SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING, AND CONSTRUCTION MANAGEMENT

The School of Civil and Environmental Engineering, and Construction Management offers the Master of Civil Engineering degree, the Master of Science degree in Civil Engineering, the Master of Science degree in Facility Management, the Doctor of Philosophy degree in Civil Engineering, and the Doctor of Philosophy degree in Environmental Science and Engineering. The School also offers a Graduate Certificate in Construction Engineering, Science and Management and a Graduate Certificate in Facility Management.

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, geo-environmental 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.
- Official Graduate Record Examination (GRE) scores. (GRE scores are waived for current UTSA students and UTSA alumni of the B.S. in Civil Engineering and closely related engineering programs, who have an overall GPA above 3.0.)
- Test of English as a Foreign Language (TOEFL) iBT minimum score of 79.
- 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- to 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

Code	Title	Credit Hours
A. Electives (24 semester credit hours):		**24**
These can be selected from 5000- to 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):		**6**
Includes comprehensive examination/thesis defense/seminar presentation		
CE 5981	Master's Thesis	
or CE 5982	Master's Thesis	
or CE 5983	Master's Thesis	
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, geo-environmental 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.
- Test of English as a Foreign Language (TOEFL) iBT minimum score of 79.
- 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 31. At least 21 semester credit hours must be taken at UTSA. Elective courses may be chosen from the School of Civil and Environmental Engineering, and Construction Management (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

Code	Title	Credit Hours
A. Electives (30 semester credit hours):		**30**
These can be selected from 5000- to 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	1
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		**31**

Master of Science Degree in Facility Management

The Master of Science degree in Facility Management is a 100% online program, designed to educate and equip graduate-level facility management students with advanced facilities management knowledge and skills to enhance their performance and capabilities and to increase their professional qualifications. Students who complete the M.S. degree in Facility Management will be prepared to make an immediate positive impact that supports and advances the profession.

Admission Requirements

Applicants must satisfy University-wide graduate admission requirements.

A complete application package consists of the following:

- Completed Application form,
- Official transcripts from all universities attended,
- Résumé detailing your facilities management experience,
- Two Letters of Recommendation (recommended),
- and Test of English as a Foreign Language (TOEFL) scores for international applicants whose native language is not English.

Applicants for this program must have a bachelor's or master's degree in engineering, architecture, sciences, business, or other facility management-related field or discipline. Practicing facility managers with at least two years of experience in facility management and a bachelor's degree in other fields will also be admitted to the program, with approval of the program coordinator.

Applicants may be admitted as unconditional or conditional degree-seeking graduate students, or as special graduate students. Admission as a special graduate (non-degree-seeking) student does not guarantee subsequent admission as a degree-seeking student; such students must reapply for degree-seeking status.

Degree Requirements

The minimum number of semester credit hours required for the Master of Science degree in Facility Management, exclusive of coursework or other study required to remove deficiencies, is 30. The program is offered in a non-thesis option only.

Degree candidates must complete the following 30 semester credit hours of coursework:

Code	Title	Credit Hours
Required courses:		
FM 5003	Facilities Management Professional Trends	3
FM 5113	Operations and Maintenance: Management of Built Assets	3
FM 5213	Project Management: Planning and Execution of Projects	3
FM 5313	Finance and Business: Financial Aspects of Facilities Management	3
FM 5413	Leadership and Strategy: Facilities Management Leadership and Excellence	3
FM 5513	Energy, Utilities and Environmental Stewardship: Energy Management and Sustainable Facilities	3
FM 5613	Human Factors and Resources in Facilities Management	3
FM 5713	Quality, Productivity and Technology in Facility Management	3
FM 5813	Environmental Health, Safety, Risk Management, and Business Continuity in Facility Management	3
FM 5903	Graduate Capstone Project – Solving Problems in Facilities Management	3
Total Credit Hours		**30**

To maintain enrollment in the master of science degree program, students must maintain a 3.0 grade point average throughout their tenure in the program.

Doctor of Philosophy Degree in Civil Engineering

The School of Civil and Environmental Engineering, and Construction Management (CEE) 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 six separate tracks: (1) Geotechnical Engineering, (2) Structural Engineering, (3) Transportation Engineering, (4) Water Resources, (5) Building Performance, and (6) Construction Science and Management. 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 Chapter 2, General Academic Regulations, and Chapter 5, Doctoral Degree Regulations).

Admission Requirements

Applicants must satisfy the following requirements, in addition to satisfying the University-wide graduate admission requirements (refer to Chapter 1, Admission):

- A bachelor's or master's degree from an accredited university, with a minimum grade point average of 3.0 or better in upper-division and/or graduate courses. The degrees should be in Civil Engineering, Architecture, Construction Science and Management, or other related disciplines.
- Three letters of recommendation from persons familiar with the applicant's academic potential.
- Official Graduate Record Examination (GRE) scores. (GRE scores are waived for UTSA students and alumni of the B.S. or M.S. in Civil Engineering and from closely related engineering programs, who have an overall GPA above 3.0.)
- A letter of research/specialization interest.
- A résumé/curriculum vita.

Applications must be submitted to the UTSA Graduate School online at http://graduateschool.utsa.edu/. 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. Note that admission is competitive, and satisfying these requirements does not guarantee admission.

Degree Requirements

The Doctoral program in Civil Engineering requires that students complete a minimum of 50 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, Architecture, and Construction Science. 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 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 50 semester credit hours. With the approval from the chair of their Dissertation Committee, students can apply 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 74 semester credit hours to graduate. Additional degree requirements include both passing a written and/or oral qualifying examination, writing a doctoral dissertation, and passing a final examination/dissertation defense.

A minimum of 18 semester credit hours of required courses beyond the master's degree, or 42 semester credit hours beyond the bachelor's degree, 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 and Integrated Design, the College of Sciences, or by other departments at UTSA.

Geotechnical Engineering, Structural Engineering, Transportation Engineering, and Water Resources Track Degree Requirements

Students are required to complete the following courses based on the completion of a master's degree or bachelor's degree. 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 may include courses outside of traditional areas for students involved in multidisciplinary research.

Students who have obtained a master's degree are required to complete the following courses:

Code	Title	Credit Hours
A. Electives (18 semester credit hours)		**18**
These can be selected from 5000- to 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, chosen track, and dissertation objectives of the students. The plan of study will include courses that build the fundamental knowledge required to complete the dissertation and may include courses outside of traditional areas for students involved in multidisciplinary research.		
B. Seminars (2 semester credit hours)		**2**
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)		**30**
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	
or CE 7312	Doctoral Dissertation	
or CE 7311	Doctoral Dissertation	
Total Credit Hours		**50**

Students who have obtained a bachelor's degree are required to complete the following courses:

Code	Title	Credit Hours
A. Electives (42 semester credit hours)		**42**
These can be selected from 5000- to 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, chosen track, and dissertation objectives of the students. The plan of study will include courses that build the fundamental knowledge required to complete the dissertation and may include courses outside of traditional areas for students involved in multidisciplinary research.		
B. Seminars (2 semester credit hours)		**2**
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)		**30**
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	
or CE 7312	Doctoral Dissertation	
or CE 7311	Doctoral Dissertation	
Total Credit Hours		**74**

Building Performance Track Degree Requirements

Students are required to complete the following courses based on the completion of a master's degree or bachelor's degree. 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 may include courses outside of traditional areas for students involved in multidisciplinary research.

Students who have obtained a master's degree are required to complete the following courses:

Code	Title	Credit Hours
A. Core Curriculum (6 semester credit hours)		**6**
At least two Core Curriculum CEE courses will be selected from the list below with the approval of the dissertation committee chair. Other CEE courses can be substituted with the approval of the track coordinator.		
CE 5043	Advanced Civil Engineering Statistics	
CE 5093	Geographic Information Systems (GIS)	
CE 5483	Urban Transportation	
CE 5643	Sustainable Energy Systems	
CE 5713	Special Topics in Structures	
CE 5723	Special Topics in Transportation	
CE 5733	Special Topics in Environmental Engineering	
CE 6383	Global Change	
CE 6953	Independent Study	
B. Track Electives (6 semester credit hours)		**6**
These can be selected from 5000- to 7000-level courses offered in the School of Architecture and Plannning, 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 Building Performance track.		
C. Free Electives (6 semester credit hours)		**6**
These can be selected from 5000- to 7000-level courses offered in other UTSA departments, with the approval of the Dissertation Committee. The objective of these courses is to expanded knowledge outside of traditional areas and promote interdisciplinary research.		
D. Seminars (2 semester credit hours)		**2**
ARC 7011	Doctoral Seminar in Architecture (repeated)	
E. Doctoral Research and Dissertation (30 semester credit hours)		**30**
15 semester credit hours required of Doctoral Research and 15 semester credit hours required of Doctoral Dissertation:		
ARC 7213	Doctoral Research	
or ARC 7212	Doctoral Research	
or ARC 7211	Doctoral Research	
ARC 7313	Doctoral Dissertation	
or ARC 7312	Doctoral Dissertation	
or ARC 7311	Doctoral Dissertation	
Total Credit Hours		**50**

Students who have obtained a bachelor's degree are required to complete the following courses:

Code	Title	Credit Hours
A. Core Curriculum (9 semester credit hours)		**9**
At least three Core Curriculum CEE courses will be selected from the list below with the approval of the dissertation committee chair. Other CEE courses can be substituted with the approval of the track coordinator.		
CE 5043	Advanced Civil Engineering Statistics	
CE 5093	Geographic Information Systems (GIS)	
CE 5483	Urban Transportation	
CE 5643	Sustainable Energy Systems	
CE 5713	Special Topics in Structures	
CE 5723	Special Topics in Transportation	
CE 5733	Special Topics in Environmental Engineering	
CE 6383	Global Change	
CE 6953	Independent Study	
B. Track Electives (21 semester credit hours)		**21**
These can be selected from 5000- to 7000-level courses offered in the School of Architecture and Planning, 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 Building Performance track.		
C. Free Electives (12 semester credit hours)		**12**

These can be selected from 5000- to 7000-level courses offered in other UTSA departments, with the approval of the Dissertation Committee. The objective of these courses is to expanded knowledge outside of traditional areas and promote interdisciplinary research.

D. Seminars (2 semester credit hours)		**2**
ARC 7011	Doctoral Seminar in Architecture (repeated)	
E. Doctoral Research and Dissertation (30 semester credit hours)		**30**
15 semester credit hours required of Doctoral Research and 15 semester credit hours required of Doctoral Dissertation:		
ARC 7213	Doctoral Research	
or ARC 7212	Doctoral Research	
or ARC 7211	Doctoral Research	
ARC 7313	Doctoral Dissertation	
or ARC 7312	Doctoral Dissertation	
or ARC 7311	Doctoral Dissertation	
Total Credit Hours		**74**

Construction Science and Management Track Degree Requirements

Students are required to complete the following courses based on the completion of a Master's degree or Bachelor's degree. 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.

Students who have obtained a master's degree are required to complete the following courses:

Code	Title	Credit Hours
A. Core Curriculum (6 semester credit hours)		**6**
At least two Core Curriculum CEE courses will be selected from the list below with the approval of the dissertation committee chair. Other CEE courses can be substituted with the approval of the track coordinator.		
CE 5023	Finite Element Methods	
CE 5043	Advanced Civil Engineering Statistics	
CE 5093	Geographic Information Systems (GIS)	
CE 5143	Numerical Methods in Civil Engineering	
CE 5453	Transportation Engineering	
CE 5463	Foundation Engineering	
CE 5643	Sustainable Energy Systems	
CE 5703	Special Topics in Hydraulics and Hydrology	
CE 5713	Special Topics in Structures	
CE 5733	Special Topics in Environmental Engineering	
CE 5743	Special Topics in Geotechnical Engineering	
CE 6953	Independent Study	
B. Track Electives (12 semester credit hours)		**12**
Student must select required CSM courses or other electives from the list below according to his/her selected track of study and the requirements above. Other courses can be substituted with the approval of the Dissertation Committee.		
CSM 5133	Construction Practice in a Global Setting	
CSM 5223	Building Information Modeling for Construction Management	
CSM 5243	Sustainable Construction and Delivery	
CSM 5413	Advanced Topics in Construction Systems	
CSM 5423	Advanced Topics in Project Controls and Scheduling	
CSM 5433	Construction Safety Planning and Management	
CSM 5633	Advanced Construction Management	
CSM 6643	Artificial Intelligence in Construction Management	
CSM 6951	Independent Study	
CSM 6953	Independent Study	
CSM 6973	Special Topics	
CSM 6976	Special Topics	
CSM 7103	Decision-Making in Construction Management	
CSM 7113	Resiliency within the Built Environment	
CSM 7203	Research Methods	
C. Seminars (2 semester credit hours)		**2**
CSM 7011	Construction Graduate Seminar (repeated)	
D. Doctoral Research and Dissertation (30 semester credit hours)		**30**
15 semester credit hours required of Doctoral Research and 15 semester credit hours required of Doctoral Dissertation:		
CSM 7213	Doctoral Research	
or CSM 7212	Doctoral Research	
or CSM 7211	Doctoral Research	
CSM 7313	Doctoral Dissertation	
or CSM 7312	Doctoral Dissertation	
or CSM 7311	Doctoral Dissertation	
Total Credit Hours		**50**

Students who have obtained a bachelor's degree are required to complete the following courses:

Code	Title	Credit Hours
A. Core Curriculum (9 semester credit hours)		**9**
At least three Core Curriculum CEE courses will be selected from the list below with the approval of the dissertation committee chair. Other CEE courses can be substituted with the approval of the track coordinator.		
CE 5023	Finite Element Methods	
CE 5043	Advanced Civil Engineering Statistics	
CE 5093	Geographic Information Systems (GIS)	
CE 5143	Numerical Methods in Civil Engineering	
CE 5453	Transportation Engineering	
CE 5463	Foundation Engineering	
CE 5643	Sustainable Energy Systems	
CE 5703	Special Topics in Hydraulics and Hydrology	
CE 5713	Special Topics in Structures	
CE 5733	Special Topics in Environmental Engineering	
CE 5743	Special Topics in Geotechnical Engineering	
CE 6953	Independent Study	
B. Track Electives (33 semester credit hours)		**33**

Student must select required CSM courses or other electives from the list below according to his/her selected track of study and the requirements above. Other courses could be substituted with the approval of the Dissertation Committee.		
CSM 5133	Construction Practice in a Global Setting	
CSM 5223	Building Information Modeling for Construction Management	
CSM 5243	Sustainable Construction and Delivery	
CSM 5413	Advanced Topics in Construction Systems	
CSM 5423	Advanced Topics in Project Controls and Scheduling	
CSM 5433	Construction Safety Planning and Management	
CSM 5633	Advanced Construction Management	
CSM 6643	Artificial Intelligence in Construction Management	
CSM 6951	Independent Study	
CSM 6953	Independent Study	
CSM 6973	Special Topics	
CSM 6976	Special Topics	
CSM 7103	Decision-Making in Construction Management	
CSM 7113	Resiliency within the Built Environment	
CSM 7203	Research Methods	
C. Seminars (2 semester credit hours)		**2**
CSM 7011	Construction Graduate Seminar (repeated)	
D. Doctoral Research and Dissertation (30 semester credit hours)		**30**
15 semester credit hours required of Doctoral Research and 15 semester credit hours required of Doctoral Dissertation:		
CSM 7213	Doctoral Research	
or CSM 7212	Doctoral Research	
or CSM 7211	Doctoral Research	
CSM 7313	Doctoral Dissertation	
or CSM 7312	Doctoral Dissertation	
or CSM 7311	Doctoral Dissertation	
Total Credit Hours		**74**

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 School, and the remaining members must be members of the graduate faculty. For the Building Performance Track and the Construction Science and Management Track, the chair of the committee must be a member of the graduate faculty from the School of Architecture and Planning, and the School of Civil and Environmental Engineering, and Construction Science and Management, respectively. 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 six technical areas, namely structures, geotechnical, transportation, water resources, building performance, and construction science and management. In addition, the students may be asked to carry out a critical review of engineering or other relevant research publications. A written qualifying examination will be administered by the CEE graduate studies committee (GSC) with input from the faculty participating in the program. The qualifying examination for the Building Performance Track and the Construction Science and Management Track will include questions on fundamental and applied topics related to Building Performance and Construction Science and Management, respectively. 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.

Upon successful completion of the qualifying examination, students are allowed to take Doctoral Research credit hours. 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 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 School of Civil and Environmental Engineering and Construction Management (CECM) 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 CECM. It encompasses faculty and facilities from the Klesse College of Engineering and Integrated Design and the College of Sciences, as well as individual faculty from other UTSA departments. The program has four separate tracks: Environmental Science, Environmental Engineering, Water Resources, and Geoscience. 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's or master's degree from an accredited university, and a minimum grade point average of 3.0 in upper-division and/or graduate courses. The degrees should be in Biology, Ecology, Environmental Science, Chemistry, Geology, Geography, Environmental Engineering, Civil Engineering, or another related scientific or engineering discipline.
- 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 to UTSA Graduate Admissions online at http://graduateschool.utsa.edu. Incomplete applications will not be considered. Acceptance to the program is determined by the Doctoral Studies Committee (DSC), comprised of graduate faculty members selected from CECM and the College of Sciences, contingent upon available funding. Full-time students accepted to the program are eligible to apply for financial support in the form of competitive teaching assistantships, research assistantships, or research fellowships. Note that admission is competitive, and satisfying these requirements does not guarantee admission.

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. With the approval from the chair of their Dissertation Committee, students can apply 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 75 semester credit hours to graduate. Additional degree requirements include passing a written and/or oral qualifying examination, writing a doctoral dissertation, and passing a final examination/dissertation defense.

A minimum of twenty one (21) semester credit hours of required elective courses must be selected by each student according to their selected track of study, as defined below. These need to be approved by the student's Dissertation Committee and the Chair of the DSC. These elective courses may be offered by departments in the College of Sciences, the Klesse College of Engineering and Integrated Design, or by other departments at UTSA.

Students who have obtained a master's degree are required to complete the following courses:

Code	Title	Credit Hours
A. Degree Core Curriculum (10 semester credit hours):		**10**
CE 5001	Process and Ethics in Thesis/Dissertation Research Development	
CE 5043	Advanced Civil Engineering Statistics	
or ES 5023	Environmental Statistics	
or STA 5103	Applied Statistics	
or GEO 5063	Applied Statistics for Geoinformatics	
ES 5233	Experimental Design and Analysis	
or CE 5143	Numerical Methods in Civil Engineering	
or ES 6033	Applied Multivariate Statistics for Ecological Data	
or STA 6813	Multivariate Analysis	
or STA 6863	Spatial Statistics	
Select one of the following:		
CE 5093	Geographic Information Systems (GIS)	
CE 6383	Global Change	
ES 5043	Global Change	
GEO 5033	Geographical Information Systems	
GEO 6043	Global Change	
B. Track Electives (12 semester credit hours):		**12**

These can be selected from 5000- to 7000- level courses offered in CECM, Department of Earth and Planetary Sciences, Department of Integrative Biology, or other departments, with the approval of the student's Dissertation Committee and the Chair of the DSC. The objective of these courses is to provide advanced training in areas considered to form the foundation for these disciplines. Faculty advisor will develop a plan of study based on the career goals, chosen track, and dissertation objectives of the student. The plan of study will include courses that build the fundamental knowledge required to complete the dissertation, and courses outside of traditional areas for the student involved in multidisciplinary research.

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 chemical, physical, and/or biological sciences in solving environmental problems. These elective courses can be selected from the graduate courses offered by the College of Sciences, CECM, 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 Committee Chair 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, CECM, 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. Water Resources Track Electives

The objective of this track is to train students in conducting research in the various aspects of water resources, with an emphasis on the application of science and engineering principles in the study of physical, chemical, biological, and social factors that affect water quantity and quality. Elective courses can be selected from the graduate courses offered by the College of Sciences, CECM, 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.

4. Geoscience Track Electives

The objective of this track is to train students in conducting research in the various aspects of geoscience, with a focus on the application of physical science in solving problems relating to the past, present, and future of the Earth system, and of other planets. Elective courses can be selected from the graduate courses offered by the College of Sciences, CECM, 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.

C. Other Electives		**6**
These can be selected from 5000- to 7000-level courses offered in CECM or other departments, with the approval of the Environmental Science and Engineering Doctoral Studies Committee.		
D. Seminars (2 semester credit hours);		**2**
CE 6621	Graduate Seminar in Environmental Science and Engineering	
or ES 5981	Graduate Seminar in Environmental Science and Engineering	
or GEO 5991	Graduate Seminar in Geosciences	
E. Doctoral Research and Dissertation (30 semester credit hours):		**30**
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, or CE 7211)	
CE 7313	Doctoral Dissertation (or CE 7312, or CE 7311)	
Option II:		
ES 7213	Doctoral Research (or ES 7212, or ES 7211)	
ES 7313	Doctoral Dissertation (or ES 7312, or ES 7311)	
Option III:		
GEO 7213	Doctoral Research (or GEO 7212, or GEO 7211)	
GEO 7313	Doctoral Dissertation (or GEO 7312, or GEO 7311)	
Total Credit Hours		**60**

Students who have obtained a bachelor's degree are required to complete the following courses:

Code	Title	Credit Hours
A. Degree Core Curriculum (10 semester credit hours):		**10**
CE 5001	Process and Ethics in Thesis/Dissertation Research Development	
CE 5043	Advanced Civil Engineering Statistics	
or ES 5023	Environmental Statistics	
or GEO 5063	Applied Statistics for Geoinformatics	
ES 5233	Experimental Design and Analysis	
or CE 5143	Numerical Methods in Civil Engineering	
or ES 6033	Applied Multivariate Statistics for Ecological Data	
or STA 6813	Multivariate Analysis	

or STA 6863	Spatial Statistics	
Select one of the following:		
CE 6383	Global Change	
CE 5093	Geographic Information Systems (GIS)	
ES 5043	Global Change	
GEO 5033	Geographical Information Systems	
GEO 6043	Global Change	
B. Track Electives (21 semester credit hours):		**21**
These can be selected from 5000- to 7000-level courses offered in CECM 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 chemical, physical, and/or biological sciences in solving environmental problems. These elective courses can be selected from the graduate courses offered by the College of Sciences, CECM, 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, CECM, 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. Water Resources Track Electives		
The objective of this track is to train students in conducting research in the various aspects of water resources, with an emphasis on the application of science and engineering principles in study of physical, chemical, biological, and social factors that affect water quantity and quality. Elective courses can be selected from the graduate courses offered by the College of Sciences, CECM, 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.		
4. Geoscience Track Electives		
The objective of this track is to train students in conducting research in the various aspects of geoscience, with a focus on the application of physical science in solving problems relating to the past, present, and future of the Earth system, and of other planets. Elective courses can be selected from the graduate courses offered by the College of Sciences, CECM, 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.		
C. Other Electives		**12**
These can be selected from 5000- to 7000-level courses offered in the CECM or other departments, with the approval of the Environmental Science and Engineering Doctoral Studies Committee.		
D. Seminars (2 semester credit hours:)		**2**
CE 6621	Graduate Seminar in Environmental Science and Engineering	
or ES 5981	Graduate Seminar in Environmental Science and Engineering	
or GEO 5991	Graduate Seminar in Geosciences	
E. Doctoral Research and Dissertation (30 semester credit hours:)		**30**
Select one of the following options:		
Option I:		
CE 7213	Doctoral Research (or CE 7212, or CE 7211)	
CE 7313	Doctoral Dissertation (or CE 7312, or CE 7311)	
Option II:		
ES 7213	Doctoral Research (or ES 7212, or ES 7211)	
ES 7313	Doctoral Dissertation (or ES 7312, or ES 7311)	
Option III:		
GEO 7213	Doctoral Research (or GEO 7212, or GEO 7211)	
GEO 7313	Doctoral Dissertation (or GEO 7312, or GEO 7311)	
Total Credit Hours		**75**

Dissertation Committee

Students must choose a Dissertation Committee consisting of a chair and at least three additional graduate faculty members. This committee must include a minimum of one faculty member from CECM 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 year of study.

Advancement to Candidacy

Ph.D. students advance to candidacy after completing their written and/or oral qualifying examinations. First, students must complete the core curriculum courses and then take the qualifying examination. Full-time students must take the qualifying examination by the end of their second year of study. Part-time students need to take the written qualifying examination at a time dictated by the DSC. The qualifying examination may include questions on six core areas, including statistics/spatial data science, hydrogeology, biology, chemistry, environmental engineering, and water resources. In addition, the students may be asked to carry out a critical review of a topic related to their doctoral research. 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 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 qualifying examination are permitted. Students who fail the qualifying examination twice are terminated from the program.

Upon successful completion of the qualifying examination, students are allowed to take Doctoral Research credit hours. 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 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. Results of the written and/or oral examination 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

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.

- Graduate Certificate in Construction Engineering, Science and Management (p. 10)
- Graduate Certificate in Facility Management (p. 11)

Graduate Certificate in Construction Engineering, Science and Management

The Graduate Certificate in Construction Engineering, Science and Management (CESM) is designed to prepare individuals with important practical knowledge necessary for successful careers in the construction industry. It certifies to employers that the individual that received the CESM graduate certificate has completed coursework essential to be a valuable asset to companies. The CESM graduate certificate courses will provide students with working knowledge in the areas of Project Controls and Scheduling, Construction Safety Planning and Management, Cost Estimating, Building Information Modeling, Sustainable Construction and Delivery, Artificial Intelligence in Construction Management, Decision-Making in Construction Management, and Resiliency within the Built Environment and Leadership.

Admission Requirements

The requirement for admission to the certificate program includes at least a senior level of a four year undergraduate degree in either engineering, architecture, business, or other related disciplines. Students admitted to the program will be required to have a minimum overall GPA of 3.0. Additionally, 0.1 will be added to the overall GPA for applicants for each full-time year of construction experience. For example, if an applicant has a 2.5 overall GPA and five years of construction industry experience, the finalized GPA would be 3.0, and the applicant would meet the minimum requirement for admission. Students who do not meet the admission requirements could be accepted conditionally by registering in additional leveling courses as indicated by the Chair of the CESM Graduate Certificate Committee and must obtain a minimum GPA of 3.0 in the first 6 semester credit hours in order to be in good standing.

Applications containing official transcripts and a résumé must be submitted online through the UTSA Graduate Admissions application portal. Incomplete applications will not be considered. Acceptance to the CESM graduate certificate program is determined by the CSM faculty graduate committee.

Currently enrolled graduate students should fill out the UTSA Graduate Certificate Form (https://ceid.utsa.edu/civil-environmental-construction-management/graduate/) and send to debaditya.chakraborty@utsa.edu.

Certificate Requirements

A minimum of 15 semester credit hours are required for completion of the graduate CESM certificate program. Students are expected to complete 3 semester credit hours of CSM 6943 Construction Internship. In exceptional cases, and with the approval from the Chair of the Graduate CESM certificate committee, CSM 6973 Special Topics might be approved as a replacement course for CSM 6943. The remaining 12 semester credit hours will be selected from prescribed elective courses below.

Code	Title	Credit Hours
A. Required Course:		**3**
CSM 6943	Construction Internship	
or CSM 6973	Special Topics	
B. Prescribed Graduate Construction Electives. Select 12 semester credit hours from the following courses:		**12**
CSM 5033	Construction Cost Estimating for International Projects	
CSM 5133	Construction Practice in a Global Setting	
CSM 5223	Building Information Modeling for Construction Management	
CSM 5243	Sustainable Construction and Delivery	
CSM 5413	Advanced Topics in Construction Systems	
CSM 5423	Advanced Topics in Project Controls and Scheduling	
CSM 5433	Construction Safety Planning and Management	
CSM 5633	Advanced Construction Management	
CSM 6643	Artificial Intelligence in Construction Management	
CSM 6953	Independent Study	

CSM 6973	Special Topics
CSM 7103	Decision-Making in Construction Management
CSM 7113	Resiliency within the Built Environment
Total Credit Hours	**15**

Graduate Certificate in Facility Management

The graduate certificate in Facility Management is a 100% online, 15-semester-credit-hour certificate program, designed to educate and equip graduate-level facility management students with advanced facilities management knowledge and skills to enhance their performance and capabilities and to increase their professional qualifications. Students who complete the Facility Management graduate certificate will be prepared to make an immediate positive impact that supports and advances the profession.

Admission Requirements

Applicants for this program must have a bachelor's or master's degree in engineering, architecture, sciences, business, or other facility management-related field or discipline. Practicing facility managers with at least two years of experience in facility management and a bachelor's degree in other fields will also be admitted to the program, with approval of the program coordinator.

Applicants will apply for admission to the certificate as a special (non-degree-seeking) graduate student according to UTSA's admission requirements for certificate programs (see Certificate Program Regulations in this catalog). Additionally, applicants will be required to submit a résumé detailing their facilities management experience.

Certificate Program Requirements

To satisfy the requirements for the Graduate Certificate in Facility Management, students must complete 15 semester credit hours as follows:

Code	Title	Credit Hours
A. 15 semester credit hours of the following required courses:		15
FM 5003	Facilities Management Professional Trends	
FM 5113	Operations and Maintenance: Management of Built Assets	
FM 5213	Project Management: Planning and Execution of Projects	
FM 5313	Finance and Business: Financial Aspects of Facilities Management	
FM 5413	Leadership and Strategy: Facilities Management Leadership and Excellence	
Total Credit Hours		**15**

To maintain enrollment in the certificate program, students must maintain a 3.0 grade point average throughout their tenure in the program.

Civil Engineering (CE) Courses

CE 5001. Process and Ethics in Thesis/Dissertation Research Development. (1-0) 1 Credit Hour.
Course discusses the process and the ethical issues involved in conducting research and developing a thesis or dissertation. It covers research organizational skills, literature searches, technical writing, honesty in writing and plagiarism issues. Differential Tuition: $55.

CE 5023. 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. (Same as ME 5483. Credit cannot be earned for both CE 5023 and ME 5483). Differential Tuition $165. Course fees: LRE1 $25; STSE $30.

CE 5033. Experiential Learning in Civil Engineering. (3-0) 3 Credit Hours.
Students may obtain credit for professional work experiences outside of UTSA that align with areas of graduate study in Civil Engineering. Students must develop a portfolio of work demonstrating that they have achieved learning objectives established by a faculty advisor. The portfolio will be evaluated by the faculty advisor, and if approved, the student must pass a proficiency exam evaluating his/her proficiency in the course learning outcomes. Differential Tuition: $165.

CE 5043. Advanced Civil Engineering Statistics. (3-0) 3 Credit Hours.
Statistical analysis methods include descriptive statistics, interval estimation and hypothesis testing, analysis of variance, design of experiments, regression analysis, and time series analysis. Additional topics covered include probabilistic methods, decision analysis and reliability analysis applied to civil engineering systems. Differential Tuition: $165.

CE 5093. Geographic Information Systems (GIS). (3-0) 3 Credit Hours.
Introduces vector, raster and tabular concepts, emphasizing the vector approach. Topics include spatial relationships, map features, attributes, relational database, layers of data, data ingesting, digitizing from maps, projections, output, applications, and availability of public data sets. Focus will be placed on spatial/temporal data analyses using digitized maps and database information in an area of CE specialization. (Formerly CE 5293. Credit cannot be earned for both CE 5093 and CE 5293.) Differential Tuition: $165.

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 5323, 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.
Asphalt concrete and portland concrete pavement analysis and design. Layered elastic, nonlinear, and viscoelastic analysis. Slabs under environmental and traffic stresses. Software for layer analysis and slab analysis. AASHTO 1993 design method. Asphalt Institute and Portland Cement Association method. NCHRP 1-37A developed mechanistic-empirical design method. (Formerly CE 5513 Topic 5: Pavement Design. Credit cannot be earned for both CE 5423 and CE 5513 Pavement Design.) Differential Tuition: $165.

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 5463. 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 5353 Topic 2: Advanced Foundation Engineering. Credit cannot be earned for both CE 5463 and CE 5353 Advanced Foundation Engineering). Differential Tuition $165. Course fees: LRE1 $25; STSE $30.

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 5493. Traffic Engineering. (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 5523. Retaining Structures. (3-0) 3 Credit Hours.
This course covers lateral earth pressure theories and their applications in various retaining wall designs. The included types of retaining walls are mechanically stabilized earth (MSE) wall, soil nail wall, tie-back wall, soldier pile wall, and drilled shaft wall. Students will be required to design and analyze different types of retaining structures using the learned theories. In addition, popular computer software packages will also be introduced in this course as design tools. 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. Course fees: LRE1 $25; STSE $30.

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. Course fees: LRE1 $25; STSE $30.

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. Course fees: LRE1 $25; STSE $30.

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. The grade report for this course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). 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 6143. Engineering Reliability Analysis. (3-0) 3 Credit Hours.
This course introduces students to the use of statistical and computational techniques for uncertainty quantification and propagation, and for reliability assessment of engineering systems. This course provides insights and perspectives on the use of these tools in engineering decision-making, based on exemplar applications and case studies on engineering systems. This course will cover topics related to probability theory, random variables and probability distributions, functions of random variables, Monte-Carlo simulations, first-order reliability analysis, Markov chain and time-dependent reliability, and Bayesian updating. 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.
Prerequisites: CE 5163 and CE 6173 or equivalents. Condition assessment of existing structures. Evaluation of in-situ capacity of structures using advanced modeling and numerical simulation techniques. Methods for repair and rehabilitation of deficient structures. Differential Tuition: $165.

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 6113. 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 statnamic 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. Course fees: LRE1 $25; STSE $30.

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 from 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 from 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 from 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 from 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.

Construction Science and Management (CSM) Courses

CSM 5033. Construction Cost Estimating. (3-0) 3 Credit Hours.
Emphasis on pricing work, subcontracting, and bidding strategies utilizing applicable software. Generally offered: Fall, Spring. Differential Tuition: $165.

CSM 5133. Construction Practice in a Global Setting. (3-0) 3 Credit Hours.
Seminar dealing with national and international business and legal environments in the construction industry. Topics include agreement and delivery options, forms of construction, project procedures and administration, liability, contract documents, and ethics. Differential Tuition: $165. Course fees: STSE $30; SAP1 $25.

CSM 5223. Building Information Modeling for Construction Management. (3-0) 3 Credit Hours.
Advanced techniques used in development and management of Building Information Models. Emphasis on constructability and management. Differential Tuition: $165.

CSM 5243. Sustainable Construction and Delivery. (3-0) 3 Credit Hours.
Sustainability principles applied to design, construction and operation of built environment. Emphasis on site management and constructability. Differential Tuition: $165.

CSM 5413. Advanced Topics in Construction Systems. (1-4) 3 Credit Hours.
The management of the construction process pertaining to large, complex, and unique buildings. The management of sustainable construction, adaptive use of existing buildings, and historic preservation projects will be included. (Formerly ARC 5413. Credit cannot be earned for both CSM 5413 and ARC 5413.) Differential Tuition: $165.

CSM 5423. Advanced Topics in Project Controls and Scheduling. (3-0) 3 Credit Hours.
Advanced techniques used in scheduling and planning processes in construction project control, including resource allocations and schedule recovery. Differential Tuition: $165.

CSM 5433. Construction Safety Planning and Management. (3-0) 3 Credit Hours.
Current construction safety and health issues. Development of site-specific plans and methodology to provide hazard reduction on job sites. Differential Tuition: $165.

CSM 5633. Advanced Construction Management. (3-0) 3 Credit Hours.
Prerequisite: Consent of instructor. Organization and integration of construction resources and activities to include consideration of ethical practice, scheduling, methods of construction, project planning and management, cost accounting, and personnel utilization. Differential Tuition: $165.

CSM 6643. Artificial Intelligence in Construction Management. (3-0) 3 Credit Hours.
This course introduces the concepts of artificial intelligence and machine learning to help construction students build data-driven solutions. Students will also learn to analyze multidimensional data and develop machine learning models in Python using datasets that are relevant to the CSM discipline. Differential Tuition: $165.

CSM 6943. Construction Internship. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing, 18 semester credit hours of graduate work, and consent of instructor. Supervised full-time construction work experience with public agencies or private companies. Individual conferences and written reports required. Differential Tuition: $165.

CSM 6951. Independent Study. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing and permission in writing (form available) from the instructor and the Graduate Advisor of Record. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours will apply to the degree. Differential Tuition: $55.

CSM 6953. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) from the instructor and the Graduate Advisor of Record. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours will apply to the degree. Differential Tuition: $165.

CSM 6973. Special Topics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing or consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Topics courses may be repeated for credit when topics vary, but not more than 6 hours of CSM 6973 or 12 hours of CSM 6976 will apply to the degree. Differential Tuition: $165. Course fees: STSE $30; SAP1 $25.

CSM 6976. Special Topics. (6-0) 6 Credit Hours.
Prerequisite: Graduate standing or consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Topics courses may be repeated for credit when topics vary, but not more than 6 hours of CSM 6973 or 12 hours of CSM 6976 will apply to the degree. Differential Tuition: $330.

CSM 7011. Construction Graduate Seminar. (1-0) 1 Credit Hour.
Will include presentations of current research by faculty ,invited guests who are experts in fields related to construction science and management, and advanced graduate students who are about to complete their dissertation research. May be repeated for credit. The grade report for the course is either "CR" (satisfactory) or "NC" (unsatisfactory). Differential Tuition: $55.

CSM 7103. Decision-Making in Construction Management. (3-0) 3 Credit Hours.
Decision processes can range from quantitative computational analysis to qualitative experiential evaluations. This course provides a set of practical tools and theoretical frameworks to help construction managers address the challenges of decision-making and problem-solving. Differential Tuition: $165.

CSM 7113. Resiliency within the Built Environment. (3-0) 3 Credit Hours.
This course provides students with the opportunity to obtain a thorough understanding of resiliency issues and its interrelation with the built environment by retrospectively investigating technological progress, addressing current issues, and contemplating on possible futures. Differential Tuition: $165.

CSM 7203. Research Methods. (3-0) 3 Credit Hours.
This course provides guidance on research formulation and methodologies adopted for scientific and engineering experiments, model building and simulations, exploration and analysis of multidimensional data. Students are introduced to concepts necessary for producing research proposals, executing the research, and reporting the results. Differential Tuition: $165.

CSM 7211. Doctoral Research. (0-0) 1 Credit Hour.
Prerequisite: Consent of advisor. 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.

CSM 7212. Doctoral Research. (0-0) 2 Credit Hours.
Prerequisite: Consent of advisor. Research work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but no more than I 5 hours may be applied to the Doctoral degree. Differential Tuition: $110.

CSM 7213. Doctoral Research. (0-0) 3 Credit Hours.
Prerequisite: Consent of advisor. 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.

CSM 7311. Doctoral Dissertation. (0-0) 1 Credit Hour.
Prerequisite: Successful defense of comprehensive exam. 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.

CSM 7312. Doctoral Dissertation. (0-0) 2 Credit Hours.
Prerequisite: Successful defense of comprehensive exam. 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.

CSM 7313. Doctoral Dissertation. (0-0) 3 Credit Hours.
Prerequisite: Successful defense of comprehensive exam. 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.

Facility Management (FM) Courses

FM 5003. Facilities Management Professional Trends. (3-0) 3 Credit Hours.
Course includes an in#depth analysis of the most common practices of Facility and Property Managers, including sustainability issues, environmental factors, buildings safety, leasing activities, building technologies, continuous quality improvement, and FM and real estate trends and practices. Differential Tuition: $165.

FM 5113. Operations and Maintenance: Management of Built Assets. (3-0) 3 Credit Hours.
Course provides in#depth discussion of Facility and Property Management Operations and Maintenance, including building systems, and approaches to operating and maintaining facilities, the effective development and management of facilities predictive, preventive, and corrective maintenance programs, and other aspects of FM maintenance and operations. Differential Tuition: $165.

FM 5213. Project Management: Planning and Execution of Projects. (3-0) 3 Credit Hours.
Course provides in#depth discussion of facilities project management from initial project planning, estimating and scope definition, through design and construction to project close out. Course includes project manager roles and responsibilities, project processes and life cycles, programming, scope, design deliverables, project plans, critical path method project scheduling and control, and project oversight from start to finish. Differential Tuition: $165.

FM 5313. Finance and Business: Financial Aspects of Facilities Management. (3-0) 3 Credit Hours.
Course includes analysis, budgeting, accounting, risk management & reporting to demonstrate applications of facility financial management to prepare students to analyze & interpret financial statements to make FM decisions, and understand & apply accounting and finance principles to facility management business operations, and manage facilities financial and other high value assets to effectively deliver facility services. Differential Tuition: $165.

FM 5413. Leadership and Strategy: Facilities Management Leadership and Excellence. (3-0) 3 Credit Hours.
Course provides fundamental FM leadership concepts and practices from strategic facility planning, development and execution of facility services, effective leadership of the facility organization, appropriate methods of measuring and evaluating facility performance, identification of root causes of negative performance and ways to continuously improve performance with a focus on performance excellence. Differential Tuition: $165.

FM 5513. Energy, Utilities and Environmental Stewardship: Energy Management and Sustainable Facilities. (3-0) 3 Credit Hours.
Course provides students an understanding of operational energy and utility system management in the context of the built environment, and equips students to understand and implement energy and utility conservation measures, and sustainability initiatives to reduce institutional carbon footprint and enhance stewardship of the natural environment. Course includes discussion of energy management systems, Energy Star and STARS assessments and ratings, energy calculations, energy efficiency programs, commissioning and retro# commissioning, energy and utility audits, and FM sustainability practices and trends. Differential Tuition: $165.

FM 5613. Human Factors and Resources in Facilities Management. (3-0) 3 Credit Hours.
Course introduces students to occupancy and human resources management in a facilities management organization, including space management, staff recruitment, hiring, job families and career paths, training and skill development, advancement, performance management, retention and termination, safety and security, and current regulatory environment. Also includes discussion of outsourcing issues, and "To# do#or#buy" analysis to aide in decision making related to potential outsourcing of facility functions. Differential Tuition: $165.

FM 5713. Quality, Productivity and Technology in Facility Management. (3-0) 3 Credit Hours.
Course will provide foundational concepts relating to facility management technology and how it is used to assure quality, productivity and operational excellence in facility operations. Includes the use technology, quality assurance, economics and life#cycle cost analysis and performance measurement and operational reporting to advance the productivity of facilities staff and provide customers and stakeholders with excellence in FM Services. Differential Tuition: $165.

FM 5813. Environmental Health, Safety, Risk Management, and Business Continuity in Facility Management. (3-0) 3 Credit Hours.
Course will provide students an understanding of environmental health, safety, and risk management issues in the built environment and equip them to effectively develop and implement emergency management and business continuity plans, and respond to workplace emergencies and other contingencies impacting the ability of the organization to perform its mission. Differential Tuition: $165.

FM 5903. Graduate Capstone Project - Solving Problems in Facilities Management. (3-0) 3 Credit Hours.
Prerequisites: FM 5003, FM 5113, FM 5213, FM 5313, FM 5413, FM 5513, FM 5613, FM 5713, and FM 5813. Capstone course will be a student# led effort to identify a significant facility management challenge, analyze causes and impacts of the challenge, consider various solution options, and implications of each, and develop a thoughtful and effective solution to address the challenge. Includes the study of formal problem solving principles, and presentation of multi#media findings to address all aspects of the challenge and solution to executive leadership. Differential Tuition: $165.