DEPARTMENT OF INTEGRATIVE BIOLOGY

The Department of Integrative Biology offers Master of Science degrees in Biology, Biotechnology, and Environmental Science. The department also offers graduate certificates in Environmental Science and Environmental Sustainability.

- M.S. in Biology (p. 1)
- M.S. in Biotechnology (p. 2)
- M.S. in Environmental Science (p. 3)
- Ph.D. in Environmental Science and Engineering (p. 5)

Master of Science Degree in Biology

The graduate program offers opportunities for advanced study and research leading to the Master of Science degree in Biology. A thesis option is offered to students who want an extended opportunity to develop expertise in research techniques and data analysis. There are three emphases within which to conduct a thesis: cell and molecular biology, microbiology and immunology, and neuroscience. The thesis option is recommended for students who plan a career in research or contemplate pursuing a doctorate in one of the life sciences. A non-thesis option is offered for those who want an extended opportunity to earn the Master of Science degree primarily through organized coursework. The non-thesis option allows students to take a wider variety of elective courses to provide a more expansive knowledge of several areas in the life sciences.

Graduate faculty research interests include biochemistry, cellular biology, developmental biology, genetics, microbiology, neuroscience, physiology, and plant sciences. The multidisciplinary nature of the program allows students the opportunity to broaden their educational background at the graduate level. Individual programs are organized around each student’s interests in consultation with the student’s graduate advisor.

Qualified students are encouraged to apply for teaching assistantships and fellowships.

Program Admission Requirements

To be considered for degree-seeking status, applicants must submit, along with the application, two letters of recommendation, a Statement of Future Plans, including a reason why you wish to pursue an M.S. in Biology, and scores from the Graduate Record Examination (GRE). In addition to satisfying the University-wide graduate admission requirements, applicants are expected to have completed an undergraduate major in one of the biological sciences, with coursework comparable to that required for the Bachelor of Science degree in Biology at UTSA. A minimum grade point average of 3.0 (on a 4.0 scale) is required for admission. Students whose undergraduate preparation is deficient in certain areas but who meet the minimum University standards for admission may be conditionally admitted and required to complete specific undergraduate or graduate courses as conditions of admission. In such cases, students should anticipate that additional time will be required to complete the degree. Students who are denied admission to the M.S. Program must reapply if interested in acceptance as a special graduate student.

Degree Requirements

Degree-seeking students are required to complete a minimum of 36 semester credit hours that must be approved by the student’s Graduate Advisor and Comprehensive Examination Committee, as well as the Graduate Advisor of Record. Students are expected to meet with their assigned Graduate Advisor early in the first semester of study to prepare a course-degree-plan and organize a Committee as early as possible. Students must work closely with their Advisor and Committee to gain maximum benefit from this program.

Program of Study

I. Thesis Option

A. Emphasis in Cell and Molecular Biology

The emphasis in Cell and Molecular Biology (CMB) is a thesis-track degree program designed to prepare students who may wish to pursue a Ph.D. in Biology with an emphasis in Cell and Molecular Biology at UTSA or elsewhere. The Master’s level CMB emphasis provides a prospective student with the coursework and preliminary research background found in a successful CMB Ph.D. applicant. Core coursework is directly transferable toward the Ph.D. degree (if the student is accepted into the Ph.D. program), and elective coursework may also be transferable with committee approval if it was not used to fulfill requirements for the M.S. degree. Core and elective coursework must have a grade of B or higher in order to transfer to the Ph.D. program.

1. 6 semester credit hours of the following core lecture courses are required:
   - BIO 5123 Principles of Molecular Biology
   - BIO 5133 Principles of Cell Biology
   - BIO 5213 Principles of Chemical Biology

2. 6 semester credit hours of research support courses are required:
   - BIO 7013 Seminar in Life Sciences (repeated for a total of 3 hours)
   - BIO 7051 Seminar in Life Sciences (repeated for a total of 3 hours)

3. 12 semester credit hours from the following research-based courses are required:
   - BIO 5973 Directed Research
   - BIO 6953 Independent Study
   - BIO 5973 Master’s Thesis (repeated for a total of 6 hours)

4. 12 semester credit hours of electives from 5000-7000 BIO courses as approved by the Graduate Advisor of Record are required.

Total Credit Hours: 36

B. Emphasis in Microbiology and Immunology

The emphasis in Microbiology and Immunology is a thesis-track degree program designed to prepare students who may wish to pursue a Ph.D. in Biology with an emphasis in Microbiology and Immunology at UTSA or elsewhere. This emphasis provides a prospective student with the coursework and preliminary research background found in a successful Ph.D. applicant. Core coursework is directly transferable toward the Ph.D. degree (if the student is accepted into the Ph.D. program), and elective coursework may also be transferable if it was not used to fulfill requirements for the M.S. degree. Core and elective coursework must have a grade of B or higher in order to transfer to the Ph.D. program.

1. 6 semester credit hours of the following core lecture courses are required:
   - BIO 5123 Principles of Molecular Biology
II. Non-Thesis Option

Open Emphasis

The open emphasis in Biology offers students the opportunity to acquire a sound preparation of the fundamentals in several areas of Biology, and to introduce students to recent advances in biological theory and methods. Students may take a total of 3 semester credit hours of BIO 5971-3 Directed Research or BIO 6951-3 Independent Study as electives.

1. 3 semester credit hours of the following core lecture courses are required:
   - BIO 5123 Principles of Molecular Biology

Department of Integrative Biology

| Total Credit Hours | 36 |

C. Emphasis in Neuroscience

The emphasis in Neuroscience is a thesis-track degree program designed for students who may wish to pursue a Ph.D. in Biology with an emphasis in Neuroscience at UTSA. The Master’s level Neuroscience emphasis provides a prospective student with the coursework and preliminary research background found in a successful Neuroscience Ph.D. applicant. Core and elective coursework is transferable and can count toward the Ph.D. degree (if the student is accepted into the Ph.D. program). Elective coursework may also be transferable, with the doctoral studies committee approval, if it was not used to fulfill requirements for the M.S. degree. Core and elective coursework must have a grade of B or higher in order to transfer to the Ph.D. program.

1. 6 semester credit hours of the following core lecture courses are required:
   - BIO 5433 Systems Neuroscience
   - BIO 5443 Molecular Neurobiology

2. 6 semester credit hours of research support courses are required:
   - BIO 7041 Biology Colloquium (repeated for a total of 3 hours)
   - BIO 7051 Seminar in Life Sciences (repeated for a total of 3 hours)

3. 12 semester credit hours from the following research-based courses are required:
   - BIO 5973 Directed Research
   - or BIO 6953 Independent Study
   - BIO 6983 Master’s Thesis (repeated for a total of 6 hours)

4. 12 semester credit hours of electives from 5000-7000 BIO courses as approved by the Graduate Advisor of Record are required:

Total Credit Hours

| 36 |

Comprehensive Examination

As specified by University regulations, candidates must pass a comprehensive examination administered by the student’s Graduate Committee. For non-thesis students, this examination (which has oral and written components) must be given in the semester prior to the semester during which degree requirements are to be completed. Students who do not achieve the criteria (or necessary expectations) to pass the exam will be required to retake the comprehensive exam after consultation with the student’s graduate committee. Certain rules must be adhered to concerning the composition of the Master’s Thesis Committee and the Master’s Comprehensive Examination Committee. Only tenured or tenure-track faculty members from UTSA can chair these committees, and no more than one member of either committee can be a fixed-term track faculty member, or be from another institution. Students electing the thesis option must successfully defend their thesis research before their Graduate Committee prior to the submission of the thesis to the Dean of the Graduate School for approval.

Master of Science Degree in Biotechnology

The Master of Science degree in Biotechnology offers opportunities for rigorous, advanced study and research in biotechnology, in order to prepare students for employment and research in this rapidly advancing and expanding field. A broad common base of knowledge for biotechnology is provided in the Master’s degree by a comprehensive core curriculum that includes key areas in biochemistry, cell and molecular biology, and immunology. All students receive practical training through the completion of at least two laboratory courses. Additional coursework is selected from a list of approved lecture-based and laboratory courses, and can include up to 9 hours of biomedical engineering lectures, or 12 hours on aspects of management of biotechnology. The opportunity to gain research experience or develop further technical expertise is also possible through an internship in a biotechnology-based company or by conducting a Master’s thesis.

Program Admission Requirements

To be considered for degree-seeking status, applicants must submit, along with the application, two letters of recommendation, a Statement of Future Plans for a career in Biotechnology, and scores from the Graduate Record Examination (GRE). In addition to satisfying the University-wide graduate admission requirements, applicants are expected to have completed an undergraduate major in the sciences with coursework comparable to the core required for the Bachelor of Science degree in Biology at UTSA. In particular, incoming students are required to have taken, and received at least a grade of “B” in upper-division undergraduate
lecture and laboratory courses in cell biology and biochemistry, and undergraduate coursework in microbiology and immunology is recommended. Students whose undergraduate preparation is deficient in one of these areas of requirements but who meet the remaining standards for admission may be conditionally admitted and required to complete specific undergraduate course(s) as a condition of admission. In such cases, students should anticipate that additional time will be required to complete the degree. A minimum grade point average of 3.0 (on a 4.0 scale) is required for admission. Students who are denied admission to this M.S. program must reapply if interested in acceptance as a special graduate student.

Degree Requirements

Degree-seeking students are required to complete a minimum of 36 semester credits at the graduate level. Admission to this M.S. program does not guarantee admission to the graduate program, and applications must be submitted separately. Students who have not taken a course in cell biology and biochemistry must complete BIO 5123 and BIO 5133. Students who have not had undergraduate coursework in microbiology and immunology must complete BIO 5001 and BIO 5002. In such cases, students should anticipate that additional time will be required to complete the degree. A minimum grade point average of 3.0 (on a 4.0 scale) is required for admission. Students who are denied admission to this M.S. program must reapply if interested in acceptance as a special graduate student.

Program of Study

A. Biotechnology lectures – core curriculum: 12

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 5001</td>
<td>Ethical Conduct in Research</td>
</tr>
<tr>
<td>BIO 5123</td>
<td>Principles of Molecular Biology</td>
</tr>
<tr>
<td>BIO 5133</td>
<td>Principles of Cell Biology</td>
</tr>
<tr>
<td>BIO 5213</td>
<td>Principles of Chemical Biology</td>
</tr>
<tr>
<td>BIO 5762</td>
<td>Fundamentals of Immunology for Biotechnology</td>
</tr>
</tbody>
</table>

B. 3 semester credit hours in basic laboratory techniques are required:

- BIO 5033 Biotechnology Laboratory

C. A minimum of 3 semester credit hours of additional organized laboratory experience are required from the following:

- BIO 5143 Advanced Nucleic Acids Laboratory
- BIO 5163 Recombinant Protein Biotechnology Laboratory

D. Applications of Biotechnology electives. 18 hours of Biotechnology electives are required. These can be from 5000-7000 BIO courses. Alternatively, up to 9 hours of electives can be 5000-7000 Management of Technology (MOT) courses. All non-BIO courses must be approved by the Graduate Advisor of Record.

Total Credit Hours 36

Biotechnology Internship

(Subject to availability.) The internship (Practicum in Biotechnology BIO 7563) will require prior arrangement with biotechnology-based companies and approval of the Graduate Advisor of Record. May be repeated for credit, but no more than 9 hours will be approved and applied toward program of study. Students must take an internship if they select the thesis option.

Thesis Option

Students electing the thesis option must complete 6 semester credit hours of BIO 5973 Directed Research as Directed Research and 6 semester credit hours of BIO 6983 Master’s Thesis/Master’s Thesis.

Comprehensive Examination

As specified by University regulations, degree candidates must pass a comprehensive examination administered by the student’s Graduate Committee. For non-thesis students, this examination (which has oral and written components) must be given in the semester prior to the semester during which degree requirements are to be completed. Students electing to do a thesis must successfully defend their thesis research before their Graduate Committee prior to the submission of the thesis to the Dean of the Graduate School for approval. Certain rules must be adhered to concerning the composition of the Master’s Comprehensive Examination Committee and the Master’s Thesis Committee. Only tenured or tenure-track faculty members from UTSA can chair the Committee, and no more than one member of the Committee may be fixed-term track faculty or from another institution. Students who do not achieve the criteria (or necessary expectations) to pass the Comprehensive Examination can retake the comprehensive exam one additional time.

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 Integrative Biology, Chemistry, Civil and Environmental Engineering, & Construction management, and Earth and Planetary 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 have taken coursework in the following areas: 1) one semester in general statistics, and 2) one semester of environmental science. Students who have not had any undergraduate course work in Environmental Law, will be required to take ES 5133 Fundamentals of Environmental Law/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>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 5011</td>
<td>Graduate Studies in Environmental Science</td>
<td>12</td>
</tr>
<tr>
<td>ES 5013</td>
<td>Survey Topics in Environmental Science</td>
<td>3</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>3</td>
</tr>
<tr>
<td>ES 5981</td>
<td>Graduate Seminar in Environmental Science and Engineering</td>
<td>3</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>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 6953</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>12</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 2 semester credit hours in graduate seminar or 2 semester credit hours in colloquium are required. It may be any combination of hours from these courses.
3. 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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 5011</td>
<td>Graduate Studies in Environmental Science</td>
<td>4</td>
</tr>
<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 5143</td>
<td>Technical Writing for Environmental Scientists</td>
<td>3</td>
</tr>
<tr>
<td>ES 5233</td>
<td>Experimental Design and Analysis</td>
<td></td>
</tr>
<tr>
<td>ES 5503</td>
<td>Policy and Principles of Environmental Law</td>
<td>3</td>
</tr>
<tr>
<td>ES 6103</td>
<td>Environmental Assessment</td>
<td></td>
</tr>
<tr>
<td>ES 6723</td>
<td>Application of Federal Environmental Law at the State Level</td>
<td>2</td>
</tr>
</tbody>
</table>

And 2 hours of the following in any combination:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 5981</td>
<td>Graduate Seminar in Environmental Science and Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ES 6941</td>
<td>Environmental Science Colloquium</td>
<td>3</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**

36

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 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 School of Civil and Environmental Engineering, & Construction Management. Most of the participating graduate faculty are in the College of Sciences (including Department of Earth and Planetary Sciences) and College of Engineering and Integrated Design (School of Civil and Environmental Engineering, & Construction Management); additional faculty in this interdisciplinary program are from other colleges. Please refer to the School of Civil and Environmental Engineering, & Construction Management (http://catalog.utsa.edu/graduate/engineeringintegrateddesign/civilenvironmentalengineeringconstructionmanagement/) section of this catalog for details about this program.

- Graduate Certificate in Environmental Science (p. 5)
- Graduate Certificate in Environmental Sustainability (p. 5)

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:

<table>
<thead>
<tr>
<th>Required Courses (15 semester credit hours)</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 5013 Survey in Environmental Science</td>
<td></td>
</tr>
<tr>
<td>ES 5103 Applied Ecology</td>
<td></td>
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<tr>
<td>ES 5133 Fundamentals of Environmental Law</td>
<td></td>
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<tr>
<td>or ES 5503 Policy and Principles of Environmental Law</td>
<td></td>
</tr>
<tr>
<td>ES 5143 Technical Writing for Environmental Scientists</td>
<td></td>
</tr>
<tr>
<td>ES 6103 Environmental Assessment</td>
<td></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:

<table>
<thead>
<tr>
<th>Required Courses (15 semester credit hours)</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 5043 Global Change</td>
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<tr>
<td>ES 5133 Fundamentals of Environmental Law</td>
<td></td>
</tr>
<tr>
<td>or ES 5503 Policy and Principles of Environmental Law</td>
<td></td>
</tr>
<tr>
<td>ES 5153 Urban Environmental Planning and Sustainability</td>
<td></td>
</tr>
<tr>
<td>ES 5753 Conservation and Restoration Ecology</td>
<td></td>
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<tr>
<td>ES 6053 Sustainability and Renewable Energy</td>
<td></td>
</tr>
</tbody>
</table>

Total Credit Hours 15
Biology (BIO) Courses

BIO 5001. Ethical Conduct in Research. (1-0) 1 Credit Hour.
Prerequisite: Graduate standing. This course provides a basic overview of the requirements for ethical conduct within the research laboratory. The grade report for this course is either “CR” (satisfactory completion) or “NC” (unsatisfactory completion). (Credit cannot be earned for both BIO 5001 and BIO 7413.) Differential Tuition: $50. Course Fees: GS01 $30.

BIO 5003. Epigenetics and Metabolism. (3-0) 3 Credit Hours.
Scientific overview and discussion course related topics including stem cells, diseases, and interaction between metabolism and different epigenetic mechanisms. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5033. Biotechnology Laboratory. (0-6) 3 Credit Hours.
Prerequisite: Graduate standing. Concurrent enrollment in BIO 5323 is strongly recommended for M.S. in Biotechnology students. An organized course offering an introduction to routine procedures employed in the modern research laboratory. Differential Tuition: $150. Course Fees: GS01 $90; IUB1 $10; L001 $30.

BIO 5123. Principles of Molecular Biology. (3-0) 3 Credit Hours.
Prerequisite: BIO 3513 or an equivalent. Molecular structure and function of genes and nucleic acids, and the processes of DNA replication, mutation and repair, as well as transcription and translation of genetic material. Genome projects, functional genomics and the genetic control of development will also be covered. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5133. Principles of Cell Biology. (3-0) 3 Credit Hours.
Prerequisites: BIO 3513 and BIO 3813, or their equivalents. Basic structure, organization and differentiation of cells. Cell cycle, signaling, growth and movement of cells, as well as cellular immunology and cellular aspects of infectious disease will also be covered. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5143. Advanced Nucleic Acids Laboratory. (0-6) 3 Credit Hours.
Prerequisite: BIO 3913 or an equivalent, BIO 5033 recommended. An introduction to advanced techniques of molecular biology dealing with manipulations and analyses of DNA, including preparation and analysis of genomic DNA, genomic cloning, the polymerase chain reaction (PCR), Southern blotting, DNA sequencing and computational analysis of DNA sequence data. (Formerly titled "Advanced Molecular Biology Laboratory – DNA Techniques") Differential Tuition: $150. Course Fees: GS01 $90; IUB1 $10; L001 $30.

BIO 5163. Recombinant Protein Biotechnology Laboratory. (0-6) 3 Credit Hours.
Prerequisite: Satisfactory completion of BIO 5033. Small- to large-scale growth of microorganisms and eukaryotic cells followed by downstream processing of supernatants and/or cell pellets, protein purification and protein analysis. (Formerly BIO 5742 and BIO 7543. Credit cannot be earned for both BIO 5163 and BIO 5742 or BIO 7543.) Differential Tuition: $150. Course Fees: GS01 $90; IUB1 $10; L001 $30.

BIO 5213. Principles of Chemical Biology. (3-0) 3 Credit Hours.
Prerequisites: BIO 3513 and BIO 3813, or equivalents. The role of chemistry in prokaryotic and eukaryotic biological systems. Topics will cover the probing and controlling biological systems using chemical methods and the manipulation of biological systems via novel chemistries to advance fundamental knowledge which serve as a basis for translational approaches. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5233. Medicinal Plants. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in Biology or Chemistry. An overview of plant secondary metabolism, and the ethnobotany, biochemistry, and pharmacology of some of our most important plant-derived pharmaceuticals. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5343. Proteins and Nucleic Acids. (3-0) 3 Credit Hours.
Prerequisite: BIO 3513 or equivalent. Protein sequences, domains, folding, proteomics, glycoproteins, protein-DNA interaction, RNA conformations. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5423. Neuroanatomy. (3-0) 3 Credit Hours.
Prerequisite: Consent of instructor. The anatomy of the vertebrate nervous system. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5433. Systems Neuroscience. (3-0) 3 Credit Hours.
Prerequisite: BIO 3422 or an equivalent. The fundamentals of neurophysiology are presented from the cellular to the systems level. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5443. Molecular Neurobiology. (3-0) 3 Credit Hours.
Prerequisite: BIO 3433 or an equivalent, BIO 3513 or an equivalent recommended. An introduction to the biochemical basis of synaptic transmission, and the pathological changes in synaptic transmission associated with neurobiological diseases and disorders. (Formerly titled "Neurochemistry") Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5463. Reproductive Biology. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in Biology. Mammalian reproduction including mechanisms involved in sexual differentiation, fertilization, and fetal development. Endocrine regulation and environmental influences with a focus on human reproduction. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5483. Computational Neuroscience. (3-0) 3 Credit Hours.
Prerequisite: BIO 3433 or an equivalent. A non-mathematical approach to the computational functions of the brain, including sensory coding, neural control of movement, and the computational properties of neurons and neuronal networks. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5493. Cognitive Neuroscience. (3-0) 3 Credit Hours.
Prerequisite: BIO 3433 (or PSY 3103) recommended, or consent of instructor. The biological foundations of mental phenomena, including perception, attention, learning, memory, language, motor control, and executive function, as well as functional specialization, development and plasticity, through various methodologies. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5523. Enzymes. (3-0) 3 Credit Hours.
Prerequisite: BIO 3513 or an equivalent. A study of enzyme structure and mechanism, inhibitors, cofactor, kinetics, and regulation. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5543. Pharmacology and Toxicology. (3-0) 3 Credit Hours.

BIO 5613. Neurodegenerative Disease. (3-0) 3 Credit Hours.
Prerequisite: BIO 3513, BIO 3813, or consent of instructor; BIO 5433 or BIO 5443 is recommended. The pathogenesis of neurodegenerative diseases will be covered with an emphasis on the molecular mechanisms and experimental approaches. Current research progress will be covered. Differential Tuition: $150. Course Fees: GS01 $90.
BIO 5643. Bioinformatics and Computational Biology. (3-0) 3 Credit Hours.
Prerequisites: BIO 2313 or an equivalent; enrollment in Biology Ph.D. program required, or permission of the Biology Department or instructor. Computational analysis of sequences, protein structures, and gene expression network on a large scale. Comparative genomics, functional genomics, and proteomics will also be covered. (Credit cannot be earned for both BIO 5643 and BIO 5623.) Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5663. Applications of Recombinant DNA Technology. (3-0) 3 Credit Hours.
A course on recombinant DNA technology, concentrating on major DNA manipulation methods, including their use in vaccine and bioactive protein production, gene therapy, plant genetic engineering along with ethical and safety considerations. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5713. 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 ES 5763. Credit cannot be earned for both BIO 5713 and ES 5763.) Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5733. Advanced Medical Mycology. (3-0) 3 Credit Hours.
Prerequisites: BIO 3522 and BIO 3722. This course is a comprehensive study of the etiological agents and host factors that lead to fungal disease in humans. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5743. Advanced Virology. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in Biology. A detailed study of the diversity of viruses and biochemical mechanisms for their replication. (Formerly titled "Biochemical Virology") Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5753. Conservation Biology. (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 ES 5753. Credit cannot be earned for both BIO 5753 and ES 5753.) Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5762. Fundamentals of Immunology for Biotechnology. (2-0) 2 Credit Hours.
An integrated examination of the principles of immunology pertaining to the Biotechnology Industry. An emphasis on current immunological techniques, including: recombinant antibody, flow cytometry and elispot technology. Issues related to vaccine production and therapeutics will also be considered. Differential Tuition: $100. Course Fees: GS01 $60.

BIO 5783. Introduction to Good Manufacturing Practices and Good Laboratory Practices. (3-0) 3 Credit Hours.
Review of FDA and U.S. Pharmacopoeia regulations. Practical considerations for the implementation of GMP/GLP systems; data management and reporting, as well as problem solving and interpretive skills, will be emphasized. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5813. Frontiers in Human Pluripotent Stem Cells. (3-0) 3 Credit Hours.
Integrates the fundamental aspects of developmental biology with emerging concepts in embryonic and adult stem cells and regenerative medicine. A discussion of various stem cell applications in industry, military, medicine, and ethics of regenerative medicine is presented. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5833. Membrane Structure and Function. (3-0) 3 Credit Hours.

BIO 5873. Plant Biotechnology. (3-0) 3 Credit Hours.
Prerequisite: BIO 5353 or equivalent, BIO 5123 is recommended. The principles of plant physiology, genetics, and techniques used in plant modification, and principles of plant breeding and quantitative genetics as applied to plant biotechnology. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 5971. Directed Research. (0-0) 1 Credit Hour.
Prerequisites: Admission to either the Biology or Biotechnology Master's program or admission as a special graduate or non-degree-seeking student, and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours, regardless of discipline, in combination with BIO 6951-3 (Independent Study), will apply to the Master's degree. Differential Tuition: $50. Course Fees: GS01 $30.

BIO 5972. Directed Research. (0-0) 2 Credit Hours.
Prerequisites: Admission to either the Biology or Biotechnology Master's program or admission as a special graduate or non-degree-seeking student, and permission in writing (form available) of the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours, regardless of discipline, in combination with BIO 6951-3 (Independent Study), will apply to the Master's degree. Differential Tuition: $100. Course Fees: GS01 $60.

BIO 5973. Directed Research. (0-0) 3 Credit Hours.
Prerequisites: Admission to either the Biology or Biotechnology Master's program or admission as a special graduate or non-degree-seeking student, and permission in writing (form available) of the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours, regardless of discipline, in combination with BIO 6951-3 (Independent Study), will apply to the Master's degree. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6133. Methods in Field Biology. (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. (Same as ES 6133. Credit cannot be earned for both BIO 6133 and ES 6133.) Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6213. Advanced Ecology. (3-0) 3 Credit Hours.
Prerequisite: BIO 3283 or an equivalent. Interaction of organisms with their environment, allelopathy, competition, distribution, succession, and factors that control growth and dispersal. Special consideration is given to the concepts of climax, succession, and land management. (Same as ES 6213. Credit cannot be earned for both BIO 6213 and ES 6213.) Differential Tuition: $150. Course Fees: GS01 $90.
BIO 6233. Quantitative Biology. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing or consent of instructor. An introduction of quantitative analysis of biological data and design of experiments. Topics include probability theory and distributions; descriptive statistics; hypothesis testing and confidence intervals for means, variances, and proportions; chi-square statistic; categorical data analysis; linear correlation and regression model; analysis of variance; and nonparametric methods. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6313. Molecular Biology and Biophysics of Ion Channels. (3-0) 3 Credit Hours.
Prerequisites: BIO 5433 and BIO 5443, or permission of instructor. A study of the molecular composition and biophysical properties of ion channels. The course emphasizes three families of ion channels: voltage-gated, ligand-gated and metabolically-stimulated channels. Their structure and function will be related to how ion channels mediate cellular actions in excitable cells. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6323. Essentials of Biostatistics for Biotechnology. (3-0) 3 Credit Hours.
Basic, intermediate, and advanced (but not bioinformatics) statistical vocabulary, concepts, and methods commonly used in the biotechnology industry. A focus on tests for quality control and assurance of equipment and test systems to assess accuracy, precision, and bias related to test validations. Concepts and appropriate selections of test/study design using power analyses and estimations of sample sizes; also for clinical trials. Analytical calibration curves, frequency distributions, descriptive statistics, measures of central tendency and dispersion/error, probability, paired and unpaired, one-tailed and two-tailed t-tests, correlations, regression, one-way and two-way analysis of variance with repeated measures, parametric and nonparametric tests, post hoc tests for significance, reporting and interpretations of statistical results, validations of clinical tests for specificity, sensitivity, predictive values, likelihood ratios, receiver operating characteristic curves. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6483. Animal Behavior. (3-0) 3 Credit Hours.
Prerequisite: BIO 3413 or consent of instructor. An examination of neural, endocrine, genetic, and environmental determinants of behavior. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6513. Drug Development. (3-0) 3 Credit Hours.
This course will provide students with an overview of the early drug discovery process, including target identification, validation, assay development and high throughput screening up to pre-clinical trials. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6543. Vaccine Development. (3-0) 3 Credit Hours.
Prerequisites: BIO 5762 and permission of instructor. This course will provide students with an overview of issues about the roles of vaccines in the control of infectious diseases, vaccine development, clinical trials and implementation of vaccine programs. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6573. Microbial Pathogenesis. (3-0) 3 Credit Hours.
The student will gain an understanding of the cellular and molecular mechanisms by which eukaryotic and viral pathogens cause disease and the host immune responses against these pathogens. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6803. Advanced Immunology and Immunochemistry. (3-0) 3 Credit Hours.
Prerequisite: BIO 4743 or consent of instructor. The study of current concepts of humoral and cell-mediated immunity, with emphasis on molecular mechanisms. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6883. Bacterial Pathogenesis. (3-0) 3 Credit Hours.
Prerequisites: BIO 3713 and BIO 4743, or consent of instructor. This course will present a selection of topics in the field of bacterial pathogenesis. Lectures will cover regulation of virulence; colonization and host tissue damage; vaccines, antibiotics and novel antimicrobials; evasion of the immune system; intracellular pathogens; pathogenic mechanisms of Gram-negative and Gram-positive bacteria; pathogenic mycobacteriology; and experimental tools in bacterial pathogenesis. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6951. Independent Study. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing and permission in writing 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, in combination with BIO 5971-3 Directed Research will apply to the Master's degree. Differential Tuition: $50. Course Fees: GS01 $30.

BIO 6952. Independent Study. (0-0) 2 Credit Hours.
Prerequisites: Graduate standing and permission in writing 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, in combination with BIO 5971-3 Directed Research will apply to the Master's degree. Differential Tuition: $100. Course Fees: GS01 $60.

BIO 6953. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and permission in writing 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, in combination with BIO 5971-3 Directed Research will apply to the Master's degree. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 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). Differential Tuition: $50. Course Fees: GS01 $30.
BIO 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, may be applied to the Master's degree. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 6981. Master's Thesis. (0-0) 1 Credit Hour.
Prerequisites: Permission of the Graduate Advisor of Record and thesis director. 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 in BIO 6981, BIO 6982, or BIO 6983 is required each term in which the thesis is in progress. Differential Tuition: $50. Course Fees: GS01 $30.

BIO 6982. Master's Thesis. (0-0) 2 Credit Hours.
Prerequisites: Permission of the Graduate Advisor of Record and thesis director. 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 in BIO 6981, BIO 6982, or BIO 6983 is required each term in which the thesis is in progress. Differential Tuition: $100. Course Fees: GS01 $60.

BIO 6983. Master's Thesis. (0-0) 3 Credit Hours.
Prerequisites: Permission of the Graduate Advisor of Record and thesis director. 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 in BIO 6981, BIO 6982, or BIO 6983 is required each term in which the thesis is in progress. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 7041. Biology Colloquium. (1-0) 1 Credit Hour.
Prerequisite: Graduate standing. Oral presentations, discussions, critical evaluation of students' research in progress, or discussions of current journal articles or reviews of recent scientific advances. May be repeated for credit. The grade report for this course is either “CR” (satisfactory participation in the colloquium) or “NC” (unsatisfactory participation in the colloquium). (Formerly BIO 5041. Same as ES 6941. Unless topic varies, credit cannot be earned for both BIO 7041 and ES 6941.) Differential Tuition: $50. Course Fees: GS01 $30.

BIO 7051. Seminar in Life Sciences. (1-0) 1 Credit Hour.
Prerequisite: Graduate standing. Formal presentations of research by outside authorities in the biological sciences. May be repeated for credit. The grade report for this course is either “CR” (satisfactory participation in the seminar) or “NC” (unsatisfactory participation in the seminar). Differential Tuition: $50. Course Fees: GS01 $30.

BIO 7113. Principles of Biological Scientific Teaching. (0-0) 3 Credit Hours.
Prerequisite: Admission to candidacy for the Doctoral degree. Required course for Biology doctoral students. The student will be responsible for all aspects of leading a discussion section or laboratory course. Approval by the chair of the appropriate Doctoral Studies committee required. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 7143. Principles of Biological Scientific Writing. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing. This course will provide an overview of scientific grant and manuscript preparation. The class will be directed toward producing a Ph.D. dissertation proposal and a predoctoral fellowship application. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 7211. Doctoral Research. (0-0) 1 Credit Hour.
Prerequisite: Admission to either the Neurobiology or Cell and Molecular Biology Doctoral program. May be repeated for credit, but no more than 52 hours may be applied to the Doctoral degree. Differential Tuition: $50. Course Fees: GS01 $30.

BIO 7212. Doctoral Research. (0-0) 2 Credit Hours.
Prerequisite: Admission to either the Neurobiology or Cell and Molecular Biology Doctoral program. May be repeated for credit, but no more than 52 hours may be applied to the Doctoral degree. Differential Tuition: $100. Course Fees: GS01 $60.

BIO 7213. Doctoral Research. (0-0) 3 Credit Hours.
Prerequisite: Admission to either the Neurobiology or Cell and Molecular Biology Doctoral program. May be repeated for credit, but no more than 52 hours may be applied to the Doctoral degree. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 7311. Doctoral Dissertation. (0-0) 1 Credit Hour.
Prerequisites: Admission to candidacy for the Doctoral degree and completion of at least 18 semester credit hours of BIO 7211-3. May be repeated for credit. Differential Tuition: $50. Course Fees: GS01 $30.

BIO 7312. Doctoral Dissertation. (0-0) 2 Credit Hours.
Prerequisites: Admission to candidacy for the Doctoral degree and completion of at least 18 semester credit hours of BIO 7211-3. May be repeated for credit. Differential Tuition: $100. Course Fees: GS01 $60.

BIO 7313. Doctoral Dissertation. (0-0) 3 Credit Hours.
Prerequisites: Admission to candidacy for the Doctoral degree and completion of at least 18 semester credit hours of BIO 7211-3. May be repeated for credit. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 7563. Practicum in Biotechnology. (0-0) 3 Credit Hours.
Prerequisites: Enrollment in Master's in Biotechnology program and at least 18 hours credit including satisfactory completion of BIO 5033 and one other organized laboratory course. An internship in a Biotechnology company. Must have approval of Biotechnology Graduate Studies Committee. Differential Tuition: $150. Course Fees: GS01 $90.

BIO 7571. Experimental Techniques in Biology. (0-2) 1 Credit Hour.
Prerequisite: Consent of instructor. Topics include research methods in cell and molecular biology, molecular neurobiology, and microbiology. May be repeated for credit as topics vary. (Formerly BIO 5571.) Differential Tuition: $50. Course Fees: GS01 $30.

BIO 7572. Experimental Techniques in Biology. (0-4) 2 Credit Hours.
Prerequisite: Consent of instructor. Topics include research methods in cell and molecular biology, molecular neurobiology, and microbiology. May be repeated for credit as topics vary. (Formerly BIO 5572.) Differential Tuition: $100. Course Fees: GS01 $60.

Environmental Sciences (ES) Courses
ES 5011. Graduate Studies in Environmental Science. (1-0) 1 Credit Hour.
This course offers an orientation to graduate study, introducing students to the professional standards and practices of our discipline. The course also offers a survey of environmental science. Development of a tentative program of studies and other relevant requirements will be discussed. Differential Tuition: $50. Course Fees: GS01 $30.
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.) Differential Tuition: $150 Course Fees: GS01 $90.

ES 5023. Environmental Statistics. (3-0) 3 Credit Hours.
Prerequisites: ES 1314 and MAT 1133 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 categorial data, hypothesis testing, and use of statistical software programs and applications. (Formerly EES 5023. Same as GE 5023 and CE 5043. Credit can be earned for only one of the following: EES 5023, ES 5023, GEO 5023, or CE 5043.) Differential Tuition: $150. Course Fees: GS01 $90.

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 5043 and GEO 5043. Credit can be earned for only one of the following: CE 5043, EES 5043, ES 5043, or GEO 5043.) Differential Tuition: $150. Course Fees: GS01 $90.

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 5673. Credit can be earned for only one of the following: BIO 5063, CE 5203, CE 5673, EES 5063, or ES 5063.) Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150 Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

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") Differential Tuition: $150. Course Fees: GS01 $90.

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). Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

ES 5233. Experimental Design and Analysis. (3-0) 3 Credit Hours.
Prerequisite: ES 5023 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.) Differential Tuition: $150. Course Fees: GS01 $90.
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 can be earned for only one of the following: BIO 5243, EES 5243, or ES 5243.) Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

ES 5523. Watershed Processes. (3-0) 3 Credit Hours.
This course focuses on watershed processes, watershed assessment, and watershed management. Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

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 5793. Credit cannot be earned for both BIO 5793 and ES 5773.) Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

ES 5971. Directed Research. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing and permission in writing (form available) from 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.) Differential Tuition: $50. Course Fees: GS01 $30.

ES 5973. Directed Research. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) from 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.) Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $50. Course Fees: GS01 $30.
ES 6013. Instrumental Environmental Methods for R Coding in Environmental Science and Ecology. (3-0) 3 Credit Hours.
This course will teach the management of environmental and ecological data using Program R. The focus will be on the structure and linguistics of data in R and how to integrate R in a data science workflow. Differential Tuition: $150. Course Fees: GS01 $90.

ES 6023. Plant Ecophysiology. (3-0) 3 Credit Hours.
A survey of physiological approaches to understanding plant-environment interactions from the functional perspective. Lectures cover physiological adaptation; limiting factors; resources acquisition/ allocation; photosynthesis, carbon, energy balance; water use relations nutrient relations; linking ecophysiology and stable isotopes; stress physiology; life history physiology; evolution of physiological performance; ecophysiology at the population, community, ecosystem levels. Differential Tuition: $150. Course Fees: GS01 $90.

ES 6033. Applied Multivariate Statistics for Ecological Data. (3-0) 3 Credit Hours.
Prerequisite: ES 5023. This course provides students with a conceptual and practical understanding of the application of multivariate statistics in environmental science and ecology. Course will include analysis such as classification (creating discrete groups) and dimension reduction, as well as visualization techniques such as ordination. Applications include habitat classification, clustering (i.e., community classification), and exploring community-environment relationships. Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $150. Course Fees: GS01 $90.

ES 6063. Human Dimensions of Wildlife. (3-0) 3 Credit Hours.
This course will focus on the human dimensions of wildlife and will introduce students to how people’s knowledge, values, opinions, and behaviors influence wildlife management. We will explore the ways that economics, politics, culture, and society shape wildlife management decisions and we will learn about conservation strategies that consider human dimensions. This course will have an emphasis on the human dimensions of wildlife management and conservation on private lands in Texas. Differential Tuition: $150. Course Fees: GS01 $90.

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: EES 6103, ES 5203, or ES 6103.) Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

ES 6213. Advanced Ecology. (3-0) 3 Credit Hours.
Prerequisite: BIO 3283 or an equivalent. Interaction of organisms with their environment, allelopathy, 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.) Differential Tuition: $150. Course Fees: GS01 $90.

ES 6223. Application of Federal Environmental Law at the State Level. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing. This course evaluates the framework of federal environmental 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 6273, EES 6273, or ES 6273.) Differential Tuition: $150. Course Fees: GS01 $90.

ES 6273. Analyses of Environmental Problems. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing. This course evaluates the framework of federal environmental 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 6273. Credit can be earned for only one of the following: CE 6273, EES 6273, or ES 6273.) Differential Tuition: $150. Course Fees: GS01 $90.

ES 6613. Water Resources. (3-0) 3 Credit Hours.
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.) Differential Tuition: $50. Course Fees: GS01 $30.
ES 6951. Independent Study. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing and permission in writing (form available) from 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.) Differential Tuition: $50. Course Fees: GS01 $30.

ES 6953. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) from 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.) Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $50. Course Fees: GS01 $30.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

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. Differential Tuition: $50. Course Fees: GS01 $30.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $50. Course Fees: GS01 $30.

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.) Differential Tuition: $100. Course Fees: GS01 $60.

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.) Differential Tuition: $150. Course Fees: GS01 $90.

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.) Differential Tuition: $50. Course Fees: GS01 $30.

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.) Differential Tuition: $100. Course Fees: GS01 $60.

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.) Differential Tuition: $150. Course Fees: GS01 $90.