Earth Sciences

This section presents the requirements for programs in:

- **Earth Sciences 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. General**
- **Earth Sciences and Physical Geography B.Sc. Combined Honours**
- **Earth Sciences and Geography: Concentration in Terrain Science 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. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
2. 3.5 credits in:		3.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2104 [0.5]	Igneous Systems, Geochemistry and Processes	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2406 [0.5]	Geology and Map Interpretation	
ERTH 2802 [0.5]	Field Geology I	
3. 0.5 credit from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems (See Note, below)	
4. 3.0 credits in:		3.0
ERTH 3003 [0.5]	Geochemistry and Geochronology	
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 3806 [0.5]	Structural Geology (See Note, below)	
5. 2.0 credits in ERTH at the 4000-level		2.0
6. 1.0 credit from:		1.0
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 [0.5] and 0.5 credit in ERTH at the 4000 level		
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 from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary 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
GEOM 2007 [0.5]	Geographic Information Systems	
14. 1.0 credit in Science Continuation Courses (not ERTH)		1.0
15. 0.5 credit in:		0.5
NSCI 1000 [0.5]	Seminar in Science (or approved courses outside the faculties of Science and Engineering and Design)	
16. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design		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 Finance: Resource Valuation
B.Sc. Honours (21.0 credits)

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

1. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
2. 3.0 credits in:		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	
3. 0.5 credit from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems (See Note, below)	
4. 3.0 credits in:		3.0
ERTH 3003 [0.5]	Geochemistry and Geochronology	
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 3806 [0.5]	Structural Geology (See Note, below)	
5. 0.5 credit in:		0.5
ERTH 4303 [0.5]	Resources of the Earth	
6. 1.5 credits in ERTH at the 4000-level		1.5
7. 1.0 credit from:		1.0
ERTH 4909 [0.5]	Research in Earth Sciences	
and 0.5 credit in ERTH at the 4000-level		
OR		
ERTH 4910 [1.0]	Honours Thesis in Resource Evaluation	
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 from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary 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
GEOM 2007 [0.5]	Geographic Information Systems	
13. 1.0 credit from:		1.0
STAT 2507 [0.5] & STAT 2509 [0.5]	Introduction to Statistical Modeling I Introduction to Statistical Modeling II	
STAT 2606 [0.5] & STAT 2607 [0.5]	Business Statistics I Business Statistics 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. 3.5 credits in:		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	
16. 1.0 credit from:		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

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

A. Credits Included in the Major CGPA (11.0 credits)		
1. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
2. 3.5 credits in:		3.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2104 [0.5]	Igneous Systems, Geochemistry and Processes	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2406 [0.5]	Geology and Map Interpretation	
ERTH 2802 [0.5]	Field Geology I	
3. 0.5 credit from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems (See Note, below)	
4. 3.0 credits in:		3.0
ERTH 3003 [0.5]	Geochemistry and Geochronology	
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 3806 [0.5]	Structural Geology (See Note, below)	
5. 0.5 credit from:		0.5
ERTH 4303 [0.5]	Resources of the Earth	
ERTH 4306 [0.5]	Resource Basin Analysis	
6. 1.5 credit in ERTH at the 4000-level		1.5
7. 1.0 credit from:		1.0
ERTH 4908 [1.0]	Honours Thesis	
OR		
ERTH 4909 [0.5]	Research in Earth Sciences	
and 0.5 credit in ERTH at the 4000 level		
B. Credits Not Included in the Major CGPA (9.0 credits)		
8. 3.5 credits in:		3.5
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 2030 [0.5]	Intermediate Microeconomics II: Consumers and General Equilibrium	
ECON 2210 [0.5]	Introductory Statistics for Economics	
ECON 2220 [0.5]	Introductory Econometrics	
ECON 3509 [0.5]	Development Planning and Project Evaluation	
9. 1.0 credit from:		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	
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 from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary 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
GEOM 2007 [0.5]	Geographic Information Systems	
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. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
2. 2.5 credits in:		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	
3. 0.5 credit from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems (See note, below)	
4. 2.0 credits in:		2.0
ERTH 3003 [0.5]	Geochemistry and Geochronology	
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)	
5. 0.5 credit from:		0.5
ERTH 4003 [0.5]	Directed Studies in Geology	
ERTH 4808 [0.5]	Vertebrate Paleontology Field Camp	
6. 1.0 credit from:		1.0
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 and 0.5 credit in ERTH at the 4000-level		
7. 3.0 credits from and to include 2.0 credits at the 4000-level:		3.0
BIOL 3104 [0.5]	Molecular Genetics	
BIOL 3501 [0.5]	Biomechanics	
BIOL 3605 [0.5]	Field Course I	
BIOL 3609 [0.5]	Evolutionary Concepts	
BIOL 3611 [0.5]	Evolutionary Ecology	
BIOL 3802 [0.5]	Animal Behaviour	
BIOL 4500 [0.5]	Ornithology I	
GEOM 3002 [0.5]	Introduction to Remote Sensing	
GEOG 3102 [0.5]	Geomorphology	
GEOG 3104 [0.5]	Principles of Biogeography	
ERTH 2401 [0.5]	Dinosaurs	
ERTH 3806 [0.5]	Structural Geology	
ERTH 4005 [0.5]	Micropaleontology	
ERTH 4305 [0.5]	Carbonate Sedimentology	
ERTH 4006 [0.5]	Geobiology	
ERTH 4007 [0.5]	Evolutionary Developmental Paleobiology	
ERTH 4306 [0.5]	Resource Basin Analysis	
ERTH 4403 [0.5]	Tectonic Evolution of Canada	
ERTH 4820 [0.5]	Research Methods in Earth Sciences	
B. Credits Not Included in the Major CGPA (9.5 credits)		
8. 2.5 credits in:		2.5
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
PHYS 1007 [0.5]	Elementary University Physics I	
9. 1.0 credit from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary Chemistry II	
10. 2.0 credits in:		2.0
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2104 [0.5]	Introductory Genetics	
BIOL 2600 [0.5]	Ecology	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
11. 0.5 credit in Science Faculty Electives (not ERTH or BIOL)		0.5
12. 0.5 credit in:		
GEOM 2007 [0.5]	Geographic Information Systems	
13. 0.5 credit in:		0.5
NSCI 1000 [0.5]	Seminar in Science (or approved course outside the faculties of Science and Engineering and Design)	

14. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design	1.5
15. 1.0 credits in free electives.	1.5
Total Credits	20.0

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

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

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

1. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
2. 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. 3.0 credits in:		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	
5. 0.5 credit from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems	
6. 2.5 credits in:		2.5
ERTH 3003 [0.5]	Geochemistry and Geochronology	
ERTH 3204 [0.5]	Mineral Deposits	
ERTH 3205 [0.5]	Physical Hydrogeology	
ERTH 3405 [0.5]	Geophysical Methods	
ERTH 3806 [0.5]	Structural Geology	
7. 0.5 credit in:		0.5
ERTH 4707 [0.5]	Engineering Seismology	
8. 1.0 credit from:		1.0
ERTH 4908 [1.0]	Honours Thesis	
OR		
ERTH 4909 [0.5]	Research in Earth Sciences	
and 0.5 credit in ERTH at the 4000-level		

B. Credits Not Included in the Major CGPA (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 from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary 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
GEOM 2007 [0.5]	Geographic Information Systems	
13. 4.5 credits from:		4.5
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 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	
14. 0.5 credit in:		0.5
NSCI 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. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
2. 3.5 credits in:		3.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2104 [0.5]	Igneous Systems, Geochemistry and Processes	
ERTH 2105 [0.5]	Geodynamics	

ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2406 [0.5]	Geology and Map Interpretation	
ERTH 2802 [0.5]	Field Geology I	
3. 0.5 credit from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems (See Note, below)	
4. 3.0 credits in:		3.0
ERTH 3003 [0.5]	Geochemistry and Geochronology	
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 3806 [0.5]	Structural Geology (See Note, below)	
5. 3.0 credits in ERTH at the 4000-level		3.0
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 from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary 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
GEOM 2007 [0.5]	Geographic Information Systems	
13. 1.0 credit in Science Continuation Courses (not ERTH)		1.0
14. 0.5 credit in:		0.5
NSCI 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. General (15.0 credits)

A. Credits Included in the Major CGPA (8.0 credits)		
1. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
2. 3.5 credits in:		3.5
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2104 [0.5]	Igneous Systems, Geochemistry and Processes	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2406 [0.5]	Geology and Map Interpretation	
ERTH 2802 [0.5]	Field Geology I	
3. 3.5 credits in:		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]	Sedimentary Depositional Systems	
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)		
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 from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary 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
GEOM 2007 [0.5]	Geographic Information Systems	
8. 0.5 credit in Science Continuation course (not ERTH)		0.5
9. 0.5 credit in:		0.5
NSCI 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 1006 [0.5]	Exploring Planet Earth	
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. 2.0 credits in:		2.0
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	
4. 0.5 credit in:		0.5
ERTH 2802 [0.5]	Field Geology I	
5. 1.5 credits in:		1.5
ERTH 3003 [0.5]	Geochemistry and Geochronology	
ERTH 3405 [0.5]	Geophysical Methods	
ERTH 3806 [0.5]	Structural Geology	
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
GEOM 2007 [0.5]	Geographic Information Systems	
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 from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems	
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		
ERTH 4909 [0.5]	Research in Earth Sciences	
and 0.5 credit in ERTH, GEOG or GEOM at the 4000-level		
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 from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary 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
NSCI 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

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

A. Credits Included in the Major CGPA (12.5 credits)		
1. 0.5 credit in:		0.5
GEOG 2014 [0.5]	The Earth's Surface	
2. 0.5 credit in:		0.5
ERTH 1006 [0.5]	Exploring Planet Earth	
3. 2.5 credits in:		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	
4. 0.5 credit from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems (See Note, below)	

5. 1.5 credits in:		1.5
ERTH 3205 [0.5]	Physical Hydrogeology	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3806 [0.5]	Structural Geology	
6. 1.0 credit in ERTH at the 4000-level		1.0
7. 0.5 credit from:		0.5
GEOG 2006 [0.5]	Introduction to Quantitative Research	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
8. 1.5 credits in:		1.5
GEOM 1004 [0.5]	Maps, Satellites and the Geospatial Revolution	
GEOM 2007 [0.5]	Geographic Information Systems	
GEOG 2013 [0.5]	Weather and Water	
9. 2.0 credits in:		2.0
GEOM 3002 [0.5]	Introduction to Remote Sensing	
GEOG 3102 [0.5]	Geomorphology	
GEOG 3105 [0.5]	Climate and Atmospheric Change	
GEOG 3108 [0.5]	Soil Properties	
10. 1.0 credit in:		1.0
GEOG 4101 [0.5]	Two Million Years of Environmental Change	
GEOG 4108 [0.5]	Permafrost	
11. 1.0 credit from:		1.0
GEOG 4906 [1.0]	Honours Research Project	
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 and 0.5 credit 4000-level ERTH		
B. Credits Not Included in the Major CGPA (7.5 credits)		
12. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
13. 1.0 credit from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary Chemistry II	
14. 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	
15. 0.5 credit in:		0.5
COMP 1005 [0.5]	Introduction to Computer Science I	
16. 0.5 credit in:		0.5
BIOL 1104 [0.5]	Foundations of Biology II	
17. 0.5 credit in Advanced Science Faculty electives		0.5
18. 0.5 credit in:		0.5
NSCI 1000 [0.5]	Seminar in Science (or approved course outside the faculties of Science and Engineering and Design)	
19. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design		1.5
20. 1.0 credit in free electives.		1.0
Total Credits		20.0

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

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

A. Credits Included in the Major CGPA (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. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
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. 3.0 credits in:		3.0
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 3111 [0.5]	Vertebrate Evolution: 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 from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems	
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	
ERTH 4909 [0.5]	Research in Earth Sciences (and 0.5 credit in ERTH at the 4000-level)	
B. Credits Not Included in the Major CGPA (8.0 credits)		
9. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
10. 1.0 credit from:		1.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I General Chemistry II	
CHEM 1005 [0.5] & CHEM 1006 [0.5]	Elementary Chemistry I Elementary 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 NSCI 1000)	2.0
16. 1.0 credit in free electives	1.0
Total Credits	20.0

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)		
1. 4.0 credits in:		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	
2. 1.0 credit in CHEM at the 4000-level		1.0
3. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
4. 3.0 credits in:		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	
5. 0.5 credit from:		0.5
ERTH 3203 [0.5]	Sedimentology	
ERTH 3206 [0.5]	Sedimentary Depositional Systems (See Note, below)	
6. 2.0 credits in:		2.0
ERTH 3003 [0.5]	Geochemistry and Geochronology	
ERTH 3204 [0.5]	Mineral Deposits	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3806 [0.5]	Structural Geology	
7. 1.0 credit in ERTH at the 4000-level		1.0
8. 1.0 credit from:		1.0
CHEM 4907 [1.0]	Honours Essay and Research Proposal	
CHEM 4908 [1.0]	Research Project and Seminar	
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 [0.5]	Research in Earth Sciences (and 0.5 credit in ERTH at the 4000-level)	
B. Credits Not Included in the Major CGPA (6.5 credits)		
9. 1.0 credit in:		1.0
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1107 [0.5]	Linear Algebra I	
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
GEOM 2007 [0.5]	Geographic Information Systems	
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
NSCI 1000 [0.5]	Seminar in Science (or approved course outside the faculties of Science and Engineering and Design)	
17. 1.5 credits in approved courses outside the faculties of Science and Engineering and Design		1.5
Total Credits		20.0

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

Minor in 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.

Requirements		
1. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
2. 2.5 credits from:		2.5
ERTH 2312 [0.5]	Paleontology	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
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 3206 [0.5]	Sedimentary Depositional Systems	
3. 0.5 credit in:		0.5
ERTH 4303 [0.5]	Resources of the Earth	
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 Performance Evaluation (see the *Academic Regulations of the University* section of this Calendar).

Breadth Requirement for the B.Sc.

Students in Bachelor of Science Honours, Major, or General programs 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 (but may include NSCI 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 (but may include NSCI 1000) if, on transfer, the student received credit for fewer than 10.0 credits.
2. 1.0 credit in courses outside of the faculties of Science and Engineering and Design (but may include NSCI 1000) if, on transfer, the student received credit for 10.0 or more credits.

Declared and Undeclared Students

Students who are registered in a program within the degree are called Declared students. Most students designate a program of study when they first apply for admission and so begin their studies as Declared students. Students may also choose to begin their studies within the B.Sc. degree without being registered in a program. These students are referred to as Undeclared students. The recommended course pattern for Undeclared students is provided in the Undeclared entry of the Programs section of this Calendar. Undeclared students normally must apply to enter a program before beginning their second year of study. The Science Student Success Centre (SSSC) provides Undeclared students guidance to the appropriate support services in making this decision.

Change of Program within the B.Sc. Degree

Students may transfer to a program within the B.Sc. degree if upon entry to the new program they would be in good academic standing.

Other applications for change of program will be considered on their merits; students may be accepted in the new program in *Good Standing* or on *Academic Warning*.

Applications to declare or change their program 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, 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 requires that the student be in *Good Standing* and is subject to any specific requirements of the intended Minor, Concentration or Specialization as published in the relevant Calendar entry.

Experimental Science Requirement

Students in B.Sc. Honours, Major, or General degree programs 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 1005 [0.5]	Elementary Chemistry I
CHEM 1006 [0.5]	Elementary 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 1006 [0.5]	Exploring Planet Earth
ERTH 1009 [0.5]	The Earth System Through Time
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
ERTH 3806 [0.5]	Structural Geology
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]	Integrative 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)
- 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)
- 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 General, Major, and Honours 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 1010, ERTH 1011 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)
- 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 General, Major and Honours 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 NSCI 1000)

All courses offered by the Faculty of Arts and Social Sciences, the Faculty of Public 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). NSCI 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

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 1010 [0.5]	Our Dynamic Planet Earth
ERTH 1011 [0.5]	Evolution of the Earth
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
MATH 0107 [0.5]	Algebra and Geometry
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 0005 [0.5]	Precalculus: Functions and Graphs
MATH 0006 [0.5]	Precalculus: Trigonometric Functions and Complex Numbers
MATH 1009 [0.5]	Calculus: with Applications to 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

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 is admitted to co-op from high school, their grades will be reviewed two terms to one year prior to their first work term to ensure they continue to meet the academic requirements after their 1st or 2nd year of study. The time at which evaluation takes place depends on the program of study. Students will automatically be notified via their Carleton email account if they are permitted to continue.

Students not admitted to Carleton University with the co-op option on their degree can apply for admission via the co-operative education program website. To view application deadlines, visit carleton.ca/co-op.

Admission to the co-op option is based on the completion of 5.0 or more credits at Carleton University, the CGPA requirement for the students' academic program as well as any course prerequisites. The articulated CGPA for each program is the normal standard for assessment. Please see the specific degree program sections for the unique admission and continuation requirements for each academic program.

English Language Proficiency

Students admitted to Carleton based on CAEL, IELTS or TOEFL assessments and who are required to take an

ESL course must take and pass the Oral Proficiency in Communicative Settings (OPECS) Test. The test must be taken before being permitted to register in COOP 1000. Admission to the co-op program can be confirmed with a minimum score of 4+.

Participation Requirements

COOP 1000

Once a student has been given admission or continuation confirmation to the co-op option s/he must complete and pass COOP 1000 (a mandatory online 0.0 credit course). Students will have access to this course a minimum of two terms prior to their first work term and will be notified when to register.

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 students enrolled in the co-op option of their degree program, no guarantee of employment can be made. Carleton's co-op program operates a competitive job search process and is dependent upon current market conditions. Academic performance, skills, motivation, maturity, attitude and potential will determine whether a student is offered a job. It is the student's responsibility to actively conduct a job search in addition to participation in the job search process operated by the co-op office. Once a student accepts a co-op job offer (verbally or written), his/her job search will end and access to co-op jobs will be removed for that term. Students that do not successfully obtain a co-op work term are expected to continue with their academic studies. The summer term is the exception to this rule. Students should also note that hiring priority is given to Canadian citizens for co-op positions in the Federal Government of Canada.

Registering in Co-op Courses

Students will be registered in a Co-op Work Term course while at work. The number of Co-op Work Term courses that a student is registered in is dependent upon the number of four-month work terms that a student accepts.

While on a co-op work term students may take a maximum of 0.5 credit throughout each four-month co-op work term. Courses must be scheduled outside of regular working hours.

Students must be registered as full-time before they begin their co-op job search (2.0 credits). All co-op work terms must be completed before the beginning of the final academic term. Students may not finish their degree on a co-op work term.

Work Term Assessment and Evaluation

To obtain a Satisfactory grade for the co-op work term students must have:

1. A satisfactory work term evaluation by the co-op employer;
2. A satisfactory grade on the work term report.

Students must submit a work term report at the completion of each four-month work term. Reports are due on the 16th of April, August, and December and students are notified of due dates through their Carleton email account.

Workplace performance will be assessed by the workplace supervisor. Should a student receive an unsatisfactory rating from their co-op employer, an investigation by the co-op program manager will be undertaken. An unsatisfactory employer evaluation does not preclude a student from achieving an overall satisfactory rating for the work term.

Graduation with the Co-op Designation

In order to graduate with the co-op designation, students must satisfy all requirements for their degree program in addition to the requirements according to each co-op program (i.e. successful completion of three or four work terms).

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 may withdraw from the co-op option of their degree program during a study term ONLY. Students at work may not withdraw from the work term or the co-op option until s/he has completed the requirements of the work term.

Students are eligible to continue in their regular academic program provided that they meet the academic standards required for continuation.

Involuntary or Required Withdrawal from the Co-op Option

Students may be required to withdraw from the co-op option of their degree program for one or any of the following reasons:

1. Failure to achieve a grade of SAT in COOP 1000
2. Failure to pay all co-op related fees
3. Failure to actively participate in the job search process
4. Failure to attend all interviews for positions to which the student has applied
5. Declining more than one job offer during the job search process
6. Continuing a job search after accepting a co-op position
7. Dismissal from a work term by the co-op employer
8. Leaving a work term without approval by the Co-op manager
9. Receipt of an unsatisfactory work term evaluation
10. Submission of an unsatisfactory work term report

Standing and Appeals

The Co-op and Career Services office administers the regulations and procedures that are applicable to all co-op program options. All instances of a student's failure during a work term or other issues directly related to their

participation in the co-op option will be reported to the academic department.

Any decision made by the Co-op and Career Services office can be appealed via the normal appeal process within the University.

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. It is illegal to work in Canada without the proper authorization. Students will be provided with a letter of support to accompany their application. Students must submit their application for their permit before being permitted to view and apply for jobs on the Co-op Services database. Confirmation of a position will not be approved until a student can confirm they have received their permit. Students are advised to discuss the application process and requirements with the International Student Services Office.

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

- Maintain full-time status in each study term (2.0 credits);
- Be eligible to work in Canada (for off-campus work)
- Have successfully completed COOP 1000 [0.0]

In addition to the following:

1. Completion of 5.0 or more credits at Carleton University;
2. Registered as a full-time student in the Bachelor of Science Honours degree program;
3. Obtained and maintained a major CGPA of 8.0 or higher and an overall CGPA of 6.50 or higher

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/S	Fall	S
Winter	S	Winter	S	Winter	S	Winter	*W/S	Winter	S
Summer	**O/W	Summer	*W	Summer	O/W	Summer	O/W		

Legend
S: Study
W: Work
O: Optional
***** indicates recommended work study pattern
****** student finds own employer for this work-term.

Admissions Information

Admission Requirements are for the 2019-20 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.

Degrees

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

Admission Requirements

Honours Program

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, 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, Interdisciplinary Science and Practice, 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 the Combined Honours program in Chemistry and Computer Science, 4U Chemistry and Calculus and Vectors are 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

For entry to an Honours program after the completion of 5.0 included credits, a student must have a major CGPA of 5.50 or higher, an overall CGPA of 4.50 or higher and the recommendation of the Honours department or committee. A student beginning the final 10.0 credits

towards an Honours degree must present a major CGPA of 6.00 or higher, an overall CGPA of 5.00 or higher and the recommendation of the Honours department or committee. A student beginning the final 5.0 credits towards an Honours degree must present a major CGPA of 6.50 or higher and an overall CGPA of 5.00 or higher, as calculated for graduation. Advanced standing will be granted for studies undertaken elsewhere when these are recognized as the equivalent of subjects offered at Carleton University.

Major Program

General Program

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. Equivalent courses may be substituted between the old and new Ontario mathematics curriculum.

Advanced Standing

For entry to a General or Major program after the completion of 5.0 included credits, a student must have a major and core CGPA of 3.50 or higher and an overall CGPA of 3.50 or higher. A student beginning the final 5.0 credits towards a General or Major degree must present a major and core CGPA of 4.00 or higher and an overall CGPA of 4.00 or higher, as calculated for graduation. Advanced standing will be granted for studies undertaken elsewhere when these are recognized as the equivalent of subjects offered at Carleton University.

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 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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 1001 (no longer offered), ERTH 1010, ERTH 2404.
Prerequisite(s): a 4U/M level in Advanced Functions and at least one of Biology, Chemistry, Earth and Space Sciences or Physics are recommended. This course is for students who are enrolled in the Faculty of Science.
Lectures three hours a week, a laboratory three hours a week, and a field excursion.

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

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

ERTH 1011 [0.5 credit]
Evolution of the Earth
Origin and co-evolution of Earth and life over its 4.56 billion year history. Connections between plate tectonics, rock formation, climate and global change. Early marine life, colonization of land, mass extinctions and the use of fossils for interpreting past ecosystems.
Precludes additional credit for GEOL 1008 (no longer offered) and ERTH 1009.
Prerequisite(s): a 4U/M level in Advanced Functions and at least one of Biology, Chemistry, Earth and Space Sciences or Physics are recommended; ERTH 1010 is normally taken prior to this course. This course is for students who are not enrolled in the Faculty of Science.
Lectures three hours a week.

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

ERTH 2104 [0.5 credit]
Igneous Systems, Geochemistry and Processes
The sources and magmatic evolution of volcanic and plutonic rocks systems, with emphasis on geochemical, mineralogical, and textural characteristics, and relations to igneous processes.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3202 (no longer offered).
Prerequisite(s): (CHEM 1001 or CHEM 1005) and (CHEM 1002 or CHEM 1006), (MATH 1004 or MATH 1007), (MATH 1104 or MATH 1107) and ERTH 2102.
Lectures three hours a week, laboratory three hours a 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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3805 (no longer offered).
Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013).
Lectures two hours a week and a laboratory three hours a week.

ERTH 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 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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 2318.
Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013).
Lectures three hours a week and a laboratory three hours a week.

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

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

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

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

ERTH 2403 [0.5 credit]
Introduction to Oceanography
An environmental approach to understanding the oceans; introducing the physical and biological aspects of oceanography, marine resources and marine pollution.
Precludes additional credit for ERTH 3206.
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) and ERTH 1006.
Prerequisite(s): completion of first year of any B.Eng. program.
Lectures three hours a week and a laboratory three hours a week.

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

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

ERTH 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 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 2406 and permission of the department.
Field work for two weeks off campus. A supplementary fee will apply.

ERTH 3002 [0.5 credit]
Gemology
Gemstones including their physical and chemical properties, geological formation and geographic occurrence. Introduction to gemological laboratory methods.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 2102.
Lectures two hours a week and laboratory two hours a week.

ERTH 3003 [0.5 credit]
Geochemistry and Geochronology
Geochemical composition of reservoirs from the deep Earth to surface environments. Use of geochemistry and isotope geochemistry to track geological processes. Introduction to a variety of scientific dating methods (geochronology).
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 2101 (no longer offered).
Prerequisite(s): ERTH 2102, ERTH 2104 and ERTH 2105.
Lecture three hours a week and a laboratory two hours a 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
Prerequisite(s): ERTH 1009 or BIOL 2001, or permission of the department.
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
Prerequisite(s): ERTH 1009 or BIOL 2001, 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]
Sedimentology
A 10-day field study of modern and ancient sedimentary and ecological systems and their stratigraphy in a geological region outside of the Ottawa area. Subsequent in-class seminars examine significant changes in sedimentary environments through Earth's history. A supplementary fee will apply.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3201 (no longer offered).
Prerequisite(s): ERTH 2314, enrolment in one of the ERTH Honours, Combined Honours or Major programs, a 2000-level CGPA of 8.0 and permission of the Department.
Ten-day off-campus field course.

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 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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013).
Lecture three hours a week and a laboratory three hours a week.

ERTH 3206 [0.5 credit]
Sedimentary Depositional Systems
Application of sedimentary facies in class and local field-based settings to interpret modern and ancient depositional environments and stratigraphic succession related to climatic and oceanographic influences. Subsequent in-class seminars examine significant changes in sedimentary environments through Earth's history.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 3208 (no longer offered).
Prerequisite(s): ERTH 2314.
Field and class based instruction, 6 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 2104.
Lectures two hours a week, a laboratory three hours a week and a field excursion.

ERTH 3209 [0.5 credit]
Mineral Exploration Field Geology
Introduction to the essentials of conducting a 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
Prerequisite(s): ERTH 2104, ERTH 3207, ERTH 3806.
Field work for two weeks off-campus. A supplementary fee will apply.

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 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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 2105 and ERTH 2406.
Lecture two hours a week and a laboratory three hours a week.

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

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.
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 4005 [0.5 credit]
Micropaleontology
Paleoecological and biostratigraphic significance, and evolutionary history of marine and freshwater microorganisms.
Includes: Experiential Learning Activity
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.
Field excursions in addition to lectures or 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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 2312 or BIOL 2001, and BIOL 2104.
Lectures or seminars 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 2406 and ERTH 3405.
Lectures three hours a week, laboratory three hours alternate weeks.

ERTH 4206 [0.5 credit]
Contaminant and Remediation Hydrogeology
Geochemical and physical processes controlling contaminant release, migration, and fate in groundwater along with the processes and techniques used for contaminant mitigation and remediation. Examples will include organic and inorganic contaminants in a variety of settings.
Includes: Experiential Learning Activity
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.
Includes: Experiential Learning Activity
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.
Includes: Experiential Learning Activity
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.
Includes: Experiential Learning Activity
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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 3003.
Field excursions in addition to lectures or 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.
Includes: Experiential Learning Activity
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): (MATH 1004 or MATH 1007), (MATH 1104 or MATH 1107), STAT 2507 and ERTH 3405 or permission of the department.
Also offered at the graduate level, with different requirements, as ERTH 5707, for which additional credit is precluded.
Lectures three hours a week.

ERTH 4801 [0.5 credit]
Physics of the Earth
The physical properties of the solid Earth. Gravitational, magnetic and palaeomagnetic fields; seismology and earthquake occurrence; heat flow and thermal history. Geodynamic processes.
Prerequisite(s): ERTH 3405 and ERTH 3806.
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]
Radiogenic Isotope Geology
Use of radiogenic isotope systems to understand the differentiation history and evolution of large-scale isotopic reservoirs. Data, models and interpretations behind our present day knowledge and understanding of the Earth's history. Assessment of geochronological results and interpretations.
Includes: Experiential Learning Activity
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.
Includes: Experiential Learning Activity
Prerequisite(s): ERTH 3405.
Lectures and laboratories five hours per 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 is required at the time of registration.
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 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.
Includes: Experiential Learning Activity
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.
Includes: Experiential Learning Activity
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.
Includes: Experiential Learning Activity
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.
Includes: Experiential Learning Activity
Precludes additional credit for ERTH 4908 and ERTH 4909.
Prerequisite(s): Restricted to B.Sc. Honours in Earth Sciences with Concentration in Finance: Resource Valuation. Major CGPA 8.5 or higher at time of registration for the course.