

# Earth Sciences

The B.Sc. Honours in Earth Sciences and the B.Sc. Major in Earth Sciences are available with a Minor in Business. Consult the Business program section for admission and program requirements.

The Co-operative Education option is available in Earth Sciences. See the Co-operative Education section of this Calendar for details.

## Graduation Requirements

In addition to the requirements listed below, students must satisfy:

1. the University regulations (see the *Academic Regulations of the University* section of this Calendar),
2. the Faculty regulations applying to all B.Sc. students including those relating to Science Continuation and Breadth requirements (see the *Academic Regulations for the Bachelor of Science Degree*).

Students should consult with the department, school or committee responsible for their program when planning their program and selecting courses.

## 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 Arts or Social Science
- Free Elective

## Program Requirements

### Earth Sciences

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

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

<b>1. 1.0 credit in:</b>	1.0
ERTH 1006 [0.5]	Exploring Planet Earth
ERTH 1009 [0.5]	The Earth System Through Time
<b>2. 3.5 credits in:</b>	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
<b>3. 0.5 credit from:</b>	0.5
ERTH 3203 [0.5]	Applied Sedimentology

ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records (See Note, below)	
<b>4. 3.0 credits from:</b>		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)	
<b>5. 2.0 credits in EARTH at the 4000-level</b>		2.0
<b>6. 1.0 credit from:</b>		1.0
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 and 0.5 credit in 4000-level EARTH		
<b>B. Credits Not Included in the Major CGPA (9.0 credits)</b>		
<b>7. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
<b>8. 1.0 credit from:</b>		1.0
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II	
<b>9. 1.0 credit in:</b>		1.0
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
<b>10. 0.5 credit in:</b>		0.5
BIOL 1004 [0.5]	Introductory Biology II	
<b>11. 0.5 credit in:</b>		0.5
COMP 1005 [0.5]	Introduction to Computer Science I	
<b>12. 0.5 credit in:</b>		0.5
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>13. 0.5 credit in:</b>		0.5
GEOM 2007 [0.5]	Geographic Information Systems	
<b>14. 1.0 credit in Science Continuation Courses (not EARTH)</b>		1.0
<b>15. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Science electives)	
<b>16. 1.5 credits in Approved Arts or Social Science electives</b>		1.5
<b>17. 1.0 credit in free electives.</b>		1.0
<b>Total Credits</b>		<b>20.0</b>

### Notes:

1. For Item 3 above, EARTH 3203 is required if prerequisite conditions are met.
2. For Item 4 above, EARTH 3206 may be used only if it has not already been used to fulfil the requirement for Item 3.
3. For BIOL 1004, 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)

<b>1. 1.0 credit in:</b>	1.0
ERTH 1006 [0.5]	Exploring Planet Earth
ERTH 1009 [0.5]	The Earth System Through Time
<b>2. 3.0 credits in:</b>	3.0
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
<b>3. 0.5 credit from:</b>	0.5
ERTH 3203 [0.5]	Applied Sedimentology
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records (See Note, below)
<b>4. 3.0 credits from:</b>	3.0
ERTH 3003 [0.5]	Geochemistry and Geochronology
ERTH 3204 [0.5]	Mineral Deposits
ERTH 3205 [0.5]	Physical Hydrogeology
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records (See Note, below)
ERTH 3207 [0.5]	Metamorphic Petrology and Processes
ERTH 3405 [0.5]	Geophysical Methods
ERTH 3806 [0.5]	Structural Geology (See Note, below)
<b>5. 0.5 credit from:</b>	0.5
ERTH 4303 [0.5]	Resources of the Earth
<b>6. 1.5 credits in EARTH at the 4000-level</b>	1.5
<b>7. 1.0 credit in:</b>	1.0
ERTH 4910 [1.0]	Honours Thesis in Resource Evaluation

#### B. Credits Not Included in the Major CGPA (10.5 credits)

<b>8. 1.0 credit in:</b>	1.0
MATH 1007 [0.5]	Elementary Calculus I
MATH 1107 [0.5]	Linear Algebra I
<b>9. 1.0 credit from:</b>	1.0
CHEM 1001 [0.5]	General Chemistry I
& CHEM 1002 [0.5]	and General Chemistry II
CHEM 1005 [0.5]	Elementary Chemistry I
& CHEM 1006 [0.5]	and Elementary Chemistry II
<b>10. 0.5 credit in:</b>	0.5
PHYS 1007 [0.5]	Elementary University Physics I
<b>11. 0.5 credit from:</b>	0.5
BIOL 1004 [0.5]	Introductory Biology II
COMP 1005 [0.5]	Introduction to Computer Science I
<b>12. 0.5 credit in:</b>	0.5
GEOM 2007 [0.5]	Geographic Information Systems

<b>13. 1.0 credit from:</b>	1.0
STAT 2507 [0.5]	Introduction to Statistical Modeling I
& STAT 2509 [0.5]	and Introduction to Statistical Modeling II
STAT 2606 [0.5]	Business Statistics I
& STAT 2607 [0.5]	and Business Statistics II
<b>14. 1.5 credit in:</b>	1.5
ECON 1000 [1.0]	Introduction to Economics
ECON 2009 [0.5]	Managerial Economics
<b>15. 3.5 credits in:</b>	3.5
BUSI 1001 [0.5]	Principles of Financial Accounting
BUSI 1002 [0.5]	Management Accounting
BUSI 2504 [0.5]	Business Finance I
BUSI 2505 [0.5]	Business Finance II
BUSI 3500 [0.5]	Applied Corporate Finance
BUSI 3502 [0.5]	Investments
BUSI 3512 [0.5]	Derivatives
<b>16. 1.0 credit from:</b>	1.0
ECON 3803 [0.5]	The Economics of Natural Resources
BUSI 4500 [0.5]	Advanced Corporate Finance
BUSI 4510 [0.5]	Mergers and Acquisitions
Total Credits	21.0

#### Notes:

- For **Item 3** above, EARTH 3203 Applied Sedimentology is required if prerequisite conditions are met.
- For **Item 4** above, EARTH 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)

<b>1. 1.0 credit in:</b>	1.0
ERTH 1006 [0.5]	Exploring Planet Earth
ERTH 1009 [0.5]	The Earth System Through Time
<b>2. 3.5 credits in:</b>	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
<b>3. 0.5 credit from:</b>	0.5
ERTH 3203 [0.5]	Applied Sedimentology
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records (See Note, below)
<b>4. 3.0 credits from:</b>	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)	
<b>5. 0.5 credit from:</b>		0.5
ERTH 4303 [0.5]	Resources of the Earth	
ERTH 4306 [0.5]	Resource Basin Analysis	
<b>6. 1.5 credit in EARTH at the 4000-level</b>		1.5
<b>7. 1.0 credit from:</b>		1.0
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 [0.5]	Research in Earth Sciences (and 0.5 credit EARTH at the 4000-level)	
<b>B. Credits Not Included in the Major CGPA (9.0 credits)</b>		
<b>8. 3.5 credits in:</b>		3.5
ECON 1000 [1.0]	Introduction to Economics	
ECON 2020 [0.5]	Intermediate Microeconomics I: Producers and Market Structure	
ECON 2030 [0.5]	Intermediate Microeconomics II: Consumers and General Equilibrium	
ECON 2201 [0.5]	Statistical Methods in Economics and Business I	
ECON 2202 [0.5]	Statistical Methods in Economics and Business II	
ECON 3509 [0.5]	Development Planning and Project Evaluation	
<b>9. 1.0 credit from:</b>		1.0
ECON 3803 [0.5]	The Economics of Natural Resources	
ECON 3804 [0.5]	Environmental Economics	
ECON 4030 [0.5]	Economics of Uncertainty and Information	
<b>10. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
<b>11. 1.0 credit from:</b>		1.0
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II	
<b>12. 1.0 credit in:</b>		1.0
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
<b>13. 0.5 credit in:</b>		0.5
BIOL 1004 [0.5]	Introductory Biology II	
<b>14. 0.5 credit in COMP</b>		0.5
<b>15. 0.5 credit in GEOM 2007</b>		0.5
<b>Total Credits</b>		<b>20.0</b>

#### Notes:

- For Item 3 above, EARTH 3203 is required if prerequisite conditions are met.
- For Item 4 above, EARTH 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)

<b>1. 1.0 credit in:</b>		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
<b>2. 2.5 credits in:</b>		2.5
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	
<b>3. 0.5 credit from:</b>		0.5
ERTH 3203 [0.5]	Applied Sedimentology	
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records (See note, below)	
<b>4. 2.0 credits in:</b>		2.0
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)	
<b>5. 0.5 credit from:</b>		0.5
ERTH 4003 [0.5]	Directed Studies in Geology	
ERTH 4808 [0.5]	Vertebrate Paleontology Field Camp	
<b>6. 1.0 credit from:</b>		1.0
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 and 0.5 credit in EARTH at the 4000-level		
<b>7. 3.0 credits from</b> 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>B. Credits Not Included in the Major CGPA (9.5 credits)</b>		
<b>8. 2.5 credits in:</b>		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	
<b>9. 1.0 credit from:</b>		<b>1.0</b>
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II	
<b>10. 2.0 credits in:</b>		<b>2.0</b>
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	
<b>11. 0.5 credit in Science Faculty Electives (not EARTH or BIOL)</b>		<b>0.5</b>
<b>12. 0.5 credit in:</b>		
GEOM 2007 [0.5]	Geographic Information Systems	
<b>13. 0.5 credit in:</b>		<b>0.5</b>
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences Electives)	
<b>14. 1.5 credits in Approved Arts or Social Sciences</b>		<b>1.5</b>
<b>15. 1.0 credits in free electives.</b>		<b>1.5</b>
<b>Total Credits</b>		<b>20.0</b>

**Note:**

For **Item 3** above, EARTH 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 (10.5 credits)**

<b>1. 1.0 credit in:</b>		<b>1.0</b>
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
<b>2. 1.0 credit in:</b>		<b>1.0</b>
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1104 [0.5]	Linear Algebra for Engineering or Science	
<b>3. 1.0 credit from:</b>		<b>1.0</b>
PHYS 1001 [0.5]	Foundations of Physics I	
& PHYS 1002 [0.5]	and Foundations of Physics II (recommended)	
or		
PHYS 1003 [0.5]	Introductory Mechanics and	
& PHYS 1004 [0.5]	Thermodynamics and Introductory Electromagnetism and Wave Motion	
or		
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II (with an average grade of B- or higher)	
<b>4. 3.0 credits in:</b>		<b>3.0</b>
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	
<b>5. 0.5 credit from:</b>		<b>0.5</b>
ERTH 3203 [0.5]	Applied Sedimentology	
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records	
<b>6. 2.5 credits in:</b>		<b>2.5</b>
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	
<b>7. 0.5 credit in:</b>		<b>0.5</b>
ERTH 4707 [0.5]	Engineering Seismology	
<b>8. 1.0 credit from:</b>		<b>1.0</b>
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 [0.5]	Research in Earth Sciences (and 0.5 credit in EARTH at the 4000-level)	
<b>B. Credits Not Included in the Major CGPA (9.5 credits)</b>		
<b>9. 0.5 credit from:</b>		<b>0.5</b>
COMP 1005 [0.5]	Introduction to Computer Science I	
COMP 1006 [0.5]	Introduction to Computer Science II	
<b>10. 1.0 credit from:</b>		<b>1.0</b>
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II	
<b>11. 1.0 credit in:</b>		<b>1.0</b>
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>12. 0.5 credit in:</b>		<b>0.5</b>
GEOM 2007 [0.5]	Geographic Information Systems	
<b>13. 4.5 credits from:</b>		<b>4.5</b>
ERTH 2312 [0.5]	Paleontology	
ERTH 4003 [0.5]	Directed Studies in Geology	
ERTH 4107 [0.5]	Geotechnical Mechanics	
ERTH 4206 [0.5]	Contaminant and Remediation Hydrogeology	
ERTH 4303 [0.5]	Resources of the Earth	
ERTH 4305 [0.5]	Carbonate Sedimentology	
ERTH 4306 [0.5]	Resource Basin Analysis	
ERTH 4402 [0.5]	Structural Geology	
ERTH 4403 [0.5]	Tectonic Evolution of Canada	
ERTH 4801 [0.5]	Physics of the Earth	
ERTH 4804 [0.5]	Exploration Geophysics	
ERTH 4807 [0.5]	Field Geology II	
ERTH 4820 [0.5]	Research Methods in Earth Sciences	
MATH 2004 [0.5]	Multivariable Calculus for Engineering or Physics	
MATH 3705 [0.5]	Mathematical Methods I	
PHYS 2202 [0.5]	Wave Motion and Optics	
PHYS 2604 [0.5]	Modern Physics I	
PHYS 3308 [0.5]	Electromagnetism	
PHYS 3807 [0.5]	Mathematical Physics I	



PHYS 4203 [0.5]	Physical Applications of Fourier Analysis	
<b>14. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science	
or Approved Arts or Social Sciences		
<b>15. 1.5 credits in free electives.</b>		1.5
Total Credits		20.0

## Earth Sciences

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

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

<b>1. 1.0 credit in:</b>		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
<b>2. 3.5 credits in:</b>		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	
<b>3. 0.5 credit from:</b>		0.5
ERTH 3203 [0.5]	Applied Sedimentology	
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records (See Note, below)	
<b>4. 3.0 credits from:</b>		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)	
<b>5. 3.0 credits in EARTH at the 4000-level</b>		3.0

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

<b>6. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
<b>7. 1.0 credit from:</b>		1.0
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II	
<b>8. 1.0 credit in:</b>		1.0
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
<b>9. 0.5 credit in:</b>		0.5
BIOL 1004 [0.5]	Introductory Biology II	
<b>10. 0.5 credit in:</b>		0.5
COMP 1005 [0.5]	Introduction to Computer Science I	
<b>11. 0.5 credit in:</b>		0.5
STAT 2507 [0.5]	Introduction to Statistical Modeling I	

<b>12. 0.5 credit in:</b>		0.5
GEOM 2007 [0.5]	Geographic Information Systems	
<b>13. 1.0 credit in Science Continuation Courses (not EARTH)</b>		1.0
<b>14. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Science electives)	
<b>15. 1.5 credits in Approved Arts or Social Science electives</b>		1.5
<b>16. 1.0 credits in free electives.</b>		1.0
Total Credits		20.0

#### Notes:

- For Item 3 above, EARTH 3203 is required if prerequisite conditions are met.
- For Item 4 above, EARTH 3206 may be used only if it has not already been used to fulfill the requirement for item 3.
- For BIOL 1004, Ontario 4U/M in Biology (or equivalent) is required.
- 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)

<b>1. 1.0 credit in:</b>		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
<b>2. 3.5 credits in:</b>		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	
<b>3. 3.5 credits in:</b>		3.5
ERTH 3003 [0.5]	Geochemistry and Geochronology	
ERTH 3204 [0.5]	Mineral Deposits	
ERTH 3205 [0.5]	Physical Hydrogeology	
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3405 [0.5]	Geophysical Methods	
ERTH 3806 [0.5]	Structural Geology	

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

<b>4. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
<b>5. 1.0 credit from:</b>		1.0
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II	
<b>6. 1.0 credit from:</b>		1.0

PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I and Elementary University Physics II	
BIOL 1004 [0.5] & PHYS 1007 [0.5]	Introductory Biology II and Elementary University Physics I	
<b>7. 1.0 credit in</b>	Science Continuation Courses (not EARTH)	1.0
<b>8. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
<b>9. 1.5 credits in</b>	Approved Arts or Social Sciences	1.5
<b>10. 1.0 credit in</b>	free electives.	1.0
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)

<b>1. 1.0 credit in:</b>		1.0
GEOG 2013 [0.5]	Weather and Water	
GEOG 2014 [0.5]	The Earth's Surface	
<b>2. 0.5 credit in:</b>		0.5
ERTH 1006 [0.5]	Exploring Planet Earth	
<b>3. 1.5 credits in:</b>		1.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2406 [0.5]	Geology and Map Interpretation	
<b>4. 0.5 credit in:</b>		0.5
ENSC 2000 [0.5]	Environmental Science Field Methods	
<b>5. 2.0 credits in</b>	ERTH at the 3000-level or above	2.0
<b>6. 1.0 credit in</b>	ERTH at the 4000-level	1.0
<b>7. 1.5 credits in</b>	Science Geography or Geomatics courses at the 2000-level or above to include	1.5
GEOG 2007 [0.5]	Geographic Information Systems	
<b>8. 2.0 credits in:</b>		2.0
GEOG 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	
<b>9. 1.0 credit in</b>	Science Geography or Geomatics courses at the 4000-level	1.0
<b>10. 1.0 credit from:</b>		1.0
GEOG 4906 [1.0]	Honours Research Project	
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 and 0.5 credit	4000-level EARTH	

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

<b>11. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
<b>12. 1.0 credit in:</b>		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I and General Chemistry II	
<b>13. 1.0 credit in:</b>		1.0
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I and Elementary University Physics II	
<b>14. 0.5 credit in:</b>		0.5
BIOL 1004 [0.5]	Introductory Biology II	

<b>15. 1.0 credit in</b>	MATH (MATH, STAT) at 2000-level or above; and/or in COMP	1.0
STAT 2507 [0.5]	Introduction to Statistical Modeling I (recommended)	
COMP 1004 [0.5]	Introduction to Computers for the Sciences (recommended)	
<b>16. 1.0 credit in</b>	Advanced Science Faculty Electives	1.0
<b>17. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
<b>18. 1.5 credits in</b>	Approved Arts or Social Sciences	1.5
<b>19. 0.5 credit in</b>	free electives	0.5
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)

<b>1. 0.5 credit in:</b>		0.5
GEOG 2014 [0.5]	The Earth's Surface	
<b>2. 0.5 credit in:</b>		0.5
ERTH 1006 [0.5]	Exploring Planet Earth	
<b>3. 2.5 credits in:</b>		2.5
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	
<b>4. 0.5 credit from:</b>		0.5
ERTH 3203 [0.5]	Applied Sedimentology	
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records (See Note, below)	
<b>5. 1.5 credits in:</b>		1.5
ERTH 3205 [0.5]	Physical Hydrogeology	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3806 [0.5]	Structural Geology	
<b>6. 1.0 credit in</b>	ERTH at the 4000-level	1.0
<b>7. 0.5 credit from:</b>		0.5
GEOG 2006 [0.5]	Introduction to Quantitative Research	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>8. 1.5 credits in:</b>		1.5
GEOG 1004 [0.5]	Maps, Satellites and the Geospatial Revolution	
GEOG 2007 [0.5]	Geographic Information Systems	
GEOG 2013 [0.5]	Weather and Water	
<b>9. 2.0 credits in:</b>		2.0
GEOG 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	
<b>10. 1.0 credit in:</b>		1.0
GEOG 4101 [0.5]	Two Million Years of Environmental Change	
GEOG 4108 [0.5]	Permafrost	

<b>11. 1.0 credit from:</b>	1.0
GEOG 4906 [1.0] Honours Research Project	
ERTH 4908 [1.0] Honours Thesis	
ERTH 4909 and 0.5 credit 4000-level EARTH	
<b>B. Credits Not Included in the Major CGPA (7.5 credits)</b>	
<b>12. 1.0 credit in:</b>	1.0
MATH 1007 [0.5] Elementary Calculus I	
MATH 1107 [0.5] Linear Algebra I	
<b>13. 1.0 credit from:</b>	1.0
CHEM 1001 [0.5] General Chemistry I & CHEM 1002 [0.5] and General Chemistry II	
CHEM 1005 [0.5] Elementary Chemistry I & CHEM 1006 [0.5] and Elementary Chemistry II	
<b>14. 1.0 credit from:</b>	1.0
PHYS 1003 [0.5] Introductory Mechanics and & PHYS 1004 [0.5] Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5] Elementary University Physics I & PHYS 1008 [0.5] and Elementary University Physics II	
<b>15. 0.5 credit in:</b>	0.5
COMP 1004 [0.5] Introduction to Computers for the Sciences	
<b>16. 0.5 credit in:</b>	0.5
BIOL 1004 [0.5] Introductory Biology II	
<b>17. 0.5 credit in</b> Advanced Science Faculty electives	0.5
<b>18. 0.5 credit in:</b>	0.5
NSCI 1000 [0.5] Seminar in Science (or Approved Arts or Social Sciences)	
<b>19. 1.5 credits in</b> Approved Arts or Social Sciences	1.5
<b>20. 1.0 credit in</b> free electives.	1.0
<b>Total Credits</b>	<b>20.0</b>

Note: for **Item 4** above, EARTH 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 (13.0 credits)

<b>1. 1.0 credit in:</b>	1.0
BIOL 1103 [0.5] Foundations of Biology I	
BIOL 1104 [0.5] Foundations of Biology II	
<b>2. 1.0 credit in:</b>	1.0
ERTH 1006 [0.5] Exploring Planet Earth	
ERTH 1009 [0.5] The Earth System Through Time	
<b>3. 10.0 credits in:</b> BIOL (or BIOC) and EARTH at the 2000- level or above, collectively satisfying:	10.0
a. 1.0 credit in:	
BIOL 3605 [0.5] Field Course I	
ERTH 2314 [0.5] Sedimentation and Stratigraphy or EARTH 3206 [0.5] Oceanography: Its Modern and Geologic Records	
b. at least 4.0 credits in BIOL or BIOC	
c. at least 4.0 credits in EARTH	
d. at least 4.0 credits at the 3000-level or above	
<b>4. 1.0 credit from:</b>	1.0
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 EARTH at the 4000- level)	
<b>B. Credits Not Included in the Major CGPA (7.0 credits)</b>	
<b>5. 1.0 credit in:</b>	1.0
MATH 1007 [0.5] Elementary Calculus I	
MATH 1107 [0.5] Linear Algebra I	
<b>6. 1.0 credit from:</b>	1.0
CHEM 1001 [0.5] General Chemistry I & CHEM 1002 [0.5] and General Chemistry II	
CHEM 1005 [0.5] Elementary Chemistry I & CHEM 1006 [0.5] and Elementary Chemistry II	
PHYS 1003 [0.5] Introductory Mechanics and & PHYS 1004 [0.5] Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5] Elementary University Physics I & PHYS 1008 [0.5] and Elementary University Physics II (The omitted subject, i.e. Chemistry or Physics, must have been taken at the 4U/M level)	
<b>7. 0.5 credit in</b> STAT	0.5
STAT 2507 [0.5] Introduction to Statistical Modeling I (recommended)	
<b>8. 0.5 credit in</b> COMP	0.5
COMP 1004 [0.5] Introduction to Computers for the Sciences (recommended)	
<b>9. 1.0 credit in</b> Science Faculty Electives	1.0
<b>10. 0.5 credit in:</b>	0.5
NSCI 1000 [0.5] Seminar in Science (or Approved Arts or Social Sciences)	
<b>11. 1.5 credits in</b> Approved Arts or Social Sciences	1.5
<b>12. 1.0 credit in</b> free electives.	1.0
<b>Total Credits</b>	<b>20.0</b>

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.

## Chemistry and Earth Sciences

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

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

<b>1. 4.0 credits in:</b>	4.0
CHEM 1001 [0.5] General Chemistry I	
CHEM 1002 [0.5] General Chemistry II	
CHEM 2103 [0.5] Physical Chemistry I	
CHEM 2302 [0.5] Analytical Chemistry I	
CHEM 2303 [0.5] Analytical Chemistry II	
CHEM 2501 [0.5] Introduction to Inorganic and Bioinorganic Chemistry	
CHEM 3100 [0.5] Physical Chemistry II	
CHEM 3503 [0.5] Inorganic Chemistry I	
<b>2. 1.0 credit in</b> CHEM at the 4000-level	1.0
<b>3. 1.0 credit in:</b>	1.0
ERTH 1006 [0.5] Exploring Planet Earth	

ERTH 1009 [0.5]	The Earth System Through Time	
<b>4. 3.0 credits in:</b>		<b>3.0</b>
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	
<b>5. 0.5 credit from:</b>		<b>0.5</b>
ERTH 3203 [0.5]	Applied Sedimentology	
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records (See Note, below)	
<b>6. 2.0 credits in:</b>		<b>2.0</b>
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	
<b>7. 1.0 credit in EARTH at the 4000-level</b>		<b>1.0</b>
<b>8. 1.0 credit from:</b>		<b>1.0</b>
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 EARTH at the 4000-level)	
<b>B. Credits Not Included in the Major CGPA (6.5 credits)</b>		
<b>9. 1.0 credit in:</b>		<b>1.0</b>
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1107 [0.5]	Linear Algebra I	
<b>10. 0.5 credit from:</b>		<b>0.5</b>
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
MATH 2007 [0.5]	Elementary Calculus II	
<b>11. 0.5 credit in:</b>		<b>0.5</b>
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>12. 0.5 credit in:</b>		<b>0.5</b>
GEOM 2007 [0.5]	Geographic Information Systems	
<b>13. 1.0 credit from:</b>		<b>1.0</b>
PHYS 1003 [0.5]	Introductory Mechanics and	
& PHYS 1004 [0.5]	Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
<b>14. 0.5 credit in:</b>		<b>0.5</b>
BIOL 1004 [0.5]	Introductory Biology II	
<b>15. 0.5 credit in Science Faculty Electives (not CHEM or EARTH)</b>		<b>0.5</b>
<b>16. 0.5 credit in:</b>		<b>0.5</b>
NSCI 1000 [0.5]	Seminar in Science (or 0.5 credit in Approved Arts or Social Sciences)	
<b>17. 1.5 credits in Approved Arts or Social Sciences</b>		<b>1.5</b>
Total Credits		20.0

**Note:** for item 5 above, EARTH 3203 is required if prerequisite conditions are met.

## 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

<b>1. 1.0 credit in:</b>		<b>1.0</b>
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
<b>2. 2.5 credits from:</b>		<b>2.5</b>
ERTH 2316 [0.5]	Paleoecology	
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	
<b>3. 0.5 credit in:</b>		<b>0.5</b>
ERTH 4303 [0.5]	Resources of the Earth	
Total Credits		4.0

## Department of Earth Sciences Faculty of Science

### 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 EARTH 1001 (no longer offered), EARTH 1010, EARTH 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

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 EARTH 1011.

Prerequisite(s): EARTH 1006. 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 EARTH 1001 (no longer offered) and EARTH 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 EARTH 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; EARTH 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 EARTH 3202 (no longer offered).

Prerequisite(s): EARTH 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 EARTH 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 EARTH 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 EARTH 3805 (no longer offered).

Prerequisite(s): EARTH 1001 (no longer offered) or EARTH 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 EARTH 2316, GEOL 2301 (no longer offered) and GEOL 2306 (no longer offered).

Prerequisite(s): EARTH 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 EARTH 2318.

Prerequisite(s): EARTH 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 EARTH 2312. Not available for credit in B.Sc. Earth Sciences programs.

Prerequisite(s): EARTH 1006 and EARTH 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 EARTH 2314. Not available for credit in B.Sc. Earth Sciences programs.

Prerequisite(s): EARTH 1006 and EARTH 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 EARTH 2414 (no longer offered) and EARTH 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): EARTH 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, tsunamis, landslides, hurricanes and meteor impacts.

Discussion on historical perspective, societal impact and mitigation strategies. Emphasis on Canadian case histories.

Precludes additional credit for EARTH 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): EARTH 2406 and permission of the department.

Field work for two weeks off campus.

**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): EARTH 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 EARTH 2101 (no longer offered).

Prerequisite(s): EARTH 2102, EARTH 2104 and EARTH 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): EARTH 1006 and EARTH 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): EARTH 1006 and EARTH 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 EARTH 3201 (no longer offered).

Prerequisite(s): EARTH 2102, EARTH 2104, EARTH 2105, EARTH 2312, EARTH 2314, EARTH 2406, EARTH 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): EARTH 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): EARTH 1006 and (EARTH 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 EARTH 3208.

Prerequisite(s): EARTH 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 EARTH 3202 (no longer offered).

Prerequisite(s): EARTH 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 EARTH 3206.

Prerequisite(s): (EARTH 1006 or EARTH 1010) and (EARTH 1009 or EARTH 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 EARTH 2405 (no longer offered).

Prerequisite(s): EARTH 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): EARTH 2105 and EARTH 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, paleolimnology 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 completion of the third-year Earth Sciences course requirements, or permission of the Department.

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, lectures, or seminars three hours per week.

**ERTH 4707 [0.5 credit]****Engineering Seismology**

Seismological topics with engineering applications. Characterization of seismicity and seismic sources (areas and faults). Seismic hazard analysis. Empirical and theoretical modeling of strong ground motion in time and frequency domains.

Prerequisite(s): one of MATH 1007 or MATH 1004, and one of MATH 1107 or MATH 1104, STAT 2507, and one of ERTH 2404, ERTH 2406.

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 2105.

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 of ERTH 4807 and ERTH 4808.

Prerequisite(s): completion of the third-year Earth Sciences course requirements and permission of the Department. A supplementary fee may apply.

Field Studies

**ERTH 4808 [0.5 credit]****Vertebrate Paleontology Field Camp**

Two-week field camp at Dinosaur Provincial Park (Alberta) designed to extend 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 of ERTH 4807 and ERTH 4808.

Prerequisite(s): completion of third-year course requirements within the Vertebrate Paleontology concentration, and permission of the Department.

**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, 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 and-or 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.

Honours Thesis .