Test of English as a Foreign Language (TOEFL) minimum scores of 79 or 60 for Internet or paper versions, respectively
- A statement of specialization interest
- A favorable recommendation by the Civil Engineering Graduate Studies Committee

Degree Requirements

The minimum number of semester credit hours required for the degree is 34. At least 24 semester credit hours must be taken at UTSA. Elective courses may be chosen from the Department of Civil and Environmental Engineering (CEE) or outside the department, with approval from the CEE Graduate Studies Committee. Any grade lower than “B” in a graduate course cannot be counted toward the coursework requirement.

Students will be assigned an advisor and develop a degree plan that must be approved by the student’s advisor/or the Graduate Advisor of Record by the end of the first semester.
Program of Study

A. Electives (33 semester credit hours):

These can be selected from 5000–7000 level courses offered in
Civil and Environmental Engineering, or other departments with
the approval of the Graduate Research Advisor. The objective of
these courses is to provide advanced training in areas considered
to form the foundation for the disciplines of Civil Engineering,
namely structures, geotechnical, transportation and water
resources. Students in consultation with a faculty advisor will
develop a plan of study based on their career goals.

B. Seminars (1 semester credit hour):

| CE 5991 | Graduate Seminar |
| or CE 6991 | Graduate Seminar in Civil Engineering |
| or CE 6621 | Graduate Seminar in Environmental Science and Engineering |
| or ES 5981 | Graduate Seminar in Environmental Science and Engineering |

C. Comprehensive Examination

Total Credit Hours 34

Doctor of Philosophy Degree in Civil Engineering

The Civil and Environmental Engineering (CEE) Department offers the
opportunity for advanced study and research leading to the Doctor of
Philosophy degree in Civil Engineering. The educational objective of this
program is to produce graduates who are capable of conducting original
research in industry or academia as well as assuming a leadership role
in their chosen employment field. The program has four separate tracks,
namely Geotechnical Engineering, Structural Engineering, Transportation
Engineering, and Water Resources. The Ph.D. degree in Civil Engineering
is awarded to candidates who display an in-depth understanding of
the subject matter and demonstrate the ability to make an original
contribution to knowledge in their field of specialty.

The regulations for this degree comply with the general University
regulations (refer to Student Policies, General Academic Regulations, and
the Graduate Catalog, Doctoral Degree Regulations).

Admission Requirements

Applicants must satisfy the following requirements, in addition to
satisfying the University-wide graduate admission requirements (refer to
Student Policies, Admission Policies):

- A Bachelor of Science degree and a Master of Science degree from
  an accredited university, and a minimum grade point average of 3.0
  in upper-division and graduate courses. The degrees should be in
civil engineering or other related scientific or engineering discipline.
  Exceptional applicants without a Master of Science degree may be
  considered for admission to the program on a case-by-case basis.
- Three letters of recommendation from persons familiar with the
  applicant’s academic potential
- Official Graduate Record Examination (GRE) scores
- A letter of research/specialization interest
- A résumé/curriculum vita

Applications must be submitted online (https://graduateschool.utsa.edu/
admissions/graduate-application) to the UTSA Graduate School.
Incomplete applications will not be considered. Acceptance to the
program is determined by the Department Graduate Studies Committee
(GSC) contingent upon available funding. Full-time students accepted to
the program are eligible for financial support in the form of competitive
teaching assistantships, research assistantships, or research fellowships.

Degree Requirements

The Doctoral program in Civil Engineering requires that students
complete a minimum of 60 semester credit hours beyond the Master’s
degree. This coursework includes courses that have been designed
to provide advanced instruction in areas considered to form the
foundation for the disciplines of civil engineering. Enrollment in the
Graduate Seminar is required for a minimum of 2 semester credit hours.
A minimum of 15 semester credit hours of Doctoral Research and
15 semester credit hours minimum of Doctoral Dissertation must be
completed prior to graduation. Any grade lower than “B” in graduate or
remedial coursework at the undergraduate level does not count toward
the 60 semester credit hours. Students can apply, with the approval from
the chair of their Dissertation Committee, up to 12 semester credit hours
of graduate coursework to elective courses (see below), if not applied
at their Master’s degree. Students with only a baccalaureate degree
are required to have a minimum of 75 semester credit hours to graduate.
Additional degree requirements include both passing a written and/or oral
qualifying examinations, writing a doctoral dissertation, and passing a
final examination/dissertation defense.

Twenty-eight semester credit hours of required elective courses must be
selected by each student according to his/her selected track of study, as
defined below. These need to be approved by the student’s Dissertation
Committee. These elective courses may be offered by departments in the
College of Engineering, the College of Sciences or by other departments
at UTSA.

Students that have obtained a Master’s degree are required to
complete the following courses:

A. Electives (28 semester credit hours)

These can be selected from 5000–7000 level courses offered in
Civil and Environmental Engineering or other departments with
the approval of the Dissertation Committee. The objective of these
courses is to provide advanced training in areas considered to
form the foundation for the disciplines of Civil Engineering, namely
structures, geotechnical, transportation and water resources. Faculty advisors will develop a plan of study based on the career
goals and dissertation objectives of the students. The plan of
study will include courses that build the fundamental knowledge
required to complete the dissertation, and courses outside
of traditional areas for students involved in multidisciplinary
research.

B. Seminars (2 semester credit hours)

| CE 6991 | Graduate Seminar in Civil Engineering (repeated) |
| or CE 5991 | Graduate Seminar |
| or CE 6621 | Graduate Seminar in Environmental Science and Engineering |
| or ES 5981 | Graduate Seminar in Environmental Science and Engineering |

C. Doctoral Research and Dissertation (30 semester credit hours)

15 semester credit hours required of Doctoral Research and 15
semester credit hours required of Doctoral Dissertation:

| CE 7213 | Doctoral Research |
| or CE 7212 | Doctoral Research |
| or CE 7211 | Doctoral Research |
| CE 7313 | Doctoral Dissertation |
Students that have obtained a Bachelor's degree are required to complete the following courses:

**A. Electives (43 semester credit hours)**

These can be selected from 5000–7000 level courses offered in Civil and Environmental Engineering or other departments, with the approval of the Dissertation Committee. The objective of these courses is to provide advanced training in areas considered to form the foundation for the disciplines of Civil Engineering, namely structures, geotechnical, transportation and water resources. Faculty advisors will develop a plan of study based on the career goals and dissertation objectives of the students. The plan of study will include courses that build the fundamental knowledge required to complete the dissertation, and courses outside of traditional areas for students involved in multidisciplinary research.

**B. Seminars (2 semester credit hours)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 6991</td>
<td>Graduate Seminar in Civil Engineering (repeated)</td>
</tr>
<tr>
<td>or CE 5991</td>
<td>Graduate Seminar</td>
</tr>
<tr>
<td>or CE 6621</td>
<td>Graduate Seminar in Environmental Science and Engineering</td>
</tr>
<tr>
<td>or ES 5981</td>
<td>Graduate Seminar in Environmental Science and Engineering</td>
</tr>
</tbody>
</table>

**C. Doctoral Research and Dissertation (30 semester credit hours)**

15 semester credit hours required of Doctoral Research and 15 semester credit hours required of Doctoral Dissertation:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 7213</td>
<td>Doctoral Research</td>
</tr>
<tr>
<td>or CE 7212</td>
<td>Doctoral Research</td>
</tr>
<tr>
<td>or CE 7211</td>
<td>Doctoral Research</td>
</tr>
<tr>
<td>CE 7313</td>
<td>Doctoral Dissertation</td>
</tr>
<tr>
<td>or CE 7312</td>
<td>Doctoral Dissertation</td>
</tr>
<tr>
<td>or CE 7311</td>
<td>Doctoral Dissertation</td>
</tr>
</tbody>
</table>

**Dissertation Committee**

Students must choose a Dissertation Committee consisting of at least four members. The chair of the committee must be a member of the graduate faculty from the CEE Department and the remaining members must be members of the graduate faculty. A minimum of one committee member must be a graduate faculty member from a different technical area within the CEE Department, from a different department at UTSA, or an external member not affiliated with UTSA. Students must submit the names of their Dissertation Committee to the Graduate Advisor of Record (GAR) by the end of their second semester of study.

**Advancement to Candidacy**

Ph.D. students advance to candidacy after completing their written and/or oral qualifying examinations. First, students must complete fundamental courses and then take the written or oral qualifying examination. Full-time students must take the written qualifying examination by the end of their second semester of study. Part-time students need to take the written qualifying examination at a time dictated by the CEE graduate studies committee. The qualifying examination may include questions on fundamentals and applied topics related to the four Civil Engineering technical areas, namely structures, geotechnical, transportation and water resources. In addition, the students may be asked to carry out a critical review of engineering research publications. A written qualifying examination will be administered by a committee composed of two members of the graduate faculty from the student’s track and appointed by the program director. Students will be allowed to take an oral qualifying examination in lieu of the written exam. Oral qualifying examinations will be administered by the student’s dissertation committee. No more than two attempts to pass the qualifying examination are permitted. Students who fail the qualifying examination twice are terminated from the program.

Students must take their oral comprehensive examination within two semesters after passing their qualifying examination. The oral comprehensive examination is a dissertation proposal defense. The dissertation proposal should describe the topic, the literature review, the proposed methodology and experimental approach, as well as highlight the novelty and potential contribution of the topic to the scientific field. The student’s Dissertation Committee chair must approve the student’s research proposal before scheduling the oral examination. No more than two attempts to pass the comprehensive examination are permitted. Students who fail the comprehensive examination twice are terminated from the program. Upon successful completion of the oral comprehensive examination, students advance to Ph.D. candidacy and are allowed to take Doctoral Dissertation credit hours.

Results of the written and/or oral examinations must be reported to the GSC and the Dean of the Graduate School. Admission into the Doctoral program does not guarantee advancement to candidacy. After advancement to candidacy, the student’s Dissertation Committee can be changed at the student’s request and with the approval of the chair of the GSC.

**Dissertation**

Candidates must demonstrate their ability to conduct independent research by completing an original dissertation. The Dissertation Committee guides, critiques and finally approves the candidate’s dissertation. The format of the dissertation must follow the doctoral degree regulations of the Graduate School as documented in this catalog.

**Final Oral Dissertation Defense**

The final oral defense consists of a public presentation of the dissertation work by the Doctoral candidate followed by a question/answer period by his/her Dissertation Committee. The student must notify the Graduate School in writing two weeks prior to the final scheduled oral defense. Results of the oral defense are reported to the Dean of the Graduate School. Awarding of the degree is based on the approval of the candidate’s Dissertation Committee and the recommendation of the Dean of the Graduate School, who certifies the completion of all University-wide requirements.

**Doctor of Philosophy Degree in Environmental Science and Engineering**

The Civil and Environmental Engineering (CEE) Department offers the opportunity for advanced study and research leading to the Doctor of Philosophy degree in Environmental Science and Engineering. The educational objective of this program is to produce graduates who are capable of conducting original research in industry or academia as well as assuming a leadership role in their chosen employment field. This is a multidisciplinary program administered by the CEE Department. It encompasses faculty and facilities from the College of
Department of Civil and Environmental Engineering

Sciences and the CEE Department, as well as individual faculty from other UTSA departments. The program has three separate tracks, namely Environmental Science, Environmental Engineering, and Civil Engineering. The Ph.D. degree in Environmental Science and Engineering is awarded to candidates who display an in-depth understanding of the subject matter and demonstrate the ability to make an original contribution to knowledge in their field of specialty.

The regulations for this degree comply with the general University regulations (refer to Student Policies, General Academic Regulations, and the Graduate Catalog, Doctoral Degree Regulations).

Admission Requirements

Applicants must satisfy the following requirements, in addition to satisfying the University-wide graduate admission requirements (refer to Student Policies, Admission Policies):

- A Bachelor of Science degree and a Master of Science degree from an accredited university, and a minimum grade point average of 3.0 in upper-division and graduate courses. The degrees should be in biology, environmental science, chemistry, geology, geography, environmental engineering, civil engineering or other related scientific or engineering discipline. Exceptional applicants without a Master of Science degree may be considered for admission to the program on a case-by-case basis.
- Three letters of recommendation from persons familiar with the applicant’s academic potential
- Official Graduate Record Examination (GRE) scores
- A letter of research/specialization interest
- A résumé/curriculum vita

Applications must be submitted online (https://graduateschool.utsa.edu/admissions/graduate-application) to the UTSA Graduate School. Incomplete applications will not be considered. Acceptance to the program is decided by the Doctoral Studies Committee (DSC), comprised of graduate faculty members selected from the CEE Department and the College of Sciences. Full-time students accepted for the program are eligible to apply for financial support in the form of competitive teaching assistantships, research assistantships, or research fellowships.

Degree Requirements

The Doctoral program in Environmental Science and Engineering requires that students complete a minimum of 60 semester credit hours beyond the Master’s degree. This coursework includes courses that have been designed to provide advanced instruction in areas considered to form the foundation for the disciplines of environmental science and engineering. Enrollment in the Graduate Seminar is required for a minimum of 2 semester credit hours. A minimum of 15 semester credit hours of Doctoral Research and 15 semester credit hours minimum of Doctoral Dissertation must be completed prior to graduation. Any grade lower than “B” in graduate or remedial coursework at the undergraduate level does not count toward the 60 semester credit hours. Students can apply, with the approval from the chair of their Dissertation Committee, up to 12 semester credit hours of graduate coursework to elective courses (see below), if not applied toward their Master’s degree. Students with only a baccalaureate degree are required to have a minimum of 90 semester credit hours to graduate.

21 semester credit hours of required elective courses must be selected by each student according to his/her selected track of study, as defined below. These need to be approved by the Chair of the DSC and the student’s Dissertation Committee. These elective courses may be offered by departments in the College of Sciences, the College of Engineering or by other departments at UTSA.

Students that have obtained a Master's degree are required to complete the following courses:

A. Degree Core Curriculum (10 semester credit hours):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 5001</td>
<td>Process and Ethics in Thesis/Dissertation</td>
</tr>
<tr>
<td>CE 5043</td>
<td>Advanced Civil Engineering Research Development</td>
</tr>
<tr>
<td>or ES 5023</td>
<td>Environmental Statistics</td>
</tr>
<tr>
<td>or STA 5103</td>
<td>Applied Statistics</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 6383</td>
<td>Global Change</td>
</tr>
<tr>
<td>ES 5043</td>
<td>Global Change</td>
</tr>
<tr>
<td>GEO 5033</td>
<td>Geographical Information Systems</td>
</tr>
</tbody>
</table>

B. Track Electives (12 semester credit hours):

These can be selected from 5000–7000 level courses offered in Civil and Environmental Engineering or other departments, with the approval of the Environmental Science and Engineering Doctoral Studies Committee.

1. Environmental Science Track Electives

The objective of this track is to train students in conducting research in the various aspects of environmental science with a focus on the application of physical and biological sciences in solving environmental problems. These elective courses can be selected from the graduate courses offered by the College of Sciences, the CEE Department or other UTSA departments. The overall program of study for this track may differ by no more than 12 semester credit hours from the program of study for the Ph.D. degree in Environmental Science and Engineering and must be approved by the student’s Dissertation Advisor and the Doctoral Studies Committee.

2. Environmental Engineering Track Electives

The objective of this track is to train students in conducting research in the various aspects of environmental engineering with a focus on the application of science and engineering principles in sustaining the natural environment (i.e., air, water and land). Elective courses can be selected from the graduate courses offered by the College of Sciences, the CEE Department or other departments. The overall program of study for this track may differ by no more than 12 semester credit hours from the program of study for the Ph.D. degree in Environmental Science and Engineering and must be approved by the student’s Dissertation Advisor and the Doctoral Studies Committee.

3. Civil Engineering Track Electives

The objective of this track is to train students in conducting research in the various aspects of environmental engineering with a focus on the application of science and engineering principles in sustaining the natural environment (i.e., air, water and land). Elective courses can be selected from the graduate courses offered by the College of Sciences, the CEE Department or other departments. The overall program of study for this track may differ by no more than 12 semester credit hours from the program of study for the Ph.D. degree in Environmental Science and Engineering and must be approved by the student’s Dissertation Advisor and the Doctoral Studies Committee.

- GEO 5033 Geographical Information Systems

For a detailed list of courses, please refer to the course catalog for the College of Sciences and the CEE Department.
The objective of this track is to train students in conducting research in the various aspects of civil engineering with an emphasis on the application of civil engineering principles in the design, construction, and maintenance of the physical and naturally built environment. Elective courses can be selected from the graduate courses offered by the CEE Department or other College of Engineering departments. The overall program of study for this track may differ by no more than 12 semester credit hours from the program of study for the Ph.D. degree in Environmental Science and Engineering and must be approved by the student’s Dissertation Advisor and the Doctoral Studies Committee.

C. Other Electives (6 semester credit hours):

These can be selected from 5000–7000 level courses offered in Civil and Environmental Engineering or other departments, with the approval of the Environmental Science and Engineering Doctoral Studies Committee.

D. Seminars (2 semester credit hours):

CE 6621 Graduate Seminar in Environmental Science and Engineering
or ES 5981 Graduate Seminar in Environmental Science and Engineering

E. Doctoral Research and Dissertation (30 semester credit hours):

Select one of the following options (15 semester credit hours required of Doctoral Research and 15 semester credit hours required of Doctoral Dissertation):

Option I:

- CE 7213 Doctoral Research
- or CE 7212 Doctoral Research
- or CE 7211 Doctoral Research
- CE 7313 Doctoral Dissertation
- or CE 7312 Doctoral Dissertation
- or CE 7311 Doctoral Dissertation

Option II:

- ES 7213 Doctoral Research
- or ES 7212 Doctoral Research
- or ES 7211 Doctoral Research
- ES 7313 Doctoral Dissertation
- or ES 7312 Doctoral Dissertation
- or ES 7311 Doctoral Dissertation

Total Credit Hours 60

Students that have obtained a Bachelor’s degree are required to complete the following courses:

A. Degree Core Curriculum (semester credit hours):

- CE 5001 Process and Ethics in Thesis/Dissertation Research Development
- CE 5043 Advanced Civil Engineering Statistics
- or ES 5023 Environmental Statistics
- CE 5013 Civil Engineering Systems Analysis
- or ES 5233 Experimental Design and Analysis

Select one of the following:

- CE 6383 Global Change
- ES 5043 Global Change
- GEO 5033 Geographical Information Systems

B. Track Electives (21 semester credit hours):

These can be selected from 5000–7000 level courses offered in Civil and Environmental Engineering or other departments, with the approval of the Environmental Science and Engineering Doctoral Studies Committee.

1. Environmental Science Track Electives

The objective of this track is to train students in conducting research in the various aspects of environmental science with a focus on the application of physical and biological sciences in solving environmental problems. These elective courses can be selected from the graduate courses offered by the College of Sciences, the CEE Department or other UTSA departments. The overall program of study for this track may differ by no more than 12 semester credit hours from the program of study for the Ph.D. degree in Environmental Science and Engineering and must be approved by the student’s Dissertation Advisor and the Doctoral Studies Committee.

2. Environmental Engineering Track Electives

The objective of this track is to train students in conducting research in the various aspects of environmental engineering with a focus on the application of science and engineering principles in sustaining the natural environment (i.e., air, water and land). Elective courses can be selected from the graduate courses offered by the College of Sciences, the CEE Department or other departments. The overall program of study for this track may differ by no more than 12 semester credit hours from the program of study for the Ph.D. degree in Environmental Science and Engineering and must be approved by the student’s Dissertation Advisor and the Doctoral Studies Committee.  

3. Civil Engineering Track Electives

The objective of this track is to train students in conducting research in the various aspects of civil engineering with an emphasis on the application of civil engineering principles in the design, construction, and maintenance of the physical and naturally built environment. Elective courses can be selected from the graduate courses offered by the CEE Department or other College of Engineering departments. The overall program of study for this track may differ by no more than 12 semester credit hours from the program of study for the Ph.D. degree in Environmental Science and Engineering and must be approved by the student’s Dissertation Advisor and the Doctoral Studies Committee.

C. Other Electives (12 semester credit hours):

These can be selected from 5000–7000 level courses offered in Civil and Environmental Engineering or other departments, with the approval of the Environmental Science and Engineering Doctoral Studies Committee.

D. Seminars (2 semester credit hours):

CE 6621 Graduate Seminar in Environmental Science and Engineering
or ES 5981 Graduate Seminar in Environmental Science and Engineering

E. Doctoral Research and Dissertation (45 semester credit hours):

Select one of the following options:

Option I:

- CE 7213 Doctoral Research
- or CE 7212 Doctoral Research
- or CE 7211 Doctoral Research
- CE 7313 Doctoral Dissertation
- or CE 7312 Doctoral Dissertation
- or CE 7311 Doctoral Dissertation

Option II:

- ES 7213 Doctoral Research
- or ES 7212 Doctoral Research
- or ES 7211 Doctoral Research
- ES 7313 Doctoral Dissertation
- or ES 7312 Doctoral Dissertation
- or ES 7311 Doctoral Dissertation
Department of Civil and Environmental Engineering

Advancement to Candidacy

Students must complete the core curriculum courses and then take the written qualifying examination. Full-time students must take the written qualifying examination by the end of their second semester of study. Part-time students need to take the written qualifying examination at a time dictated by the DSC. The written qualifying examination may include questions on six core areas, including statistics, hydrogeology, biology, chemistry, environmental engineering and civil engineering. Students are expected to show in-depth knowledge of the topics pertaining to their track of study. This examination is administered by the DSC with input from the faculty participating in the program. The written qualifying examination tests the student’s undergraduate background, their degree of understanding of the material presented in graduate courses, as well as their critical thinking and written communication skills. No more than two attempts to pass the written qualifying examination are permitted. Students who fail the written qualifying examination twice are terminated from the program.

Upon successful completion of the written qualifying examination, students are allowed to take Doctoral Research credit hours. Students must take their oral qualifying examination within two semesters after passing their written qualifying examination. The oral qualifying examination is a dissertation proposal defense. The dissertation proposal should describe the topic, the literature review, the proposed methodology and experimental approach, as well as highlight the novelty and potential contribution of the topic to the scientific field. The student’s Dissertation Committee chair must approve the student’s research proposal before scheduling the oral examination. Upon successful completion of the oral qualifying examination, students advance to Ph.D. candidacy and are allowed to take Doctoral Dissertation credit hours. No more than two attempts to pass the oral qualifying examination are permitted. Students who fail the oral qualifying examination twice are terminated from the program.

Results of the written and oral examinations must be reported to the DSC and the Dean of the Graduate School. Admission into the Doctoral program does not guarantee advancement to candidacy. After advancement to candidacy, the student’s Dissertation Committee can be changed at the student’s request and with the approval of the chair of the DSC.

Dissertation Committee

Students must choose a Dissertation Committee consisting of a chair and at least four additional graduate faculty members. This committee must include a minimum of one faculty member from the CEE Department and one from the College of Sciences. Students must submit the names of their Dissertation Committee to the DSC Chair by the end of their second semester of study.

Dissertation

Candidates must demonstrate their ability to conduct independent research by completing an original dissertation. The Dissertation Committee guides, critiques and finally approves the candidate’s dissertation. The format of the dissertation must follow the doctoral degree regulations of the Graduate School as documented in this catalog.

Final Oral Dissertation Defense

The student must notify the Graduate School in writing two weeks prior to the final scheduled oral defense. The final oral defense consists of a public presentation of the dissertation, followed by a closed oral defense. Results of the oral defense must be reported to the Dean of the Graduate School. Awarding of the degree is based on the approval of the Dissertation Committee and the Dean of the Graduate School. The Dean of the Graduate School certifies the completion of all University-wide requirements.

Civil Engineering (CE) Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 5001</td>
<td>Process and Ethics in Thesis/Dissertation Research Development</td>
<td>1</td>
</tr>
<tr>
<td>CE 5013</td>
<td>Civil Engineering Systems Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CE 5033</td>
<td>Experiential Learning in Civil Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CE 5043</td>
<td>Advanced Civil Engineering Statistics</td>
<td>3</td>
</tr>
<tr>
<td>CE 5093</td>
<td>Geographic Information Systems (GIS)</td>
<td>3</td>
</tr>
</tbody>
</table>

The Department of Civil and Environmental Engineering offers a variety of courses designed to provide students with a comprehensive understanding of their chosen field. These courses cover a wide range of topics, from advanced statistics to geographic information systems, ensuring that students are well-prepared for their professional careers.
CE 5103. Advanced Steel Design. (3-0) 3 Credit Hours.
Connection design, welded and bolted, moment-resistant connections, plate girders, column stability, bracing design, and seismic design of frames. (Formerly CE 5343 Topic 4: Advanced Steel Design. Credit cannot be earned for both CE 5103 and CE 5343 Advanced Steel Design.) Differential Tuition: $165.

CE 5123. Bridge Engineering. (3-0) 3 Credit Hours.
Design loads, load distribution, design of superstructures and substructures, and evaluation and load rating capacity of bridges. (Formerly CE 5343 Topic 8: Bridge Engineering. Credit cannot be earned for both CE 5123 and CE 5343 Bridge Engineering.) Differential Tuition: $165.

CE 5133. Advanced Reinforced Concrete. (3-0) 3 Credit Hours.
Curved beams, torsion design, retaining walls and shear walls, stairs, two-way slabs, yield-line theory, biaxial load on columns, slenderness effects, joint design, strut-and-tie methods, and concrete elasticity and failure criteria. (Formerly CE 5343 Topic 2: Advanced Reinforced Concrete Structures. Credit cannot be earned for both CE 5133 and CE 5343 Advanced Reinforced Concrete Structures.) Differential Tuition: $165.

CE 5143. Numerical Methods in Civil Engineering. (3-0) 3 Credit Hours.
Mathematical equation root finding and optimization methods, matrix equations, solution methods, eigenvector and eigenvalue solution methods, finite difference methods, curve-fitting methods, numerical integration and differentiation techniques, and introduction to finite element formulations. Differential Tuition: $165.

CE 5153. Prestressed Concrete. (3-0) 3 Credit Hours.
Overview of prestressed concrete development; design properties of materials; analysis and design of pre-tensioned and post-tensioned concrete members; full and partial prestressing; serviceability and strength requirements, code criteria for prestressed continuous beams, statically indeterminate frames and other structures. (Formerly CE 5343 Topic 3: Prestressed Concrete. Credit cannot be earned for both CE 5153 and CE 5343 Prestressed Concrete.) Differential Tuition: $165.

CE 5163. Advanced Structural Analysis. (3-0) 3 Credit Hours.
The class covers the matrix analysis method applied to structural analysis. The course will cover all the facets of the structural analysis method including the assembly of element and structure stiffness matrices, fixed end force and moment vectors, and nodal displacements. Differential Tuition: $165.

CE 5173. Dynamics and Vibrations. (3-0) 3 Credit Hours.
The class covers the fundamentals of structural dynamics, including single-degree-of-freedom and multi-degree-of-freedom systems. The course presents common analysis techniques used to calculate the dynamic response of structures to different types of time-varying loads. Differential Tuition: $165.

CE 5183. Experimental Stress Analysis. (3-0) 3 Credit Hours.
The course covers basic principles of experimental measurements, including basic modeling theory, similitude laws, and dimensional analysis. The course will also cover basic principles of commonly-used sensors for measuring strain, displacement, and load. Students will learn to build and operate sensors through experiments. Differential Tuition: $165.

CE 5193. Finite Element Methods. (3-0) 3 Credit Hours.
Derivation and computer implementation of the finite element method for the solution of civil engineering boundary value problems. (Formerly CE 5023. Same as ME 5483. Credit cannot be earned for more than one of the following: CE 5023, CE 5193, or ME 5483.) Differential Tuition: $165.

CE 5253. Introduction to Masonry Design. (3-0) 3 Credit Hours.
Design philosophy and methodology for masonry structures. Flexure design, axial load design, and shear design of basic masonry components. Differential Tuition: $165.

CE 5263. Design of Buildings for Lateral Loads. (3-0) 3 Credit Hours.
The class will cover methods to calculate lateral loads for the design of buildings and their application to the design of steel, concrete, wood and masonry structures. Differential Tuition: $165.

CE 5283. Design of Nuclear Facilities I. (3-0) 3 Credit Hours.
The course covers U.S. Nuclear Regulatory Commission regulations, ACI and AISC design codes for nuclear safety-related structures, computation of facility-specific design loads for seismic and other natural hazards and facility operations, ACI and AISC load combinations, design of components of reinforced concrete and steel structures, and safeguards evaluation for explosive and impact loads. Differential Tuition: $165.

CE 5303. Hydrometeorology. (3-0) 3 Credit Hours.
The main objective of this course is to familiarize the student with the local and global distribution of freshwater. Conceptualizations of the water balance/budget are developed using principles of physical hydrology and meteorology. Emphasis will be on recent research and modern methods for data analysis and modeling. Real life events and phenomena will be discussed. In addition to the text, material will be presented from other sources. Guest instructors will give presentations on some case studies. Differential Tuition: $165.

CE 5323. River Science. (3-0) 3 Credit Hours.
An in-depth examination of river sediment transport principles. Topics include water and sediment supply, sediment dynamics, river morphology, and channel instability. Field trip required. (Formerly CE 5653. Same as GEO 5413. Credit can be earned for only one of the following: CE 5653, CE 5232, or GEO 5413.) Differential Tuition: $165.

CE 5363. Coastal Engineering. (3-0) 3 Credit Hours.
This course introduces coastal engineering principles. This course will cover various fundamental and applied aspects of coastal engineering, including: wave mechanics, wave-structure interaction, coastal water level fluctuations, coastal zone processes, and design considerations for coastal structures and beach nourishment projects. Differential Tuition: $165.

CE 5373. Risk Analysis of Water/Environmental Systems. (3-0) 3 Credit Hours.
This course is focused on risk and uncertainty analysis applied to hydrology, hydraulics, groundwater, water resources, and environmental engineering systems. Tools for estimating the risk of failure and the reliability of water resources and environmental engineering systems based on probability and statistical methods as well as stochastic simulation techniques will be discussed. Differential Tuition: $165.

CE 5383. Water Resources Planning and Management. (3-0) 3 Credit Hours.
Management and planning of natural and constructed water systems; the planning process, systems analysis methods; institutional framework for water resources engineering; comprehensive integration of engineering, economic, environmental, legal and political considerations in water resources development and management. Integrated management and case studies of water use and environmental resources. Differential Tuition: $165.
CE 5393. River Mechanics and Engineering Applications. (3-0) 3 Credit Hours.
Prerequisite: CE 5323 or equivalent. This course focuses on the application of sediment transport principles to practical river mechanics and environmental problems. Applications include laboratory experiments, and numerical simulations related to the solution of practical river engineering problems. (Formerly CE 5663. Credit cannot be earned for both CE 5393 and CE 5663.) Differential Tuition: $165.

CE 5403. Advanced Characterization of Highway Materials. (3-0) 3 Credit Hours.
Basic and advanced level of the fundamentals of material response to static and repeated loading; emphasis on the deformation and fatigue behavior of asphalt mixtures, constitutive modeling for mixtures, microstructure characterization for mixtures, nondestructive testing of pavements, asphalt binder characterization, unbound materials (base and sub-base materials) evaluation and characterization. Differential Tuition: $165.

CE 5423. Advanced Pavement Analysis and Design. (3-0) 3 Credit Hours.

CE 5433. Advanced Geometric Design. (3-0) 3 Credit Hours.
Course deals with the geometric design of highways and streets. Topics include highway functions, design controls and criteria, elements of design, local roads and streets, freeways, and intersections. (Formerly CE 5513 Topic 6: Advanced Geometric Design. Credit cannot be earned for both CE 5433 and CE 5513 Advanced Geometric Design.) Differential Tuition: $165.

CE 5443. Pavement Management. (3-0) 3 Credit Hours.
Pavement evaluation and performance, evaluation of pavement distress condition surveys, evaluation of pavement roughness ride quality, skid resistance of pavements, evaluation of pavement structural capacity, maintenance and rehabilitation, prioritization and optimization of pavement maintenance, and rehabilitation needs. (Formerly CE 5513 Topic 4: Pavement Management Systems. Credit cannot be earned for both CE 5443 and CE 5513 Pavement Management Systems.) Differential Tuition: $165.

CE 5453. Transportation Engineering. (3-0) 3 Credit Hours.
Study of the Highway Capacity Manual, traffic stream parameters and relationships, analytical techniques in traffic engineering such as capacity analysis, queuing theory, and traffic simulation. Design and operation of advanced traffic management systems including signalization, real-time motorist information, urban incident management, and ITS concepts. (Formerly CE 5513 Topic 8: Principles of Traffic Engineering. Credit cannot be earned for both CE 5453 and CE 5513 Principles of Traffic Engineering.) Differential Tuition: $165.

CE 5473. Transportation Planning. (3-0) 3 Credit Hours.
An introductory course in urban transportation planning. It includes, an overview of highway capacity concepts, trip generation, trip distribution, modal split and trip assignments. Course gives hands-on exposure to software implementing these steps and discusses case studies of San Antonio’s 2020 master plan. Finally, it extends this approach to air passenger and road freight transportation. Differential Tuition: $165.

CE 5483. Urban Transportation. (3-0) 3 Credit Hours.
This course is an introduction to urban passenger transportation planning in the USA with a sustainability focus. It is structured around three components: (1) History, theory, and problem definition; (2) The planning process; and (3) Solutions and analytical techniques. The course will help to understand the planning process comprehensively along with its multiple dimensions, how our current transportation systems has evolved over time, what is a sustainable system, policies and planning approaches that help to achieve it, and challenges related to planning. The course provides opportunities to hear from local and regional planners about their work, and learn from their experience about the methods they use in practice. Differential Tuition: $165.

CE 5523. Retaining Structures. (3-0) 3 Credit Hours.
This course will introduce to students the theories that seek to describe the interactions between the vehicles, drivers, and the infrastructure. The models and theories that characterize the flow of highway traffic, signalized and unsignalized intersections will also be presented. The course will also provide opportunity to learn emerging techniques and to apply them for traffic and incident management. Differential Tuition: $165.

CE 5533. Slope Stability. (3-0) 3 Credit Hours.
The course includes advanced theories of soil strength and failure, theories of lateral earth pressure with applications, infinite slope analysis, limit equilibrium slope analysis, finite element slope analysis, and mechanics and analysis of reinforced slopes using finite element software and spreadsheet applications. Differential Tuition: $165.

CE 5543. Ground Improvement. (3-0) 3 Credit Hours.
This course covers the fundamental principles and concepts of ground improvement methods. How to use these concepts for design and analysis of various ground improvements. The content of this course focus on the applicability of various ground improvement, design and analysis methods and construction details. Differential Tuition: $165.

CE 5553. Advanced Soil Mechanics. (3-0) 3 Credit Hours.
Permeability and seepage analysis involving dams and sheet piles, stress distribution in earth masses, advanced study of drained and undrained shear strength of soil, behavior of unsaturated soil, and laboratory and field methods for evaluation of soil properties in design practice. Differential Tuition: $165.

CE 5563. Foundation Engineering. (3-0) 3 Credit Hours.
Shallow and deep foundations, including footings, slabs on-grade, cofferdams, sheet-pile walls, drilled shafts, piles and retaining walls. (Formerly CE 5463. Credit cannot be earned for both CE 5463 and CE 5563.) Differential Tuition: $165.

CE 5613. Environmental Chemistry. (3-0) 3 Credit Hours.
This course explores the chemistry of the environment, the chemistry underlying environmental problems and solutions to environmental problems. Emphasis is placed on thermodynamics and kinetics of reaction cycles; sources, sinks and transport of chemical species; and quantitation of chemical species. Examples are selected from the chemistry of natural and contaminated air, water, and soil. Differential Tuition: $165.
CE 5623. Advanced Treatment Processes for Water Quality Control. (3-0) 3 Credit Hours.
Principles, modeling and design aspects of physical chemical treatment processes in drinking water, wastewater and groundwater remediation applications. (Formerly CE 5233 Topic 1: Physical and Chemical Treatment Operations. Credit cannot be earned for both CE 5623 and CE 5233 Physical and Chemical Treatment Operations.) Differential Tuition: $165.

CE 5643. Sustainable Energy Systems. (3-0) 3 Credit Hours.
Course explores various facets of sustainable energy systems and their role in securing America's energy future. It covers national and global energy trends, social, political, regulatory, technical/economic constraints and policy considerations. The course uses a systems approach in examining the technology and economics behind each alternative energy source and the major qualitative and quantitative factors affecting their large scale deployment. (Same as ME 5273. Credit cannot be earned for both CE 5643 and ME 5273.) Differential Tuition: $165.

CE 5673. Environmental Microbiology. (3-0) 3 Credit Hours.
To provide a basic understanding of environmental microbiology primarily from two aspects: microbial interactions with chemical pollutants in the environment and the fate of microbial pathogens in the environment. Topics covered include microbial environments, detection of bacteria and their activities in the environment, microbial biogeochemistry, bioremediation and water quality. (Formerly CE 5203. Same as ES 5063. Credit can be earned for only one of the following: CE 5673, CE 5203, or ES 5063.) Differential Tuition: $165.

CE 5683. Biological Phenomena in Environmental Engineering. (3-0) 3 Credit Hours.
The major biological phenomena and processes used in environmental engineering control. Fundamentals of microbiology and biochemistry as applied to wastewater treatment, drinking water treatment, and hazardous waste remediation. (Formerly CE 5213. Credit cannot be earned for both CE 5683 and CE 5213.) Differential Tuition: $165.

CE 5703. Special Topics in Hydraulics and Hydrology. (3-0) 3 Credit Hours.
Course deals with special aspects of hydraulics and hydrology. May be repeated for credit as topics vary. Differential Tuition: $165.

CE 5713. Special Topics in Structures. (3-0) 3 Credit Hours.
Course deals with special aspects of structural engineering. May be repeated for credit as topics vary. Differential Tuition: $165.

CE 5723. Special Topics in Transportation. (3-0) 3 Credit Hours.
Course deals with special aspects of transportation engineering. May be repeated for credit as topics vary. Differential Tuition: $165.

CE 5733. Special Topics in Environmental Engineering. (3-0) 3 Credit Hours.
Course deals with special aspects of environmental engineering. May be repeated for credit as topics vary. Differential Tuition: $165.

CE 5743. Special Topics in Geotechnical Engineering. (3-0) 3 Credit Hours.
Course deals with special aspects of geotechnical engineering. May be repeated for credit as topics vary. Differential Tuition: $165.

CE 5973. Special Project. (0-0) 3 Credit Hours.
Work carried out by nonthesis Master's students under the direction of their Advisory Committee to fulfill the project requirement of their degree. It may involve applied or theoretical work and a report documenting the findings. Differential Tuition: $165.

CE 5981. Master's Thesis. (0-0) 1 Credit Hour.
Prerequisite: Approval of the student's Advisory Committee. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. (Formerly CE 6983.) Differential Tuition: $55.

CE 5982. Master's Thesis. (0-0) 2 Credit Hours.
Prerequisite: Approval of the student's Advisory Committee. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. (Formerly CE 6983.) Differential Tuition: $110.

CE 5983. Master's Thesis. (0-0) 3 Credit Hours.
Prerequisite: Approval of the student's Advisory Committee. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. (Formerly CE 6983.) Differential Tuition: $165.

CE 5991. Graduate Seminar. (1-0) 1 Credit Hour.
Graduate seminar may be repeated for credit up to 3 semester credit hours. Differential Tuition: $55.

CE 6123. Theory of Plates and Shells. (3-0) 3 Credit Hours.
The class covers the fundamentals of plate and shell theories, formulation of finite element analysis using plate and shell elements, and basic solutions for various types of loading and boundary conditions in plate and shell structures. Differential Tuition: $165.

CE 6133. Advanced Behavior of Reinforced Concrete Members. (3-0) 3 Credit Hours.
The class covers the behavior of reinforced concrete members under the effects of flexure, axial load, and shear. Technical references are presented that provide the foundation for modern reinforced concrete analysis theories and reinforced concrete design codes. The references discussed in the class provide a basic understanding of the intent and limitations of design code provisions as well as introduce students to techniques for modeling the behavior of reinforced concrete structures in the nonlinear range of response. Differential Tuition: $165.

CE 6163. Non-linear Finite Element Analysis. (3-0) 3 Credit Hours.
The class covers the modeling, formulation, and application of the finite element method for nonlinear problems in structural mechanics. Differential Tuition: $165.

CE 6173. Earthquake Engineering. (3-0) 3 Credit Hours.
The class presents an introduction to engineering seismology including the most important characteristics of earthquake ground motions. The class will also cover methods to simulate the response of structures to strong earthquakes, methodologies employed by seismic design codes, and performance-based design. Differential Tuition: $165.

CE 6263. Repair and Rehabilitation of RC Structures. (3-0) 3 Credit Hours.

CE 6283. Design of Nuclear Facilities II. (3-0) 3 Credit Hours.
The course covers the structural design of nuclear facilities including steel components in accordance with AISC N690 and concrete components in accordance with ACI 349 and ACI 359. Differential Tuition: $165.
CE 6313. Hydrologic Modeling and Analysis. (3-0) 3 Credit Hours.
This course will address hydrological modeling (both theory and practical applications with focus on the latter) and related issues. Multimedia and advanced visualization will be used in lectures and class work. Most of the course is dedicated to hands-on, problem-oriented applications using a variety of practical techniques. It will provide students with the knowledge and tools necessary to use data derived from geographical information systems (GIS) to develop hydrologic estimates needed for different applications. (Formerly CE 6013. Credit cannot be earned for both CE 6313 and CE 6013.) Differential Tuition: $165.

CE 6323. Control of Floods and Droughts. (3-0) 3 Credit Hours.
This course will discuss flood and drought characteristics, impacts; structural, nonstructural flood control measures; drought prediction, drought control, and drought management. Focus will be on preparedness, mitigation, and risk management to respond to these phenomena. Differential Tuition: $165.

CE 6343. Water Resources Systems Analysis. (3-0) 3 Credit Hours.
Systems Analysis methods use algorithmic and mathematical approaches for problem-solving. These are powerful methods that can be applied to solve complex design and management problems for water resources systems and other engineering areas. This class will focus on optimization methods, such as linear programming, integer programming, nonlinear programming, genetic algorithms, and dynamic programming, and their application to water resources systems. Differential Tuition: $165.

CE 6363. Advanced Fluid Mechanics. (3-0) 3 Credit Hours.
This course will be theory oriented with advanced mathematical and physical concepts. Starting with basic conservation laws and constitutive equations of fluid mechanics and flow kinematics, the course will first cover ideal (inviscid) flows and then viscous flows of incompressible fluids. Two-dimensional potential flows will be covered as part of ideal fluid flows. Exact solutions and low-Reynolds number approximate solutions of Navier-Stokes equations will be covered as part of viscous fluid flows. Differential Tuition: $165.

CE 6383. Global Change. (3-0) 3 Credit Hours.
Changes in the global distribution of plants and animals and the causes of the changes will be examined. Factors that are apparently coupled to changes in the atmosphere and environmental temperature will be examined. (Formerly CE 6115. Same as ES 5043 and GEO 5043. Credit can be earned for only one of the following: CE 6383, CE 6113, ES 5043, or GEO 5043.) Differential Tuition: $165.

CE 6403. Airport Engineering. (3-0) 3 Credit Hours.
This course covers airport master planning and layout, aircraft characteristics and their effects on airport design, and orientation of runways and taxiways including length and cross sections. The course also covers airport capacity and delay, types of airport configurations and methods to design of airport pavements. Differential Tuition: $165.

CE 6423. Railway Engineering. (3-0) 3 Credit Hours.
This course provides an overview of industry-specific topics including key statistics that shape design, construction, maintenance, operations, and evaluation of rail infrastructure and networks. Specific topics also include track-train dynamics, safety, intercity and urban passenger and freight rail operations and capacity, motive power and equipment. Differential Tuition: $165.

CE 6453. Pavement Sustainability. (3-0) 3 Credit Hours.
This course provides design tools that will encourage the use of sustainable pavement materials and structures, such as permeable pavements, rubber asphalt, recycled asphalt pavement (RAP), recycled asphalt shingles (RAS) and alternative cement binders. The course covers potential multiple use of asphalt pavement roadways to have a considerable impact on energy production, fuel consumption, reduced greenhouse gas (GHG) emissions, and life-cycle costs. Differential Tuition: $165.

CE 6503. Landfill Design. (3-0) 3 Credit Hours.
The course will include principles of waste disposal, sanitary landfill site assessment, in-depth design, construction, operation and maintenance of sanitary landfill including landfill gas and leachate management and groundwater monitoring issues close to landfills. Differential Tuition: $165.

CE 6513. Advanced Foundation Engineering. (3-0) 3 Credit Hours.
This course is an extension of CE 5563 Foundation Engineering and covers advanced foundation theories and analytical methods. In addition, this course will cover latest advancements in foundation testing such as static load test and Osterberg tests. The concept of sustainability in foundation design will also be introduced in this course. Differential Tuition: $165.

CE 6533. Remediation Geotechnics. (3-0) 3 Credit Hours.
Application of geotechnical engineering to the disposal of wastes, remediation of polluted sites containing contaminated soil and groundwater. Topics include subsurface exploration techniques and geotechnically-oriented remedial action technologies including pump and treat method, soil vapor extractions, air sparging, PRBs, etc. Differential Tuition: $165.

CE 6603. Fate and Transport of Contaminants in the Environment. (3-0) 3 Credit Hours.
The course deals with the hydrodynamics of mixing and transport, as well as the interaction of mixing and various reaction rate processes. Applications in the course will include water and wastewater treatment, groundwater pollution, and transport and mixing in rivers, lakes and reservoirs. (Formerly CE 6103 and CE 6053 Topic 1: Fate and Transport of Contaminants in Environmental System. Credit can be earned for only one of the following CE 6603, CE 6103, or CE 6053 Fate and Transport of Contaminants in Environmental System.) Differential Tuition: $165.

CE 6621. Graduate Seminar in Environmental Science and Engineering. (1-0) 1 Credit Hour.
Will include presentations of current research by faculty and invited guests who are experts in various aspects of research in the environmental sciences and engineering, and advanced graduate students who are about to complete their dissertation research. The grade report for the course is either “CR” (satisfactory) or “NC” (unsatisfactory). May be repeated for credit. (Formerly CE 6221. Same as ES 5981.) Differential Tuition: $55.

CE 6951. Independent Study. (0-0) 1 Credit Hour.
Prerequisites: Written permission of the instructor and the student's Advisory Committee. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the student's program of study. Differential Tuition: $55.
CE 6952. Independent Study. (0-0) 2 Credit Hours.
Prerequisites: Written permission of the instructor and the student's Advisory Committee. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the student's program of study. Differential Tuition: $110.

CE 6953. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Written permission of the instructor and the student's Advisory Committee. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the student's program of study. Differential Tuition: $165.

CE 6961. Comprehensive Examination. (0-0) 1 Credit Hour.
Prerequisite: Written permission of the student's Advisory Committee. The comprehensive examination course is intended as a 1 semester credit hour substitute for the Master of Science degree in Civil Engineering thesis or the Master of Civil Engineering graduate seminar. Students may register for this course in a semester in which the examination is to be taken, if they are not enrolled in other courses. The grade report for the course is either "CR" (satisfactory performance on the Comprehensive Examination) or "NC" (unsatisfactory performance on the Comprehensive Examination). Differential Tuition: $55.

CE 6991. Graduate Seminar in Civil Engineering. (1-0) 1 Credit Hour.
Will include presentations of current research by faculty and invited guests who are experts in various aspects of research in civil engineering, and advanced graduate students who are about to complete their dissertation research. May be repeated for credit. Differential Tuition: $55.

CE 7211. Doctoral Research. (0-0) 1 Credit Hour.
Prerequisites: For CE Ph.D. students, consent of advisor; for ESE Ph.D. students, admission to Doctoral candidacy; consent of the student's Dissertation Committee and consent of the DSC. Research work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but no more than 15 hours may be applied to the Doctoral degree. Differential Tuition: $55.

CE 7212. Doctoral Research. (0-0) 2 Credit Hours.
Prerequisites: For CE Ph.D. students, consent of advisor; for ESE Ph.D. students, admission to Doctoral candidacy; consent of the student's Dissertation Committee and consent of the DSC. Research work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but no more than 15 hours may be applied to the Doctoral degree. Differential Tuition: $110.

CE 7213. Doctoral Research. (0-0) 3 Credit Hours.
Prerequisites: For CE Ph.D. students, consent of advisor; for ESE Ph.D. students, admission to Doctoral candidacy; consent of the student's Dissertation Committee and consent of the DSC. Research work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but no more than 15 hours may be applied to the Doctoral degree. Differential Tuition: $165.

CE 7311. Doctoral Dissertation. (0-0) 1 Credit Hour.
Prerequisites: For CE Ph.D. students, successful defense of comprehensive exam; for ESE Ph.D. students, successful defense of the oral defense; consent of the student's Dissertation Committee and consent of the DSC. Dissertation work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but not more than 15 hours may be applied to the Doctoral degree. Differential Tuition: $55.

CE 7312. Doctoral Dissertation. (0-0) 2 Credit Hours.
Prerequisites: For CE Ph.D. students, successful defense of comprehensive exam; for ESE Ph.D. students, successful defense of the oral defense; consent of the student's Dissertation Committee and consent of the DSC. Dissertation work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but not more than 15 hours may be applied to the Doctoral degree. Differential Tuition: $110.

CE 7313. Doctoral Dissertation. (0-0) 3 Credit Hours.
Prerequisites: For CE Ph.D. students, successful defense of comprehensive exam; for ESE Ph.D. students, successful defense of the oral defense; consent of the student's Dissertation Committee and consent of the DSC. Dissertation work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but not more than 15 hours may be applied to the Doctoral degree. Differential Tuition: $165.