# BACHELOR OF SCIENCE (BS) DEGREE WITH A MAJOR IN EARTH SCIENCE

## Program Learning Outcomes for the BS Degree with a Major in Earth Science

Upon completing the BS degree with a major in Earth Science, students will be able to:

1. Understand the structure and composition of the earth and planets, their evolution, and changing the Earth today.
2. Learn basic field geological measurements and recording.
3. Learn earth observations and recording outdoor scientific information.

## Requirements for the BS Degree with a Major in Earth Science

For general university requirements, see Graduation Requirements ([ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements](ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements)). Students pursuing the BS degree with a major in Earth Science must complete:

- A minimum of 20-22 courses (69-73 credit hours) depending on course selection to satisfy major requirements.
- A minimum of 129-133 credit hours to satisfy degree requirements.
- A minimum of 60 credit hours outside of major requirements.
- A minimum of 8-12 courses (28-40 credit hours, depending on course selection) taken at the 300-level or above.
- The requirements for one area of specialization (see below for areas of specialization). The BS degree with a major in Earth Science offers five areas of specialization:
  - Environmental Earth Science (p. )
  - Geochemistry (p. 2)
  - Geology (p. 3)
  - Geophysics (p. 3)
  - Self-Designed (p. 4).

The courses listed below satisfy the requirements for this major. In certain instances, courses not on this official list may be substituted upon approval of the major’s academic advisor, or where applicable, the department’s Director of Undergraduate Studies. (Course substitutions must be formally applied and entered into Degree Works by the major’s Official Certifier ([https://registrar.rice.edu/facstaff/degreeworks/officialcertifier](https://registrar.rice.edu/facstaff/degreeworks/officialcertifier)).) Students and their academic advisors should identify and clearly document the courses to be taken.

## Degree Requirements

### Core Requirements

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 101</td>
<td>SINGLE VARIABLE CALCULUS I</td>
<td>3</td>
</tr>
<tr>
<td>or MATH 105</td>
<td>AP/OTH CREDIT IN CALCULUS I</td>
<td></td>
</tr>
<tr>
<td>MATH 102</td>
<td>SINGLE VARIABLE CALCULUS II</td>
<td>3</td>
</tr>
<tr>
<td>or MATH 106</td>
<td>AP/OTH CREDIT CALCULUS II</td>
<td></td>
</tr>
</tbody>
</table>

### Select 1 from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title, Laboratory</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 121 &amp; CHEM 123</td>
<td>GENERAL CHEMISTRY I and GENERAL CHEMISTRY LABORATORY I</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 151 &amp; CHEM 153</td>
<td>HONORS CHEMISTRY I and HONORS CHEMISTRY LABORATORY I</td>
<td></td>
</tr>
</tbody>
</table>

### Select 1 from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 122 &amp; CHEM 124</td>
<td>GENERAL CHEMISTRY II and GENERAL CHEMISTRY LABORATORY II</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 152 &amp; CHEM 154</td>
<td>HONORS CHEMISTRY II and HONORS CHEMISTRY LABORATORY II</td>
<td></td>
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</tbody>
</table>

### Select 1 from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 101 &amp; PHYS 103</td>
<td>MECHANICS (WITH LAB) and MECHANICS DISCUSSION</td>
<td></td>
</tr>
<tr>
<td>PHYS 111</td>
<td>HONORS MECHANICS (WITH LAB)</td>
<td>4</td>
</tr>
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</table>

### Select 1 from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title, Laboratory</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>PHYS 102 &amp; PHYS 104</td>
<td>ELECTRICITY &amp; MAGNETISM (WITH LAB) and ELECTRICITY AND MAGNETISM DISCUSSION</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 112</td>
<td>HONORS ELECTRICITY &amp; MAGNETISM (WITH LAB)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Title, Area</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESCI 101 / ENST 101</td>
<td>THE EARTH</td>
<td>3 or 4</td>
</tr>
<tr>
<td>or ESCI 115</td>
<td>INTRODUCTION TO THE EARTH</td>
<td></td>
</tr>
<tr>
<td>ESCI 321</td>
<td>EARTH SYSTEM EVOLUTION AND CYCLES</td>
<td>4</td>
</tr>
<tr>
<td>ESCI 322</td>
<td>EARTH CHEMISTRY AND MATERIALS</td>
<td>4</td>
</tr>
<tr>
<td>ESCI 323</td>
<td>EARTH STRUCTURE AND DEFORMATION</td>
<td>4</td>
</tr>
<tr>
<td>ESCI 324</td>
<td>EARTH’S INTERIOR</td>
<td>4</td>
</tr>
<tr>
<td>ESCI 334</td>
<td>GEOLOGICAL TECHNIQUES</td>
<td>3</td>
</tr>
</tbody>
</table>

### Area of Specialization

Select 1 from the following Areas of Specialization (see Areas of Specialization below):

- Environmental Earth Science
- Geochemistry
- Geology
- Geophysics
- Self-Designed

### Total Credit Hours Required for the Major in Earth Science

<table>
<thead>
<tr>
<th>Description</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Credit Hours Required for the Major in Earth Science</td>
<td>68-73</td>
</tr>
<tr>
<td>Total Credit Hours Required for the BS Degree with a Major in Earth Science</td>
<td>129-133</td>
</tr>
</tbody>
</table>

For University Graduation Requirements ([ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements](ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements)), 60 credit hours are required.
Footnotes and Additional Information
* Includes coursework completed as distribution credit, FWIS, LPAP, upper-level, residency (hours taken at Rice), 60 hours outside of the major (if applicable), and any additional academic program requirements. The "hours outside of the major" requirement may include all of the above university requirements.

Areas of Specialization
To fulfill the remaining Earth Science major requirements, students must complete the requirements for one of the following areas of specialization.

Area of Specialization: Environmental Earth Science

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC 201</td>
<td>INTRODUCTORY BIOLOGY</td>
<td>3</td>
</tr>
<tr>
<td>CAAM 210</td>
<td>INTRODUCTION TO ENGINEERING COMPUTATION</td>
<td>3</td>
</tr>
<tr>
<td>ESCI 391</td>
<td>EARTH SCIENCE FIELD EXPERIENCE (at least 3 credit hours)</td>
<td>3</td>
</tr>
<tr>
<td>MATH 211</td>
<td>ORDINARY DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>STAT 280</td>
<td>ELEMENTARY APPLIED STATISTICS</td>
<td>4</td>
</tr>
</tbody>
</table>

Elective Requirements
Select 3-4 from the following with at least 2 courses (6 credit hours) taken from ESCI course offerings:

- CEVE 401 CHEMISTRY FOR ENVIRONMENTAL ENGINEERING AND SCIENCE LAB
- CEVE 406 / ENST 406 INTRODUCTION TO ENVIRONMENTAL LAW
- CEVE 412 HYDROLOGY AND WATER RESOURCES ENGINEERING
- CEVE 434 FATE AND TRANSPORT OF CONTAMINANTS IN THE ENVIRONMENT
- CHEM 211 & CHEM 213 ORGANIC CHEMISTRY I and ORGANIC CHEMISTRY DISCUSSION
- EBIO 202 INTRODUCTORY BIOLOGY II
- ESCI 340 / EBIO 340 / ENST 340 GLOBAL BIOGEOCHEMICAL CYCLES
- ESCI 410 OPTICAL MINERALOGY AND PETROGRAPHY
- ESCI 411 ADVANCED PETROLOGY II
- ESCI 412 ADVANCED PETROLOGY
- ESCI 419 MATERIALS CHARACTERIZATION
- ESCI 421 PALEOECEANOGRAPHY
- ESCI 425 / CHEM 425 / ENST 425 ORGANIC GEOCHEMISTRY
- ESCI 426 INTERPRETATION OF REGIONAL 2-D SEISMIC DATA
- ESCI 429 MAGMATIC, VOLCANIC AND HYDROTHERMAL PROCESSES
- ESCI 430 TRACE-ELEMENT AND ISOTOPE GEOCHEMISTRY FOR EARTH AND ENVIRONMENTAL SCIENCE
- ESCI 472 EARTH SYSTEMS MODELING: NUMERICAL TECHNIQUES AND APPLICATIONS

Geochemistry Area of Specialization Electives
Select 2-4 courses from the following or from any ESCI course offerings at the 300-level or above:

- BIOC 211 INTERMEDIATE EXPERIMENTAL BIOSCIENCES
- CAAM 210 INTRODUCTION TO ENGINEERING COMPUTATION
- CEVE 401 CHEMISTRY FOR ENVIRONMENTAL ENGINEERING AND SCIENCE LAB
Bachelor of Science (BS) Degree with a Major in Earth Science

CEVE 434  FATE AND TRANSPORT OF CONTAMINANTS IN THE ENVIRONMENT
CEVE 550  ENVIRONMENTAL ORGANIC CHEMISTRY
CHEM 211  ORGANIC CHEMISTRY I
& CHEM 213  and ORGANIC CHEMISTRY DISCUSSION
CHEM 212  ORGANIC CHEMISTRY II
& CHEM 214  and ORGANIC CHEM DISCUSSION II
CHEM 415  CHEMICAL KINETICS AND DYNAMICS
CHEM 495  TRANSITION METAL CHEMISTRY
EBIO 202  INTRODUCTORY BIOLOGY II
MATH 212  MULTIVARIABLE CALCULUS

Required Courses

MATH 211  ORDINARY DIFFERENTIAL EQUATIONS
& LINEAR ALGEBRA 3
ESCI 390  GEOLOGY FIELD CAMP (at least 3 credit hours) 3
CAAM 210  INTRODUCTION TO ENGINEERING COMPUTATION 3
ESCI 412  ADVANCED PETROLOGY 3
or ESCI 430  TRACE-ELEMENT AND ISOTOPE GEOCHEMISTRY FOR EARTH AND ENVIRONMENTAL SCIENCE

Elective Requirements

Area of Specialization: Geology

Select 2 from the following:

ESCI 421  PALEOCEANOGRAPHY 6
ESCI 427  SEQUENCE STRATIGRAPHY
ESCI 431  GEOMORPHOLOGY
ESCI 435  MECHANICS OF SEDIMENT TRANSPORT
ESCI 504  SILICICLASTIC DEPOSITIONAL SYSTEMS
ESCI 506  CARBONATE DEPOSITIONAL SYSTEMS
ESCI 552  MARINE GEOLOGY SYSTEMS

Group B

Select 2 from the following:

ESCI 410  OPTICAL MINERALOGY AND PETROGRAPHY 6
ESCI 411  ADVANCED PETROLOGY II
ESCI 418 / CEVE 418  QUANTITATIVE HYDROGEOLOGY
ESCI 419  MATERIALS CHARACTERIZATION
ESCI 426  INTERPRETATION OF REGIONAL 2-D SEISMIC DATA 6
ESCI 429  MAGMATIC, VOLCANIC AND HYDROTHERMAL PROCESSES
ESCI 442  EXPLORATION GEOPHYSICS
ESCI 463  STRUCTURE AND EVOLUTION OF TECTONIC SYSTEMS
ESCI 464  GLOBAL TECTONICS
ESCI 467  GEOMECHANICS

ESCI 472  EARTH SYSTEMS MODELING: NUMERICAL TECHNIQUES AND APPLICATIONS

Total Credit Hours 27

Area of Specialization: Geophysics

Courses chosen from the list of ESCI course offerings must be 3 credit hours or more.

Required Courses

CAAM 210  INTRODUCTION TO ENGINEERING COMPUTATION 3
ESCI 391  EARTH SCIENCE FIELD EXPERIENCE (at least 3 credit hours) 3
MATH 211  ORDINARY DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA 3
MATH 212  MULTIVARIABLE CALCULUS 3
PHYS 201  WAVES, LIGHT, AND HEAT 3
PHYS 231  ELEMENTARY PHYSICS LAB 1

Elective Requirements

Select 2 from the following:

ESCI 418 / CEVE 418  QUANTITATIVE HYDROGEOLOGY 6
ESCI 426  INTERPRETATION OF REGIONAL 2-D SEISMIC DATA
ESCI 440  GEOPHYSICAL DATA ANALYSIS: DIGITAL SIGNAL PROCESSING
ESCI 441  GEOPHYSICAL DATA ANALYSIS: INVERSE METHODS
ESCI 442  EXPLORATION GEOPHYSICS
ESCI 450 / CEVE 450  REMOTE SENSING
ESCI 452  GIS FOR SCIENTISTS AND ENGINEERS
ESCI 461  SEISMOLOGY I
ESCI 462  TECTONOPHYSICS
ESCI 463  STRUCTURE AND EVOLUTION OF TECTONIC SYSTEMS
ESCI 464  GLOBAL TECTONICS
ESCI 467  GEOMECHANICS
ESCI 472  EARTH SYSTEMS MODELING: NUMERICAL TECHNIQUES AND APPLICATIONS
ESCI 542  SEISMOLOGY II
ESCI 564  SEISMIC REFLECTION DATA PROCESS

Geophysics Area of Specialization Electives

Select 2 from the following:

Any course from ESCI course offerings between ESCI 410 and ESCI 475, except for research and special studies
Any course from MATH, CAAM, or PHYS course offerings at the 300-level or above

CHEM 301  PHYSICAL CHEMISTRY I

Total Credit Hours 28
Area of Specialization: Self-Designed
The department recognizes the interdisciplinary nature of modern earth science and the opportunity for students to specialize in nontraditional and emerging fields. Therefore, students can design their own specialty track, normally in close consultation with one faculty member and followed by approval from the department’s undergraduate advisor. In addition to required earth science courses and related courses, these tracks will generally comprise 18 additional hours that target a coherent theme from an approved list of coursework at the 300-level or above, from inside or outside the department. Interested students are expected to submit a statement of rationale by the beginning of their third year.

Directed Electives in Self-Designed Specialization
Students must complete a total of 6 courses at the 300-level or higher targeting a coherent theme selected with the approval of the department’s undergraduate advisor

Total Credit Hours

Policies for the BS Degree with a Major in Earth Science
Transfer Credit
For Rice University’s policy regarding transfer credit, see Transfer Credit (ga.rice.edu/undergraduate-students/academic-policies-procedures/transfer-credit). Some departments and programs have additional restrictions on transfer credit. The Office of Academic Advising maintains the university’s official list of transfer credit advisors on their website: https://oaa.rice.edu. Students are encouraged to meet with their academic program’s transfer credit advisor when considering transfer credit possibilities.

Departmental Transfer Credit Guidelines
Students pursuing the major in Earth Science should be aware of the following departmental transfer credit guidelines:

- Requests for transfer credit will be considered by the program director (and/or the program’s official transfer credit advisor) on an individual case-by-case basis.

Additional Information
For additional information, please see the Earth Science major page, on the Department of Earth, Environmental, and Planetary Sciences website: http://earthscience.rice.edu/academics/undergraduate-program/

Opportunities for the BS Degree with a Major in Earth Science
Undergraduate Independent Research
The department encourages, but does not require, Earth Science undergraduate majors to pursue independent supervised research in ESCI 481. This can also be carried out as part of the Earth Science Honors Thesis Program.

Academic Honors
The university recognizes academic excellence achieved over an undergraduate’s academic history at Rice. For information on university honors, please see Latin Honors (ga.rice.edu/undergraduate-students/honors-distinctions/university) (summa cum laude, magna cum laude, and cum laude) and Distinction in Research and Creative Work (ga.rice.edu/undergraduate-students/honors-distinctions/university). Some departments have department-specific Honors awards or designations.

Honors Research
Undergraduates are encouraged to embark on an undergraduate honors thesis. The purpose of the honors thesis is for students to develop and demonstrate their creative and independent research potential. Students are recommended to begin in the fall of their junior year to provide ample time for research projects to be developed, executed and written. Students are expected to enroll in at least two semesters of the course ESCI 481, spanning their senior year. Juniors who have identified a research project and mentor can also enroll in ESCI 481. Students should sign up for ESCI 481 for 3 credits.

Criteria for Participating in Undergraduate Honors Thesis Research
- Strong performance in ESCI courses, in particular, ESCI 321, ESCI 322, ESCI 323, ESCI 324, and ESCI 334
- A grade of A- or better in ESCI 481
- Letter of recommendation of a faculty research mentor
- Research proposal

Requirements for Completing an Undergraduate Honors Thesis
Spring Semester of Junior Year
Each honors thesis candidate should choose a research topic, identify a faculty research advisor, and initiate independent research. The student should select a thesis committee, consisting of a faculty advisor, one member of the honors thesis committee, and one other faculty member of their choosing. Candidates are expected to turn in a preliminary written proposal (2 pages) at the end of their spring semester, accompanied by a formal application, both of which will be evaluated by the honors thesis committee for consideration of acceptance into the honors thesis program in their senior year. Required courses:

And if they have research project and mentor identified, they can also take:

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESCI 401</td>
<td>SEMINAR: UNDERGRADUATE HONORS THESIS</td>
<td>1</td>
</tr>
<tr>
<td>ESCI 403</td>
<td>SEMINAR: DEPARTMENT RESEARCH</td>
<td>1</td>
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</table>
Fall Semester of Senior Year

Students accepted into the honors thesis program continue to develop and refine their proposed research in concert with their research advisor and thesis committee. Students participate in meetings with other honors thesis candidates to discuss basic research protocols and philosophies, and meet independently with their chosen scientific advisor, and generate data, experiments or models. Students will give oral presentations of their research proposals in public by mid-semester, in the presence of their examining committee. At the end of the semester, students must submit final versions of their proposals, describing motivation, hypothesis, methodology, and preliminary results. The honors thesis committee will evaluate the proposals, and if approved, students can continue in the honors thesis program. Required courses:

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<tr>
<td>ESCI 401</td>
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</tr>
<tr>
<td>ESCI 404</td>
<td>SEMINAR: DEPARTMENT RESEARCH</td>
<td>1</td>
</tr>
<tr>
<td>ESCI 481</td>
<td>UNDERGRADUATE RESEARCH IN EARTH SCIENCE</td>
<td>3</td>
</tr>
</tbody>
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Spring Semester of Senior Year

Students continue and complete their research. A mid-semester progress report must be submitted to the thesis committee for feedback. At the end of the spring semester, students submit their final theses, and give public oral exit talks. To complete the honors thesis program, student theses must be approved by the honors thesis committee. Required courses:

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<td>UNDERGRADUATE RESEARCH IN EARTH SCIENCE</td>
<td>3</td>
</tr>
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</table>

Further details about the program, and expectations and criteria for the thesis proposal and final thesis can be found on the Department of Earth, Environmental, and Planetary Sciences website (earthscience.rice.edu).

Application Process

Students must apply and be accepted to participate in the senior honors research program. The application form can be downloaded from Department of Earth, Environmental, and Planetary Sciences website (earthscience.rice.edu), and should be submitted along with a ~two page thesis proposal at the end of the spring semester of the junior year. Students will be informed of their acceptance into the honors thesis program before the start of the following fall semester.

Other Points of Consideration

Students who are accepted into the 'RUSP Rice Undergraduate Scholars Program' can substitute ESCI 481 courses for semesters 2 and 3 with HONS 470 and HONS 471. However, the students will have to meet all other requirements of the honors thesis set by the department of the honors thesis set by the department.

Other expectations, conditions, and opportunities related to carrying out an Earth Science Honors Thesis can be found on the Department of Earth, Environmental, and Planetary Sciences website (earthscience.rice.edu).

Additional Information

For additional information, please see the Earth Science major page, on the Department of Earth, Environmental, and Planetary Sciences website: http://earthscience.rice.edu/academics/undergraduate-program/