Earth Sciences

Program Requirements

Course Categories for Earth Sciences Programs

The program descriptions below make use of the following course categories that are defined in the Academic Regulations for the Bachelor of Science Degree section of this Calendar:

• Science Faculty Electives
• Advanced Science Faculty Electives
• Science Continuation Courses
• Science Geography
• Science Psychology
• Approved Courses Outside the Faculties of Science and Engineering and Design
• Free Elective

Earth Sciences

B.Sc. Honours (20.0 credits)

A. Credits Included in the Major CGPA (11.0 credits)

1. 1.0 credit in:
   - ERTH 1006 [0.5] Exploring Planet Earth
   - ERTH 1009 [0.5] The Earth System Through Time

2. 3.5 credits in:
   - ERTH 2102 [0.5] Mineralogy to Petrology
   - ERTH 2104 [0.5] Igneous Systems, Geochemistry and Processes
   - ERTH 2105 [0.5] Geodynamics
   - ERTH 2312 [0.5] Paleontology
   - ERTH 2314 [0.5] Sedimentation and Stratigraphy
   - ERTH 2406 [0.5] Geology and Map Interpretation
   - ERTH 2802 [0.5] Field Geology I

3. 0.5 credit from:
   - ERTH 3203 [0.5] Applied Sedimentology
   - ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records (See Note, below)

4. 3.0 credits from:
   - ERTH 3003 [0.5] Geochemistry and Geochronology
   - ERTH 3204 [0.5] Mineral Deposits
   - ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records
   - ERTH 3205 [0.5] Physical Hydrogeology
   - ERTH 3207 [0.5] Metamorphic Petrology and Processes
   - ERTH 3405 [0.5] Geophysical Methods
   - ERTH 3806 [0.5] Structural Geology (See Note, below)

5. 2.0 credits in ERTH at the 4000-level
6. 1.0 credit from:
   - ERTH 4908 [1.0] Honours Thesis
   - ERTH 4909 and 0.5 credit in 4000-level ERTH

B. Credits Not Included in the Major CGPA (9.0 credits)

7. 1.0 credit in:
   - MATH 1007 [0.5] Elementary Calculus I
   - MATH 1107 [0.5] Linear Algebra I

8. 1.0 credit from:
   - CHEM 1001 [0.5] General Chemistry I
   & CHEM 1002 [0.5] General Chemistry II
   - CHEM 1005 [0.5] Elementary Chemistry I
   & CHEM 1006 [0.5] Elementary Chemistry II

9. 1.0 credit in:
   - PHYS 1007 [0.5] Elementary University Physics I
   & PHYS 1008 [0.5] Elementary University Physics II

10. 0.5 credit in:
    - BIOL 1104 [0.5] Foundations of Biology II

11. 0.5 credit in:
    - COMP 1005 [0.5] Introduction to Computer Science I

12. 0.5 credit in:
    - STAT 2507 [0.5] Introduction to Statistical Science I

13. 0.5 credit in:
    - GEOM 2007 [0.5] Geographic Information Systems

14. 1.0 credit in Science Continuation Courses (not ERTH)

15. 0.5 credit in:
    - NSCI 1000 [0.5] Seminar in Science (or approved courses outside the faculties of Science and Engineering and Design)

16. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design

17. 1.0 credit in free electives.

Total Credits 20.0

Notes:

1. For Item 3 above, ERTH 3203 is required if prerequisite conditions are met.
2. For Item 4 above, ERTH 3206 may be used only if it has not already been used to fulfill the requirement for Item 3.
3. For BIOL 1104, Ontario 4U/M in Biology (or equivalent) is required.
4. For Items 14-17, students admitted to the Minor in Business should substitute the requirements for the Minor. See the Business section of this Calendar.

Earth Sciences with Concentration in Finance: Resource Valuation

B.Sc. Honours (21.0 credits)

A. Credits included in the Major CGPA (10.5 credits)

1. 1.0 credit in:
   - ERTH 1006 [0.5] Exploring Planet Earth
   - ERTH 1009 [0.5] The Earth System Through Time

2. 3.0 credits in:
   - ERTH 2102 [0.5] Mineralogy to Petrology
   - ERTH 2104 [0.5] Igneous Systems, Geochemistry and Processes
   - ERTH 2105 [0.5] Geodynamics
   - ERTH 2314 [0.5] Sedimentation and Stratigraphy
   - ERTH 2406 [0.5] Geology and Map Interpretation
   - ERTH 2802 [0.5] Field Geology I

3. 2.0 credits in ERTH at the 4000-level

4. 1.0 credit from:
   - ERTH 4908 [1.0] Honours Thesis
   - ERTH 4909 and 0.5 credit in 4000-level ERTH

B. Credits Not Included in the Major CGPA (9.0 credits)

7. 1.0 credit in:
   - MATH 1007 [0.5] Elementary Calculus I
   - MATH 1107 [0.5] Linear Algebra I

8. 1.0 credit from:
   - CHEM 1001 [0.5] General Chemistry I
   & CHEM 1002 [0.5] General Chemistry II
   - CHEM 1005 [0.5] Elementary Chemistry I
   & CHEM 1006 [0.5] Elementary Chemistry II

9. 1.0 credit in:
   - PHYS 1007 [0.5] Elementary University Physics I
   & PHYS 1008 [0.5] Elementary University Physics II

10. 0.5 credit in:
    - BIOL 1104 [0.5] Foundations of Biology II

11. 0.5 credit in:
    - COMP 1005 [0.5] Introduction to Computer Science I

12. 0.5 credit in:
    - STAT 2507 [0.5] Introduction to Statistical Science I

13. 0.5 credit in:
    - GEOM 2007 [0.5] Geographic Information Systems

14. 1.0 credit in Science Continuation Courses (not ERTH)

15. 0.5 credit in:
    - NSCI 1000 [0.5] Seminar in Science (or approved courses outside the faculties of Science and Engineering and Design)

16. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design

17. 1.0 credit in free electives.

Total Credits 21.0

Notes:

1. For Item 3 above, ERTH 3203 is required if prerequisite conditions are met.
2. For Item 4 above, ERTH 3206 may be used only if it has not already been used to fulfill the requirement for Item 3.
3. For BIOL 1104, Ontario 4U/M in Biology (or equivalent) is required.
4. For Items 14-17, students admitted to the Minor in Business should substitute the requirements for the Minor. See the Business section of this Calendar.
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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tr>
<td>ERTH 3206 [0.5]</td>
<td>Oceanography: Its Modern and Geologic Records (See Note, below)</td>
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<tr>
<td>4.  3.0 credits from:</td>
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<tr>
<td>ERTH 3003 [0.5]</td>
<td>Geochemistry and Geochronology</td>
</tr>
<tr>
<td>ERTH 3204 [0.5]</td>
<td>Mineral Deposits</td>
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<td>ERTH 3205 [0.5]</td>
<td>Physical Hydrogeology</td>
</tr>
<tr>
<td>ERTH 3206 [0.5]</td>
<td>Oceanography: Its Modern and Geologic Records (See Note, below)</td>
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<tr>
<td>ERTH 3207 [0.5]</td>
<td>Metamorphic Petrology and Processes</td>
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<td>ERTH 3405 [0.5]</td>
<td>Geophysical Methods</td>
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<td>ERTH 3806 [0.5]</td>
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<tr>
<td>6.  1.5 credits in ERTH at the 4000-level</td>
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<td>7.  1.0 credit from:</td>
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<tr>
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<tr>
<td>ERTH 4910 [1.0]</td>
<td>Honours Thesis in Resource Evaluation</td>
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<td>BIOL 1104 [0.5]</td>
<td>Foundations of Biology II</td>
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<tr>
<td>COMP 1005 [0.5]</td>
<td>Introduction to Computer Science I</td>
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<td>12.  0.5 credit in:</td>
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<tr>
<td>GEOM 2007 [0.5]</td>
<td>Geographic Information Systems</td>
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<td>STAT 2507 [0.5]</td>
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<td>ECON 2009 [0.5]</td>
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<td>BUSI 2505 [0.5]</td>
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<td>BUSI 3502 [0.5]</td>
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<td>BUSI 3512 [0.5]</td>
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<td>ECON 3803 [0.5]</td>
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<tr>
<td>BUSI 4500 [0.5]</td>
<td>Advanced Corporate Finance</td>
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<td>BUSI 4510 [0.5]</td>
<td>Mergers and Acquisitions</td>
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Notes:
1. For Item 3 above, ERTH 3203 Applied Sedimentology is required if prerequisite conditions are met.
2. For Item 4 above, ERTH 3206 Oceanography: Its Modern and Geologic Records may be used only if it has not already been used to fulfill the requirement for Item 3.

Earth Sciences with Concentration in Resource Economics
B.Sc. Honours (20.0 credits)

A. Credits Included in the Major CGPA (11.0 credits)
1.  1.0 credit in: 1.0
ERTH 1006 [0.5] Exploring Planet Earth
ERTH 1009 [0.5] The Earth System Through Time
2.  3.5 credits in: 3.5
ERTH 2102 [0.5] Mineralogy to Petrology
ERTH 2104 [0.5] Igneous Systems, Geochemistry and Processes
ERTH 2105 [0.5] Geodynamics
ERTH 2312 [0.5] Paleontology
ERTH 2314 [0.5] Sedimentation and Stratigraphy
ERTH 2406 [0.5] Geology and Map Interpretation
ERTH 2802 [0.5] Field Geology I
3.  0.5 credit from: 0.5
ERTH 3203 [0.5] Applied Sedimentology
ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records (See Note, below)
4.  3.0 credits from: 3.0
ERTH 3003 [0.5] Geochemistry and Geochronology
ERTH 3204 [0.5] Mineral Deposits
ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records
ERTH 3205 [0.5] Physical Hydrogeology
ERTH 3207 [0.5] Metamorphic Petrology and Processes
ERTH 3405 [0.5] Geophysical Methods
ERTH 3806 [0.5] Structural Geology (See Note, below)
5.  0.5 credit from: 0.5
ERTH 4303 [0.5] Resources of the Earth
ERTH 4306 [0.5] Resource Basin Analysis
6.  1.5 credit in ERTH at the 4000-level 1.5
7.  1.0 credit from: 1.0
ERTH 4908 [1.0] Honours Thesis
ERTH 4909 [0.5] Research in Earth Sciences (and 0.5 credit ERTH at the 4000-level)
B. Credits Not Included in the Major CGPA (9.0 credits)
8.  3.5 credits in: 3.5
ECON 1000 [1.0] Introduction to Economics
ECON 2020 [0.5] Intermediate Microeconomics I: Producers and Market Structure
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<td>ECON 2210</td>
<td>Introductory Statistics for Economics</td>
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<td>ECON 2220</td>
<td>Introductory Econometrics</td>
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<td>ECON 3509</td>
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<tr>
<td>ECON 2030 [0.5]</td>
<td>Intermediate Microeconomics II: Consumers</td>
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<td>and General Equilibrium</td>
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<td>ECON 2210 [0.5]</td>
<td>Introductory Statistics for Economics</td>
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<tr>
<td>ECON 2220 [0.5]</td>
<td>Introductory Econometrics</td>
</tr>
<tr>
<td>ECON 3509 [0.5]</td>
<td>Development Planning and Project Evaluation</td>
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</table>

9. 1.0 credit from:
- ECON 3803 [0.5] The Economics of Natural Resources
- ECON 3804 [0.5] Environmental Economics
- ECON 4030 [0.5] Economics of Uncertainty and Information

10. 1.0 credit in:
- MATH 1007 [0.5] Elementary Calculus I
- MATH 1107 [0.5] Linear Algebra I

11. 1.0 credit from:
- CHEM 1001 [0.5] General Chemistry I
- & CHEM 1002 [0.5] General Chemistry II
- CHEM 1005 [0.5] Elementary Chemistry I
- & CHEM 1006 [0.5] Elementary Chemistry II

12. 1.0 credit in:
- PHYS 1007 [0.5] Elementary University Physics I
- & PHYS 1008 [0.5] Elementary University Physics II

13. 0.5 credit in:
- BIOL 1104 [0.5] Foundations of Biology II

14. 0.5 credit in:
- COMP 1005 [0.5] Introduction to Computer Science I

15. 0.5 credit in GEOM 2007

Total Credits 20.0

Notes:
1. For Item 3 above, ERTH 3203 is required if prerequisite conditions are met.
2. For Item 4 above, ERTH 3206 may be used only if it has not already been used to fulfill the requirement for Item 3.

Earth Sciences with Concentration in Vertebrate Paleontology and Paleoecology
B.Sc. Honours (20.0 credits)

A. Credits Included in the Major CGPA (10.5 credits)

1. 1.0 credit in:
- ERTH 1006 [0.5] Exploring Planet Earth
- ERTH 1009 [0.5] The Earth System Through Time

2. 2.5 credits in:
- ERTH 2102 [0.5] Mineralogy to Petrology
- ERTH 2105 [0.5] Geodynamics
- ERTH 2312 [0.5] Paleontology
- ERTH 2314 [0.5] Sedimentation and Stratigraphy
- ERTH 2406 [0.5] Geology and Map Interpretation

3. 0.5 credit from:
- ERTH 3203 [0.5] Applied Sedimentology
- ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records (See note, below)

4. 2.0 credits in:
- ERTH 3003 [0.5] Geochemistry and Geochronology
- ERTH 3111 [0.5] Vertebrate Evolution II
- ERTH 3112 [0.5] Vertebrate Evolution I
- ERTH 3113 [0.5] Geology of Human Origins (See Note, below)

5. 0.5 credit from: 0.5
- ERTH 4003 [0.5] Directed Studies in Geology
- ERTH 4808 [0.5] Vertebrate Paleontology Field Camp

6. 1.0 credit from: 1.0
- ERTH 4908 [1.0] Honours Thesis

7. 3.0 credits from and to include 2.0 credits at the 4000-level: 3.0
- BIOL 3104 [0.5] Molecular Genetics
- BIOL 3501 [0.5] Biomechanics
- BIOL 3605 [0.5] Field Course I
- BIOL 3609 [0.5] Evolutionary Concepts
- BIOL 3611 [0.5] Evolutionary Ecology
- BIOL 3802 [0.5] Animal Behaviour
- BIOL 4500 [0.5] Ornithology I
- GEOM 3002 [0.5] Air Photo Interpretation and Remote Sensing
- GEOG 3102 [0.5] Geomorphology
- GEOG 3104 [0.5] Principles of Biogeography
- ERTH 2401 [0.5] Dinosaurs
- ERTH 3806 [0.5] Structural Geology
- ERTH 4005 [0.5] Micropaleontology
- ERTH 4305 [0.5] Carbonate Sedimentology
- ERTH 4006 [0.5] Geobiology
- ERTH 4007 [0.5] Evolutionary Developmental Paleobiology
- ERTH 4306 [0.5] Resource Basin Analysis
- ERTH 4403 [0.5] Tectonic Evolution of Canada
- ERTH 4820 [0.5] Research Methods in Earth Sciences

B. Credits Not Included in the Major CGPA (9.5 credits)

8. 2.5 credits in: 2.5
- BIOL 1103 [0.5] Foundations of Biology I
- BIOL 1104 [0.5] Foundations of Biology II
- MATH 1007 [0.5] Elementary Calculus I
- MATH 1107 [0.5] Linear Algebra I
- PHYS 1007 [0.5] Elementary University Physics I

9. 1.0 credit from: 1.0
- CHEM 1001 [0.5] General Chemistry I
- & CHEM 1002 [0.5] General Chemistry II
- CHEM 1005 [0.5] Elementary Chemistry I
- & CHEM 1006 [0.5] Elementary Chemistry II

10. 2.0 credits in: 2.0
- BIOL 2001 [0.5] Animals: Form and Function
- BIOL 2104 [0.5] Introductory Genetics
- BIOL 2600 [0.5] Introduction to Ecology
- STAT 2507 [0.5] Introduction to Statistical Modeling I

11. 0.5 credit in Science Faculty Electives (not ERTH or BIOL) 0.5

12. 0.5 credit in: 0.5
- GEOM 2007 [0.5] Geographic Information Systems

13. 0.5 credit in: 0.5
### Earth Sciences

#### B.Sc. Honours (20.0 credits)

**A. Credits Included in the Major CGPA (11.0 credits)**

1. **1.0 credit in:**
   - ERTH 1006 [0.5] Exploring Planet Earth
   - ERTH 1009 [0.5] The Earth System Through Time

2. **1.0 credit in:**
   - MATH 1004 [0.5] Calculus for Engineering or Physics
   - MATH 1104 [0.5] Linear Algebra for Engineering or Science

3. **1.0 credit from:**
   - PHYS 1001 [0.5] & PHYS 1002 [0.5] Foundations of Physics I & II (recommended)
   - or
   - PHYS 1003 [0.5] & PHYS 1004 [0.5] Introductory Mechanics and Thermodynamics

4. **3.0 credits in:**
   - ERTH 2102 [0.5] Mineralogy to Petrology
   - ERTH 2104 [0.5] Igeous Systems, Geochemistry and Processes
   - ERTH 2105 [0.5] Geodynamics
   - ERTH 2314 [0.5] Sedimentation and Stratigraphy
   - ERTH 2406 [0.5] Geology and Map Interpretation
   - ERTH 2802 [0.5] Field Geology I

5. **0.5 credit from:**
   - ERTH 3203 [0.5] Applied Sedimentology
   - ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records

6. **2.5 credits in:**
   - ERTH 3003 [0.5] Geochemistry and Geochronology
   - ERTH 3204 [0.5] Mineral Deposits
   - ERTH 3205 [0.5] Physical Hydrogeology
   - ERTH 3405 [0.5] Geophysical Methods
   - ERTH 3806 [0.5] Structural Geology

7. **0.5 credit in:**
   - ERTH 4707 [0.5] Engineering Seismology

8. **1.0 credit from:**
   - ERTH 4908 [1.0] Honours Thesis

9. **1.5 credits in:**
   - approved courses outside the Faculties of Science and Engineering and Design

**Total Credits**: 20.0

**Note:**

For Item 3 above, ERTH 3203 is required if prerequisite conditions are met.

### Earth Sciences with Concentration in Geophysics

**B.Sc. Honours (20.0 credits)**

**A. Credits Included in the Major CGPA (11.0 credits)**

1. **1.0 credit in:**
   - ERTH 1006 [0.5] Exploring Planet Earth
   - ERTH 1009 [0.5] The Earth System Through Time

2. **1.0 credit in:**
   - MATH 1004 [0.5] Calculus for Engineering or Physics
   - MATH 1104 [0.5] Linear Algebra for Engineering or Science

3. **1.0 credit from:**
   - PHYS 1001 [0.5] & PHYS 1002 [0.5] Foundations of Physics I & II (recommended)
   - or
   - PHYS 1003 [0.5] & PHYS 1004 [0.5] Introductory Mechanics and Thermodynamics

4. **3.0 credits in:**
   - ERTH 2102 [0.5] Mineralogy to Petrology
   - ERTH 2104 [0.5] Igeous Systems, Geochemistry and Processes
   - ERTH 2105 [0.5] Geodynamics
   - ERTH 2314 [0.5] Sedimentation and Stratigraphy
   - ERTH 2406 [0.5] Geology and Map Interpretation
   - ERTH 2802 [0.5] Field Geology I

5. **0.5 credit from:**
   - ERTH 3203 [0.5] Applied Sedimentology
   - ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records

6. **2.5 credits in:**
   - ERTH 3003 [0.5] Geochemistry and Geochronology
   - ERTH 3204 [0.5] Mineral Deposits
   - ERTH 3205 [0.5] Physical Hydrogeology
   - ERTH 3405 [0.5] Geophysical Methods
   - ERTH 3806 [0.5] Structural Geology

7. **0.5 credit in:**
   - ERTH 4707 [0.5] Engineering Seismology

8. **1.0 credit from:**
   - ERTH 4908 [1.0] Honours Thesis

9. **1.5 credits in:**
   - approved courses outside the Faculties of Science and Engineering and Design

**Total Credits**: 20.0

### Earth Sciences

#### B.Sc. Major (20.0 credits)

**A. Credits Included in the Major CGPA (11.0 credits)**

1. **1.0 credit in:**
   - ERTH 1006 [0.5] Exploring Planet Earth
   - ERTH 1009 [0.5] The Earth System Through Time

2. **3.5 credits in:**
   - ERTH 2102 [0.5] Mineralogy to Petrology

3. **0.5 credit in:**
   - NSCI 1000 [0.5] Seminar in Science

4. **0.5 credit in:**
   - approved courses outside the Faculties of Science and Engineering and Design

**Total Credits**: 20.0
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</table>

3. 0.5 credit from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 3203</td>
<td>Applied Sedimentology</td>
</tr>
<tr>
<td>ERTH 3206</td>
<td>Oceanography: Its Modern and Geologic Records (See Note, below)</td>
</tr>
</tbody>
</table>

4. 3.0 credits from:

<table>
<thead>
<tr>
<th>Course Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>ERTH 3003</td>
<td>Geochemistry and Geochronology</td>
</tr>
<tr>
<td>ERTH 3204</td>
<td>Mineral Deposits</td>
</tr>
<tr>
<td>ERTH 3206</td>
<td>Oceanography: Its Modern and Geologic Records</td>
</tr>
<tr>
<td>ERTH 3205</td>
<td>Physical Hydrogeology</td>
</tr>
<tr>
<td>ERTH 3207</td>
<td>Metamorphic Petrology and Processes</td>
</tr>
<tr>
<td>ERTH 3405</td>
<td>Geophysical Methods</td>
</tr>
<tr>
<td>ERTH 3806</td>
<td>Structural Geology (See Note, below)</td>
</tr>
</tbody>
</table>

5. 3.0 credits in ERTH at the 4000-level

B. Credits Not Included in the Major CGPA (9.0 credits)

6. 1.0 credit in:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1007</td>
<td>Elementary Calculus I</td>
</tr>
<tr>
<td>MATH 1107</td>
<td>Linear Algebra I</td>
</tr>
</tbody>
</table>

7. 1.0 credit from:

<table>
<thead>
<tr>
<th>Course Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1001</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>&amp; CHEM 1002</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>CHEM 1005</td>
<td>Elementary Chemistry I</td>
</tr>
<tr>
<td>&amp; CHEM 1006</td>
<td>Elementary Chemistry II</td>
</tr>
</tbody>
</table>

8. 1.0 credit in:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 1007</td>
<td>Elementary University Physics I</td>
</tr>
<tr>
<td>&amp; PHYS 1008</td>
<td>Elementary University Physics II</td>
</tr>
</tbody>
</table>

9. 0.5 credit in:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 1104</td>
<td>Foundations of Biology II</td>
</tr>
</tbody>
</table>

10. 0.5 credit in:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP 1005</td>
<td>Introduction to Computer Science I</td>
</tr>
</tbody>
</table>

11. 0.5 credit in:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 2507</td>
<td>Introduction to Statistical Modeling I</td>
</tr>
</tbody>
</table>

12. 0.5 credit in:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOM 2007</td>
<td>Geographic Information Systems</td>
</tr>
</tbody>
</table>

13. 1.0 credit in Science Continuation Courses (not ERTH)

14. 0.5 credit in:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSCI 1000</td>
<td>Seminar in Science (or approved courses outside the Faculties of Science and Engineering and Design)</td>
</tr>
</tbody>
</table>

15. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design

16. 1.0 credits in free electives.

Total Credits 20.0

Notes:

1. For Item 3 above, ERTH 3203 is required if prerequisite conditions are met.
2. For Item 4 above, ERTH 3206 may be used only if it has not already been used to fulfill the requirement for item 3.
3. For BIOL 1104, Ontario 4U/M in Biology (or equivalent) is required.
4. For Items 13-16, students admitted to the Minor in Business should substitute the requirements for the Minor. See the Business section of this Calendar.

Earth Sciences

B.Sc. General (15.0 credits)

A. Credits Included in the Major CGPA (8.0 credits)

1. 1.0 credit in:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 1006</td>
<td>Exploring Planet Earth</td>
</tr>
<tr>
<td>ERTH 1009</td>
<td>The Earth System Through Time</td>
</tr>
</tbody>
</table>

2. 3.5 credits in:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>ERTH 2102</td>
<td>Mineralogy to Petrology</td>
</tr>
<tr>
<td>ERTH 2104</td>
<td>Igneous Systems, Geochemistry and Processes</td>
</tr>
<tr>
<td>ERTH 2105</td>
<td>Geodynamics</td>
</tr>
<tr>
<td>ERTH 2312</td>
<td>Paleontology</td>
</tr>
<tr>
<td>ERTH 2314</td>
<td>Sedimentation and Stratigraphy</td>
</tr>
<tr>
<td>ERTH 2406</td>
<td>Geology and Map Interpretation</td>
</tr>
<tr>
<td>ERTH 2802</td>
<td>Field Geology I</td>
</tr>
</tbody>
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3. 3.5 credits in:

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<tbody>
<tr>
<td>ERTH 3003</td>
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<td>ERTH 3204</td>
<td>Mineral Deposits</td>
</tr>
<tr>
<td>ERTH 3205</td>
<td>Physical Hydrogeology</td>
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<tr>
<td>ERTH 3206</td>
<td>Oceanography: Its Modern and Geologic Records</td>
</tr>
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<td>ERTH 3207</td>
<td>Metamorphic Petrology and Processes</td>
</tr>
<tr>
<td>ERTH 3405</td>
<td>Geophysical Methods</td>
</tr>
<tr>
<td>ERTH 3806</td>
<td>Structural Geology</td>
</tr>
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</table>

B. Credits Not Included in the Major CGPA (7.0 credits)

4. 1.0 credit in:

<table>
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<tr>
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<tbody>
<tr>
<td>MATH 1007</td>
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<td>MATH 1107</td>
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5. 1.0 credit from:

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<td>Elementary Chemistry II</td>
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6. 1.0 credit in:

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<tbody>
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<td>Elementary University Physics I</td>
</tr>
<tr>
<td>&amp; PHYS 1008</td>
<td>Elementary University Physics II</td>
</tr>
</tbody>
</table>

7. 1.0 credit in Science Continuation Courses (not ERTH)

8. 0.5 credit in:

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<tr>
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<tbody>
<tr>
<td>NSCI 1000</td>
<td>Seminar in Science (or approved courses outside the Faculties of Science and Engineering and Design)</td>
</tr>
</tbody>
</table>

9. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design

10. 1.0 credit in free electives.

Total Credits 15.0
Earth Sciences and Physical Geography
B.Sc. Combined Honours (20.0 credits)

A. Credits Included in the Major CGPA (12.0 credits)

1. 1.0 credit in:
   GEOG 2013 [0.5] Weather and Water
   GEOG 2014 [0.5] The Earth's Surface

2. 0.5 credit in:
   ERTH 1006 [0.5] Exploring Planet Earth

3. 1.5 credits in:
   ERTH 2102 [0.5] Mineralogy to Petrology
   ERTH 2314 [0.5] Sedimentation and Stratigraphy
   ERTH 2406 [0.5] Geology and Map Interpretation

4. 0.5 credit in:
   ENSC 2000 [0.5] Environmental Science Field Methods

5. 2.0 credits in ERTH at the 3000-level or above

6. 1.0 credit in ERTH at the 4000-level

7. 1.5 credits in Science Geography or Geomatics courses at the 2000-level or above to include:
   GEOM 2007 [0.5] Geographic Information Systems

8. 2.0 credits in:
   GEOM 3002 [0.5] Air Photo Interpretation and Remote Sensing
   GEOG 3102 [0.5] Geomorphology
   GEOG 3105 [0.5] Climate and Atmospheric Change
   GEOG 3108 [0.5] Soil Properties

9. 1.0 credit in Science Geography or Geomatics courses at the 4000-level

10. 1.0 credit from:
    GEOG 4006 [1.0] Honours Research Project
    ERTH 4008 [1.0] Honours Thesis
    ERTH 4009 and 0.5 credit 4000-level ERTH

B. Credits Not Included in the Major CGPA (7.5 credits)

11. 1.0 credit in:
    MATH 1007 [0.5] Elementary Calculus I
    MATH 1007 [0.5] Linear Algebra I

12. 1.0 credit in:
    CHEM 1001 [0.5] General Chemistry I
    & CHEM 1002 [0.5] General Chemistry II

13. 1.0 credit in:
    PHYS 1007 [0.5] Elementary University Physics I
    & PHYS 1008 [0.5] Elementary University Physics II

14. 0.5 credit in:
    BIOL 1104 [0.5] Foundations of Biology II

15. 1.0 credit in MATH (MATH, STAT) at 2000-level or above; and/or in COMP
    STAT 2507 [0.5] Introduction to Statistical Modeling I (recommended)
    COMP 1004 [0.5] Introduction to Computers for the Sciences (recommended)

16. 1.0 credit in Advanced Science Faculty Electives

17. 0.5 credit in:
   NSCI 1000 [0.5] Seminar in Science (or Approved Arts or Social Sciences)

18. 1.5 credits in Approved Arts or Social Sciences

19. 0.5 credit in free electives

Total Credits 20.0

Earth Sciences and Geography: Concentration in Terrain Science
B.Sc. Combined Honours (20.0 credits)

A. Credits Included in the Major CGPA (12.5 credits)

1. 0.5 credit in:
   GEOG 2014 [0.5] The Earth's Surface

2. 0.5 credit in:
   ERTH 1006 [0.5] Exploring Planet Earth

3. 2.5 credits in:
   ERTH 2102 [0.5] Mineralogy to Petrology
   ERTH 2104 [0.5] Igneous Systems, Geochemistry and Processes
   ERTH 2314 [0.5] Sedimentation and Stratigraphy
   ERTH 2406 [0.5] Geology and Map Interpretation
   ERTH 2802 [0.5] Field Geology I

4. 0.5 credit from:
   ERTH 3203 [0.5] Applied Sedimentology
   ERTH 3206 [0.5] Structural Geology

5. 1.5 credits in:
   ERTH 3205 [0.5] Physical Hydrogeology
   ERTH 3207 [0.5] Metamorphic Petrology and Processes
   ERTH 3806 [0.5] Structural Geology

6. 1.0 credit in ERTH at the 4000-level

7. 0.5 credit from:
   GEOG 2006 [0.5] Introduction to Quantitative Research
   STAT 2507 [0.5] Introduction to Statistical Modeling I

8. 1.5 credits in:
   GEOM 1004 [0.5] Maps, Satellites and the Geospatial Revolution
   GEOM 2007 [0.5] Geographic Information Systems
   GEOG 2013 [0.5] Weather and Water

9. 2.0 credits in:
   GEOM 3002 [0.5] Air Photo Interpretation and Remote Sensing
   GEOG 3102 [0.5] Geomorphology
   GEOG 3105 [0.5] Climate and Atmospheric Change
   GEOG 3108 [0.5] Soil Properties

10. 1.0 credit in:
    GEOG 4101 [0.5] Two Million Years of Environmental Change
    GEOG 4108 [0.5] Permafrost

11. 1.0 credit from:
    GEOG 4906 [1.0] Honours Research Project
    ERTH 4908 [1.0] Honours Thesis
    ERTH 4909 and 0.5 credit 4000-level ERTH

B. Credits Not Included in the Major CGPA (7.5 credits)

12. 1.0 credit in:
    MATH 1007 [0.5] Elementary Calculus I
    MATH 1107 [0.5] Linear Algebra I

13. 1.0 credit from:
    CHEM 1001 [0.5] General Chemistry I
    & CHEM 1002 [0.5] General Chemistry II
    CHEM 1005 [0.5] Elementary Chemistry I
    & CHEM 1006 [0.5] Elementary Chemistry II
B.Sc. Combined Honours (20.0 credits)

A. Credits Included in the Major CGPA (12.0 credits)

1. 1.5 credits in:
   - BIOL 1103 [0.5] Foundations of Biology I
   - BIOL 1104 [0.5] Foundations of Biology II
   - BIOL 2001 [0.5] Animals: Form and Function

2. 1.0 credit in:
   - ERTH 1006 [0.5] Exploring Planet Earth
   - ERTH 1009 [0.5] The Earth System Through Time

3. 0.5 credit from:
   - BIOL 2600 [0.5] Introduction to Ecology
   - BIOL 3605 [0.5] Field Course I

4. 3.5 credits in BIOL or BIOC, with at least 1.0 credit at the 3000-level and 1.0 credit at the 4000-level

5. 3.0 credits in:
   - ERTH 2102 [0.5] Mineralogy to Petrology
   - ERTH 2312 [0.5] Paleontology
   - ERTH 2314 [0.5] Sedimentation and Stratigraphy
   - ERTH 3111 [0.5] Vertebrate Evolution II
   - ERTH 3112 [0.5] Vertebrate Evolution I
   - ERTH 3113 [0.5] Geology of Human Origins

6. 0.5 credit from:
   - ERTH 3203 [0.5] Applied Sedimentology
   - ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records

7. 1.0 credit in ERTH at the 4000-level

8. 1.0 credit from:
   - BIOL 4905 [1.0] Honours Workshop
   - BIOL 4907 [1.0] Honours Essay and Research Proposal
   - BIOL 4908 [1.0] Honours Research Thesis
   - ERTH 4908 [1.0] Honours Thesis
   - ERTH 4909 [0.5] Research in Earth Sciences (and 0.5 credit in ERTH at the 4000-level)

B. Credits Not Included in the Major CGPA (8.0 credits)

9. 1.0 credit in:
   - MATH 1007 [0.5] Elementary Calculus I
   - MATH 1107 [0.5] Linear Algebra I

10. 1.0 credit from:
    - CHEM 1001 [0.5] General Chemistry I
    - CHEM 1002 [0.5] General Chemistry II
    - CHEM 2005 [0.5] Elementary Chemistry I
    - CHEM 2006 [0.5] Elementary Chemistry II

11. 1.0 credit in:
    - ERTH 1007 [0.5] Elementary University Physics I
    - ERTH 1008 [0.5] Elementary University Physics II
    - STAT 2507 [0.5] Introduction to Statistical Modeling I

12. 0.5 credit in:
    - COMP 1005 [0.5] Introduction to Computer Science I

13. 1.0 credit in Science Continuation courses

14. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

15. 1.0 credit in free electives

Total Credits 20.0

Note: for Item 4 above, ERTH 3203 is required if prerequisite conditions are met.

Biology and Earth Sciences
B.Sc. Combined Honours (20.0 credits)

A. Credits Included in the Major CGPA (13.5 credits)

1. 4.0 credits in:
   - CHEM 1005 [0.5] General Chemistry I
   - CHEM 1006 [0.5] General Chemistry II
   - CHEM 2003 [0.5] Analytical Chemistry I
   - CHEM 2004 [0.5] Analytical Chemistry II
   - CHEM 2501 [0.5] Introduction to Inorganic and Bioinorganic Chemistry
   - CHEM 3001 [0.5] Physical Chemistry I
   - CHEM 3002 [0.5] Physical Chemistry II
   - CHEM 3503 [0.5] Inorganic Chemistry I
   - CHEM 3504 [0.5] Quantum Chemistry I

2. 1.0 credit in CHEM at the 4000-level

3. 1.0 credit in:
   - ERTH 1006 [0.5] Exploring Planet Earth
   - ERTH 1009 [0.5] The Earth System Through Time

4. 3.0 credits in:
   - ERTH 2102 [0.5] Mineralogy to Petrology
   - ERTH 2104 [0.5] Igneous Systems, Geochemistry and Processes
   - ERTH 2105 [0.5] Geodynamics
   - ERTH 2314 [0.5] Sedimentation and Stratigraphy
   - ERTH 2406 [0.5] Geology and Map Interpretation
   - ERTH 2802 [0.5] Field Geology I

5. 0.5 credit from:
   - ERTH 3203 [0.5] Applied Sedimentology

Note: Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM.
ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records (See Note, below)

6. 2.0 credits in: 2.0
ERTH 3003 [0.5] Geochemistry and Geochronology
ERTH 3204 [0.5] Mineral Deposits
ERTH 3207 [0.5] Metamorphic Petrology and Processes
ERTH 3806 [0.5] Structural Geology

7. 1.0 credit in ERTH at the 4000-level 1.0

8. 1.0 credit from: 1.0
CHEM 4908 [1.0] Research Project and Seminar
ERTH 4908 [1.0] Honours Thesis
ERTH 4909 [0.5] Research in Earth Sciences (and 0.5 credit in ERTH at the 4000-level)

B. Credits Not Included in the Major CGPA (6.5 credits)

9. 1.0 credit in: 1.0
MATH 1004 [0.5] Calculus for Engineering or Physics
MATH 1107 [0.5] Linear Algebra I
MATH 1005 [0.5] Differential Equations and Infinite Series for Engineering or Physics
MATH 2007 [0.5] Elementary Calculus II

10. 0.5 credit in: 0.5
STAT 2507 [0.5] Introduction to Statistical Modeling I

11. 0.5 credit in: 0.5
PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics
& PHYS 1004 [0.5] Introductory Electromagnetism and Wave Motion

PHYS 1007 [0.5] Elementary University Physics I
& PHYS 1008 [0.5] Elementary University Physics II

12. 0.5 credit in: 0.5
GEOM 2007 [0.5] Geographic Information Systems

13. 1.0 credit in: 1.0
BUSI 1003 [0.5] Survey of Accounting

14. 0.5 credit in: 0.5
BIOL 1104 [0.5] Foundations of Biology II

15. 0.5 credit in Science Faculty Electives (not CHEM or ERTH) 0.5

16. 0.5 credit in: 0.5
NSCI 1000 [0.5] Seminar in Science (or 0.5 credit in approved courses outside the faculties of Science and Engineering and Design)

17. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design 1.5

Total Credits: 20.0

Note: for Item 5 above, ERTH 3203 is required if prerequisite conditions are met.

Minor in Business for B.Sc. Honours, B.Sc. Major Earth Sciences (4.0 credits)

In the B.Sc. Honours Earth Sciences, Items 14-17 are replaced with the following requirements and in the B.Sc. Major Earth Sciences, Items 13-16 are replaced with the following requirements.

Requirements

1. 1.0 credit in: 1.0
BUSI 1003 [0.5] Survey of Accounting

2. 2.0 credits in:

BUSI 2121 [0.5] Introduction to Organizational Behaviour
BUSI 2204 [0.5] Basic Marketing
BUSI 2301 [0.5] Introduction to Operations Management
BUSI 2400 [0.5] Foundations of Information Systems

3. 1.0 credit in BUSI at the 2000-level or higher. 1.0
Recommended:

BUSI 2701 [0.5] Fundamentals of International Business
BUSI 3102 [0.5] Introduction to Human Resources Management
BUSI 3103 [0.5] Introduction to Organization Theory
BUSI 3208 [0.5] Business-to-Business Marketing
BUSI 3309 [0.5] Project Management
BUSI 3600 [0.5] Entrepreneurial Strategies

Total Credits: 4.0

Minor in Earth Sciences: Earth Resources and Processes (4.0 credits)

The Minor (4.0 credits) in Earth Sciences offers a focus on earth resources and major geological processes that have shaped the planet's geological history, including resource distribution and character. The Minor is available to students registered in degree programs other than those offered by the Department of Earth Sciences. The courses should be taken in the order shown.

Requirements

1. 1.0 credit in:
ERTH 1006 [0.5] Exploring Planet Earth
ERTH 1009 [0.5] The Earth System Through Time

2. 2.5 credits from:

ERTH 2316 [0.5] Paleocology
ERTH 2318 [0.5] Sedimentology
ERTH 2401 [0.5] Dinosaurs
ERTH 2402 [0.5] Climate Change: An Earth Sciences Perspective
ERTH 2403 [0.5] Introduction to Oceanography
ERTH 2415 [0.5] Natural Disasters
ERTH 3113 [0.5] Geology of Human Origins
ERTH 3208 [0.5] Oceanography: An Earth Sciences Perspective

3. 0.5 credit in:
ERTH 4303 [0.5] Resources of the Earth

Total Credits: 4.0
Earth Sciences (ERTH) Courses

ERTH 1006 [0.5 credit]
Exploring Planet Earth
Origin of the Earth, concepts of geological time, and exploration of the interaction and duration of geological processes that shape the surface to deep interior of our planet, the climate, and formation of rocks and earth resources. Precludes additional credit for ERTH 1001 (no longer offered), ERTH 1010, ERTH 2404. Prerequisite(s): a 4U/M level in Advanced Functions and at least one of Biology, Chemistry, Earth and Space Sciences or Physics are recommended. This course is for students who are enrolled in the Faculty of Science. Lectures three hours a week, a laboratory three hours a week, and a field excursion.

ERTH 1009 [0.5 credit]
The Earth System Through Time
Origin and co-evolution of Earth and life over its 4.56 billion year history. Connections between plate tectonics, rock formation, climate and global change. Early marine life, colonization of land, mass extinctions, and the use of fossils for interpreting past ecosystems. Precludes additional credit for GEOL 1008 (no longer offered), ERTH 1011. Prerequisite(s): This course is for students who are enrolled in the Faculty of Science. Lectures three hours a week, a laboratory three hours a week.

ERTH 1010 [0.5 credit]
Our Dynamic Planet Earth
Origin of the Earth, concepts of geological time, and exploration of the interaction and duration of geological processes that shape the surface to deep interior of our planet, the climate, and formation of rocks and earth resources. Precludes additional credit for ERTH 1001 (no longer offered) and ERTH 1006. Prerequisite(s): a 4U/M level in Advanced Functions and at least one of Biology, Chemistry, Earth and Space Sciences or Physics are recommended. This course is for students who are not enrolled in the Faculty of Science. Lectures three hours a week.

ERTH 1011 [0.5 credit]
Evolution of the Earth
Earth’s changing patterns of continent and ocean basin distribution related to plate tectonics; resulting change in global sea level, sedimentation, paleoclimates and life on Earth. Precludes additional credit for GEOL 1008 (no longer offered) and ERTH 1009. Prerequisite(s): a 4U/M level in Advanced Functions and at least one of Biology, Chemistry, Earth and Space Sciences or Physics are recommended; ERTH 1010 is normally taken prior to this course. This course is for students who are not enrolled in the Faculty of Science. Lectures three hours a week.

ERTH 2102 [0.5 credit]
Mineralogy to Petrology
Chemical, optical and crystallographic properties of common rock-forming minerals, with introduction to common mineral assemblages of igneous, sedimentary, and metamorphic rocks. Precludes additional credit for ERTH 3202 (no longer offered). Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013) and (CHEM 1001 or CHEM 1005) and (CHEM 1002 or CHEM 1006) and (MATH 1004 or MATH 1007) and (MATH 1104 or MATH 1107). Lectures two hours a week and laboratory three hours a week.

ERTH 2104 [0.5 credit]
Igneous Systems, Geochemistry and Processes
The sources and magmatic evolution of volcanic and plutonic rocks systems, with emphasis on geochemical, mineralogical, and textural characteristics, and relations to igneous processes. Precludes additional credit for ERTH 3202 (no longer offered). Prerequisite(s): (CHEM 1001 or CHEM 1005) and (CHEM 1002 or CHEM 1006), (MATH 1004 or MATH 1007), (MATH 1104 or MATH 1107) and ERTH 2102. Lectures two hours a week, laboratory three hours a week, tutorial one hour per week, and a field excursion.

ERTH 2105 [0.5 credit]
Geodynamics
The structure, composition, and rheological properties of the Earth: lithosphere, mantle and core. Plate tectonics and its relation to geophysical fields, driving mechanisms, and processes at plate boundaries and in plate interiors. Precludes additional credit for ERTH 3805 (no longer offered). Prerequisite(s): ERTH 1001 (no longer offered) or ERTH 1006 and (ERTH 1009 or GEOG 2013). Lectures two hours a week and a laboratory three hours a week.

ERTH 2312 [0.5 credit]
Paleontology
Introduction to macrofossil and microfossil groups, their paleoenvironmental significance, and principles of evolutionary paleoecology. Precludes additional credit for ERTH 2316, GEOL 2301 (no longer offered) and GEOL 2306 (no longer offered). Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013). Lectures two hours a week and a laboratory three hours a week.
ERTH 2314 [0.5 credit]
Sedimentation and Stratigraphy
Origin of sediments and their transport, distribution, and primary structures; processes of sediment-to-rock transformation; spatial patterns; controls of stratigraphy; methods of correlation.
Precludes additional credit for ERTH 2318.
Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013).
Lectures three hours a week and a laboratory three hours a week.

ERTH 2316 [0.5 credit]
Paleoecology
Introduction to macrofossil and microfossil groups, their paleoenvironmental significance, and principles of evolutionary paleoecology.
Precludes additional credit for ERTH 2312. Not available for credit in B.Sc. Earth Sciences programs.
Prerequisite(s): ERTH 1006 and ERTH 1009. Priority given to students in the Minor in Earth Sciences.
Lectures two hours a week.

ERTH 2318 [0.5 credit]
Sedimentology
Origin of sediments and their transport, distribution, and primary structures; processes of sediment-to-rock transformation; spatial patterns; controls of stratigraphy and methods of correlation.
Precludes additional credit for ERTH 2314. Not available for credit in B.Sc. Earth Sciences programs.
Prerequisite(s): ERTH 1006 and ERTH 1009. Priority given to students in the Minor in Earth Sciences.
Lectures three hours a week.

ERTH 2401 [0.5 credit]
Dinosaurs
A general introduction to dinosaurs, their place in evolution, their social behaviour, the Mesozoic landscape and extinction theories.
Lectures three hours a week.

ERTH 2402 [0.5 credit]
Climate Change: An Earth Sciences Perspective
An exploration of the often dramatic climate changes that have occurred through earth history from a geological perspective, emphasizing the history of earth climates, geological causes of climate change and impact that rapid climate change has had on the biosphere.
Lectures three hours a week.

ERTH 2403 [0.5 credit]
Introduction to Oceanography
An environmental approach to understanding the oceans; introducing the physical and biological aspects of oceanography, marine resources and marine pollution.
Lectures three hours per week.

ERTH 2404 [0.5 credit]
Engineering Geoscience
Applications of the basic concepts of geology, earth materials and earth processes to practical engineering and environmental science. Topics include rock and soil mechanics, slope stability, hydrogeology, geological hazards, and site investigations. Overview of related geophysical methods.
Precludes additional credit for ERTH 2414 (no longer offered) and ERTH 1006.
Prerequisite(s): completion of first year of any B.Eng. program.
Lectures three hours a week and a laboratory three hours a week.

ERTH 2406 [0.5 credit]
Geology and Map Interpretation
Analysis and interpretation of geological features and processes using rocks, maps and cross sections. Introduction to computational methods.
Prerequisite(s): ERTH 2102 and GEOM 2007.
Lectures two hours a week and a laboratory three hours a week.

ERTH 2415 [0.5 credit]
Natural Disasters
Physical characteristics and causes of natural disasters of geological origin such as volcanic eruptions, earthquakes, tsunami, landslides, hurricanes and meteor impacts. Discussion on historical perspective, societal impact and mitigation strategies. Emphasis on Canadian case histories.
Precludes additional credit for ERTH 1003 (no longer offered).
Prerequisite(s): second-year standing in any degree program. With the exception of the Minor in Earth Sciences, available as a free elective only in any B.Sc. program, including Earth Sciences.
Lectures three hours a week.

ERTH 2802 [0.5 credit]
Field Geology I
Field analysis using geological, geophysical and computational methods leading to the interpretation of the origins of geological features and processes.
Prerequisite(s): ERTH 2406 and permission of the department.
Field work for two weeks off campus. A supplementary fee may apply.

ERTH 3002 [0.5 credit]
Gemology
Gemstones including their physical and chemical properties, geological formation and geographic occurrence. Introduction to gemological laboratory methods.
Prerequisite(s): ERTH 2102.
Lectures two hours a week and laboratory two hours a week.
ERTH 3003 [0.5 credit]
**Geochemistry and Geochronology**
Geochemical processes within crustal to surface environments, and use of isotopic variations of certain elements to define geochronological frameworks and geochemical pathways to better understand the earth's history.
Precludes additional credit for ERTH 2101 (no longer offered).
Prerequisite(s): ERTH 2102, ERTH 2104 and ERTH 2105.
Lecture two hours a week, and a laboratory three hours a week.

ERTH 3111 [0.5 credit]
**Vertebrate Evolution II**
Evolution of mammals, reptiles and birds. Emphasis on surveying amniote diversity, and the origin of key amniote transformations, as evidenced by the fossil record.
Prerequisite(s): ERTH 1006 and ERTH 1009, BIOL 2001 (may be taken concurrently) or permission of the department.
Lectures two hours a week and a laboratory three hours a week.

ERTH 3112 [0.5 credit]
**Vertebrate Evolution I**
Evolution of fish and amphibians. Emphasis on surveying fish and amphibian diversity, and the origin of key transformations of these groups, as evidenced by the fossil record.
Prerequisite(s): ERTH 1006 and ERTH 1009, BIOL 2001 (may be taken concurrently) or permission of the department.
Lectures two hours a week and a laboratory three hours a week.

ERTH 3113 [0.5 credit]
**Geology of Human Origins**
The origin and evolution of our species from geological, biological and cultural perspectives. The course traces human ancestry from our primate roots through time and changing environments, and explores controversies, frauds, and misperceptions.
Prerequisite(s): any 1000- or 2000-level Earth Sciences course.
Lectures three hours per week.

ERTH 3203 [0.5 credit]
**Applied Sedimentology**
Field-based analysis of sedimentary processes as developed in modern and preserved in ancient geological environments. This course occurs off campus over a 10-day period. A supplementary fee may apply.
Precludes additional credit for ERTH 3201 (no longer offered).
Prerequisite(s): ERTH 2102, ERTH 2104, ERTH 2105, ERTH 2312, ERTH 2314, ERTH 2406, ERTH 2802 and a second-year Earth Sciences average of 8.00 and permission of the department.

ERTH 3204 [0.5 credit]
**Mineral Deposits**
Analysis and interpretation of the geological and geochemical processes responsible for mineral deposit genesis in a global context.
Prerequisite(s): ERTH 2104.
Lectures and laboratory five hours a week.

ERTH 3205 [0.5 credit]
**Physical Hydrogeology**
Principles of deep- to shallow fluid flow within the Earth's crust, and introduction to the exploration, development and management of groundwater as a global resource.
Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013).
Lecture three hours a week and a laboratory three hours a week.

ERTH 3206 [0.5 credit]
**Oceanography: Its Modern and Geologic Records**
Composition and movement of the oceans, processes of sediment production and its distribution, ocean/climate interactions, geological proxies for ancient oceanographic conditions, and cyclic sedimentary and geochemical patterns.
Precludes additional credit for ERTH 3208.
Prerequisite(s): ERTH 2314.
Lectures three hours a week and a laboratory three hours a week.

ERTH 3207 [0.5 credit]
**Metamorphic Petrology and Processes**
Genesis of metamorphic rocks as determined from field, petrographic and geochemical data.
Precludes additional credit for ERTH 3202 (no longer offered).
Prerequisite(s): ERTH 2104.
Lectures two hours a week, a laboratory three hours a week and a field excursion.

ERTH 3208 [0.5 credit]
**Oceanography: An Earth Sciences Perspective**
The principal geological, physical, chemical and biological oceanographic processes and their interaction in today's oceans in comparison to a succession of critical stages of oceanographic development through geologic time.
Precludes additional credit for ERTH 3206.
Prerequisite(s): (ERTH 1006 or ERTH 1010) and (ERTH 1009 or ERTH 1011).
Lectures three hours a week.

ERTH 3405 [0.5 credit]
**Geophysical Methods**
An introduction to the tools of applied geophysics including seismology, electrical, magnetic, and gravitational surveying methods.
Precludes additional credit for ERTH 2405 (no longer offered).
Prerequisite(s): ERTH 2105.
Lecture two hours a week and a laboratory three hours a week.
ERTH 3806 [0.5 credit]
Structural Geology
Structures and deformational processes in a variety of crustal settings. Applications to geological engineering and mineral and petroleum exploration.
Prerequisite(s): ERTH 2105 and ERTH 2406. Lecture two hours a week and a laboratory three hours a week.

ERTH 3999 [0.0 credit]
Co-operative Work Term

ERTH 4003 [0.5 credit]
Directed Studies in Geology
One or more projects involving at least 15 days field and/or laboratory research, not related to thesis research. Assessment based on written reports and an oral presentation. Expenses for long-distance travel are borne by the student.
Prerequisite(s): fourth-year standing in any B.Sc. Hons. or Combined Hons. program in Earth Sciences. Schedule to be arranged.

ERTH 4004 [0.5 credit]
Special Topics in Earth Sciences
Field, laboratory or literature research, not related to thesis research. Assessment based on written reports and an oral presentation. Expenses for travel are borne by the student.
Prerequisite(s): fourth-year standing in any B.Sc. Hons. or Combined Hons. program in Earth Sciences. Major CGPA 8.5 or higher at time of registration for the course. Schedule to be arranged.

ERTH 4005 [0.5 credit]
Micropaleontology
Paleoecological and biostratigraphic significance, and evolutionary history of marine and freshwater microorganisms.
Prerequisite(s): ERTH 2312.
Lectures, seminars and/or laboratory five hours a week.

ERTH 4006 [0.5 credit]
Geobiology
Exploration of the relationship between micro- and macro-evolutionary processes and the Earth’s physical and chemical environment. Paleobiology and evolutionary ecology in the context of paleoceanography, paleoecology and paleoclimatology. May include one or two weeks of field based instruction with costs borne by the student.
Prerequisite(s): ERTH 2312.
Lectures and seminars three hours a week.

ERTH 4007 [0.5 credit]
Evolutionary Developmental Paleobiology
This course explores the mechanistic basis of organismic evolution from genetic, morphogenetic and epigenetic perspectives, within a phylogenetic context of living and extinct vertebrates.
Prerequisite(s): ERTH 2312 and BIOL 2001.
Lectures two hours a week and a laboratory three hours per week.

ERTH 4107 [0.5 credit]
Geotechnical Mechanics
Soil composition and soil classification. Soil properties, compaction, seepage and permeability. Concepts of pore water pressure, capillary pressure and hydraulic head. Principle of effective stress, stress-deformation and strength characteristics of soils, consolidation, stress distribution with soils, and settlement. Laboratory testing. Also listed as CIVE 3208.
Prerequisite(s): ERTH 2406 and ERTH 3405.
Lectures three hours a week, laboratory three hours alternate weeks.

ERTH 4206 [0.5 credit]
Contaminant and Remediation Hydrogeology
Geochemical and physical processes controlling contaminant release, migration, and fate in groundwater along with the processes and techniques used for contaminant mitigation and remediation. Examples will include organic and inorganic contaminants in a variety of settings.
Prerequisite(s): ERTH 3003 and ERTH 3205.
Lectures and seminars three hours per week.

ERTH 4303 [0.5 credit]
Resources of the Earth
Earth’s resources: where they occur, how they are concentrated, how they are extracted and used, and how human exploitation of natural resources impacts on the environment.
Prerequisite(s): third-year standing in any degree program.
Lectures three hours a week.

ERTH 4305 [0.5 credit]
Carbonate Sedimentology
The origin, composition and diagenesis of carbonate rocks. Study of modern and ancient platform systems; development of facies models; petrographic and geochemical analysis of limestones and dolostones.
Prerequisite(s): ERTH 3203 or ERTH 3206.
Lecture two hours a week and a laboratory three hours a week.
ERTH 4306 [0.5 credit]  
Resource Basin Analysis  
Surface and subsurface geological and geophysical techniques used to define the distribution and origin of geological basins, the architecture of basin fill, and characterize the distribution of water, petroleum and mineral resources.  
Prerequisite(s): ERTH 3203 or ERTH 3206, ERTH 3205, and ERTH 3806.  
Lectures, seminars and laboratory five hours a week.

ERTH 4402 [0.5 credit]  
Structural Geology  
A study of the structural evolution of mountain belts, with emphasis on field methods.  
Prerequisite(s): ERTH 3806.  
Lectures, seminars and laboratory five hours a week.

ERTH 4403 [0.5 credit]  
Tectonic Evolution of Canada  
Geologic evolution of Canada focusing on geological styles and tectonic processes of Archean cratons, Proterozoic and Phanerozoic orogenic belts.  
Prerequisite(s): ERTH 3806.  
Lectures and seminars three hours a week.

ERTH 4504 [0.5 credit]  
Advanced Igneous Petrology  
Volcanology, petrology, mineralogy and geochemistry of igneous rocks and their tectonic setting; may include one to two weeks of field-based instruction with costs borne by the student.  
Prerequisite(s): ERTH 2104 and ERTH 3003.  
Field excursions, seminars three hours per week.

ERTH 4507 [0.5 credit]  
Advanced Metamorphic Petrology  
Introduction to the quantitative analysis of pressure-temperature-time trajectories and rock-forming processes during metamorphic petrogenesis; may include one or two weeks of field-based instruction, with costs borne by the student.  
Prerequisite(s): ERTH 2802 and ERTH 3207.  
Field excursions, seminars or laboratories three hours per week.

ERTH 4707 [0.5 credit]  
Engineering Seismology  
Prerequisite(s): MATH 1004 or MATH 1007, MATH 1104 or MATH 1107, STAT 2507 and ERTH 3405 or permission of the department.  
Also offered at the graduate level, with different requirements, as ERTH 5707, for which additional credit is precluded.  
Lectures three hours a week.

ERTH 4801 [0.5 credit]  
Physics of the Earth  
The physical properties of the solid Earth. Gravitational, magnetic and palaeomagnetic fields; seismology and earthquake occurrence; heat flow and thermal history. Geodynamic processes.  
Prerequisite(s): ERTH 3405.  
Also offered at the graduate level, with different requirements, as ERTH 5701, for which additional credit is precluded.  
Lectures three hours a week.

ERTH 4803 [0.5 credit]  
Advanced Isotope Geology  
Chemical evolution of the Earth, meteorites; mantle and crustal evolution; radiogenic and stable isotopes; noble gas isotopes; applications to mineral deposits; environmental applications.  
Prerequisite(s): ERTH 3003.  
Also offered at the graduate level, with different requirements, as ERTH 5609, for which additional credit is precluded.  
Lectures, seminars or laboratories three hours per week.

ERTH 4804 [0.5 credit]  
Exploration Geophysics  
Application of geophysical methods to explore for petroleum and mineral resources, with emphasis on seismic and electromagnetic methods. Case histories illustrate the concepts.  
Prerequisite(s): ERTH 3405.  
Lectures and laboratories five hours per week.

ERTH 4807 [0.5 credit]  
Field Geology II  
Two-week field camp integrates advanced field, theory and experimental data. Assessment is based on reports, seminars, and oral examinations. Part of the cost is borne by the student. Departmental funding assistance is available for only one 4000-level field course per student.  
Prerequisite(s): completion of the third-year Earth Sciences course requirements and permission of the Department. A supplementary fee may apply.

ERTH 4808 [0.5 credit]  
Vertebrate Paleontology Field Camp  
Two-week field camp extends the student's vertebrate paleontological knowledge by integrating field, theory, and experimental data. Assessment based on written reports and seminars. Part of the cost is borne by the student. Departmental funding assistance is available for only one 4000-level field course per student.  
Prerequisite(s): ERTH 3003, ERTH 3111, ERTH 3112 and ERTH 3113. A Major CGPA of 8.5 or higher is required at the time of registration.
ERTH 4815 [0.5 credit]
Natural Hazards in Canada
Overview of the main natural hazards (such as floods, landslides, forest fires, earthquakes) and severe weather phenomena (such as ice storms, hail, tornadoes) in the Canadian environment. Risk of catastrophic events and their impact on society and infrastructure.
Prerequisite(s): third-year standing in earth science programs or permission of the department. Also offered at the graduate level, with different requirements, as ERTH 5215 and IPIS 5505, for which additional credit is precluded. Lectures three hours a week.

ERTH 4820 [0.5 credit]
Research Methods in Earth Sciences
Research approaches, methodologies and resources in Earth Sciences; analytical methods in Earth Sciences; data acquisition, evaluation and interpretation; principles and strategies of scientific and professional writing; and communication of results.
Prerequisite(s): third-year standing in Earth Sciences programs. Lectures, seminars, or laboratories three hours a week. May also include visits to other research institutes or workshops with visiting instructors.

ERTH 4908 [1.0 credit]
Honours Thesis
Independent studies. Requires prior written approval of a topic from a supervisor and the course co-ordinator. Oral and written proposal, progress and defence reports are required. Precludes additional credit for ERTH 4909, ERTH 4910. Prerequisite(s): restricted to B.Sc. Honours and Combined Honours ERTH programs. Major CGPA 8.5 or higher at time of registration for the course.

ERTH 4909 [0.5 credit]
Research in Earth Sciences
Understanding research methods, data interpretation and presentation, through readings, seminars andor laboratory projects related to a topic selected by the student with approval of a faculty advisor. Precludes additional credit for ERTH 4908, ERTH 4910. Prerequisite(s): restricted to B.Sc. Honours and Combined Honours Earth Sciences programs.

ERTH 4910 [1.0 credit]
Honours Thesis in Resource Evaluation
Independent studies: Analysis and interpretation of geological, environmental and/or financial data to determine economic value of a natural resource, and its viability for sustainable development. Requires approval of the supervisor and course coordinator. Oral and written proposal, progress and defense reports are required. Precludes additional credit for ERTH 4908 and ERTH 4909. Prerequisite(s): Restricted to B.Sc. Honours in Earth Sciences with Concentration in Finance: Resource Valuation. Major CGPA 8.5 or higher at time of registration for the course.

Summer session: some of the courses listed in this Calendar are offered during the summer. Hours and scheduling for summer session courses will differ significantly from those reported in the fall/winter Calendar. To determine the scheduling and hours for summer session classes, consult the class schedule at central.carleton.ca

Not all courses listed are offered in a given year. For an up-to-date statement of course offerings for the current session and to determine the term of offering, consult the class schedule at central.carleton.ca