Earth Sciences

This section presents the requirements for programs in:

- **Earth Sciences B.Sc. Honours**
- **Earth Sciences with Concentration in Environmental Geosciences B.Sc. Honours**
- **Earth Sciences with Concentration in Finance: Resource Valuation B.Sc. Honours**
- **Earth Sciences with Concentration in Resource Economics B.Sc. Honours**
- **Earth Sciences with Concentration in Vertebrate Paleontology and Paleoecology B.Sc. Honours**
- **Earth Sciences with Concentration in Geophysics B.Sc. Honours**
- **Earth Sciences B.Sc. Major**
- **Earth Sciences B.Sc.**
- **Earth Sciences and Physical Geography B.Sc. Combined Honours**
- **Biology and Earth Sciences B.Sc. Combined Honours**
- **Chemistry and Earth Sciences B.Sc. Combined Honours**
- **Minor in Earth Sciences: Earth Resources and Processes**

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.	**0.5 credit in:**		0.5
	ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
2.	**4.5 credits in:**		4.5
	ERTH 2102 [0.5]	Mineralogy to Petrology	
	ERTH 2105 [0.5]	Geodynamics	
	ERTH 2106 [0.5]	Geochemistry	
	ERTH 2312 [0.5]	Paleontology	
	ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
	ERTH 2407 [0.5]	Structural Geology	
	ERTH 2419 [0.5]	On the Origin of Planets	
	ERTH 2802 [0.5]	Field Geology I	
	ERTH 3004 [0.5]	Igneous Petrology	
3.	**2.5 credits from:**		2.5
	ERTH 3111 [0.5]	Vertebrate Evolution: Mammals, Reptiles, and Birds	
	ERTH 3112 [0.5]	Vertebrate Evolution: Fish and Amphibians	
	ERTH 3204 [0.5]	Mineral Deposits	
	ERTH 3205 [0.5]	Physical Hydrogeology	
	ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
	ERTH 3405 [0.5]	Geophysical Methods	
	ERTH 3703 [0.5]	Isotope Geochemistry and Geochronology	
4.	**0.5 credit from:**		0.5
	ERTH 4006 [0.5]	Field Environmental Geobiology	
	ERTH 4209 [0.5]	Mineral Exploration Field Geology	
	ERTH 4807 [0.5]	Field Geology II	
5.	**2.0 credits in** ERTH at the 4000-level		2.0
6.	**1.0 credit in:**		1.0
	ERTH 4908 [1.0]	Honours Thesis	
B. Credits Not Included in the Major CGPA (9.0 credits)			
7.	**1.0 credit in:**		1.0
	MATH 1007 [0.5]	Elementary Calculus I	
	MATH 1107 [0.5]	Linear Algebra I	
8.	**1.0 credit in:**		1.0
	CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
9.	**1.0 credit in:**		1.0
	PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I Elementary University Physics II	
10.	**0.5 credit in:**		0.5
	BIOL 1104 [0.5]	Foundations of Biology II	
11.	**0.5 credit in:**		0.5
	COMP 1005 [0.5]	Introduction to Computer Science I	
12.	**0.5 credit in:**		0.5
	STAT 2507 [0.5]	Introduction to Statistical Modeling I	
13.	**0.5 credit in:**		0.5
	ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution	
14.	**1.0 credit in** Science Continuation Courses (not ERTH)		1.0
15.	**0.5 credit in:**		0.5
	ISAP 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		1.5
17.	**1.0 credit in** free electives.		1.0
Total Credits			**20.0**

Note:

1. 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 Environmental Geosciences B.Sc. Honours (20.5 credits)

A. Credits Included in the Major CGPA (11.5 credits)		
1. 0.5 credit in:		0.5
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
2. 4.0 credits in:		4.0
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2106 [0.5]	Geochemistry	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2407 [0.5]	Structural Geology	
ERTH 2419 [0.5]	On the Origin of Planets	
ERTH 2802 [0.5]	Field Geology I	
GEOG 2013 [0.5]	Weather and Water	
3. 1.0 credit in:		1.0
ERTH 2312 [0.5]	Paleontology	
ERTH 3204 [0.5]	Mineral Deposits	
4. 2.5 credits in:		2.5
ERTH 3004 [0.5]	Igneous Petrology	
ERTH 3205 [0.5]	Physical Hydrogeology	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3405 [0.5]	Geophysical Methods	
GEOG 3108 [0.5]	Soil Properties	
5. 0.5 credit in:		0.5
ERTH 4006 [0.5]	Field Environmental Geobiology	
6. 0.5 credit in:		0.5
ERTH 4302 [0.5]	Frozen Earth: Unveiling the Snowball Earth Catastrophe	
7. 0.5 credit from:		0.5
ERTH 4008 [0.5]	Topics in Paleobiology and Evolution	
ERTH 4206 [0.5]	Contaminant and Remediation Hydrogeology	
ERTH 4815 [0.5]	Natural Hazards in Canada	
8. 1.0 credit in ERTH at the 4000-level		1.0
9. 1.0 credit in:		1.0
ERTH 4908 [1.0]	Honours Thesis (in the field of Environmental Geosciences)	
***See Note 1 below**		
B. Credits Not Included in the Major CGPA (9.0 credits)		
10. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
11. 1.0 credit in:		1.0
CHEM 1001 [0.5]	General Chemistry I	
CHEM 1002 [0.5]	General Chemistry II	
12. 1.0 credit in:		1.0
PHYS 1007 [0.5]	Elementary University Physics I	
PHYS 1008 [0.5]	Elementary University Physics II	
13. 2.0 credits in:		2.0
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
COMP 1005 [0.5]	Introduction to Computer Science I	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
14. 1.0 credit in Science Continuation Courses (not ERTH)		1.0
BIOL 2600 [0.5]	Ecology	
BIOL 3601 [0.5]	Ecosystems and Environmental Change	
CHEM 2302 [0.5]	Analytical Chemistry I	
CHEM 2303 [0.5]	Analytical Chemistry II	
CHEM 2800 [0.5]	Foundations for Environmental Chemistry	
CHEM 3305 [0.5]	Advanced Analytical Chemistry Laboratory	
CHEM 3800 [0.5]	The Chemistry of Environmental Pollutants	
GEOG 3103 [0.5]	Watershed Hydrology	
GEOG 3104 [0.5]	Principles of Biogeography	
GEOG 3105 [0.5]	Climate and Atmospheric Change	
GEOG 3106 [0.5]	Aquatic Science and Management	
15. 1.5 credits in:		1.5
ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution	
ERTH 2402 [0.5]	Climate Change: An Earth Sciences Perspective	
PHIL 2380 [0.5]	Introduction to Environmental Ethics	
16. 1.0 credit in approved courses outside the faculty of Science and Engineering and Design		1.0
17. 0.5 credit in free electives.		0.5
Total Credits		**20.5**

Note 1: the thesis (ERTH 4908) or research project (ERTH 4909) is to be undertaken in the field of Environmental Geoscience.

Earth Sciences with Concentration in Finance: Resource Valuation B.Sc. Honours (20.5 credits)

A. Credits included in the Major CGPA (10.0 credits)		
1. 0.5 credit in:		0.5
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
2. 3.0 credits in:		3.0
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2106 [0.5]	Geochemistry	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2407 [0.5]	Structural Geology	
ERTH 2802 [0.5]	Field Geology I	
3. 3.0 credits in:		3.0
ERTH 3004 [0.5]	Igneous Petrology	
ERTH 3204 [0.5]	Mineral Deposits	
ERTH 3205 [0.5]	Physical Hydrogeology	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3405 [0.5]	Geophysical Methods	
ERTH 3703 [0.5]	Isotope Geochemistry and Geochronology	
4. 0.5 credit from:		0.5
ERTH 4006 [0.5]	Field Environmental Geobiology	
ERTH 4209 [0.5]	Mineral Exploration Field Geology	
ERTH 4807 [0.5]	Field Geology II	

6. 2.0 credits in ERTH at the 4000-level		2.0
7. 1.0 credit in:		1.0
ERTH 4908 [1.0]	Honours Thesis	
B. Credits Not Included in the Major CGPA (10.5 credits)		
8. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
9. 1.0 credit in:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
10. 0.5 credit in:		0.5
PHYS 1007 [0.5]	Elementary University Physics I	
11. 0.5 credit from:		0.5
BIOL 1104 [0.5]	Foundations of Biology II	
COMP 1005 [0.5]	Introduction to Computer Science I	
12. 0.5 credit in:		0.5
ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution	
13. 1.0 credit in:		1.0
STAT 2507 [0.5] & STAT 2509 [0.5]	Introduction to Statistical Modeling I Introduction to Statistical Modeling II	
14. 1.5 credit in:		1.5
ECON 1001 [0.5] & ECON 1002 [0.5]	Introduction to Microeconomics Introduction to Macroeconomics	
ECON 2009 [0.5]	Managerial Economics	
15. 3.0 credits in:		3.0
BUSI 1001 [0.5]	Principles of Financial Accounting	
BUSI 1002 [0.5]	Management Accounting	
BUSI 2503 [0.5]	Introduction to Finance	
BUSI 3500 [0.5]	Applied Corporate Finance	
BUSI 3502 [0.5]	Investments	
BUSI 3512 [0.5]	Derivatives	
16. 1.5 credit in:		1.5
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		**20.5**

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

A. Credits Included in the Major CGPA (11.0 credits)		
1. 0.5 credit in:		0.5
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
2. 3.5 credits in:		3.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2106 [0.5]	Geochemistry	
ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2407 [0.5]	Structural Geology	
ERTH 2802 [0.5]	Field Geology I	
3. 3.5 credits in:		3.5
ERTH 2419 [0.5]	On the Origin of Planets	
ERTH 3004 [0.5]	Igneous Petrology	
ERTH 3204 [0.5]	Mineral Deposits	
ERTH 3205 [0.5]	Physical Hydrogeology	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3405 [0.5]	Geophysical Methods	
ERTH 3703 [0.5]	Isotope Geochemistry and Geochronology	
4. 0.5 credit from:		0.5
ERTH 4006 [0.5]	Field Environmental Geobiology	
ERTH 4209 [0.5]	Mineral Exploration Field Geology	
ERTH 4807 [0.5]	Field Geology II	
6. 2.0 credit in ERTH at the 4000-level		2.0
7. 1.0 credit in:		1.0
ERTH 4908 [1.0]	Honours Thesis	
B. Credits Not Included in the Major CGPA (9.0 credits)		
8. 2.0 credits in:		2.0
ECON 1001 [0.5] & ECON 1002 [0.5]	Introduction to Microeconomics Introduction to Macroeconomics	
ECON 2020 [0.5]	Intermediate Microeconomics I: Producers and Market Structure	
ECON 2210 [0.5]	Introductory Statistics for Economics	
ECON 3509 [0.5]	Development Planning and Project Evaluation	
9. 1.5 credit in:		1.5
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 Science Faculty Electives		1.0
10. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
11. 1.0 credit in:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
12. 1.0 credit in:		1.0
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I Elementary University Physics II	
13. 0.5 credit in:		0.5
BIOL 1104 [0.5]	Foundations of Biology II	
14. 0.5 credit in:		0.5
COMP 1005 [0.5]	Introduction to Computer Science I	
15. 0.5 credit in:		0.5
ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution	
Total Credits		**20.0**

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. 0.5 credit in:		0.5
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
2. 2.5 credits in:		2.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2106 [0.5]	Geochemistry	
ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
3. 2.0 credits in:		2.0
ERTH 3111 [0.5]	Vertebrate Evolution: Mammals, Reptiles, and Birds	
ERTH 3112 [0.5]	Vertebrate Evolution: Fish and Amphibians	
ERTH 3113 [0.5]	Geology of Human Origins (See Note, below)	
ERTH 4302 [0.5]	Frozen Earth: Unveiling the Snowball Earth Catastrophe	
4. 0.5 credit from:		0.5
ERTH 4003 [0.5]	Directed Studies in Earth Sciences	
ERTH 4808 [0.5]	Vertebrate Paleontology Field Camp	
5. 1.0 credit in:		1.0
ERTH 4908 [1.0]	Honours Thesis	
6. 4.0 credits from and to include 2.0 credits at the 4000-level:		4.0
BIOL 3104 [0.5]	Molecular Genetics	
BIOL 3202 [0.5]	Principles of Developmental Biology	
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 4102 [0.5]	Molecular Ecology	
BIOL 4103 [0.5]	Population Genetics	
BIOL 4104 [0.5]	Evolutionary Genetics	
BIOL 4207 [0.5]	Advanced Embryology & Developmental Biology	
BIOL 4500 [0.5]	The Biology of Birds	
BIOL 4501 [0.5]	The Taxonomy of Birds	
BIOL 4502 [0.5]	Herpetology	
BIOL 4604 [0.5]	Landscape Ecology	
BIOL 4802 [0.5]	Advanced Animal Behaviour	
ERTH 2401 [0.5]	Dinosaurs	
ERTH 2407 [0.5]	Structural Geology	
ERTH 2419 [0.5]	On the Origin of Planets	
ERTH 4006 [0.5]	Field Environmental Geobiology	
ERTH 4007 [0.5]	Evolutionary Developmental Paleobiology	
GEOG 3102 [0.5]	Geomorphology	
GEOG 3104 [0.5]	Principles of Biogeography	

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

7. 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	
8. 1.0 credit in:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
9. 2.0 credits in:		2.0
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2104 [0.5]	Introductory Genetics	
BIOL 2600 [0.5]	Ecology	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
10. 0.5 credit in Science Faculty Electives (not ERTH or BIOL)		0.5
11. 0.5 credit in:		0.5
ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution	
12. 0.5 credit in:		0.5
ISAP 1000 [0.5]	Seminar in Science	
13. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design		1.5
14. 1.0 credits in free electives.		1.0
Total Credits		**20.0**

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

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

1. 0.5 credit in:		0.5
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
2. 1.0 credit in:		1.0
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1104 [0.5]	Linear Algebra for Engineering or Science	
3. 1.0 credit in:		1.0
PHYS 1001 [0.5] & PHYS 1002 [0.5]	Foundations of Physics I Foundations of Physics II (recommended)	
OR		
PHYS 1003 [0.5] & PHYS 1004 [0.5]	Introductory Mechanics and Thermodynamics Introductory Electromagnetism and Wave Motion	
OR		
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I Elementary University Physics II (with an average grade of B- or higher)	
4. 3.5 credits in:		3.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2106 [0.5]	Geochemistry	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2407 [0.5]	Structural Geology	
ERTH 2419 [0.5]	On the Origin of Planets	
ERTH 2802 [0.5]	Field Geology I	

5. 2.5 credits in:		2.5
ERTH 3004 [0.5]	Igneous Petrology	
ERTH 3204 [0.5]	Mineral Deposits	
ERTH 3205 [0.5]	Physical Hydrogeology	
ERTH 3405 [0.5]	Geophysical Methods	
ERTH 3703 [0.5]	Isotope Geochemistry and Geochronology	
6. 0.5 credit from:		0.5
ERTH 4006 [0.5]	Field Environmental Geobiology	
7. 0.5 credit in:		0.5
ERTH 4815 [0.5]	Natural Hazards in Canada	
8. 1.0 credit from:		1.0
ERTH 4908 [1.0]	Honours Thesis	
B. Credits Not Included in the Major CGPA (9.5 credits)		
9. 0.5 credit from:		0.5
COMP 1005 [0.5]	Introduction to Computer Science I	
COMP 1006 [0.5]	Introduction to Computer Science II	
10. 1.0 credit in:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
11. 1.0 credit in:		1.0
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
12. 0.5 credit in:		0.5
ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution	
13. 4.5 credits from:		4.5
COMP 2402 [0.5]	Abstract Data Types and Algorithms	
COMP 2406 [0.5]	Fundamentals of Web Applications	
ERTH 2312 [0.5]	Paleontology	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 4003 [0.5]	Directed Studies in Earth Sciences	
ERTH 4004 [0.5]	Special Topics in Earth Sciences	
ERTH 4107 [0.5]	Geotechnical Mechanics	
ERTH 4206 [0.5]	Contaminant and Remediation Hydrogeology	
ERTH 4209 [0.5]	Mineral Exploration Field Geology	
ERTH 4305 [0.5]	Advanced Sedimentary Geology and Earth History	
ERTH 4507 [0.5]	Advanced Petrology	
ERTH 4801 [0.5]	Physics of the Earth	
ERTH 4807 [0.5]	Field Geology II	
MATH 2004 [0.5]	Multivariable Calculus for Engineering or Physics	
MATH 2107 [0.5]	Linear Algebra II	
MATH 3107 [0.5]	Linear Algebra III	
MATH 3705 [0.5]	Mathematical Methods I	
MATH 3800 [0.5]	Mathematical Modeling and Computational Methods	
PHYS 2202 [0.5]	Wave Motion and Optics	
PHYS 2305 [0.5]	Electricity and Magnetism	
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	
STAT 3503 [0.5]	Regression Analysis	
STAT 3507 [0.5]	Sampling Methodology	
14. 0.5 credit in:		0.5
ISAP 1000 [0.5]	Seminar in Science	
or approved course outside the Faculties of Science and Engineering and Design		
15. 1.5 credits in free electives.		1.5
Total Credits		**20.0**

Earth Sciences
B.Sc. Major (20.0 credits)

A. Credits Included in the Major CGPA (11.0 credits)		
1. 0.5 credit in:		0.5
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
2. 4.5 credits in:		4.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2106 [0.5]	Geochemistry	
ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2407 [0.5]	Structural Geology	
ERTH 2419 [0.5]	On the Origin of Planets	
ERTH 2802 [0.5]	Field Geology I	
ERTH 3004 [0.5]	Igneous Petrology	
3. 3.0 credit from:		3.0
ERTH 3111 [0.5]	Vertebrate Evolution: Mammals, Reptiles, and Birds	
ERTH 3112 [0.5]	Vertebrate Evolution: Fish and Amphibians	
ERTH 3204 [0.5]	Mineral Deposits	
ERTH 3205 [0.5]	Physical Hydrogeology	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3405 [0.5]	Geophysical Methods	
ERTH 3703 [0.5]	Isotope Geochemistry and Geochronology	
4. 0.5 credits from:		0.5
ERTH 4006 [0.5]	Field Environmental Geobiology	
ERTH 4209 [0.5]	Mineral Exploration Field Geology	
ERTH 4807 [0.5]	Field Geology II	
5. 2.5 credits in ERTH at the 4000-level		2.5
B. Credits Not Included in the Major CGPA (9.0 credits)		
6. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
7. 1.0 credit in:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
8. 1.0 credit in:		1.0
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I Elementary University Physics II	
9. 0.5 credit in:		0.5
BIOL 1104 [0.5]	Foundations of Biology II	
10. 0.5 credit in:		0.5

	COMP 1005 [0.5]	Introduction to Computer Science I
11. 0.5 credit in:		0.5
	STAT 2507 [0.5]	Introduction to Statistical Modeling I
12. 0.5 credit in:		0.5
	ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution
13. 1.0 credit in Science Continuation Courses (not ERTH)		1.0
14. 0.5 credit in:		0.5
	ISAP 1000 [0.5]	Seminar in Science (or approved courses outside the Faculties of Science and Engineering and Design)
15. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design		1.5
16. 1.0 credits in free electives.		1.0
Total Credits		**20.0**

Note:

1. 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. (15.0 credits)

A. Credits Included in the Major CGPA (8.0 credits)		
1. 0.5 credit in:		0.5
	ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years
2. 4.0 credits in:		4.0
	ERTH 2102 [0.5]	Mineralogy to Petrology
	ERTH 2105 [0.5]	Geodynamics
	ERTH 2106 [0.5]	Geochemistry
	ERTH 2312 [0.5]	Paleontology
	ERTH 2314 [0.5]	Sedimentation and Stratigraphy
	ERTH 2407 [0.5]	Structural Geology
	ERTH 2419 [0.5]	On the Origin of Planets
	ERTH 2802 [0.5]	Field Geology I
3. 3.5 credits in:		3.5
	ERTH 3004 [0.5]	Igneous Petrology
	ERTH 3111 [0.5]	Vertebrate Evolution: Mammals, Reptiles, and Birds
	ERTH 3112 [0.5]	Vertebrate Evolution: Fish and Amphibians
	ERTH 3204 [0.5]	Mineral Deposits
	ERTH 3205 [0.5]	Physical Hydrogeology
	ERTH 3207 [0.5]	Metamorphic Petrology and Processes
	ERTH 3405 [0.5]	Geophysical Methods
	ERTH 3703 [0.5]	Isotope Geochemistry and Geochronology
B. Credits Not Included in the Major CGPA (7.0 credits)		
4. 1.0 credit in:		1.0
	MATH 1007 [0.5]	Elementary Calculus I
	MATH 1107 [0.5]	Linear Algebra I
5. 1.0 credit in:		1.0
	CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II
6. 1.0 credit from:		1.0
	PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I Elementary University Physics II
	BIOL 1104 [0.5] & PHYS 1007 [0.5]	Foundations of Biology II Elementary University Physics I
7. 0.5 credit in:		0.5
	ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution
8. 0.5 credit in Science Continuation course (not ERTH)		0.5
9. 0.5 credit in:		0.5
	ISAP 1000 [0.5]	Seminar in Science (or approved course outside the faculties of Science and Engineering and Design)
10. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design		1.5
11. 1.0 credit in 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 (13.0 credits)		
1. 1.0 credit in:		1.0
	ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years
	GEOG 1010 [0.5]	Global Environmental Systems
2. 1.0 credit in:		1.0
	GEOG 2013 [0.5]	Weather and Water
	GEOG 2014 [0.5]	The Earth's Surface
3. 2.5 credits in:		2.5
	ERTH 2102 [0.5]	Mineralogy to Petrology
	ERTH 2106 [0.5]	Geochemistry
	ERTH 2312 [0.5]	Paleontology
	ERTH 2314 [0.5]	Sedimentation and Stratigraphy
	ERTH 2407 [0.5]	Structural Geology
4. 0.5 credit in:		0.5
	ERTH 2802 [0.5]	Field Geology I
5. 1.0 credits in:		1.0
	ERTH 3004 [0.5]	Igneous Petrology
	ERTH 3405 [0.5]	Geophysical Methods
6. 0.5 credit from:		0.5
	ERTH 3205 [0.5]	Physical Hydrogeology
	GEOG 3103 [0.5]	Watershed Hydrology
7. 1.0 credit in:		1.0
	ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution
	GEOM 3002 [0.5]	Introduction to Remote Sensing
8. 2.0 credits from:		2.0
	GEOG 3003 [0.5]	Quantitative Geography
	GEOG 3010 [0.5]	Field Methods in Physical Geography
	GEOG 3102 [0.5]	Geomorphology
	GEOG 3104 [0.5]	Principles of Biogeography
	GEOG 3105 [0.5]	Climate and Atmospheric Change
	GEOG 3106 [0.5]	Aquatic Science and Management
	GEOG 3108 [0.5]	Soil Properties
9. 0.5 credit in:		0.5
	ERTH 4302 [0.5]	Frozen Earth: Unveiling the Snowball Earth Catastrophe

10. 1.0 credit in Science Geography or Geomatics courses at the 2000-level or above		1.0
11. 1.0 credit in Earth Sciences, Science Geography or Geomatics courses at the 4000-level		1.0
12. 1.0 credit from:		1.0
ERTH 4908 [1.0]	Honours Thesis	
OR		
GEOG 4005 [0.5]	Directed Studies in Geography	
and 0.5 credit in ERTH, GEOG or GEOM at the 4000-level		
OR		
GEOG 4906 [1.0]	Honours Research Project	
B. Credits Not Included in the Major CGPA (7.0 credits)		
13. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
14. 1.0 credit in:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
15. 1.0 credit in:		1.0
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I Elementary University Physics II	
16. 0.5 credit from:		0.5
GEOG 2006 [0.5]	Introduction to Quantitative Research	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
17. 0.5 credit in:		0.5
COMP 1005 [0.5]	Introduction to Computer Science I	
18. 0.5 credit in approved electives (see list below)		0.5
19. 0.5 credit in:		0.5
ISAP 1000 [0.5]	Seminar in Science (or approved course outside of the faculties of Science and Engineering and Design)	
20. 1.5 credits in approved courses outside of the faculties of Science and Engineering and Design		1.5
21. 0.5 credit in free elective		0.5
Total Credits		**20.0**

Approved Electives - B.Sc. Earth Sciences and Physical Geography

Biology	
BIOL 1103 [0.5]	Foundations of Biology I
BIOL 1104 [0.5]	Foundations of Biology II
Computer Science	
COMP 1006 [0.5]	Introduction to Computer Science II
Chemistry	
CHEM 2103 [0.5]	Physical Chemistry I
CHEM 2203 [0.5]	Organic Chemistry I
CHEM 2207 [0.5]	Introduction to Organic Chemistry I
CHEM 2501 [0.5]	Introduction to Inorganic and Bioinorganic Chemistry
Mathematics	
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics
MATH 2007 [0.5]	Elementary Calculus II
MATH 2107 [0.5]	Linear Algebra II
Physics	
PHYS 2202 [0.5]	Wave Motion and Optics
Statistics	
STAT 2509 [0.5]	Introduction to Statistical Modeling II

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

A. Credits Included in the Major CGPA (12.0 credits)		
1. 1.5 credits in:		1.5
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. 0.5 credit in:		0.5
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
3. 0.5 credit from:		0.5
BIOL 2600 [0.5]	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		3.5
5. 3.5 credits in:		3.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2106 [0.5]	Geochemistry	
ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 3111 [0.5]	Vertebrate Evolution: Mammals, Reptiles, and Birds	
ERTH 3112 [0.5]	Vertebrate Evolution: Fish and Amphibians	
ERTH 3113 [0.5]	Geology of Human Origins	
6. 0.5 credit in:		0.5
ERTH 4302 [0.5]	Frozen Earth: Unveiling the Snowball Earth Catastrophe	
7. 1.0 credit in ERTH at the 4000-level		1.0
8. 1.0 credit from:		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	
B. Credits Not Included in the Major CGPA (8.0 credits)		
9. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
10. 1.0 credit in:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
11. 1.0 credit in:		1.0
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I Elementary University Physics II	
12. 0.5 credit in:		0.5
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
13. 0.5 credit in:		0.5
COMP 1005 [0.5]	Introduction to Computer Science I	
14. 1.0 credit in Science Continuation courses		1.0
15. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include ISAP 1000)		2.0

16. 1.0 credit in free electives		1.0
Total Credits		**20.0**

Chemistry 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:		4.0
CHEM 1011 [0.5]	Enriched General Chemistry 1	
CHEM 1012 [0.5]	Enriched General Chemistry 2	
CHEM 2103 [0.5]	Physical Chemistry I	
CHEM 2104 [0.5]	Physical Chemistry II	
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 3503 [0.5]	Inorganic Chemistry I	
2. 1.0 credit in CHEM at the 4000-level		1.0
3. 0.5 credit in:		0.5
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
4. 3.5 credits in:		3.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2106 [0.5]	Geochemistry	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2407 [0.5]	Structural Geology	
ERTH 2419 [0.5]	On the Origin of Planets	
ERTH 2802 [0.5]	Field Geology I	
5. 2.0 credits in:		2.0
ERTH 3004 [0.5]	Igneous Petrology	
ERTH 3204 [0.5]	Mineral Deposits	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3703 [0.5]	Isotope Geochemistry and Geochronology	
6. 0.5 credit from:		0.5
ERTH 4006 [0.5]	Field Environmental Geobiology	
ERTH 4209 [0.5]	Mineral Exploration Field Geology	
ERTH 4807 [0.5]	Field Geology II	
7. 1.0 credit in ERTH at the 4000-level		1.0
8. 1.0 credit from:		1.0
CHEM 4907 [1.0]	Honours Essay and Research Proposal	
CHEM 4908 [1.0]	Research Project and Seminar	
ERTH 4908 [1.0]	Honours Thesis	
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	
10. 0.5 credit from:		0.5
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
MATH 2007 [0.5]	Elementary Calculus II	
11. 0.5 credit in:		0.5
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
12. 0.5 credit in:		0.5
ERTH 2004 [0.5]	Maps, Satellites and the Geospatial Revolution	
13. 1.0 credit from:		1.0
PHYS 1003 [0.5] & PHYS 1004 [0.5]	Introductory Mechanics and Thermodynamics Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I Elementary University Physics II	
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
ISAP 1000 [0.5]	Seminar in Science	
17. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design		1.5
Total Credits		**20.0**

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

The Minor is available to students registered in degree programs other than those offered by the Department of Earth Sciences.

Students are required to present a Minor CGPA of 4.00 or higher at graduation in order to be awarded a Minor in Earth Sciences: Earth Resources and Processes.

Requirements		
1. 0.5 credit in:		0.5
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years	
2. 1.0 credit from:		1.0
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2316 [0.5]	Paleoecology	
3. 1.5 credit in ERTH at the 2000-level or higher		1.5
4. 1.0 credit in ERTH at the 3000-level or higher		1.0
Total Credits		**4.0**

Regulations

In addition to program requirements described here, 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.

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

B.Sc. Regulations

The regulations presented in this section apply to all Bachelor of Science programs. In addition to the requirements presented here, students must satisfy the University regulations common to all undergraduate students including the process of Academic Continuation Evaluation (see the *Academic Regulations of the University* section of this Calendar).

Breadth Requirement for the B.Sc.

Students in a Bachelor of Science program must present the following credits at graduation:

1. 2.0 credits in Science Continuation courses not in the major discipline; **students completing a double major are considered to have completed this requirement providing they have 2.0 credits in Science Continuation courses in each of the two majors;**
2. 2.0 credits in courses outside of the faculties of Science and Engineering and Design (may include ISAP 1000)

In most cases, the requirements for individual B.Sc. programs, as stated in this Calendar, contain these requirements, explicitly or implicitly.

Students admitted to B.Sc. programs by transfer from another institution must present at graduation (whether taken at Carleton or elsewhere):

1. 2.0 credits in courses outside of the faculties of Science and Engineering and Design (may include ISAP 1000) if the student received fewer than 10.0 transfer credits; or,
2. 1.0 credit in courses outside of the faculties of Science and Engineering and Design (may include ISAP 1000) if the student received 10.0 or more transfer credits.

Declared and Undeclared Students

Degree students are considered "Undeclared" if they have been admitted to a degree, but have not yet selected and been accepted into a program within that degree. The status "Undeclared" is available only in the B.A. and B.Sc. degrees. Undeclared students must apply to enter a program upon or before completing 3.5 credits.

Change of Program within the B.Sc. Degree

To transfer to a program within the B.Sc. degree, applicants must normally be *Eligible to Continue* (EC) in the new program, by meeting the CGPA thresholds described in Section 3.1.9 of the *Academic Regulations of the University.*

Applications to declare or change programs within the B.Sc. degree must be made online through Carleton Central by completing a Change of Program Elements (COPE) application form within the published deadlines. Acceptance into a program, or into a program element or option, is subject to any enrolment limitations, and/or specific program, program element or option requirements as published in the relevant Calendar entry.

Minors, Concentrations, and Specializations

Students may add a Minor, Concentration, or Specialization by completing a Change of Program Elements (COPE) application form online through Carleton Central. Acceptance into a Minor, Concentration, or Specialization normally requires that the student be *Eligible to Continue* (EC) and is meeting the minimum CGPAs described in Section 3.1.9 of the *Academic Regulations of the University*, as well as being subject to any specific requirements of the intended Minor, Concentration, or Specialization as published in the relevant Calendar entry.

Experimental Science Requirement

Students in a B.Sc. degree program must present at graduation at least two full credits of Experimental Science chosen from two different departments or institutes from the list below:

Approved Experimental Science Courses

Biochemistry	
BIOC 2200 [0.5]	Cellular Biochemistry
BIOC 4001 [0.5]	Methods in Biochemistry
BIOC 4201 [0.5]	Advanced Cell Culture and Tissue Engineering
Biology	
BIOL 1103 [0.5]	Foundations of Biology I
BIOL 1104 [0.5]	Foundations of Biology II
BIOL 2001 [0.5]	Animals: Form and Function
BIOL 2002 [0.5]	Plants: Form and Function
BIOL 2104 [0.5]	Introductory Genetics
BIOL 2200 [0.5]	Cellular Biochemistry
BIOL 2600 [0.5]	Ecology
Chemistry	
CHEM 1001 [0.5]	General Chemistry I
CHEM 1002 [0.5]	General Chemistry II
CHEM 2103 [0.5]	Physical Chemistry I
CHEM 2203 [0.5]	Organic Chemistry I
CHEM 2204 [0.5]	Organic Chemistry II
CHEM 2302 [0.5]	Analytical Chemistry I
CHEM 2303 [0.5]	Analytical Chemistry II
CHEM 2800 [0.5]	Foundations for Environmental Chemistry
Earth Sciences	
ERTH 1002 [0.5]	The Earth and Life Odyssey: A Journey Through Billions of Years
ERTH 2102 [0.5]	Mineralogy to Petrology
ERTH 2404 [0.5]	Engineering Geoscience
ERTH 2802 [0.5]	Field Geology I
ERTH 3111 [0.5]	Vertebrate Evolution: Mammals, Reptiles, and Birds
ERTH 3112 [0.5]	Vertebrate Evolution: Fish and Amphibians
ERTH 3204 [0.5]	Mineral Deposits
ERTH 3205 [0.5]	Physical Hydrogeology
Food Sciences	
FOOD 3001 [0.5]	Food Chemistry
FOOD 3002 [0.5]	Food Analysis
FOOD 3005 [0.5]	Food Microbiology
Geography	
GEOG 1010 [0.5]	Global Environmental Systems
GEOG 3108 [0.5]	Soil Properties
Neuroscience	
NEUR 3206 [0.5]	Sensory and Motor Neuroscience
NEUR 3207 [0.5]	Systems Neuroscience
NEUR 4600 [0.5]	Advanced Lab in Neuroanatomy
Physics	
PHYS 1001 [0.5]	Foundations of Physics I
PHYS 1002 [0.5]	Foundations of Physics II

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
PHYS 2202 [0.5]	Wave Motion and Optics
PHYS 2604 [0.5]	Modern Physics I
PHYS 3007 [0.5]	Third Year Physics Laboratory: Selected Experiments and Seminars
PHYS 3606 [0.5]	Modern Physics II
PHYS 3608 [0.5]	Modern Applied Physics

Course Categories for B.Sc. Programs

Science Geography Courses

GEOG 1010 [0.5]	Global Environmental Systems
GEOG 2006 [0.5]	Introduction to Quantitative Research
GEOG 2013 [0.5]	Weather and Water
GEOG 2014 [0.5]	The Earth's Surface
GEOG 3003 [0.5]	Quantitative Geography
GEOG 3010 [0.5]	Field Methods in Physical Geography
GEOG 3102 [0.5]	Geomorphology
GEOG 3103 [0.5]	Watershed Hydrology
GEOG 3104 [0.5]	Principles of Biogeography
GEOG 3105 [0.5]	Climate and Atmospheric Change
GEOG 3106 [0.5]	Aquatic Science and Management
GEOG 3108 [0.5]	Soil Properties
GEOG 4000 [0.5]	Field Studies
GEOG 4005 [0.5]	Directed Studies in Geography
GEOG 4013 [0.5]	Cold Region Hydrology
GEOG 4017 [0.5]	Global Biogeochemical Cycles
GEOG 4101 [0.5]	Two Million Years of Environmental Change
GEOG 4103 [0.5]	Water Resources Engineering
GEOG 4104 [0.5]	Microclimatology
GEOG 4108 [0.5]	Permafrost

Science Psychology Courses

PSYC 2001 [0.5]	Introduction to Research Methods in Psychology
PSYC 2002 [0.5]	Introduction to Statistics in Psychology
PSYC 2700 [0.5]	Introduction to Cognitive Psychology
PSYC 3000 [1.0]	Design and Analysis in Psychological Research
PSYC 3506 [0.5]	Cognitive Development
PSYC 3700 [1.0]	Cognition (Honours Seminar)
PSYC 3702 [0.5]	Perception
PSYC 2307 [0.5]	Human Neuropsychology I
PSYC 3307 [0.5]	Human Neuropsychology II

Science Continuation Courses

A course at the 2000 level or above may be used as a Science Continuation credit in a B.Sc. program if it is not in the student's major discipline, and is chosen from the following:

- BIOC (Biochemistry)
- BIOL (Biology) Biochemistry students may use BIOL 2005 only as a free elective.
- CHEM (Chemistry)
- COMP (Computer Science) A maximum of two half-credits at the 1000-level in COMP, excluding COMP 1001 may be used as Science Continuation credits.
- ERTH (Earth Sciences), except ERTH 2415 which may be used only as a free elective for any B.Sc. program. Students in Earth Sciences programs may use ERTH 2401, ERTH 2402, and ERTH 2403 only as free electives.
- Engineering. Students wishing to register in Engineering courses must obtain the permission of the Faculty of Engineering and Design.
- ENSC (Environmental Science)
- FOOD (Food Science and Nutrition)
- GEOM (Geomatics)
- HLTH (Health Sciences)
- ISAP (Interdisciplinary Science Practice)
- MATH (Mathematics)
- NEUR (Neuroscience)
- PHYS (Physics), except PHYS 2903
- Science Geography Courses (see list above)
- Science Psychology Courses (see list above)
- STAT (Statistics)
- TSES (Technology, Society, Environment) except TSES 2305. Biology students may use these courses only as free electives. Integrated Science and Environmental Science students may include these courses in their programs but may not count them as part of the Science Sequence.

Science Faculty Electives

Science Faculty Electives are courses at the 1000-4000 level chosen from:

- BIOC (Biochemistry)
- BIOL (Biology) Biology & Biochemistry students may use BIOL 1010 and BIOL 2005 only as free electives
- CHEM (Chemistry) except CHEM 1003, CHEM 1004 and CHEM 1007
- COMP (Computer Science) except COMP 1001
- ERTH (Earth Sciences) except ERTH 1004 and ERTH 2415. Earth Sciences students may use ERTH 2401, ERTH 2402 and ERTH 2403 only as free electives.
- Engineering
- ENSC 2001
- FOOD (Food Science and Nutrition)
- GEOM (Geomatics)
- HLTH (Health Science)
- ISAP (Interdisciplinary Science Practice)
- MATH (Mathematics)
- NEUR (Neuroscience)
- PHYS (Physics) except PHYS 1901, PHYS 1902, PHYS 1905, PHYS 2903
- Science Geography (see list above)
- Science Psychology (see list above)
- STAT (Statistics)

TSES (Technology, Society, Environment) Biology students may use these courses only as free electives.

Advanced Science Faculty Electives

Advanced Science Faculty Electives are courses at the 2000-4000 level chosen from the Science Faculty Electives list above.

Approved Courses Outside the Faculties of Science and Engineering and Design (may include ISAP 1000)

All courses offered by the Faculty of Arts and Social Sciences, the Faculty of Public and Global Affairs, and the Sprott School of Business are approved as Arts or Social Sciences courses EXCEPT FOR: All Science Geography courses (see list above), all Geomatics (GEOM) courses, all Science Psychology courses (see list above). ISAP 1000 may be used as an Approved Course Outside the Faculties of Science and Engineering and Design.

Free Electives

Any course is allowable as a Free Elective providing it is not prohibited (see below). Students are expected to comply with prerequisite requirements and enrolment restrictions for all courses as published in this Calendar.

Courses Allowable Only as Free Electives in any B.Sc. Program

BIOL 4810 [0.5]	Education Research in Undergraduate Science
CHEM 1003 [0.5]	The Chemistry of Food, Health and Drugs
CHEM 1004 [0.5]	Drugs and the Human Body
CHEM 1007 [0.5]	Chemistry of Art and Artifacts
ERTH 1004 [0.5]	Earth's Epic Tale: A Story Across Billions of Years
ERTH 2415 [0.5]	Natural Disasters
ISCI 1001 [0.5]	Introduction to the Environment
ISCI 2000 [0.5]	Natural Laws
ISCI 2002 [0.5]	Human Impacts on the Environment
PHYS 1901 [0.5]	Planetary Astronomy
PHYS 1902 [0.5]	From our Star to the Cosmos
PHYS 1905 [0.5]	Physics Behind Everyday Life
PHYS 2903 [0.5]	Physics Towards the Future

Prohibited Courses

The following courses are not acceptable for credit in any B.Sc. program:

COMP 1001 [0.5]	Introduction to Computational Thinking for Arts and Social Science Students
MATH 1009 [0.5]	Mathematics for Business
MATH 1119 [0.5]	Linear Algebra: with Applications to Business
MATH 1401 [0.5]	Elementary Mathematics for Economics I
MATH 1402 [0.5]	Elementary Mathematics for Economics II

all 0000-level courses

Co-operative Education

For more information about how to apply for the Co-op program and how the Co-op program works please visit the Co-op website.

All students participating in the Co-op program are governed by the Undergraduate Co-operative Education Policy.

Undergraduate Co-operative Education Policy

Admission Requirements

Students can apply to Co-op in one of two ways: directly from high school, or after beginning a degree program at Carleton.

If a student applies to a degree program with a Co-op option from high school, their university grades will be reviewed two terms to one year prior to their first work term to ensure they meet the academic requirements after their first or second year of study. The time at which the evaluation takes place depends on the program of study. Students will automatically receive an admission decision via their Carleton email account.

Students who did not request Co-op at the time they applied to Carleton can request Co-op after they begin their university studies. To view application instructions and deadlines, please visit carleton.ca/co-op.

To be admitted to Co-op, a student must successfully complete 5.0 or more credits that count towards their degree, meet the minimum CGPA requirement(s) for the student's Co-op option, and fulfil any specified course prerequisites. To see the unique admission and continuation requirements for each Co-op option, please refer to the specific degree programs listed in the Undergraduate Calendar.

Participation Requirements

Co-op Participation Agreement

All students must adhere to the policies found within the Co-op Participation Agreement.

COOP 1000

Once a student has been admitted to the Co-op Program, they will be given access to register in COOP 1000. This zero-credit online course must be completed at least two terms prior to the student's first work term.

Communication with the Co-op Office

Students must maintain contact with the Co-op Office during their job search and while on a work term. All email communication will be conducted via the students' Carleton email account.

Employment

Although every effort is made to ensure a sufficient number of job postings for all Co-op students, no guarantee of employment can be made. The Co-op job search process is competitive, and success is dependent upon factors such as current market conditions, academic performance, skills, motivation, and level of commitment to the job search. It is the student's responsibility to apply for positions via the Co-op job board in addition to actively conducting a self-directed job search. Students who do not obtain a co-op work term are expected to continue with their academic studies. It should be noted that hiring priority for positions within the Federal Government of Canada is given to Canadian citizens.

Registration

- Students must be registered as full-time during all fall and winter study terms beginning the term in which they enroll in COOP 1000.
- Students will be registered in a Co-op Work Term course while at work. This course does not carry academic course credit, but is noted on academic transcripts.
- Students may register in a 0.5 credit during a work term, provided the course is offered during the evening or is offered asynchronously online.
- Students must have at least one term of full-time studies left to complete following their final co-op work term. Students cannot end their degree on a work term.

Work Term Assessment and Evaluation

Work Term Evaluation

Employers are responsible for submitting to Carleton University final performance evaluations for their Co-op students at the end of their work terms.

Work Term Assessment

In order to successfully complete the co-op work term, students must receive a Satisfactory (SAT) grade on their Co-op Work Term Report, which they must submit at the completion of each four-month work term.

Graduation with the Co-op Designation

In order to graduate with the Co-op Designation, students must satisfy all requirements of the degree program in addition to the successful completion of three or four work terms (the number is dependent upon the student's academic program). Students found in violation of the Co-op Participation Agreement may have the Co-op Designation withheld.

Note: Participation in the co-op option will add up to one additional year for a student to complete their degree program.

Voluntary Withdrawal from the Co-op Option

Students who are currently on a co-op work term or who have already committed to a co-op work term either verbally or in writing may not leave the position and/or withdraw from the co-op option until they have completed the work term and all related requirements.

Involuntary or Required Withdrawal from the Co-op Option

Students may be removed from the Co-op Program for any of the following reasons:

1. Failure to achieve a grade of SAT in COOP 1000;
2. Failure to attend all interviews for positions to which the student has applied;
3. Declining more than one job offer during the job search;
4. Reneging on a co-op position that the student has accepted either verbally or in writing;
5. Continuing a job search after accepting a co-op position;
6. Dismissal from a work term by the co-op employer;
7. Leaving a work term without approval from the Co-op Management Team;
8. Receipt of an unsatisfactory work term evaluation;
9. Receiving a grade of UNS on the work term report.

International Students

All international students are required to possess a Co-op Work Permit issued by Immigration, Refugees and Citizenship Canada before they can begin working. The Co-operative Education Office will provide students with a letter of support to accompany their Co-op Work Permit application. Students are advised to discuss the application process and application requirements with the International Student Services Office.

Co-op Fees

All participating Co-op students are required to pay Co-op fees. For full details, please see the Co-op website.

B.Sc. Honours Earth Sciences: Co-op Admission and Continuation Requirements

- Maintain full-time status in each study term;
- Be eligible to work in Canada (for off-campus work);
- Have successfully completed COOP 1000 .

In addition to the following:

1. Registered as a full-time student in the B.Sc. Honours Earth Sciences program;
2. Successfully completed 5.0 or more credits;
3. Obtained an Overall CGPA of at least 6.50 and a Major CGPA of at least 8.00. These CGPAs must be maintained throughout the duration of the degree.

B.Sc. Honours Earth Sciences students must successfully complete three (3) work terms to obtain the Co-op Designation.

Work Term Course: ERTH 3999
Work/Study Pattern:

Year 1		Year 2		Year 3		Year 4		Year 5	
Term	**Pattern**	**Term**	**Pattern**	**Term**	**Pattern**	**Term**	**Pattern**	**Term**	**Pattern**
Fall	S	Fall	S	Fall	S	Fall	W	Fall	S
Winter	S	Winter	S	Winter	S	Winter	W	Winter	S
Summer		Summer	W	Summer	W	Summer	W		

Legend
S: Study
W: Work

Admissions Information

Admission Requirements are for the 2025-26 year only, and are based on the Ontario High School System. Holding the minimum admission requirements only establishes eligibility for consideration. The cut-off averages for admission may be considerably higher than the minimum. See also the **General Admission and Procedures** section of this Calendar. An overall average of at least 70% is normally required to be considered for admission. Some programs may also require specific course prerequisites and prerequisite averages and/or supplementary admission portfolios. Higher averages are required for admission to programs for which the

demand for places by qualified applicants exceeds the number of places available. The overall average required for admission is determined each year on a program by program basis. Consult admissions.carleton.ca for further details.

Note: Courses listed as *recommended* are not mandatory for admission. Students who do not follow the recommendations will not be disadvantaged in the admission process.

Admissions Information

Admission requirements are based on the Ontario High School System. Prospective students can view the admission requirements through the Admissions website at admissions.carleton.ca. The overall average required for admission is determined each year on a program-by-program basis. Holding the minimum admission requirements only establishes eligibility for consideration; higher averages are required for admission to programs for which the demand for places by qualified applicants exceeds the number of places available. All programs have limited enrolment and admission is not guaranteed. Some programs may also require specific course prerequisites and prerequisite averages and/or supplementary admission portfolios. Consult admissions.carleton.ca for further details.

Note: If a course is listed as *recommended*, it is not mandatory for admission. Students who do not follow the recommendations will not be disadvantaged in the admission process.

Degrees

- B.Sc. (Honours)
- B.Sc. (Major)
- B.Sc.

Admission Requirements

B. Sc. Honours

First Year

The Ontario Secondary School Diploma (OSSD) or equivalent including a minimum of six 4U or M courses. For most programs including Biochemistry, Bioinformatics, Biotechnology, Chemistry, Combined Honours in Biology and Physics, Chemistry and Physics, Computational Biochemistry, Food Science, Nanoscience, Neuroscience and Biology, Neuroscience and Mental Health, and Psychology, the six 4U or M courses must include Advanced Functions, and two of Biology, Chemistry, Earth and Space Sciences, or Physics. (Calculus and Vectors is strongly recommended).

Specific Honours Admission Requirements
For the Honours programs in Earth Sciences, Environmental Science, Geomatics, Integrated Science, and Physical Geography, Calculus and Vectors may be substituted for Advanced Functions.

For the Honours programs in Physics and Applied Physics, and for double Honours in Mathematics and Physics, Calculus and Vectors is required in addition to Advanced Functions and one of 4U Physics, Chemistry, Biology, or Earth and Space Sciences. For all programs in Physics, 4U Physics is strongly recommended.

For Honours in Psychology, a 4U course in English is recommended.

For Honours in Environmental Science, a 4U course in Biology and Chemistry is recommended.

Advanced Standing

Applications for admission beyond first year will be assessed on their merits. Applicants must normally be *Eligible to Continue* in their year level, in addition to meeting the CGPA thresholds described in Section 3.1.9 of the Academic Regulations of the University. Advanced standing will be granted only for those subjects deemed appropriate for the program and stream selected.

B.Sc. Major and B.Sc.

First Year

The Ontario Secondary School Diploma (OSSD) or equivalent including a minimum of six 4U or M courses. The six 4U or M courses must include Advanced Functions and two of Calculus and Vectors, Biology, Chemistry, Earth and Space Science, or Physics (Calculus and Vectors is strongly recommended). For the B.Sc. Major in Physics, 4U Physics is strongly recommended.

Advanced Standing

Applications for admission beyond first year will be assessed on their merits. Applicants must normally be *Eligible to Continue* (EC) in their year level. Advanced standing will be granted only for those subjects deemed appropriate for the program and stream selected.

Co-op Option

Direct Admission to the First Year of the Co-op Option
Applicants must:

1. meet the required overall admission cut-off average and prerequisite course average. These averages may be higher than the stated minimum requirements;
2. be registered as a full-time student in the Bachelor of Science Honours program;
3. be eligible to work in Canada (for off-campus work placements).

Note that meeting the above requirements only establishes eligibility for admission to the program. The prevailing job market may limit enrolment in the co-op option.

Note: continuation requirements for students previously admitted to the co-op option and admission requirements for the co-op option after beginning the program are described in the Co-operative Education Regulations section of this Calendar.

Earth Sciences (ERTH) Courses

ERTH 1002 [0.5 credit]
The Earth and Life Odyssey: A Journey Through Billions of Years
Embark on a thrilling journey through Earth's epic history! Discover the groundbreaking events and powerful forces that shaped our planet, revealing the dramatic story behind the world we live in today.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 1004, ERTH 1006 (no longer offered), ERTH 1009 (no longer offered), ERTH 1010 (no longer offered) and ERTH 1011 (no longer offered).
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 per week, and a field excursion.

ERTH 1004 [0.5 credit]
Earth's Epic Tale: A Story Across Billions of Years
Embark on a thrilling journey through Earth's epic history! Discover the groundbreaking events and powerful forces that shaped our planet, revealing the dramatic story behind the world we live in today.
Precludes additional credit for ERTH 1002, ERTH 1006 (no longer offered), ERTH 1009 (no longer offered), ERTH 1010 (no longer offered) and ERTH 1011 (no longer offered).
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 except the Bachelor of Computer Science.
Lectures three hours a week.

ERTH 2004 [0.5 credit]
Maps, Satellites and the Geospatial Revolution
Introduction to the creation and use of maps using a variety of geospatial tools to better understand and resolve physical, social and environmental problems. Overview of geomatics (cartography and map design, geographic information systems, GPS, remote sensing).
Also listed as GEOM 1004.
Precludes additional credit for GEOM 2004 (no longer offered).
Lectures and laboratory, four hours a week.

ERTH 2012 [0.5 credit]
Planet Hollywood
Earth Science concepts and content portrayed in Hollywood films are sometimes accurate but more frequently misrepresented. This course will examine popular Hollywood films to critically evaluate the Earth Science concepts and content that they present and directly compare them to the actual science.
Online modules, bi-weekly film screenings and discussions four hours per 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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3202 (no longer offered).
Prerequisite(s): ERTH 1002, CHEM 1001, and CHEM 1002.
Lectures two hours a week and laboratory three hours a week.

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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3805 (no longer offered).
Prerequisite(s): ERTH 1002 or GEOG 2013.
Lectures two hours a week and a laboratory three hours a week.

ERTH 2106 [0.5 credit]
Geochemistry
This course looks at geochemical processes from deep Earth to surface environments, and the use of geochemical pathways in order to better understand the Earth’s history.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3003 (no longer offered).
Prerequisite(s): ERTH 1002, CHEM 1001 and CHEM 1002.
Lecture 1.5 hours per week, a laboratory three hours per week.

ERTH 2312 [0.5 credit]
Paleontology
Introduction to macrofossil and microfossil groups, their paleoenvironmental significance, and principles of evolutionary paleoecology.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 2316, GEOL 2301 (no longer offered) and GEOL 2306 (no longer offered).
Prerequisite(s): ERTH 1002 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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 2318 (no longer offered).
Prerequisite(s): ERTH 1002 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.
Lectures two 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.
Precludes additional credit for ERTH 2422.
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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 2414 (no longer offered), ERTH 1006 (no longer offered) and ERTH 1010 (no longer offered).
Prerequisite(s): completion of first year of any B.Eng. program.
Lectures three hours a week and a laboratory three hours a week.

ERTH 2407 [0.5 credit]
Structural Geology
Structures and deformation of earth materials. Topics include stress, strain, folding and faulting.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3806 (no longer offered).
Prerequisite(s): ERTH 1002 and ERTH 2102.
Lecture three hours a week and a laboratory 3 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 2419 [0.5 credit]
On the Origin of Planets
Origin and evolution of all planetary objects in the solar system. Topics include the geology of comets, asteroids, the terrestrial planets and rocky moons, Earth's formation and early evolution, ocean worlds, the search for exoplanets and detection of extraterrestrial life.
Lectures three hours a week.

ERTH 2420 [0.5 credit]
UNESCO World Geoparks and Geoheritage
Development of the geologic sciences and enhanced knowledge of the Earth and its history through the lens of inspiring and extraordinary global geological sites that have contributed significantly to science and culture.
Lectures three hours a week.

ERTH 2421 [0.5 credit]
A Geologic Tour of the National Parks of North America
An introduction to the geology of North America's National parks, the ultimate awe-inspiring educational experience, and how these parks collectively tell the story of the processes that have shaped the continent.
Lectures three hours a week.

ERTH 2422 [0.5 credit]
Drivers of Climate Change through Geological Time
A survey of Earth's 4.5-billion-year climate history, focusing on the use of geologic data to understand the drivers of climate change and their impact on the development of the lithosphere, hydrosphere, atmosphere, and biosphere. Course includes experiential learning assignments.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 2402.
Lecture three hours per week; also includes additional online synchronous/asynchronous experiential learning practicum.

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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 2314 and ERTH 2407 and permission of the department.
Field work for two weeks off campus. A supplementary fee will apply.

ERTH 3004 [0.5 credit]
Igneous Petrology
Origins and evolution of igneous rocks through partial melting, crystallization, degassing, and assimilation of host rocks. Phase diagrams and classification schemes will be used to provide systematic tools for the description and interpretation of igneous rocks.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 2104 (no longer offered).
Prerequisite(s): ERTH 2102.
Lecture three hours per week, a laboratory three hours per week.

ERTH 3111 [0.5 credit]
Vertebrate Evolution: Mammals, Reptiles, and Birds
Evolution of mammals, reptiles and birds. Emphasis on surveying amniote diversity, and the origin of key amniote transformations, as evidenced by the fossil record.
Includes: Experiential Learning Activity
Also listed as BIOL 3111.
Prerequisite(s): ERTH 1002 or BIOL 2001.
Lectures two hours a week and a laboratory three hours a week.

ERTH 3112 [0.5 credit]
Vertebrate Evolution: Fish and Amphibians
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.
Includes: Experiential Learning Activity
Also listed as BIOL 3112.
Prerequisite(s): ERTH 1002 or BIOL 2001.
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 or Biology course.
Lectures three hours per week.

ERTH 3114 [0.5 credit]
Evolution of Mammals, Reptiles and Birds
Evolution of mammals, reptiles and birds. Emphasis on surveying amniote diversity, and the origin of key amniote transformations, as evidences by the fossil record.
Precludes additional credit for ERTH 3111 and BIOL 3111.
Prerequisite(s): any 1000- or 2000-level Earth Sciences or Biology course.
Lectures two hours per week.

ERTH 3115 [0.5 credit]
Evolution of Fish and Amphibians
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.
Precludes additional credit for ERTH 3112 and BIOL 3112.

Prerequisite(s): any 1000- or 2000-level Earth Sciences or Biology course.
Lectures two hours per week.

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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 2102 and ERTH 2106.
Lectures two hours and a laboratory three 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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 1002 or GEOG 2013.
Lecture 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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3202 (no longer offered).
Prerequisite(s): ERTH 2102.
Lectures two hours a week, a laboratory three hours a week and a field excursion.

ERTH 3405 [0.5 credit]
Geophysical Methods
An introduction to the tools of applied geophysics including seismology, electrical, magnetic, and gravitational surveying methods.
Includes: Experiential Learning Activity
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 3703 [0.5 credit]
Isotope Geochemistry and Geochronology
This course looks at stable and radiogenic isotope systematics applied to different Earth environments. Students will delve into geochronological techniques and their applications, and apply the principles of elemental and isotopic fractionation to investigate several geological processes.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 4803 (no longer offered).
Prerequisite(s): ERTH 2106.
Lecture 1.5 hours per week, a laboratory three hours per week.

ERTH 3999 [0.0 credit]
Co-operative Work Term
Includes: Experiential Learning Activity

ERTH 4003 [0.5 credit]
Directed Studies in Earth Sciences
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.
Includes: Experiential Learning Activity
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 4006 [0.5 credit]
Field Environmental Geobiology
Exploration of the relationship between micro- and macro-ecological and evolutionary processes and the Earth's physical and chemical environment. Paleobiology and evolutionary ecology in the context of paleoceanography, paleolimnology and/or paleoclimatology. Will include one or two weeks of field based instruction with costs borne by student.
Prerequisite(s): 2nd year standing in a Faculty of Science program and permission of the Department.
Field work off campus.

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.
Includes: Experiential Learning Activity
Precludes additional credit for BIOL 4007.
Prerequisite(s): ERTH 2312 or BIOL 2001, and BIOL 2104.
Lectures or seminars three hours per week.

ERTH 4008 [0.5 credit]
Topics in Paleobiology and Evolution
This multidisciplinary seminar course investigates various topics in paleobiology, paleoecology and evolutionary theory.
Prerequisite(s): 3rd year standing in any Faculty of Science program.
Lectures and seminar discussion, 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.
Includes: Experiential Learning Activity
Also listed as CIVE 3208.
Prerequisite(s): 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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 2106 and ERTH 3205.
Lectures three hours per week and a laboratory three hours per week.

ERTH 4209 [0.5 credit]
Mineral Exploration Field Geology
Introduction to the essentials of conducting geological mapping campaign in the Canadian Shield in a field area that has seen considerable industry exploration for volcanogenic massive sulfide mineralization. Activities include outcrop and trench mapping, strain analysis, interpretation of geophysical data, drilling proposals, report writing.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3209.
Prerequisite(s): ERTH 2407 or ERTH 3004 and ERTH 3207.
Field work for two weeks off-campus. A supplementary fee will apply.

ERTH 4302 [0.5 credit]
Frozen Earth: Unveiling the Snowball Earth Catastrophe
Discover how icy cataclysms shaped our planet through Earth's most extreme climate event: Snowball Earth! We will explore this theory's origins, examine compelling geologic and geochemical evidence, and dive into topics such as glacial sedimentology, the carbon cycle, evolution, and more on this thrilling adventure.
Prerequisite(s): ERTH 2314 or permission of the department.
Lectures three hours per week.

ERTH 4305 [0.5 credit]
Advanced Sedimentary Geology and Earth History
The origin, composition and diagenesis of sedimentary rocks throughout Earth history. Study of modern and ancient sedimentary systems; development of facies models; petrographic and geochemical analysis of sedimentary rocks.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 2314.
Lecture two hours a week and a laboratory three hours a week.

ERTH 4507 [0.5 credit]
Advanced Petrology
Analysis of the physical and chemical conditions, rock-forming processes, as well as the tectonic settings, that control the formation of different rock types. May include one to two weeks of field-based instruction, with costs borne by the student.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 3207.
Field excursions, lectures or seminars three hours per 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 4807 [0.5 credit]
Field Geology II
Field camp integrating 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.
Includes: Experiential Learning Activity
Prerequisite(s): completion of the third-year Earth Sciences course requirements and permission of the Department. A supplementary fee will apply.
Field work off campus.

ERTH 4808 [0.5 credit]
Vertebrate Paleontology Field Camp
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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 3111 or ERTH 3112, and ERTH 3113. A Major CGPA of 8.5 or higher and permission of the department. This course is only available to Undergraduate students enrolled in the BSc Earth Sciences with concentration in Vertebrate Paleontology and Paleoecology Honours program.
Field work for two weeks off campus. A supplementary fee will apply.

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 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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 4909, ERTH 4910 (no longer offered).
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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 4908, ERTH 4910 (no longer offered).
Prerequisite(s): restricted to B.Sc. Honours and Combined Honours Earth Sciences programs.