DEPARTMENT OF GEOLOGICAL SCIENCES

The undergraduate degree programs offered by the Department of Geological Sciences - a Bachelor of Science degree in Geology, a Bachelor of Arts degree in Geology, a Minor in Geology, and a Certificate in Geographic Information Systems (GIS) - reflect the Department's policy of offering the opportunity for a comprehensive education of the highest quality, individualized to the needs and interests of the student. Completion of a basic science curriculum allows students to apply for entry into one of several highly specialized areas in geology. Students who have majored in one of these degree programs are eligible to apply for positions in education, industry, or government as well as for entry into professional or graduate schools.

- B.S. degree in Geology (p. 1)
- B.A. degree in Geology (p. 3)

Bachelor of Science Degree in Geology

The Bachelor of Science (B.S.) degree in Geology provides opportunities to prepare for careers in the geosciences and for successful studies in graduate school. The program of study focuses on fundamentals and learning skills used by geologists in their professional careers.

The minimum number of semester credit hours required for this degree, including the Core Curriculum requirements, is 120, at least 39 of which must be at the upper-division level. All major and support work courses must be completed with a grade of "C-" or better.

All candidates seeking this degree must fulfill the Core Curriculum requirements and the degree requirements, which are listed below.

Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.S. degree in Geology must fulfill University Core Curriculum requirements in the same manner as other students. If courses are taken to satisfy both degree requirements and Core Curriculum requirements, then students may need to take additional courses in order to meet the minimum number of semester credit hours required for this degree.

Core Curriculum Component Area Requirements (http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/)

First Year Experience Requirement 3
Communication 6
Mathematics 3
Life and Physical Sciences 6
Language, Philosophy and Culture 3
Creative Arts 3
American History 6
Government-Political Science 6
Social and Behavioral Sciences 3
Component Area Option 3
Total Credit Hours 42

Gateway Courses

Students pursuing the B.S. degree in Geology must successfully complete each of the following Gateway Courses with a grade of "C-" or better in no more than two attempts. A student who is unable to successfully complete these courses within two attempts, including dropping a course with a grade of "W" or taking an equivalent course at another institution, will be required to change his or her major.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 1113</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>&amp; CHE 1131</td>
<td>and General Chemistry II Laboratory</td>
</tr>
<tr>
<td>GEO 1103</td>
<td>Physical Geology</td>
</tr>
<tr>
<td>&amp; GEO 1111</td>
<td>and Physical Geology Laboratory</td>
</tr>
<tr>
<td>MAT 1224</td>
<td>Calculus II</td>
</tr>
</tbody>
</table>

Degree Requirements

A. Major courses

1. Required courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEO 1103</td>
<td>Physical Geology</td>
</tr>
<tr>
<td>&amp; GEO 1111</td>
<td>and Physical Geology Laboratory</td>
</tr>
<tr>
<td>GEO 1123</td>
<td>Life Through Time</td>
</tr>
<tr>
<td>&amp; GEO 1131</td>
<td>and Life Through Time Laboratory</td>
</tr>
<tr>
<td>GEO 2003</td>
<td>Mineralogy</td>
</tr>
<tr>
<td>&amp; GEO 2011</td>
<td>and Mineralogy Laboratory</td>
</tr>
<tr>
<td>GEO 2113</td>
<td>Fundamentals of Geographic Information Systems (GIS)</td>
</tr>
<tr>
<td>GEO 3043</td>
<td>Petrology</td>
</tr>
<tr>
<td>&amp; GEO 3051</td>
<td>and Petrology Laboratory</td>
</tr>
<tr>
<td>GEO 3063</td>
<td>Paleontology</td>
</tr>
<tr>
<td>&amp; GEO 3071</td>
<td>and Paleontology Laboratory</td>
</tr>
<tr>
<td>GEO 3103</td>
<td>Structural Geology</td>
</tr>
<tr>
<td>&amp; GEO 3111</td>
<td>and Structural Geology Laboratory</td>
</tr>
<tr>
<td>GEO 3113</td>
<td>Geologic Field Investigations</td>
</tr>
<tr>
<td>GEO 3123</td>
<td>Sedimentation and Stratigraphy</td>
</tr>
<tr>
<td>&amp; GEO 3131</td>
<td>and Sedimentation and Stratigraphy Laboratory</td>
</tr>
<tr>
<td>GEO 4933</td>
<td>Field Geology Part I</td>
</tr>
<tr>
<td>GEO 4943</td>
<td>Field Geology Part II</td>
</tr>
</tbody>
</table>

2. Select 20 additional semester credit hours at the upper-division level from the remaining GEO course offerings. Students should meet with their academic advisor and/or a member of the Department of Geological Sciences to verify that they have taken the necessary prerequisites.

B. Courses within the College of Sciences

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 1103</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>&amp; CHE 1121</td>
<td>and General Chemistry I Laboratory</td>
</tr>
<tr>
<td>CHE 1113</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>&amp; CHE 1131</td>
<td>and General Chemistry II Laboratory</td>
</tr>
<tr>
<td>CS 1173</td>
<td>Data Analysis and Visualization</td>
</tr>
<tr>
<td>MAT 1214</td>
<td>Calculus I</td>
</tr>
<tr>
<td>MAT 1224</td>
<td>Calculus II</td>
</tr>
<tr>
<td>PHY 1943</td>
<td>Physics for Scientists and Engineers I</td>
</tr>
<tr>
<td>&amp; PHY 1951</td>
<td>and Physics for Scientists and Engineers I Laboratory</td>
</tr>
<tr>
<td>PHY 1963</td>
<td>Physics for Scientists and Engineers II</td>
</tr>
<tr>
<td>&amp; PHY 1971</td>
<td>and Physics for Scientists and Engineers II Laboratory</td>
</tr>
</tbody>
</table>

Total Credit Hours 87
Concentrations
For those students interested in addressing water resource or climate issues, the Department of Geological Sciences offers two areas of concentration. To declare a concentration, or obtain advice, students should consult an undergraduate advisor in the Mathematics and Physical Sciences Advising Center. To receive credit for the concentration area of study, students must successfully complete all requirements for the B.S. degree along with all courses listed under each concentration area. Students who do not successfully complete all courses of a given concentration area will receive a standard B.S. degree in Geology.

Concentration in Hydrology
All candidates for the Concentration in Hydrology must complete the following courses:

- GEO 3374 Geochemistry 4
- GEO 4203 Aqueous Geochemistry 3
- GEO 4623 Groundwater Hydrogeology 3
- GEO 4133 River Science 3
- GEO 4503 Hydrogeophysics 3
- GEO 4511 Hydrogeophysics Laboratory 1

Total Credit Hours 17

Concentration in Earth System and Climate
All candidates for the Concentration in Earth System and Climate must complete the following courses:

- GEO 3003 Fundamentals of Meteorology 3
- GEO 3163 Oceanography 3
- GEO 3173 Polar Regions and Climate Change 3
- GEO 4053 Climate Change: Past, Present, Future 3
- GEO 4113 Geomorphology 4
- GEO 4121 and Geomorphology Laboratory

Total Credit Hours 16

Course Sequence Guide for B.S. Degree in Geology
This course sequence guide is designed to assist students in completing their UTSA undergraduate Geology degree requirements. This is merely a guide and students must satisfy other requirements of this catalog and meet with their academic advisor for individualized degree plans. Progress within this guide depends upon such factors as course availability, individual student academic preparation, student time management, work obligations, and individual financial considerations. Students may choose to take courses during Summer terms to reduce course loads during long semesters.

B.S. in Geology – Recommended Four-Year Academic Plan
First Year
<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>AIS 1203</td>
<td>Academic Inquiry and Scholarship</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>CHE 1103</td>
<td>General Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&amp; CHE 1121</td>
<td>and General Chemistry I Laboratory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GEO 1103</td>
<td>Physical Geology</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&amp; GEO 1111</td>
<td>and Physical Geology Laboratory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WRC 1013</td>
<td>Freshman Composition I (core)</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credit Hours 14

Second Year
<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>GEO 3003</td>
<td>Fundamentals of Meteorology</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>GEO 3163</td>
<td>Oceanography</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>GEO 3173</td>
<td>Polar Regions and Climate Change</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>GEO 4053</td>
<td>Climate Change: Past, Present, Future</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>GEO 4113</td>
<td>Geomorphology</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&amp; GEO 4121</td>
<td>and Geomorphology Laboratory</td>
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</table>

Total Credit Hours 16

Third Year
<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>GEO 3113</td>
<td>Geologic Field Investigations</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>POL 1013</td>
<td>Introduction to American Politics (core)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Upper-division GEO elective</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper-division GEO elective</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Component Area Option core</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Total Credit Hours 15

Spring
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 1113</td>
<td>General Chemistry II and General Chemistry II Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CS 1173</td>
<td>Data Analysis and Visualization</td>
<td>3</td>
</tr>
<tr>
<td>GEO 1123</td>
<td>Life Through Time and Life Through Time Laboratory (core and major)</td>
<td>4</td>
</tr>
<tr>
<td>MAT 1214</td>
<td>Calculus I (core and major)</td>
<td>4</td>
</tr>
</tbody>
</table>

Total Credit Hours 15

Second Year
<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>GEO 2003</td>
<td>Mineralogy and Mineralogy Laboratory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>GEO 3063</td>
<td>Paleontology and Paleontology Laboratory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>MAT 1224</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>PHY 1943</td>
<td>Physics for Scientists and Engineers I</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&amp; PHY 1951</td>
<td>and Physics for Scientists and Engineers I Laboratory (core and major)</td>
<td></td>
</tr>
</tbody>
</table>

Total Credit Hours 16

Third Year
<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>GEO 3113</td>
<td>Geologic Field Investigations</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>POL 1013</td>
<td>Introduction to American Politics (core)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Upper-division GEO elective</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper-division GEO elective</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Component Area Option core</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Total Credit Hours 15

Spring
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEO 3103</td>
<td>Structural Geology</td>
<td>4</td>
</tr>
<tr>
<td>&amp; GEO 3111</td>
<td>and Structural Geology Laboratory</td>
<td></td>
</tr>
<tr>
<td>GEO 3123</td>
<td>Sedimentation and Stratigraphy and Sedimentation and Stratigraphy Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>&amp; GEO 3131</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POL 1133</td>
<td>Texas Politics and Society (core) or Civil Rights in Texas and America</td>
<td>3</td>
</tr>
<tr>
<td>or POL 1213</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper-division GEO elective</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Total Credit Hours 14
Summer
GEO 4933  Field Geology Part I  3
GEO 4943  Field Geology Part II  3
Credit Hours  6

Fourth Year
Fall
American History core  3
Language, Philosophy & Culture core  3
Upper-division GEO elective  3
Upper-division GEO elective  3
Credit Hours  12
Spring
American History core  3
Creative Arts  3
Social & Behavioral Sciences core  3
Upper-division GEO elective  3
Upper-division GEO elective  2
Credit Hours  14
Total Credit Hours  120

1  These laboratory courses include a lecture component as indicated on the University Schedule of Classes.

Note: Some courses are only offered once a year: Fall or Spring. Check with the Department of Geological Sciences for scheduling of courses.

Bachelor of Arts Degree in Geology

The Bachelor of Arts (B.A.) degree in Geology provides opportunities to prepare for careers in fields such as earth science education, law, insurance, financial services, energy business, and environmental management. It is not recommended for students planning to pursue careers as professional geologists or graduate studies in geology or related fields.

The minimum number of semester credit hours required for this degree, including the Core Curriculum requirements, is 120, at least 39 of which must be at the upper-division level. All major and support work courses must be completed with a grade of "C-" or better.

All candidates seeking this degree must fulfill the Core Curriculum requirements and the degree requirements, which are listed below.

Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.A. degree in Geology must fulfill University Core Curriculum requirements in the same manner as other students. If courses are taken to satisfy both degree requirements and Core Curriculum requirements, then students may need to take additional courses in order to meet the minimum number of semester credit hours required for this degree.

Core Curriculum Component Area Requirements (http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/)
First Year Experience Requirement  3
Communication  6
Mathematics  3
Life and Physical Sciences  6

Language, Philosophy and Culture  3
Creative Arts  3
American History  6
Government-Political Science  6
Social and Behavioral Sciences  3
Component Area Option  3
Total Credit Hours  42

Gateway Courses

Students pursuing the B.A. degree in Geology must successfully complete each of the following Gateway Courses with a grade of "C-" or better in no more than two attempts. A student who is unable to successfully complete these courses within two attempts, including dropping a course with a grade of "W" or taking an equivalent course at another institution, will be required to change his or her major.

CHE 1113  General Chemistry II
& CHE 1131  and General Chemistry II Laboratory
GEO 1103  Physical Geology
& GEO 1111  and Physical Geology Laboratory
MAT 1214  Calculus I

Degree Requirements

A. Major courses

1. Required courses
GEO 1103  Physical Geology
& GEO 1111  and Physical Geology Laboratory
GEO 1123  Life Through Time
& GEO 1131  and Life Through Time Laboratory
GEO 2003  Mineralogy
& GEO 2011  and Mineralogy Laboratory
GEO 2113  Fundamentals of Geographic Information Systems (GIS)
GEO 3043  Petrology
& GEO 3051  and Petrology Laboratory
GEO 3063  Paleontology
& GEO 3071  and Paleontology Laboratory
GEO 3123  Sedimentation and Stratigraphy
& GEO 3131  and Sedimentation and Stratigraphy Laboratory

2. Select 16 semester credit hours at the upper-division level from among the remaining GEO course offerings. Students should meet with their academic advisor and/or a member of the Department of Geological Sciences to verify that they have taken the necessary prerequisites.

B. Courses within the College of Sciences

CHE 1103  General Chemistry I
& CHE 1121  and General Chemistry I Laboratory
CHE 1113  General Chemistry II
& CHE 1131  and General Chemistry II Laboratory
or GEO 3374  Geochemistry
CS 1173  Data Analysis and Visualization
MAT 1214  Calculus I
PHY 1603  Algebra-based Physics I
& PHY 1611  and Algebra-based Physics I Laboratory
or
**Department of Geological Sciences**

**PHY 1943** & **PHY 1951**
Physics for Scientists and Engineers I
and Physics for Scientists and Engineers I Laboratory

**PHY 1623** & **PHY 1631**
Algebra-based Physics II
and Algebra-based Physics II Laboratory

or

**PHY 1963** & **PHY 1971**
Physics for Scientists and Engineers II
and Physics for Scientists and Engineers II Laboratory

**C. Electives**
Select 18 semester credit hours of electives to meet the 120 semester credit hour degree minimum with an appropriate number of credit hours at the upper-division level to meet the UTSA minimum of 39 upper-division hours. If PHY 1943 and PHY 1963 are taken under section B above, MAT 1224 should be used to fulfill 3 hours of electives.

Total Credit Hours

84

**Concentrations**

For those students interested in addressing water resource or climate issues, the Department of Geological Sciences offers two areas of concentration. To declare a concentration, or obtain advice, students should consult an undergraduate adviser in the Mathematics and Physical Sciences Advising Center. To receive credit for the concentration area of study, students must successfully complete all requirements for the B.A. degree along with all courses listed under each concentration area. Students who do not successfully complete all courses of a given concentration area will receive a standard B.A. degree in Geology.

**Concentration in Hydrology**
All candidates for the Concentration in Hydrology must complete the following courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEO 3374</td>
<td>Geochemistry</td>
<td>4</td>
</tr>
<tr>
<td>GEO 4203</td>
<td>Aqueous Geochemistry</td>
<td>3</td>
</tr>
<tr>
<td>GEO 4623</td>
<td>Groundwater Hydrogeology</td>
<td>3</td>
</tr>
<tr>
<td>GEO 4133</td>
<td>River Science</td>
<td>3</td>
</tr>
<tr>
<td>GEO 4503</td>
<td>Hydrogeophysics</td>
<td>3</td>
</tr>
<tr>
<td>GEO 4511</td>
<td>Hydrogeophysics Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Credit Hours

17

**Concentration in Earth System and Climate**
All candidates for the Concentration in Earth System and Climate must complete the following courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEO 3003</td>
<td>Fundamentals of Meteorology</td>
<td>3</td>
</tr>
<tr>
<td>GEO 3163</td>
<td>Oceanography</td>
<td>3</td>
</tr>
<tr>
<td>GEO 3173</td>
<td>Polar Regions and Climate Change</td>
<td>3</td>
</tr>
<tr>
<td>GEO 4053</td>
<td>Climate Change: Past, Present, Future</td>
<td>3</td>
</tr>
<tr>
<td>GEO 4113</td>
<td>Geomorphology</td>
<td>4</td>
</tr>
</tbody>
</table>
& GEO 4121  and Geomorphology Laboratory

Total Credit Hours

16

**Course Sequence Guide for B.A. Degree in Geology**

This course sequence guide is designed to assist students in completing their UTSA undergraduate Geology degree requirements. This is merely a guide and students must satisfy other requirements of this catalog and meet with their academic advisor for individualized degree plans. Progress within this guide depends upon such factors as course availability, individual student academic preparation, student time management, work obligations, and individual financial considerations. Students may choose to take courses during Summer terms to reduce course loads during long semesters.

**B.A. in Geology – Recommended Four-Year Academic Plan**

**First Year**

<table>
<thead>
<tr>
<th>Term</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fall</strong></td>
<td>AIS 1203</td>
<td>Academic Inquiry and Scholarship</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>CHE 1103</td>
<td>General Chemistry I</td>
<td>4</td>
</tr>
</tbody>
</table>
& CHE 1121 & General Chemistry I Laboratory 1
| GEO 1103    | Physical Geology                            | 4            |
& GEO 1111 & Physical Geology Laboratory
| WRC 1013    | Freshman Composition I (core)               | 3            |

Total Credit Hours

14

<table>
<thead>
<tr>
<th>Term</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spring</strong></td>
<td>CS 1173</td>
<td>Data Analysis and Visualization</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>GEO 1123</td>
<td>Life Through Time</td>
<td>4</td>
</tr>
</tbody>
</table>
& GEO 1131 & Life Through Time Laboratory (core and major)
| MAT 1214    | Calculus I (core and major)             | 4            |
|             | Life & Physical Sciences core            | 3            |

Total Credit Hours

14

<table>
<thead>
<tr>
<th>Term</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Second Year</strong></td>
<td>GEO 2003</td>
<td>Mineralogy</td>
<td>4</td>
</tr>
</tbody>
</table>
& GEO 2011 & Mineralogy Laboratory
| WRC 1023    | Freshman Composition II (core)         | 3            |
|             | Creative Arts core                      | 3            |
|             | Select one of the following:            | 4            |
|             | CHE 1113    | General Chemistry II              | 3            |
& CHE 1131 & General Chemistry II Laboratory 1
| GEO 3374    | Geochemistry                      | 4            |

Total Credit Hours

17

<table>
<thead>
<tr>
<th>Term</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spring</strong></td>
<td>GEO 2113</td>
<td>Fundamentals of Geographic</td>
<td>3</td>
</tr>
</tbody>
</table>
Information Systems (GIS)
| GEO 3043    | Petrology                                                   | 4            |
& GEO 3051 & Petrology Laboratory
| PHY 1603    | Algebra-based Physics I                                   | 4            |
& PHY 1611 & Algebra-based Physics I Laboratory
or
| PHY 1943    | Physics for Scientists and Engineers I                    | 4            |
& PHY 1951 & Physics for Scientists and Engineers I Laboratory
|             | Free elective                                       | 3            |
|             | Free elective                                       | 3            |

Total Credit Hours

17
## Third Year

### Fall
- **GEO 3063** & **GEO 3071**
  - Paleontology and Paleontology Laboratory
  - 4 Credit Hours
- **PHY 1623** & **PHY 1631**
  - Algebra-based Physics II and Algebra-based Physics II Laboratory
  - 4 Credit Hours
  or
- **PHY 1963** & **PHY 1971**
  - Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory
  - 4 Credit Hours
- **Language, Philosophy & Culture core**
  - 3 Credit Hours
- **Upper-division GEO elective**
  - 3 Credit Hours

### Spring
- **GEO 3123** & **GEO 3131**
  - Sedimentation and Stratigraphy and Sedimentation and Stratigraphy Laboratory
  - 4 Credit Hours
- **POL 1013**
  - Introduction to American Politics (core)
  - 3 Credit Hours
- **Upper-division GEO elective**
  - 3 Credit Hours
- **Component Area Option core**
  - 3 Credit Hours

### Upper-division GEO elective

| Credit Hours | 14 |

### Fourth Year

### Fall
- **Free elective**
  - 3 Credit Hours
- **Free elective**
  - 3 Credit Hours
- **Upper-division Free elective**
  - 3 Credit Hours
- **Upper-division GEO elective**
  - 3 Credit Hours
- **American History core**
  - 3 Credit Hours

### Spring
- **POL 1133**
  - Texas Politics and Society (core) or Civil Rights in Texas and America
  - 3 Credit Hours
  or **POL 1213**
- **American History core**
  - 3 Credit Hours
- **Social & Behavioral Sciences core**
  - 3 Credit Hours
- **Upper-division Free elective**
  - 3 Credit Hours
- **Upper-division GEO elective**
  - 3 Credit Hours
- **Upper-division GEO elective**
  - 1 Credit Hours

### Upper-division GEO elective

| Credit Hours | 16 |

### Total Credit Hours

| 120 |

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## Minor in Geology

All students pursuing the Minor in Geology must complete 21 semester credit hours. All coursework must be completed with a grade of "C-" or better.

### A. Required courses
- **GEO 1103** & **GEO 1111**
  - Physical Geology and Physical Geology Laboratory
  - 4 Credit Hours
- **GEO 1123** & **GEO 1131**
  - Life Through Time and Life Through Time Laboratory
  - 4 Credit Hours
- **GEO 2003** & **GEO 2011**
  - Mineralogy and Mineralogy Laboratory
  - 4 Credit Hours
  or **GEO 3004**
  - Rocks, Fossils, and Global Tectonics

### B. Electives
- **Approved upper-division geology electives**
  - 9 Credit Hours

### Total Credit Hours

| 21 |

To declare a Minor in Geology, obtain advice about prerequisites about approved upper-division geology electives, or seek approval of substitutions for course requirements, students should consult their academic advisor.

## Certificate in Geographic Information System

Understanding and use of geospatial information is needed to address issues related to geological, environmental, biological, physical, business, and social processes. The objectives of the program is to train undergraduate students from any discipline of UTSA to be expert in using Geographic Information System (GIS) tool for creating, operating, and managing geospatial data, making professional maps, and analyzing data for various science and technique applications.

This is an interdisciplinary program and it is administrated through the Geological Sciences department. Courses currently offered through different departments (Geological Sciences, Environmental Science and Ecology, Civil and Environmental Engineering, Political Science and Geography) can be used for the certificate program.

The requirement for the certificate is 15 semester credit hours (five courses). Courses taken in the certificate program may be applied towards to other B.S. or B.A. degrees, depending on program requirements and with approval of the undergraduate advisor of record of the degree program. Student who is not currently in any UTSA degree program can apply as non-degree-seeking special student at the undergraduate level to pursue this certificate.

Students pursuing the Certificate in Geographic Information System must complete a minimum of 15 semester credit hours:

### A. One of the following:
- **CE 4293**
  - Geographic Information Systems (GIS)
- **ES 2113**
  - Fundamentals of Geographic Information Systems (GIS)
- **GEO 2113**
  - Fundamentals of Geographic Information Systems (GIS)
- **GES 3314**
  - Introduction to Geographic Information Systems

### B. One of the following:
- **GES 3323**
  - Spatial Analysis

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1. These laboratory courses include a lecture component as indicated on the University Schedule of Classes.

Note: Some courses are only offered once a year: Fall or Spring. Check with the Department of Geological Sciences for scheduling of courses.
C. One of the following: 3
- GEO 4093 Principles of Remote Sensing
- GES 3363 GIS Cartography

D. Courses within Geological Sciences: 6
- GEO 4073 Web GIS
- GEO 4103 Programming and Statistics for GIS

Total Credit Hours 15

Geology (GEO) Courses

GEO 1013. The Third Planet. (3-0) 3 Credit Hours. (TCCN = GEOL 1301)
Evolution of ideas concerning the earth’s origin, structure, and age; social impact of recognizing the antiquity of the planet and humankind's brief presence; examination of how the distribution of planetary resources influenced the rise and clash of civilizations. May not be applied to a major in geology. May apply toward the Core Curriculum requirement in Life and Physical Sciences. Generally offered: Fall, Spring, Summer. Course Fees: DL01 $75; LRC1 $12; LRS1 $45; STSI $21.

GEO 1103. Physical Geology. (3-0) 3 Credit Hours. (TCCN = GEOL 1303)
Prerequisites: Completion of or concurrent enrollment in CHE 1103, CHE 1121, and MAT 1093 or higher, or satisfactory performance on placement exam. Completion of or concurrent enrollment in GEO 1111 required. This course is intended for geology majors and minors as well as others interested in the geologic sciences. It constitutes an introduction to the geology major and skillsets needed by the practicing geologist including: mineral and rock identification, microscopy, deep time, outcrop descriptions, and mapping. The course includes an introduction to the theory of plate tectonics and its relation to the Earth’s internal structure, surface features, hydrosphere, earthquakes, and volcanism. One or more field trips may be required. Generally offered: Fall, Spring. Course Fees: IUE1 $15; LRS1 $15; STSI $7.

GEO 1111. Physical Geology Laboratory. (1-3) 1 Credit Hour. (TCCN = GEOL 1103)
Prerequisite: Completion of or concurrent enrollment in GEO 1103. Relation of the earth’s present processes to its resources, structure, and internal composition. Field and laboratory study of minerals, rocks, maps, and aerial and satellite photos. Field trips may be required. (Formerly titled “Introduction to Earth Systems Laboratory.”) Generally offered: Fall, Spring. Course Fees: IUE1 $15; LRS1 $15; STSI $7.

GEO 1123. Life Through Time. (3-0) 3 Credit Hours. (TCCN = GEOL 1304)
Concurrent enrollment in GEO 1131 recommended. A study of the origin and evolution of life on Earth including major events from the beginning of the Earth and solar system to the present, as well as the interaction of life with the lithosphere, atmosphere, and hydrosphere. This course will explore the fossil record, sedimentary rocks, plate tectonics, evolution, and climate change. May apply toward the Core Curriculum requirement in Life and Physical Sciences. Generally offered: Fall, Spring. Course Fees: IUE1 $15; LRS1 $15; STSI $7.

GEO 1131. Life Through Time Laboratory. (1-3) 1 Credit Hour. (TCCN = GEOL 1104)
Prerequisite: Completion of or concurrent enrollment in GEO 1123. Laboratory and field study of minerals, rocks, fossils, sequences of rocks, and mapping for the interpretation of life through time and the interpretation of Earth history. This course is intended and required for Geological Science majors and minors and will introduce students to many concepts covered in upper level courses. Field trips may be required. Generally offered: Fall, Spring. Course Fees: IUE1 $15; LRS1 $15; STSI $7.

GEO 2003. Mineralogy. (3-0) 3 Credit Hours.
Prerequisites: CHE 1103, CHE 1121, GEO 1103, GEO 1111, MAT 1093 or higher, or satisfactory performance on placement exam. Completion of or concurrent enrollment in GEO 2011. Crystallography, crystal chemistry, and the physical and optical properties of minerals. Principles of optical mineralogy and the microscopic determination of nonopaque minerals. Field trips may be required. Generally offered: Fall. Course Fees: LRS1 $45; STSI $21.

GEO 2011. Mineralogy Laboratory. (1-4) 1 Credit Hour.
Corequisite: GEO 2003. Laboratory study of crystal models, crystals, and minerals. Use of physical properties and the petrographic microscope for mineral identification. Field trips may be required. (Formerly GEO 2012. Credit cannot be earned for both GEO 2011 and GEO 2012.) Generally offered: Fall. Course Fees: IUE1 $15; LRS1 $15; STSI $7.

GEO 2113. Fundamentals of Geographic Information Systems (GIS). (2-2) 3 Credit Hours.
Prerequisite: CS 1173 or equivalent. This course will serve as a basic introduction to the concepts and techniques of utilizing a Geographic Information System (GIS) to study and model environmental issues. In lecture and laboratory, students will study methods of querying, analyzing, creating and displaying GIS data utilizing industry standard software. Students will also be introduced to using the Global Positioning System (GPS) as a means for creating GIS data. (Credit cannot be earned for both GEO 2113 and ES 2113.) Generally offered: Fall, Spring. Course Fees: LRS1 $45; STSI $21.

GEO 3001. Preparation for the Geoscience Workforce. (1-0) 1 Credit Hour.
Prerequisites: GEO 1103, GEO 1123, and at least junior standing. This course provides the opportunity to engage in professional development activities in preparation for a career in the geosciences and aligned fields. Activities will include workshops, seminars, and assignments. Differential Tuition: $50.

GEO 3003. Fundamentals of Meteorology. (3-0) 3 Credit Hours.
Prerequisites: GEO 1103 and GEO 1123. Introduction to atmospheric sciences and how the energy from the Sun shapes the weather on the Earth, from weather prediction to hurricanes forecast, to El Niño to La Niña. Generally offered: Fall (online), Spring (in class). Differential Tuition: $150.

GEO 3004. Rocks, Fossils, and Global Tectonics. (2-4) 4 Credit Hours.
Prerequisites: GEO 1103 and GEO 1111. An investigation of the major rock forming minerals, petrogenesis of the major rock types, and their plate tectonic context. Study of major trends in fauna and flora through time and their application to interpreting plate tectonics, paleoenvironments, and paleoclimate. Credit may not be applied to a B.S. or B.A. major in Geology. Differential Tuition: $200.

GEO 3013. Fundamentals of Plate Tectonics. (3-0) 3 Credit Hours.
Prerequisites: GEO 1103, GEO 1111, GEO 2003, GEO 2011, and MAT 1093. This course introduces the student to the mechanics of lithospheric plate motion and the physical phenomena driving the motion. The relationships between plate tectonics, mantle convection, and geomagnetism are explored, as well as common structures associated with plate boundaries. Mathematical models are introduced and used to describe plate motion on a sphere. Historical development of plate tectonic theory is also covered. Generally offered spring. Differential Tuition: $150.

GEO 3043. Petrology. (3-0) 3 Credit Hours.
Prerequisites: GEO 2003, GEO 2011, MAT 1214, and completion of or concurrent enrollment in GEO 3051. Description, classification, occurrence, and origin of igneous and metamorphic rocks. Field trips may be required. Generally offered: Spring. Differential Tuition: $150.
GEO 3051. Petrology Laboratory. (1-4) 1 Credit Hour.
Prerequisites: GEO 2003, GEO 2011, and completion of or concurrent enrollment in GEO 3043. Laboratory study of igneous and metamorphic rocks in hand specimen and thin section. Field trips may be required. (Formerly GEO 3052. Credit cannot be earned for both GEO 3051 and GEO 3052.) Generally offered: Spring. Differential Tuition: $50.

GEO 3063. Paleontology. (3-0) 3 Credit Hours.
Prerequisites: GEO 1103, GEO 1111, GEO 1123, GEO 1131, or consent of instructor, and concurrent enrollment in GEO 3071. Study of fossil animals and plants. Emphasis on invertebrate animals. Systematics, biostratigraphy, paleoecology, and evolution of fossil organisms. Field trips may be required. Generally offered: Fall. Differential Tuition: $150.

GEO 3071. Paleontology Laboratory. (1-3) 1 Credit Hour.

GEO 3103. Structural Geology. (3-0) 3 Credit Hours.
Prerequisites: GEO 3043, GEO 3051, GEO 3113, and completion of or concurrent enrollment in GEO 3111. Description and origin of geologic structures at the microscopic, hand specimen and mountain scales with emphasis on the response of Earth materials to stress and the role of rheology. Relationships between structure and tectonics will be explored. Field trips may be required. Generally offered: Spring. Differential Tuition: $150.

GEO 3111. Structural Geology Laboratory. (1-3) 1 Credit Hour.
Prerequisite: Completion of or concurrent enrollment in GEO 3103. Laboratory study of structural features and concepts using maps, cross-sections, photographs, and descriptive geometric and stereographic methods. Field trips may be required. Generally offered: Spring. Differential Tuition: $50.

GEO 3113. Geologic Field Investigations. (1-4) 3 Credit Hours.
Prerequisites: GEO 2003 and GEO 2011. Introduction to techniques for studying geologic features and processes in the field, including rock identification, construction of geological maps, orientation analysis, and report writing. Some half-day and Saturday field trips may be required. (Formerly GEO 3112. Credit cannot be earned for both GEO 3112 and GEO 3113.) Generally offered: Fall, Spring. Differential Tuition: $150.

GEO 3123. Sedimentation and Stratigraphy. (3-0) 3 Credit Hours.
Prerequisites: GEO 2003, GEO 2011, GEO 3063, GEO 3071, and completion of or concurrent enrollment in GEO 3131. Processes of erosion, transportation, and deposition that form bodies of sedimentary rock. Depositional systems and modeling are a significant area of study. Stratigraphic principles and temporal and spatial facies relationships at various scales. Field trips may be required. (Formerly titled "Sedimentary Geology") Generally offered: Spring. Differential Tuition: $150.

GEO 3131. Sedimentation and Stratigraphy Laboratory. (1-3) 1 Credit Hour.
Prerequisites: GEO 2003, GEO 2011, GEO 3063, GEO 3071, and completion of or concurrent enrollment in GEO 3123. Laboratory studies of sedimentary processes and their products. Hand specimens, thin sections, sedimentary structures, and interpretation of depositional environments. Stratigraphic case studies, including surface, subsurface, and sequence stratigraphic analysis. Field trips may be required. (Formerly titled "Sedimentary Geology Laboratory") Generally offered: Spring. Differential Tuition: $50. Course Fee: IUE1 $15.

GEO 3163. Oceanography. (3-0) 3 Credit Hours.
General oceanography, with emphasis on marine geology and especially the continental margins. An optional field trip may be offered. (Credit cannot be earned for both GEO 3163 and ES 3133.) Generally offered: Fall (in class), Spring (online). Differential Tuition: $150. Course Fee: DL01 $75.

GEO 3173. Polar Regions and Climate Change. (3-0) 3 Credit Hours.
This course covers properties, areal distribution, seasonal change and climatic change of the major constituents of the Polar Regions: the large ice sheets of Greenland and Antarctica; seasonal snow cover in the high and mid latitudes; sea ice covers in the Arctic, Southern Ocean and other seas; mountain glaciers from the tropics to the polar regions; and permafrost in the high latitude land areas of the Northern Hemisphere. How to examine these constituents will be presented with illustrative examples of monitoring climate-induced changes in the Polar Regions using remote sensing and field investigations of processes and properties. Applications discussed will include: snow and ice covers as agents of geological change; snow and ice impacts as water resources in Asia and western North America, and global environmental impact through for example, effects on the earth's radiation budget, and contributions to sea level change. Human impacts covered will include effects of ice covers of rivers and sea ice such as on petroleum extraction, transportation and navigation, frost and freezing damage to crops, and hazards of blizzards and avalanches. Differential Tuition: $150.

GEO 3343. Introduction to Geospatial Technologies. (3-0) 3 Credit Hours.
This course introduces several aspects of geospatial technologies, not only what they are but how they are used in hands-on applications, all based on free internet resources not commercial software packages. This course provides a solid foundation on which further knowledge in more specialized classes, such as Geographic Information Systems, Global Positioning Systems, and Remote Sensing, can be built on. Differential Tuition: $150.

PHY 1963. This course examines the interrelated geology and physics of the Earth's interior as deduced from earthquake seismology, gravity and magnetic fields, and the application of geophysical methods to the exploration of near-surface cultural and natural resources. Topics in archeological, environmental, and engineering geophysics will be explored through the methods of refraction seismology, electrical resistivity, electromagnetic induction, microgravity, and ground penetrating radar. Field trips may be required. Generally offered: Fall. Differential Tuition: $150.
GEO 3393. Introduction to Isotope Geochemistry. (3-0) 3 Credit Hours. Prerequisites: GEO 1103, GEO 1111, CHE 1103, CHE 1121, and MAT 1214. The course includes a review of theories of nuclear structure, stability of nucleus, nucleosynthesis and origin of elements, and introduces both radiogenic and stable isotope geochemistry. Topics include radioactive decay schemes for tritium-helium, U-Pb, Rb-Sr, Sm-Nd, K-Ar, and U-Th-Pb-He systems; isotopic fractionations of stable isotopes of C, H, O, N, and S; and application of radiogenic and stable isotopes to petrology, evolution of the crust and mantle, geochronology, geothermometry, archaeology, ecology, hydrology, and paleoclimatic interpretation. Generally offered: Fall. Differential Tuition: $150.

GEO 4001. Experiential Learning Experience. (0-0) 1 Credit Hour. Prerequisites: Completion of GEO 3001 with at least a B grade on +/- scale and a major grade point average of 2.67 or better. The opportunity to apply geological principles and skills during a semester-long internship in an organization that utilizes geoscience to accomplish its mission. The grade report for this course is either "CR" (satisfactory participation in the internship) or "NC" (unsatisfactory participation in the internship). Differential Tuition: $50.

GEO 4002. Experiential Learning Experience. (0-0) 2 Credit Hours. Prerequisites: Completion of GEO 3001 with at least a B grade on +/- scale and a major grade point average of 2.67 or better. The opportunity to apply geological principles and skills during a semester-long internship in an organization that utilizes geoscience to accomplish its mission. The grade report for this course is either "CR" (satisfactory participation in the internship) or "NC" (unsatisfactory participation in the internship). Differential Tuition: $100.

GEO 4003. Experiential Learning Experience. (0-0) 3 Credit Hours. Prerequisites: Completion of GEO 3001 with at least a B grade on +/- scale and a major grade point average of 2.67 or better. The opportunity to apply geological principles and skills during a semester-long internship in an organization that utilizes geoscience to accomplish its mission. The grade report for this course is either "CR" (satisfactory participation in the internship) or "NC" (unsatisfactory participation in the internship). Differential Tuition: $150.

GEO 4013. Volcanology. (3-0) 3 Credit Hours. Prerequisite: GEO 3043 or consent of instructor. A survey of volcanoes and volcanic processes, including historically important volcanic eruptions and the prediction and mitigation of volcanic hazards. Field trips may be required. Generally offered: Fall. Differential Tuition: $150.

GEO 4023. Engineering Geology. (3-0) 3 Credit Hours. Prerequisites: PHY 1963 (engineering majors only) or PHY 1603 or PHY 1943, and MAT 1214; or consent of instructor. Geologic factors in construction. Geotechnical properties of minerals, rocks, and soils. Case studies. May not be applied to a major in geology. Generally offered: Fall, Spring, Summer. Differential Tuition: $150.

GEO 4033. Profession of Geology. (3-0) 3 Credit Hours. Prerequisites: GEO 2113, GEO 3123, GEO 3131, GEO 3113. This course is designed to provide the basic knowledge required by the ASBOG National Geologist Examination (Fundamentals) for licensure as a Professional Geologist, and introduces the geoscience student to the fundamentals of professional practice that impact, health, safety, and well-being of the public. The emphasis will be on principles and practices of geoscience that affect the economy, feasibility and design of engineering works, siting criteria, site selection and investigation, human-land interactions, site assessment, liability, responsibility, professional report writing, and licensure. Differential Tuition: $150.

GEO 4053. Climate Change: Past, Present, Future. (3-0) 3 Credit Hours. Prerequisite: GEO 3003. Investigation of the climate system and its evolution during the Earth's history, to build a comprehensive and greater understanding of issues linked to climate change, its impact on ecosystems vulnerabilities and human needs in natural resources. Generally offered: Fall (online) and Spring (in class). Differential Tuition: $150.

GEO 4063. Advanced Environmental Geology. (3-0) 3 Credit Hours. Prerequisites: GEO 1103 and GEO 1111. An analysis of human interaction with geologic systems; the risks and effects of natural geologic hazards such as volcanic eruptions, earthquakes, and floods. Topics will include the effects of human activity on natural systems such as groundwater quality and recharge, river systems, coastal hazards, energy resources, and climate change. The meaning of "sustainability" as a long-term concept and tools to assess and work with Earth systems to avoid endangering human life and property are also topics that are applied and addressed. GEO 4063 is a writing intensive course and project management skills are utilized in working on geologic investigations and solutions for resource management and in analyzing and mitigating natural hazard events. Differential Tuition: $150.

GEO 4073. Web GIS. (2-2) 3 Credit Hours. Prerequisites: ES 2113 or GEO 2113 or GEO 3343, or consent of instructor. This course will focus upon developing GIS applications to be served out via the Internet or a Local Area Network (LAN). Additional topics include the use of Web authoring software. The course presents and introductory level skill set for the creation and publishing of web mapping applications using the ESRI ArcGIS Online resources and available tools. The technical focus of the course includes computer lab tutorials and case studies. Differential Tuition: $150.

GEO 4083. Computer Application for Geoscience. (2-2) 3 Credit Hours. This course will focus upon developing GIS applications to be served out via the Internet or a Local Area Network (LAN). Additional topics include the use of Web authoring software. The course presents and introductory level skill set for the creation and publishing of web mapping applications using the ESRI ArcGIS Online resources and available tools. The technical focus of the course includes computer lab tutorials and case studies. Differential Tuition: $150.

GEO 4093. Principles of Remote Sensing. (2-2) 3 Credit Hours. Prerequisites: MAT 1214 or higher and PHY 1943. This course will provide a thorough introduction to remote sensing theory, technology, and application. The emphasis in this course is on understanding the underlying principles of acquiring, interpreting, and applying data from imaging systems covering the electromagnetic spectrum from the ultraviolet through the microwave. Generally offered: Fall. Differential Tuition: $150.

GEO 4103. Programming and Statistics for GIS. (2-2) 3 Credit Hours. Prerequisites: ES 2113 or GEO 2113 or GEO 3343, or consent of instructor. This course provides students with the basics of Python programming language and how GIS uses it as a scripting language to perform sophisticated statistical, map, and analysis calculations. They will be able to understand the desired outcomes of a project and organize tasks and processes to achieve said goal. Students will learn and master powerful Python tools that automate procedures, and carry out integration with data from many applications. As a result, they will have the ability to transform or create robust GIS datasets, and provide with in depth analysis leading to solid decision making. Differential Tuition: $150.
**GEO 4113. Geomorphology. (3-0) 3 Credit Hours.**
Prerequisites: GEO 1103 or GEO 2613, or consent of instructor, and junior or senior standing, and concurrent enrollment in GEO 4121. Examination of landforms on the Earth's surface and landscape-forming processes. Field trips may be required. Differential Tuition: $150.

**GEO 4121. Geomorphology Laboratory. (1-3) 1 Credit Hour.**
Prerequisites: GEO 1103 or GEO 2613, or consent of instructor, and junior or senior standing, and concurrent enrollment in GEO 4113. Interpretation of landforms and their formative processes from maps, aerial photographs, and calculations. Field trips may be required. Differential Tuition: $50. Course Fee: IUE1 $15.

**GEO 4133. River Science. (3-0) 3 Credit Hours.**
Prerequisites: GEO 1103 or GEO 2613, or consent of instructor, and junior or senior standing. An in-depth examination of river sediment transport principles. Topics include water and sediment supply, sediment dynamics, river morphology, and channel instability. Field trips may be required. Differential Tuition: $150.

**GEO 4203. Aqueous Geochemistry. (3-0) 3 Credit Hours.**
Prerequisites: GEO 3374, or consent of instructor. This course will facilitate to understand in detail the fundamental (primarily thermodynamic) controls on the composition of natural waters and the response of natural waters to variations in various physico-chemical parameters. Characterization of dissolved organic matter in natural waters will be introduced. This course will explore applications to environmental problems like contaminants migration in waters (ground waters, surface waters), weathering, etc., learn to solve numerical problems related to the behavior of chemical components in natural waters, and gain familiarity with simple analytical techniques for the characterization of natural waters. Differential Tuition: $150.

**GEO 4204. Chemical Hydrology. (3-2) 4 Credit Hours.**
Prerequisites: GEO 3374 or GEO 4623, or consent of instructor. Discussion of the basic chemical principles of the water cycle, as well as environmentally relevant applications based on case studies. Detailed Groundwater Hydrogeochemistry, Surface Water Hydrogeochemistry, Surface water and Groundwater Interaction - Geochemical Principles governing, Quantitative and Modeling analysis and geologic effects on quality and flow of groundwater. Coverage of contemporary global issues related to water resources, including pollution control, environmental rehabilitation, sustainable development, and global warming exploration of anthropogenic. Topics include land-atmosphere interactions, movement of water and water rock interaction, contaminant transport in groundwater systems. ASBOG Test Syllabus and web-based teaching are followed. Differential Tuition: $200.

**GEO 4503. Hydrogeophysics. (3-0) 3 Credit Hours.**
Prerequisites: MAT 1214 or higher and PHY 1963. Completion of or concurrent enrollment in GEO 4511. The presence of water and other fluids in subsurface formations, from the macro aquifer level to the micro pore level, are ultimately detected and observed through the application of geophysical principles and survey methods. This course will explore the fundamental science of hydrological geophysics, through the examination of the fundamental petrophysics and the various geophysical surface and borehole methods, such as seismic refraction, electrical resistivity and induced polarization, electromagnetic induction, microgravimetry, and geo-radar as applied to hydrogeologic investigations. Differential Tuition: $150.

**GEO 4511. Hydrogeophysics Laboratory. (1-3) 1 Credit Hour.**
Prerequisite: Completion of or concurrent enrollment in GEO 4503. Laboratory and field-based course exploring geophysical survey systems, survey planning, data collection and analysis. Differential Tuition: $50.

**GEO 4623. Groundwater Hydrogeology. (3-0) 3 Credit Hours.**
Prerequisites: GEO 1103, GEO 1111, PHY 1943, and MAT 1214. Hydrologic cycle and the occurrence and movement of groundwater. Recharge and discharge of aquifers; water quality; exploration and development of ground-water supplies. Field trips may be required. Generally offered: Spring. Differential Tuition: $150.

**GEO 4813. Planetary Geology. (3-0) 3 Credit Hours.**
Prerequisites: PHY 1963, or consent of instructor. This course is designed for students in the Sciences or Engineering and no prior Geological knowledge is assumed, although Earth will be our point of reference. Survey of the interior and surface geology of solid bodies in our Solar System and beyond (planets, moons, asteroids, comets, Kuiper Belt Objects and exoplanets). Topics will include bulk composition and differentiation of planetary interiors, surface processes such as (cryo-) volcanism and meteorite impacts, erosion and sedimentation by fluids and wind, and heat transfer styles. There will be an emphasis on how we know things and what we don’t know, quantifying uncertainties in measurements and models, and the nature of planetary scientific enquiry. Differential Tuition: $150.

**GEO 4911. Independent Study. (0-0) 1 Credit Hour.**
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 Studies may be repeated for credit, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor’s degree in geology. Differential Tuition: $50.

**GEO 4912. Independent Study. (0-0) 2 Credit Hours.**
Prerequisites: Permission in writing (form available) of the instructor, the student’s advisor, the Department Chair, and the Dean of the College in which the course is offered. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor’s degree in geology. Differential Tuition: $100.

**GEO 4913. Independent Study. (0-0) 3 Credit Hours.**
Prerequisites: Permission in writing (form available) of the instructor, the student’s advisor, the Department Chair, and the Dean of the College in which the course is offered. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor’s degree in geology. Differential Tuition: $150.

**GEO 4933. Field Geology Part I. (1-6) 3 Credit Hours.**
Prerequisites: GEO 3103, GEO 3111, GEO 3123, and GEO 3131 or consent of instructor. Part I: Field mapping and measurements. Field trips are required. Differential Tuition: $150.

**GEO 4943. Field Geology Part II. (1-6) 3 Credit Hours.**
Prerequisite: GEO 4933 or consent of instructor. Part II: Field mapping and measurements. Field trips are required. Differential Tuition: $150.

**GEO 4951. Special Studies in Geology. (1-0) 1 Credit Hour.**
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 Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor’s degree. Course Fees: LRS1 $5; STSI $5.
GEO 4953. Special Studies in Geology. (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 Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor’s degree. Generally offered: Fall. Differential Tuition: $150.

GEO 4961. Special Studies in Geology Laboratory. (1-3) 1 Credit Hour.
Prerequisite: Consent of instructor. An organized laboratory course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor’s degree. Differential Tuition: $50.

GEO 4993. Honors Research. (0-0) 3 Credit Hours.
Prerequisites: Enrollment limited to candidates for College Honors during their last two semesters; approval by the College Honors Committee. Supervised research and preparation of an honors thesis. May be repeated only once with approval. Differential Tuition: $150.