DEPARTMENT OF ENVIRONMENTAL SCIENCE AND ECOLOGY

The Department of Environmental Science and Ecology offers a Master of Science degree in Environmental Science with two options: 1) thesis, or 2) professional (non-thesis). The Department also offers graduate certificates in Environmental Science and Environmental Sustainability.

UTSA offers a Graduate Studies program leading to the Ph.D. degree in Environmental Science and Engineering. This program is administered by the Department of Civil and Environmental Engineering.

- M.S. in Environmental Science
- Ph.D. in Environmental Science and Engineering

Master of Science Degree in Environmental Science

The College of Sciences offers opportunities for advanced study and research leading to the Master of Science degree in Environmental Science. The regulations for this degree comply with the general University regulations as outlined in this catalog and indicated below.

The Master of Science in Environmental Science Program is multidisciplinary, and draws on faculty from many departments, including Biology, Chemistry, Civil and Environmental Engineering, and Geological Sciences. Specific information about faculty research can be found through departmental websites or by contacting individual faculty members. The nature of the environmental science program allows students the opportunity to broaden their scientific background at the graduate level. Individual programs are organized around each student's interests in consultation with the student's Graduate Advisor and Graduate Committee.

Program Admission Requirements

In addition to satisfying the University-wide graduate admission requirements, all prospective students must have a Bachelor of Arts or Bachelor of Science degree from an accredited university and a minimum grade point average of 3.0 (on a 4.0 scale) in upper-division and graduate work. The degree should be in biology, ecology, environmental science, chemistry, geology, engineering, or some other related scientific discipline. Additionally, it is required that applicants will have taken coursework in the following areas: 1) one semester in general statistics, and 2) one semester of environmental science. Applicants lacking these requirements will be asked to complete these deficiencies within the first 12 credit hours. Students who have not had any undergraduate course work in Environmental Law, will be required to take ES 5133 Fundamentals of Environmental Law during their first semester, which can be applied to the degree. Applications for admission will be considered on a case-by-case basis.

Applicants whose native language is not English must score at least 60 (paper version) or 79 (Internet version) on the Test of English as a Foreign Language (TOEFL), or 6.5 on the International English Language Testing System (IELTS). Applicants must submit a minimum of two letters of recommendation from persons familiar with the applicant's academic record, a personal statement of research interest as well as professional and academic goals, and a résumé. All supporting documents should be sent to the Graduate School. Incomplete applications will not be considered until all required items are in an applicant's file.

The Graduate Studies Committee, comprised of members selected from the graduate faculty, will be responsible for recommending acceptance into the program. Some teaching assistantships, research assistantships, or research fellowships are available, but require a separate application; requests should be addressed to the Graduate Advisor of Record (GAR) for the Environmental Science program.

Degree Requirements

The Master of Science degree requires a minimum of 36 semester credit hours beyond the baccalaureate degree (exclusive of coursework or other study required to remove deficiencies). The thesis option is recommended for students who are planning a career in environmental education, research, or who are planning to go on and earn a doctorate degree.

A professional (non-thesis) option is also available for those interested in developing skills and knowledge to assume professional research and/or managerial positions within public, private, and nonprofit organizations. The program is designed to develop skills in data analysis, oral and written communication, and interdisciplinary teamwork. This degree is considered a terminal degree and is not recommended for those students who want to consider earning a doctorate degree in environmental science.

Degree candidates are required to complete a minimum of 36 semester credit hours approved by the student's Graduate Advisor and Graduate Committee. Final approval is made by the Graduate Advisor of Record. These credit hours are subject to the following conditions:

Thesis Option

A. Required Organized Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 5013</td>
<td>Survey Topics in Environmental Science</td>
<td>1</td>
</tr>
<tr>
<td>ES 5023</td>
<td>Environmental Statistics</td>
<td></td>
</tr>
<tr>
<td>ES 5503</td>
<td>Policy and Principles of Environmental Law</td>
<td></td>
</tr>
<tr>
<td>ES 5981</td>
<td>Graduate Seminar in Environmental Science and Engineering</td>
<td>2</td>
</tr>
<tr>
<td>ES 6941</td>
<td>Environmental Science Colloquium (may be repeated)</td>
<td>2</td>
</tr>
</tbody>
</table>

B. Organized courses within the College of Sciences in consultation with the student's Graduate Advisor and Graduate Committee

Up to 6 semester credit hours of approved upper-division undergraduate coursework may be applied. If approved to enroll in undergraduate coursework students must complete the Permission for Enrolling in Undergraduate Courses While a Graduate form and receive all approvals.

C. 12 semester credit hours of research:

<table>
<thead>
<tr>
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<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 6935</td>
<td>Independent Study</td>
<td>3</td>
</tr>
<tr>
<td>or ES 6951</td>
<td>Independent Study</td>
<td>3</td>
</tr>
<tr>
<td>ES 6983</td>
<td>Master's Thesis (A total of 6 hours of Master's Thesis is required.)</td>
<td>36</td>
</tr>
</tbody>
</table>

Total Credit Hours: 36

1 This course must be taken in the first two semesters of the program.
2 A maximum of 3 semester credit hours in graduate seminar or 3 semester credit hours in colloquium are required. It may be any combination of hours from these courses.
A total of 6 hours of independent study hours may be applied in any combination from ES 6951 and ES 6953.

Candidates for the Master of Science degree electing the thesis option must first pass a research proposal examination in front of their Graduate Committee. The student should schedule the research proposal examination during the second semester but no later than the third semester of graduate work. The research proposal examination will be oral and will cover a written document that includes the thesis topic, objectives, and research proposed by the student, and will take one to two hours to complete. The research proposal examination may only be taken twice. If it is not passed the first time it may be scheduled again in the following semester. Finally, candidates in the thesis option must successfully defend their thesis before their Graduate Committee. The thesis defense will take two to three hours to complete. The thesis defense is normally scheduled in the last semester before the degree requirements are to be completed. Part of the thesis defense will be a public presentation in an open, advertised forum.

**Professional (Non-Thesis) Option**

**A. Required Organized Courses**

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<tbody>
<tr>
<td>ES 5013</td>
<td>Survey Topics in Environmental Science 1</td>
</tr>
<tr>
<td>ES 5023</td>
<td>Environmental Statistics</td>
</tr>
<tr>
<td>ES 5143</td>
<td>Technical Writing for Environmental Scientists</td>
</tr>
<tr>
<td>ES 5233</td>
<td>Experimental Design and Analysis</td>
</tr>
<tr>
<td>ES 5503</td>
<td>Policy and Principles of Environmental Law</td>
</tr>
<tr>
<td>ES 6103</td>
<td>Environmental Assessment</td>
</tr>
<tr>
<td>ES 6723</td>
<td>Application of Federal Environmental Law at the State Level</td>
</tr>
<tr>
<td>ES 5981</td>
<td>Graduate Seminar in Environmental Science and Engineering</td>
</tr>
<tr>
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</tr>
</tbody>
</table>

And 3 hours of the following in any combination:

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<td>Environmental Science Colloquium</td>
</tr>
</tbody>
</table>

**B. An additional 12 semester credit hours of approved graduate credit is required. This may include 6 hours of ES 6953 Independent Study. Up to 6 semester credit hours of approved upper-division undergraduate coursework and a maximum of 3 semester credit hours in a graduate seminar or 3 semester credit hours in colloquium (ES 5981 Graduate Seminar in Environmental Science and Engineering or ES 6941 Environmental Science Colloquium) may be applied to the degree.**

**Total Credit Hours**

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<td>ES 6941</td>
<td>Environmental Science Colloquium</td>
</tr>
</tbody>
</table>

1. This course must be taken in the first two semesters of the program.
2. If approved to enroll in undergraduate coursework students must complete the Permission for Enrolling in Undergraduate Courses While a Graduate form and receive all approvals.

Professional students should consult the Graduate Advisor of Record on their program of study and organize a Graduate Committee during the first semester of residence. Candidates are required to pass a written comprehensive examination that will cover 1) fundamentals of environmental science, 2) data analyses and experimental design, 3) environmental law, and 4) an additional topic to be determined by the Graduate Committee. This written examination should be arranged by the student with the Graduate Advisor of Record and their Graduate Committee. In addition, an oral examination will be administered by the student’s Graduate Committee. The oral examination will focus on academic material that the student is expected to have mastered during his or her course of study. The examinations are taken after the student has completed at least 30 semester credit hours of coursework. The written and oral examination may only be taken twice. If it is not passed the first time, it may be scheduled again in the following semester. If ES 6961 Comprehensive Examination is taken, it does not contribute toward the 36-semester-credit-hour minimum (refer to the Course Descriptions section).

**Graduate Committee**

As specified by University regulations, candidates for the Master of Science degree must have a Graduate Committee. The Committee will be chaired by the student’s Graduate Advisor and will consist of a minimum of two other members. The Committee should be appointed by the end of the first semester of the student’s graduate program. Certain rules must be adhered to concerning the composition of the Graduate Committee. Only tenured or tenure-track faculty members can chair these committees, and no more than one member can be a non tenure-track faculty member or be from another university.

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

UTSA offers a graduate-studies program leading to the Ph.D. degree in Environmental Science and Engineering. This program is administered by the Department of Civil and Environmental Engineering. Most of the participating graduate faculty are in the College of Sciences (including Department of Geological Sciences) and College of Engineering (Department of Civil and Environmental Engineering); additional faculty in this interdisciplinary program are from other colleges. Please refer to the Department of Civil and Environmental Engineering section of this catalog for details about this program.

- Graduate Certificate in Environmental Science
- Graduate Certificate in Environmental Sustainability

**Graduate Certificate in Environmental Science**

This 15-hour certificate in Environmental Science is designed to meet the needs of prospective students interested in developing skills in environmental science. The purpose of this certificate is to provide professionals who already have undergraduate degrees with graduate instruction in environmental science as a means of maintaining and promoting their professional development. Environmental science is an interdisciplinary subject; therefore, the certificate program is designed to provide graduates with coursework in environmental science in appropriate areas outside of their undergraduate major. The certificate provides students with a post-baccalaureate educational opportunity that is narrower in scope and shorter in duration than its associated master’s graduate degree program in the Environmental Science Academic Programs.

**Description of Certificate Program**

The certificate in Environmental Science is a 15-semester-credit-hour program. The prerequisites for this program are a bachelor’s degree with a current status as a degree-seeking or special student in a graduate-level program. To maintain enrollment in the certificate program, students should maintain a 3.0 grade point average throughout tenure in the program. No more than 3 semester credit hours may be transferred from another institution.
Program Requirements
To earn the Environmental Science certificate, students must complete 15 semester credit hours of required courses:

Required Courses (15 semester credit hours):

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 5033</td>
<td>3</td>
</tr>
<tr>
<td>ES 5103</td>
<td>3</td>
</tr>
<tr>
<td>ES 5133</td>
<td>3</td>
</tr>
<tr>
<td>or ES 5503</td>
<td>3</td>
</tr>
<tr>
<td>ES 5143</td>
<td>3</td>
</tr>
<tr>
<td>ES 6103</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credit Hours: 15

Graduate Certificate in Environmental Sustainability
This 15-hour certificate in Environmental Sustainability is designed to meet the needs of prospective students interested in developing knowledge in environmental sustainability. The purpose of this certificate is to provide professionals who already have undergraduate degrees with graduate instruction in environmental sustainability as a means of maintaining and promoting their professional development. The goal of this certificate is to fill specific gaps in knowledge for environmental professionals who are seeking advanced knowledge and skills in environmental sustainability. The certificate also builds a strong foundation for participants to obtain a master's degree at a future date.

Description of Certificate Program
The certificate in Environmental Sustainability is a 15-semester-credit-hour program. The prerequisites for this program are a bachelor's degree with a current status as a degree-seeking or special student in a graduate-level program. To maintain enrollment in the certificate program, students should maintain a 3.0 grade point average throughout tenure in the program. No more than 3 semester credit hours may be transferred from another institution.

Program Requirements
To earn the Environmental Sustainability certificate, students must complete 15 semester credit hours of required courses:

Required Courses (15 semester credit hours):

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 5043</td>
<td>3</td>
</tr>
<tr>
<td>ES 5133</td>
<td>3</td>
</tr>
<tr>
<td>or ES 5503</td>
<td>3</td>
</tr>
<tr>
<td>ES 5153</td>
<td>3</td>
</tr>
<tr>
<td>ES 5753</td>
<td>3</td>
</tr>
<tr>
<td>ES 6053</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credit Hours: 15

Environmental Sciences (ES) Courses
ES 5013. Survey Topics in Environmental Science. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing. Analysis of the basic concepts and new scientific developments in environmental science. Case studies will cover a range of relevant topics to promote a thorough understanding of the emergent issues in environmental science. Emphasis will be placed on developing both written and verbal scientific presentation skills. (Formerly EES 5013. Same as BIO 5013. Credit can be earned for only one of the following: BIO 5013, EES 5013, or ES 5013.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5023. Environmental Statistics. (3-0) 3 Credit Hours.
Prerequisites: ES 1314 and MAT 1033 or their equivalents, or consent of instructor. Emphasis on methods and applications of statistics for environmental science. Measure of location, variability, and association. Interpretation of categorical data, hypothesis testing, and use of statistical software programs and applications. (Formerly EES 5023. Same as GEO 5023 and CE 5043. Credit can be earned for only one of the following: EES 5023, ES 5023, GEO 5023, or CE 5043.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5043. Global Change. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in the program or consent of instructor. 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 EES 5043. Same as CE 6383 and GEO 5043. Credit can be earned for only one of the following: CE 6113, CE 6383, EES 5043, ES 5043, or GEO 5043.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5063. Environmental Microbiology. (3-0) 3 Credit Hours.
Prerequisite: BIO 3713 or consent of instructor. 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 EES 5063. Same as BIO 5063 and CE 5573. Credit can be earned for only one of the following: BIO 5063, CE 5203, CE 5573, EES 5063, or ES 5063.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5083. Mammalogy. (3-0) 3 Credit Hours.
Prerequisite: Graduate Standing. An advanced course covering various aspects of the biology of mammals, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Field trips may be required. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5093. Herpetology. (3-0) 3 Credit Hours.
Prerequisite: Graduate Standing. An advanced course covering various aspects of the biology of herpetofaunal, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Field trips may be required. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5103. Applied Ecology. (3-0) 3 Credit Hours.
The impact of humanity's activities on the environment: their effect on water, land, animal, and human resources. An evaluation of present and future strategies to preserve a healthy environment. (Formerly EES 5103. Credit cannot be earned for both EES 5103 and ES 5103.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5113. River Ecosystems. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in biology or environmental science, or consent of instructor. This course examines the physical, chemical, and biological factors that determine biodiversity and the structure and function of aquatic and riparian ecosystems. Key ecological and hydrogeomorphology concepts and their application to environmental concerns are covered. Field trip required. (Same as BIO 5103. Credit cannot be earned for both BIO 5103 and ES 5113. Formerly titled "Freshwater Ecology.") Course Fees: GS01 $90; LRS1 $15; STSI $15.
ES 5133. Fundamentals of Environmental Law. (3-0) 3 Credit Hours. 
Prerequisite: Graduate Standing. This course exposes students to basic legal theories relevant to contemporary environmental practice, and provides an introduction to administrative law as well as six federal environmental statutes: the Clean Air Act, Clean Water Act, National Environmental Policy Act, Endangered Species Act, Resource Conservation and Recovery Act, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5143. Technical Writing for Environmental Scientists. (3-0) 3 Credit Hours. 
Prerequisite: Graduate standing. A course designed to give graduate students the skills necessary to write a manuscript for peer review and to prepare other professional materials for presentation or publication. Topics covered in this course include: searching the scientific literature; scientific writing style; writing graduate level papers, proposals, projects, and thesis components; preparing scientific presentations; presentation of data; using visual aids; and using word processing, spreadsheet, and presentation software. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5153. Urban Environmental Planning and Sustainability. (3-0) 3 Credit Hours. 
This course examines how the concept of sustainable development applies to buildings, cities and urban regions and gives students insight into a variety of contemporary urban planning and green building issues through the sustainability lens. Ways to coordinate goals of environmental, economic, and social equity at different scales of planning are addressed, including the region, the city, the neighborhood, the site, and buildings. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5213. Environmental Geology. (3-0) 3 Credit Hours. 
Prerequisite: GEO 4063 or consent of instructor. Geologic materials and processes as related to their influence on the human physical environment. Effects of landscape modification and geologic hazards such as earthquakes and landslides. Properties of minerals, rocks, and soils and geologic aspects of waste disposal and water resources are examined. Course cannot be used for graduate credit by students in Geology. (Formerly EES 5213. Credit cannot be earned for both EES 5213 and ES 5213.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5233. Experimental Design and Analysis. (3-0) 3 Credit Hours. 
Prerequisite: ES 5203 or an equivalent, or consent of instructor. Fundamental concepts of the statistical design and analysis of environmental experiments will be presented. Students will be required to design experiments and to analyze data using computer software. (Formerly EES 5233. Credit cannot be earned for both EES 5233 and ES 5233.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5243. Advanced Plant Ecology. (3-0) 3 Credit Hours. 
Prerequisites: BIO 3283 and BIO 3292, or consent of instructor. A study of the major biomes of the world, including North America and Texas, and the factors that influence the development of these biomes. Special consideration is given to species interactions that lead to high and low density species. (Formerly EES 5243. Same as BIO 5243. Credit cannot be earned for only one of the following: BIO 5243, EES 5243, or ES 5243.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5493. Water Pollution Control. (3-0) 3 Credit Hours. 
Principles and methods of water pollution control process design and operation; selection and optimization of total treatment processes as well as appurtenances and accessory equipments; and methods involved in the design process and the selection of the hardware. (Formerly EES 5493. Credit cannot be earned for both EES 5493 and ES 5493.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5503. Policy and Principles of Environmental Law. (3-0) 3 Credit Hours. 
Prerequisite: ES 3203 or ES 5133, or equivalent. This course exposes students to advanced policies and principles relevant to contemporary environmental practice, and provides advanced knowledge of the six federal environmental statutes: the Clean Air Act, Clean Water Act, National Environmental Policy Act, Endangered Species Act, Resource Conservation and Recovery Act, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). (Same as PAD 5483. Credit can be earned for only one of the following: EES 5503, ES 5503, or PAD 5483.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5513. Aquatic Ecology. (3-0) 3 Credit Hours. 
Study of aquatic ecosystems including streams, wetlands, and lakes. Topics include watershed processes, biological communities, physical habitats, nutrient cycling, energy flow, and management issues. The course culminates with individual research projects focused on local watersheds. Field trips may be required. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5523. Watershed Processes. (3-0) 3 Credit Hours. 
This course focuses on watershed processes, watershed assessment, and watershed management. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5533. Planning and Response to Environmental Disasters. (3-0) 3 Credit Hours. 
This course will focus on planning, response and recovery from large, complex environmental disasters and the roles and implications for Response Managers and Environmental Scientists. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5623. 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. (Same as CE 5613. Credit cannot be earned for both ES 5623 and CE 5613.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5743. Ichthyology. (3-0) 3 Credit Hours. 
Study of fishes, and includes a wide range of topics including taxonomy, systematics, and biogeography, anatomy and physiology, and behavior and ecology. This course will focus on form and function, behavior, life history, ecology, and key taxonomic characteristics of most of the orders of fishes. Field trips may be required. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5753. Conservation and Restoration Ecology. (3-0) 3 Credit Hours. 
The class topics will include the nature of the biosphere, threats to its integrity, and ecologically sound responses to these threats. Also included will be the origin and preservation of biotic diversity, how the rich variety of plant and animal life arose, how it has been maintained by natural processes, and how its destruction can be prevented. (Same as BIO 5753. Credit cannot be earned for both BIO 5753 and ES 5753.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5763. Ornithology. (3-0) 3 Credit Hours. 
A course covering various aspects of the biology of birds, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Field trips may be included. (Same as BIO 5713. Credit cannot be earned for both BIO 5713 and ES 5763.) Course Fees: GS01 $90; LRS1 $15; STSI $15.
ES 5773. Wildlife Ecology. (3-0) 3 Credit Hours.
An introduction to wildlife management including ecological principles dealing with ecosystems, natural communities, and populations. The importance of animal behavior, the availability of food, cover, wildlife diseases, predators, hunting, and trapping will be included. Field trips may be included. (Same as BIO 5773. Credit cannot be earned for both BIO 5773 and ES 5773.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5783. Evaluation and Valuation of Ecosystem Services. (3-0) 3 Credit Hours.
This course will examine the flow of goods and services provided by the ecosystem that are important to sustaining human well-being. The value of ecosystem goods is generally set by trading the market place, while the value of ecosystems services is often ignored, yet also important in sustaining human well-being. This course will explore methods to evaluate and value these ecosystem services. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5793. Environmental Remediation. (3-0) 3 Credit Hours.
Prerequisite: CHE 2603 or an equivalent. This course will focus on the fundamentals associated with environmental remediation in relation to overall environmental quality and protection. Topics covered include contaminant fate and transport; physical, chemical, and biological processes/characteristics of the air, soil, and water; remediation/ restoration methods; environmental monitoring; environmental assessments; environmental regulations; and water/wastewater treatment. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5971. Directed Research. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student’s Graduate Advisor of Record. The directed research course may involve a laboratory, field-based, or theoretical problem. May be repeated for credit, but not more than 3 hours, regardless of discipline, will apply to the Master’s degree. (Formerly EES 5971-3.) Course Fees: GS01 $30; LRS1 $5; STSI $5.

ES 5973. Directed Research. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student’s Graduate Advisor of Record. The directed research course may involve a laboratory, field-based, or theoretical problem. May be repeated for credit, but not more than 3 hours, regardless of discipline, will apply to the Master’s degree. (Formerly EES 5971-3.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 5981. Graduate Seminar in Environmental Science and Engineering. (1-0) 1 Credit Hour.
Prerequisite: Graduate standing in the program or consent of instructor. Topical issues of current research will be examined. Presentations will be by current faculty, invited guests and Master’s or Doctoral candidates. May be repeated for credit but only 2 hours may be applied toward the Master’s degree. The grade report for this course is either “CR” (satisfactory) or “NC” (unsatisfactory). (Formerly EES 5981 and ES 5991. Same as CE 6621.) Course Fees: GS01 $30; LRS1 $5; STSI $5.

ES 6043. Soil Chemistry. (3-0) 3 Credit Hours.
Prerequisites: CHE 1113 and CHE 2603. Overview of basic soil science and soil chemistry. Examination of the interactions between soil solids, precipitates, and solution phases will include mineralogy, ion exchange, adsorption/desorption, soil colloid behavior, acidic/basic soils, salinity, solid/solution phase interactions, and biological features. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6053. Sustainability and Renewable Energy. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing. This course provides an introduction to energy systems and renewable energy resources. It will be a scientific examination of the energy field and an emphasis on alternate energy sources, their technology, application, and how they can lead to a more sustainable future. The class will explore society's present needs and future energy demands, examine conventional energy sources and systems, and then focus on alternate, renewable energy sources and how they can lead to sustainability. Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6103. Environmental Assessment. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing. This course evaluates the framework of an impact assessment and details regarding the environment (air, water, soil), its pollutants (atmospheric, noise, water, solid waste), their impacts (physical, social, economic), relevant regulations, and pollution minimization or management strategies. Students will use this information to prepare a hypothetical Environmental Impact Statement (EIS). (Formerly EES 6103 and ES 5203. Credit can be earned for only one of the following: ES 6103, EE 5203, or ES 6103.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6113. Advanced Plant Physiology. (3-0) 3 Credit Hours.
Principles of plant physiology and biochemistry, with particular emphasis on plant hormones, nitrogen fixation, plant respiration, photosynthesis, and current research work. (Formerly EES 6113. Same as BIO 6113. Credit can be earned for only one of the following: BIO 6113, EES 6113, or ES 6113.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6133. Methods in Field Ecology. (3-0) 3 Credit Hours.
Prerequisite: BIO 3283 or an equivalent. Examination of techniques to collect, identify, and preserve plants and animals. Field methods used in the analysis of populations and communities are considered. (Formerly EES 6133. Same as BIO 6133. Credit can be earned for only one of the following: BIO 6133, EES 6133, or ES 6133.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6213. Advanced Ecology. (3-0) 3 Credit Hours.
Prerequisite: BIO 3283 or an equivalent. Interaction of organisms with their environment, allopaphy, competition, distribution, succession, and factors that control growth and dispersal. Special consideration is given to the concepts of climax, succession, and land management. (Formerly EES 6213. Same as BIO 6213. Credit can be earned for only one of the following: BIO 6213, EES 6213, or ES 6213.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6223. Application of Federal Environmental Law at the State Level. (3-0) 3 Credit Hours.
Prerequisite: ES 5503. This course exposes students the application of federal laws at the State level. The course will provide information on how environmental laws should be enforced, and whether the state or federal government should have the final word in specific environmental debates. (Formerly EES 6223. Credit can be earned for only one of the following: CE 6223, EES 6223, or ES 6223.) Course Fees: GS01 $90; LRS1 $15; STSI $15.
ES 6813. Water Resources. (3-0) 3 Credit Hours.
Application of management principles to the efficient use of water resources by people and their public and private institutions. Water is examined in terms of its value, use, and changing role in the context of economics, history, politics, and technology. (Formerly EES 6813. Credit can be earned for only one of the following: EES 6813, ES 6813, or GEO 6813.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6941. Environmental Science Colloquium. (1-0) 1 Credit Hour.
Prerequisite: Graduate standing. Discussions of current journal articles, reviews, and recent advances in specialized areas of the biological sciences. May be repeated for credit as topics vary. The grade report for this course is either "CR" (satisfactory participation in the colloquium) or "NC" (unsatisfactory participation in the colloquium). (Formerly EES 6941. Same as BIO 7041. Unless topic varies, credit can be earned for only one of the following: BIO 7041, EES 6941, or ES 6941.) Course Fees: GS01 $30; LRS1 $5; STSI $5.

ES 6951. Independent Study. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student's 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, regardless of discipline, will apply to the Master's degree. (Formerly EES 6951-3.) Course Fees: GS01 $30; LRS1 $5; STSI $5.

ES 6953. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student's 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, regardless of discipline, will apply to the Master's degree. (Formerly EES 6951-3.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6961. Comprehensive Examination. (0-0) 1 Credit Hour.
Prerequisite: Approval of the appropriate Graduate Program Committee to take the Comprehensive Examination. Independent study course for the purpose of taking the Comprehensive Examination. May be repeated as many times as approved by the Graduate Program Committee. Enrollment is required each term in which the Comprehensive Examination is taken if no other courses are being taken that term. The grade report for the course is either "CR" (satisfactory performance on the Comprehensive Examination) or "NC" (unsatisfactory performance on the Comprehensive Examination). (Formerly EES 6961.) Course Fees: GS01 $30; LRS1 $5; STSI $5.

ES 6963. Internship. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and consent of Graduate Advisor of Record. An opportunity for students to work in a setting that permits them to apply what they have learned in the formal instruction part of the program. May be repeated for credit, but not more than 3 hours will apply to the Master's degree. (Formerly EES 6963. Credit cannot be earned for both EES 6963 and ES 6963.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6973. Special Problems. (3-0) 3 Credit Hours.
Prerequisite: 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 Problems courses may be repeated for credit when the topics vary, but not more than 6 hours, regardless of discipline, will apply to a Master's degree. Field trips may be required. (Formerly EES 6973.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 6981. Master's Thesis. (0-0) 1 Credit Hour.
Prerequisites: Permission of the Graduate Advisor of Record and thesis director. Thesis research 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. Course Fees: GS01 $30; LRS1 $5; STSI $5.

ES 6983. Master's Thesis. (0-0) 3 Credit Hours.
Prerequisites: Permission of the Graduate Advisor of Record and thesis director. Thesis research 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 EES 6983.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 7211. Doctoral Research. (0-0) 1 Credit Hour.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated for credit, but no more than 15 hours may be applied to the Doctoral degree. (Formerly EES 7211-3.) Course Fees: GS01 $30; LRS1 $5; STSI $5.

ES 7212. Doctoral Research. (0-0) 2 Credit Hours.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated for credit, but no more than 15 hours may be applied to the Doctoral degree. (Formerly EES 7211-3.) Course Fees: GS01 $60; LRS1 $10; STSI $10.

ES 7213. Doctoral Research. (0-0) 3 Credit Hours.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated for credit, but no more than 15 hours may be applied to the Doctoral degree. (Formerly EES 7211-3.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

ES 7311. Doctoral Dissertation. (0-0) 1 Credit Hour.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated for credit, but no more than 15 hours may be applied to the Doctoral degree. (Formerly EES 7311-3.) Course Fees: GS01 $30; LRS1 $5; STSI $5.

ES 7312. Doctoral Dissertation. (0-0) 2 Credit Hours.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated for credit, but no more than 15 hours may be applied to the Doctoral degree. (Formerly EES 7311-3.) Course Fees: GS01 $60; LRS1 $10; STSI $10.

ES 7313. Doctoral Dissertation. (0-0) 3 Credit Hours.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated for credit, but no more than 15 hours may be applied to the Doctoral degree. (Formerly EES 7311-3.) Course Fees: GS01 $90; LRS1 $15; STSI $15.