

GEOLOGICAL SCIENCES AND GEOLOGICAL ENGINEERING

Departmental Notes

Subject Code for Geological Sciences: **GEOL**

Subject Code for Geological Engineering: **GEOE**

World Wide Web Address: <http://www.queensu.ca/geol/>

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Chair of Undergraduate Studies (GEOL): Daniel Layton-Matthews (dlayton@queensu.ca)

Chair of Undergraduate Studies (GEOE): Bas Vriens (bas.vriens@queensu.ca)

Overview

Geoscientists are the interpreters of our natural world. They bring methods such as geophysics, geochemistry, geobiology, and field geology together to understand the modern and ancient Earth. Clues concealed in rocks and fossils, minerals and fluids, mountains and sediments, glaciers and volcanoes are marshaled to understand and explain the Earth system at all scales. Managing water, mineral, and energy resources, developing sustainable strategies for industrial growth, and coping with natural and anthropogenic hazards facing increasing global populations, including climate change, all depend on a deep understanding of natural processes. Our graduates study the Earth in this context, with careers in diverse fields including, but not limited to, research, mineral and oil exploration, policy analysis, environmental science, and resource management. The programs offered by this Department focus on the whole planet and global processes as a dynamic and integrated system.

Departmental Policies

Field Trips

Field trips are a necessary part of geological training and are offered in each year of study because the Department wishes to provide the best education possible.

Students are required to possess basic safety equipment such as a hard hat, safety glasses, reflective vest, and appropriate footwear, as specified for each course, and to have reviewed and signed the Departmental Field Safety Form and the OCASP form developed for each field trip or

course. Field equipment is available for sale in the Main Office.

The cost of field trips and courses, including transportation, accommodation, and food (when it is supplied), will be borne by the student.

A list of the field education costs for each course (<https://www.queensu.ca/geol/current-students/undergraduate/>) is provided on the departmental web page. These costs are subject to change, and will be finalized by June 1 each year for the following academic year. These costs will be payable by the due dates listed in the table. Subsidies will be provided by the Department when funding permits.

For students who are not registered in a Plan offered by the Department there will be a charge per field trip. Students are required to possess basic safety equipment such as a hard hat, safety glasses, and appropriate footwear, and to have reviewed and signed the Departmental Field Safety Form and the OCASP form developed for each field trip or course.

Advice to Students

Students should seek **academic advice** from one of the program consultants listed below

Name	Title	Contact
Environmental Geology	David McLagan	david.mclagan@queensu.ca
Structural Geology/ Tectonics/Economic Geology	Christopher Spencer	c.spencer@queensu.ca
Paleontology/ Sedimentary Geology	Guy M. Narbonne	narbonne@queensu.ca
Petrology/ Geochemistry	Gema R. Olivo	olivo@queensu.ca

Geology Plans are offered as components of a degree Program within both the Faculty of Arts and Science (p. 1) and the Faculty of Engineering and Applied Science (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/geological-engineering/>). Students applying to first year, with an interest in geology, should consult both *Calendars*. Within Arts and Science, a great deal of flexibility exists in the choice of Plans.

Students wishing to complete a Plan designed to train specialists in the Geological Sciences are encouraged



to select one of the Geology Specialization (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-specialization-science-bs-honours/>) or Major Plans (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-major-science-bs-honours/>). The Geology Specialization Plan (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-specialization-science-bs-honours/>) provides the opportunity for intensive study of Geology and the supporting sciences. It is intended to fulfill the 'Knowledge Requirements' for registration as a Professional Geoscientist. The Geology Major Plan (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-major-science-bs-honours/>) is ideal for students who are interested in a career-oriented program in the geosciences that also allows a wider choice of supporting and elective courses. Another alternative route, for students who are particularly interested in the solid-earth aspects of environmental science, is the Environmental Geology Plan (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/environmental-geology-specialization-science-bs-honours/>).

Students wishing to study geology and another subject should consider geology as one component of a Major-Minor degree combination. The Minor (Science) (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-minor-science/>) may be combined with a Major in virtually any other subject, and provides a solid introduction to the Geological Sciences. As the General (Science) (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-general-science-bs/>), this same Plan when taken alone leads to a 3-year B.Sc. degree in Geology. Students who want to explore the field of Geological Sciences but with greater flexibility in choice of courses should consider combining the Geology Minor (Arts) Plan (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-minor-arts/>) in a Major-Minor degree combination. The General (Arts) in Geology (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-general-arts-ba/>), leading to a 3-year B.A. degree, is also available using the same suite of courses as the Minor (Arts) (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-minor-arts/>).

If you have questions about the differences between the various programs, or on particular course selections, consult with the Chair of Undergraduate Studies before registration. Additional information about the various degree programs can be found by consulting the Geoscience Program webpage (<https://www.queensu.ca/geol/current-students/undergraduate/>).

Special Study Opportunities

Specialized graduate courses in some areas of Geology are available to qualified students in their final year, and may be counted for advanced standing in a Master's degree at Queen's University. For details, consult the Chair of Undergraduate Studies.

Faculty

For more information, please visit: <https://www.queensu.ca/geol/faculty-research/faculty> (<https://www.queensu.ca/geol/faculty-research/faculty/>)

- Alexander Braun
- Jennifer Day
- Mark Diederichs
- Georgia Fotopoulos
- Hom Nath Gharti
- Laurent Godin
- Rob Harrap
- Jean Hutchinson
- Daniel Layton-Matthews
- Matthew Leybourne
- David McLagan
- Guy Narbonne
- Gema Olivo
- Chris Omelon
- Peir Pufahl
- Vicki Remenda
- Christopher Spencer
- Elisabeth Steel
- Bas Vriens

Specializations

- Environmental Geology – Specialization (Science) – Bachelor of Science (Honours) (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/environmental-geology-specialization-science-bs-honours/>)
- Geological Sciences – Specialization (Science) – Bachelor of Science (Honours) (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-specialization-science-bs-honours/>)

programs/geological-sciences-engineering/geology-specialization-science-bs-honours/)

Major

- Geological Sciences – Major (Science) – Bachelor of Science (Honours) (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-major-science-bs-honours/>)

Generals/Minors

- Geological Sciences – General (Arts) – Bachelor of Arts (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-general-arts-ba/>)
- Geological Sciences – General (Science) – Bachelor of Science (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-general-science-bs/>)
- Geological Sciences – Minor (Arts) (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-minor-arts/>)
- Geological Sciences – Minor (Science) (<https://queensu-ca-public.courseleaf.com/arts-science/schools-departments-programs/geological-sciences-engineering/geology-minor-science/>)

Courses

GEOL 102 Gemstones: Their Art, History, and Science Units: 3.00

Gemstones have played an important role in society throughout history. The role of gemstones and other precious materials will be illustrated through the study of works of art and popular literature. The physical properties that make gems attractive are explained. Gemstone marketing and ethical considerations of mining methods will be explored.

Learning Hours: 120 (24 Lecture, 12 Tutorial, 36 Online Activity, 48 Private Study)

Requirements: Prerequisite None.

Offering Faculty: Faculty of Arts and Science

GEOL 104 The Dynamic Earth Units: 3.00

Introduction to the internal structure of the Earth and the processes that have shaped its surface. Global tectonics and continental movement, rock genesis, mountain building, glaciations and geological time. Laboratories include rock and mineral identification, and problem solving in historical geology, earthquakes, groundwater flow and coastal erosion. NOTE Also offered at Bader College, UK (Learning Hours may vary).

Learning Hours: 108 (36 Lecture, 12 Laboratory, 60 Private Study)

Requirements: Prerequisite None.

Course Equivalencies: GEOL 104/105 / APSC 151

Offering Faculty: Faculty of Arts and Science

GEOL 106 Environmental Geology and Natural Hazards Units: 3.00

The relationship between human-kind and our ever-changing planet, with a focus on natural geologic hazards (volcanic eruptions, earthquakes, landslides, tsunamis, mass movement, floods, extraterrestrial impacts, etc.), and environmental impacts which result from population and land-use expansion and our increased use of water, energy and mineral resources. A study of the sources and impact of pollution and global climate change. Public perception of and response to geological risk.

NOTE Also offered at Bader College, UK (Learning Hours may vary).

Learning Hours: 120 (36 Lecture, 12 Online Activity, 72 Private Study)

Requirements: Prerequisite None.

Offering Faculty: Faculty of Arts and Science

GEOL 107 History of Life Units: 3.00

The history of life, from its inception four billion years ago to the present day, focusing on the inter-relationship between organic evolution and global change. Coevolution of early life and the atmosphere; development of marine animals and their ecosystems; invasion of the land; dinosaurs and their world; mass extinctions; the Age of Mammals; and hominid evolution. Lectures plus three three-hour laboratories.

Learning Hours: 120 (36 Lecture, 12 Laboratory, 12 Online Activity, 60 Private Study)

Requirements: Prerequisite None.

Offering Faculty: Faculty of Arts and Science

**GEOL 200 Oceanography Units: 3.00**

Introduction to marine science. Topics include: ocean basins and their sediments; seawater chemistry/biochemistry; ocean waves, tides and currents; ocean-atmosphere interaction; polar to tropical organism communities; marine resources; environmental concerns; global change.

Learning Hours: 114 (36 Lecture, 12 Practicum, 12 Online Activity, 48 Private Study)

Requirements: Prerequisite BIOL 102 or BIOL 103 or CHEM 112 or GEOL 104 or GEOL 106 or GEOL 107 or PHYS 104 or PHYS 106 or (PHYS 115 and PHYS 116) or PHYS 117/6.0. Exclusion BIOL 338.

Offering Faculty: Faculty of Arts and Science

GEOL 204 Geology of the Solar System Units: 3.00

This course provides an overview of the Solar System from a geological perspective. In addition to introducing the origin and evolution of our planetary neighbourhood, we will also discuss the new frontiers of space exploration and space mining and the current geoengineering challenges relating to space habitation and mining.

Learning Hours: 120 (36 Lecture, 12 Laboratory, 12 Online Activity, 60 Private Study)

Requirements: Prerequisite (APSC 151/3.3 or ASTR 101/3.0 or ASTR 102/3.0 or BIOL 102/3.0 or BIOL 103/3.0 or CHEM 112/6.0 or GEOL 104/3.0 or GEOL 106/3.0 or GEOL 107/3.0 or GPHY 102/3.0 or PHYS P10/3.0 or PHYS 104/6.0 or [PHYS 115/3.0 and PHYS 116/3.0] or PHYS 117/6.0) or permission of the Department.

Offering Faculty: Faculty of Arts and Science

Course Learning Outcomes:

1. Understand the physical properties of the various objects in the Solar System.
2. Evaluate and synthesize theories and observations related to course material.
3. Integrate theoretical and observational information to explain the origin and evolution of various objects in the Solar System.
4. Apply knowledge of the Solar System's dynamic processes to develop a group space exploration project (poster presentation).
5. Develop writing and communication skills and project development related to planetary science and space exploration.

GEOL 212 Introduction to Mineralogy Units: 3.00

An introduction to the crystallography and crystal chemistry of rock-forming minerals for students not in the Geological Sciences. The structural, chemical and genetic aspects of the crystalline state as displayed by minerals are considered.

NOTE Mineral Identification Kit (Non-GEOL students): estimated cost \$5.

Requirements: Prerequisite GEOL 104/3.0 or permission of the Department. Recommended 4U Chemistry is required. Exclusion GEOL 232/3.0.

Offering Faculty: Faculty of Arts and Science

GEOL 221 Geological Field Methods Units: 3.00

The field study of surficial deposits, rock types, and geological processes, based on the geology of the Kingston area.

Descriptions, samples and measurements acquired on several field trips will be analyzed, and the results recorded in maps, sections, and reports throughout the course.

NOTE Transportation for multiple half-day Field Trips: estimated cost \$95.

NOTE Full Field Kit (or when multiple items are purchased individually): estimated cost \$150.

NOTE Department may require GEOL 104 and GEOL 221 be taken concurrently.

Learning Hours: 112 (24 Lecture, 48 Laboratory, 12 Tutorial, 4 Off-Campus Activity, 24 Private Study)

Requirements: Prerequisite GEOL 104/3.0 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 232 Mineralogy Units: 3.00

Characterization of rock- and soil-forming silicate and non-silicate minerals (their crystallography, optical and physical behaviour, and crystal chemistry). The structural, chemical and genetic aspects of the crystalline state as displayed by minerals are considered. Implications of mineral properties for the engineering behaviour of soils and rocks, and for human needs, are discussed.

Learning Hours: 120 (36 Lecture, 36 Laboratory, 48 Private Study)

Requirements: Prerequisite GEOL 104 or permission of the Department. Exclusion GEOL 212. Recommended 4U Chemistry is required.

Offering Faculty: Faculty of Arts and Science

GEOL 235 Igneous and Metamorphic Petrology Units: 3.00

Introduction to the genesis and characterization of igneous and metamorphic rocks. Students will acquire skills to classify rocks and the theoretical background to place these rocks in the context of where, why, and how they form with implications for resource exploration and utilization. Macroscopic and microscopic properties will be studied.

Requirements: Prerequisite GEOL 232.

Offering Faculty: Faculty of Arts and Science

GEOL 238 Sedimentology and Stratigraphy Units: 3.00

An examination of the genetic link between surficial geological processes and the sedimentary record produced by these processes. Students obtain an integrated overview of the nature and operation of the Earth-surface environment. Topics include origin of sedimentary rocks and their sedimentary structures, depositional environments and stratigraphic successions; stratigraphic principles and their application to sedimentary basins, with implications for hydrocarbon genesis; interaction of natural processes with human society.

NOTE Also offered at Bader College, UK (Learning Hours may vary).

Learning Hours: 130 (36 Lecture, 22 Laboratory, 72 Private Study)

Requirements: Prerequisite GEOL 104/3.0 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 249 Geophysical Characterization of the Earth Units: 3.00

The application of physical principles to examine and characterize the Earth at all scales. The Earth's physical properties and dynamic processes will be assessed and evaluated by integrating such topics as gravity, seismology, magnetism, geochronology, and heat flow, as related to scientific and engineering problems.

Learning Hours: 117 (36 Lecture, 48 Practicum, 7 Group Learning, 24 Private Study)

Requirements: Prerequisite GEOL 104 or permission of the Department. Corequisite (MATH 120 or MATH 121 or [MATH 123 and MATH 124]) and (PHYS 104 or PHYS 106 or PHYS 107 or PHYS 117 or PHYS 118) or permission of the Department. Exclusion GEOL 269.

Offering Faculty: Faculty of Arts and Science

GEOL 262 Geological Aspects of Mineral Deposits Units: 3.00

The basic mineralogy and petrology of mineral deposits are examined. The formation and classification of mineral deposits, considering such aspects as tectonic setting, age, rock composition, geometry, and mineralogy are investigated. Emphasis is placed on the processes by which mineral deposits are formed and transformed, and their influence on mining and production. Laboratory work integrates geological information from the scale of hand samples to regional maps as tools to assist with mine design, estimation of ore grade and evaluation of issues related to ore processing.

Learning Hours: 114 (36 Lecture, 18 Laboratory, 60 Private Study)

Requirements: Prerequisite GEOL 104. One-Way Exclusion May not be taken with or after GEOL 232; GEOL 362.

Offering Faculty: Faculty of Arts and Science

GEOL 269 Physics of the Earth Units: 3.00

An examination of the physical principles and properties exhibited by the Earth which can be used to understand its origin, structure, dynamic processes, and evolution through time. Topics such as gravity, seismology, magnetism, geochronology, and heat flow are discussed in conjunction with the unifying theory of plate tectonics.

Learning Hours: 117 (36 Lecture, 8 Tutorial, 42 Practicum, 7 Group Learning, 24 Private Study)

Requirements: Prerequisite GEOL 104 or permission of the Department. Corequisite (MATH 120 or MATH 121 or [MATH 123 and MATH 124]) or permission of the Department. Exclusion GEOL 249. Recommended 4U Physics is required.

Offering Faculty: Faculty of Arts and Science

GEOL 282 Managing Earth Systems: Resources and Environment Units: 3.00

An earth-system engineering perspective on the nature, acquisition and utilization of energy, mineral and water resources, with particular emphasis on the environmental considerations in their extraction, processing, and use. Criteria for designing resource exploration programs are examined. Practical exercises, projects and seminars (team and individual) deal with these issues, and include the design of risk-management plans, environmental life-cycle assessments, sustainable systems and ore-reserve estimations.

Requirements: Prerequisite GEOL 221 or GEOL 232 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

**GEOL 290 Worldbuilding Units: 3.00**

A blended in-person and online lecture and design studio course on the design of worlds for fiction, art, game-design, communications, and more. Lectures and guest-lectures emphasize the requisite science, humanities, and social sciences to constrain a collaborative worldbuilding exercise delivering a partially realized world.

Learning Hours: 122 (24 Lecture, 4 Seminar, 4 Laboratory, 4 Tutorial, 4 Online Activity, 82 Private Study)

Requirements: Prerequisite Level 2 or above.

Offering Faculty: Faculty of Arts and Science

GEOL 300 Geological Field School Units: 3.00

An intensive one-week course taken immediately before the beginning of third year. Teams of students design and implement a geological field investigation program to produce and interpret geological field maps.

NOTE Multiday Field/Camping Trip (Kaladar, Ontario): estimated cost \$570.

Learning Hours: 120 (120 Off-Campus Activity)

Requirements: Prerequisite (GEOL 221/3.0 and GEOL 235/3.0) or permission of the Department. Note Visit the Department of Geological Science and Geological Engineering website for more information about this course.

Offering Faculty: Faculty of Arts and Science

GEOL 301 Field Studies in Geology I Units: 1.50

A multi-day field trip that uses stratigraphic, sedimentological, and paleontological data to interpret rock successions in a paleoenvironmental and tectonic context. Enrolment is limited.

NOTE Multiday Field Trip: estimated cost \$630.

Learning Hours: 61 (1 Lecture, 30 Practicum, 15 Group Learning, 15 Private Study)

Requirements: Prerequisite GEOL 238. Corequisite (GEOL 321 or GEOL 337 or GEOL 368). Exclusion GEOL 302; GEOL 368 (prior to 2013); GEOL 478 (prior to 2013); GEOL 488 (prior to 2013). Note Visit the Department of Geological Science and Geological Engineering website for more information about this course.

Offering Faculty: Faculty of Arts and Science

GEOL 302 Problems in Sedimentary Geology Units: 1.50

An independent study of the general links between tectonics and the nature of the sedimentary record in a variety of carbonate and siliciclastic depositional environments. NOTE This course is intended to provide an option for students in lieu of GEOL 301.

Learning Hours: 60 (10 Individual Instruction, 50 Private Study)

Requirements: Prerequisite GEOL 238. Corequisite ([GEOL 321 or GEOL 337 or GEOL 368] and permission of the Department). Exclusion GEOL 301; GEOL 368 (prior to 2013); GEOL 478 (prior to 2013); GEOL 488 (prior to 2013).

Offering Faculty: Faculty of Arts and Science

GEOL 319 Applied Geophysics Units: 3.00

Geophysical methods (gravity, magnetic, electrical, and seismic) applied to engineering problems, including resource exploration and site investigation. Design of field programs considering physical principles, instrumentation, limitations, field procedures and data interpretation. Laboratory projects with geophysical equipment are undertaken.

Learning Hours: 121 (21 Lecture, 18 Laboratory, 22 Tutorial, 12 Off-Campus Activity, 48 Private Study)

Requirements: Prerequisite GEOL 249 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 321 Structural Geology Units: 3.00

The nature, origin, and interpretation of deformation and fracture of rocks, and the application of structural methods to site-investigation and resource exploitation. Topics include geometric, kinematic and dynamic analysis of brittle and ductile deformation features; and examination of deformation styles in selected tectonic environments.

NOTE Two single day Field Trips (Kaladar, Ontario): estimated cost \$40.

Learning Hours: 122 (36 Lecture, 18 Laboratory, 8 Off-Campus Activity, 60 Private Study)

Requirements: Prerequisite GEOL 221/3.0. Corequisite (GEOL 300/3.0 or permission from the Department).

Offering Faculty: Faculty of Arts and Science

GEOL 333 Terrain Evaluation Units: 3.00

An introduction to the principles of geomorphology relevant to Geological Sciences and Geological Engineering. Identification and evaluation of terrain features using analog and digital imagery via traditional and digital (GIS) methods. Digital terrain model acquisition and analysis. Introduction to digital terrain analysis.

Learning Hours: 124 (36 Lecture, 33 Laboratory, 55 Practicum)

Requirements: Prerequisite GEOL 104 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 337 Paleontology Units: 3.00

Review of the major groups of invertebrate fossils, emphasizing functional morphology, paleoecology, evolution, and geological significance.

NOTE Field Trip (Prince Edward County, Ontario): estimated cost \$40.

Learning Hours: 129 (36 Lecture, 24 Laboratory, 6 Practicum, 9 Off-Campus Activity, 54 Private Study)

Requirements: Prerequisite GEOL 238/3.0 or BIOL 202/3.0* or BIOL 200/3.0 or permission of the Department. Note Visit the Department of Geological Science and Geological Engineering website for more information about this course.

Offering Faculty: Faculty of Arts and Science

GEOL 341 Problems in Geology Units: 3.00

A problem-oriented course involving a substantial amount of self-directed learning about a topic of the student's choosing, culminating in the submission of a written report. This course is open to students only if a suitable faculty member is available.

Learning Hours: 120 (6 Individual Instruction, 114 Private Study)

Requirements: Prerequisite (Level 3 or above and registration in a GEOL Major or Specialization Plan) or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 342 Special Topics in Geology Units: 3.00

Courses offered by visiting faculty on Geological Sciences topics related to their research interests. Consult the departmental homepage for further details of specific course offerings each academic year.

NOTE This course is repeatable for credit under different topic titles.

Learning Hours: 120 (36 Lecture, 84 Private Study)

Requirements: Prerequisite (Level 3 or above and registration in a GEOL Major or Specialization Plan) or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 343 Hydrogeology Units: 3.00

Development of the equations governing flow and transport; sensitivity to sub-surface complexities. Field instrumentation, installation and sampling protocols, elements of groundwater investigation. Assessment of measurement techniques and interpretation of fundamental hydrogeological properties. Groundwater occurrence, flow system analysis, with a focus on designing extraction scheme.

NOTE Field Trip: estimated cost \$40.

Requirements: Prerequisite (GEOL 238 and CHEM 112) or permission of the Department. Note Visit the Department of Geological Science and Geological Engineering website for more information about this course.

Offering Faculty: Faculty of Arts and Science

GEOL 349 Computation and Machine Learning in Geosciences Through Music Units: 3.00

With the rapid advance of computing technology, computation and machine learning have become integral tools in many fields, including geoscience, engineering, and medical science. This principal impact course is an interdisciplinary course that combines the beauty of music with the power of advanced computation and machine learning to inspire next-generation scientists and engineers to tackle a vast array of problems in geosciences and related fields. We will collect, compute, and analyze musical or sound data, both instrumental and natural, and apply the approach to solve real-world problems.

Learning Hours: 120 (36 Lecture, 36 Laboratory, 48 Private Study)

Requirements: Prerequisite {GEOL 104/3.0 and (MATH 120/6.0 or MATH 121/6.0 or [MATH 123/3.0 and MATH 124/3.0]) and (PHYS 104/6.0 or PHYS 106/6.0 or [PHYS 115/3.0 and PHYS 116/3.0] or PHYS 117/6.0 or PHYS 118/6.0)} or permission of the Department. Recommended CISC 101/3.0 or experience in any programming language, preferably Python and/or MATLAB.

Offering Faculty: Faculty of Arts and Science

Course Learning Outcomes:

1. Acquire skills in high-performance computing and machine learning.
2. Be able to collect, process, and interpret data from anthropogenic and natural music, sound, noise, and vibration.
3. Identify complex problems in science and engineering and attempt to solve them using cutting-edge computational technology and artificial intelligence.
4. Demonstrate awareness of the environmental impact of anthropogenic sound.
5. Apply computational knowledge and skills to simulate and investigate complex human-environment interactions.

GEOL 352 Topics in Mineralogy Units: 3.00

Through lectures, seminars and assigned readings selected topics in mineralogy are explored. Emphasis on the current literature and the details of mineralogical phenomena will lead to better understanding of petrologic systems. NOTE This course may not be offered every year. Please see Departmental website.

Learning Hours: 120 (24 Lecture, 36 Laboratory, 60 Private Study)

Requirements: Prerequisite GEOL 212 or GEOL 232.

Offering Faculty: Faculty of Arts and Science



GEOL 359 Applications of Quantitative Analysis in Geological Sciences Units: 3.00

The theory and use of numerical computational procedures to solve geo-engineering and geoscience problems. The utility, significance and widespread applicability of analytical and numerical techniques will be illustrated in the evaluation and solution of practical problems.

Learning Hours: 128 (36 Lecture, 22 Tutorial, 6 Individual Instruction, 16 Off-Campus Activity, 48 Private Study)

Requirements: Prerequisite GEOL 249 and (MATH 225 or MATH 232). Corequisite STAT 263. Exclusion GEOL 349.

Offering Faculty: Faculty of Arts and Science

GEOL 362 Petrology Applied to Ore Deposit Units: 3.00

Characterization of major ore deposit types using mineralogical, petrological, geochemical, and geophysical attributes. Design and evaluation of ore deposit models and exploration programs, including ore processing and environmental issues. Laboratory work integrates techniques to evaluate paragenetic sequences, ore grades, and engineering issues.

Learning Hours: 121 (33 Lecture, 33 Laboratory, 55 Private Study)

Requirements: Prerequisite GEOL 235 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 365 Geochemical Characterization of Earth Processes Units: 3.00

The application of thermodynamics and kinetics to the understanding of natural processes in the Earth Sciences. Distribution of the elements, and practical uses of isotopes and elemental tracers. Geochemical actions and transactions within, and among, the lithosphere, hydrosphere, atmosphere and biosphere, including the impact of human evolution and environmental geochemistry. Practical application of geochemistry to solving problems in natural systems will be emphasized. A practical involving problems, laboratory experience and field experience will be part of the course.

Requirements: Prerequisite (CHEM 112 and GEOL 232 and GEOL 235) or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 368 Carbonate Sedimentology Units: 3.00

The origin, composition and diagenesis of carbonate rocks. Study of modern carbonate sediments and depositional environments; development of facies models; petrographic and geochemical analysis of limestones and dolostones. NOTE Field Trip: estimated \$40.

Learning Hours: 121 (33 Lecture, 18 Laboratory, 70 Private Study)

Requirements: Prerequisite GEOL 238 or permission of the Department. Corequisite GEOL 301. Note Visit the Department of Geological Science and Geological Engineering website for more information about this course.

Offering Faculty: Faculty of Arts and Science

GEOL 395 Geological Practicum Units: 3.00

Students working for a company or government in geology or environmental geology can apply for a practicum credit. Requirements: minimum 12 weeks of continuous employment, securing a faculty member as an advisor and evaluator, agreement with employer prior to commencement of work, and submission of a final report.

Learning Hours: 120 (120 Practicum)

Requirements: Prerequisite GEOL 104/3.0 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 400 Advanced Geological Sciences Field School Units: 3.00

Intense one-week field course taken after third year. Field assignments of geological interest, local and regional geology and tectonic evolution of the area visited. Daily assignments when in the field on a diversity of geological problems. NOTE Multiday Field Trip: estimated cost \$570.

Learning Hours: 120 (4.5L, 4.5S, 15 Group Learning, 90 Off-Campus Activity, 6 Private Study)

Requirements: Prerequisite (GEOL 300 and GEOL 321 and GEOL 365) or permission of the Department. Note Visit the Department of Geological Science and Geological Engineering website for more information about this course.

Offering Faculty: Faculty of Arts and Science

GEOL 401 Field Studies in Geology II Units: 1.50

A multi-day field trip that uses stratigraphic, sedimentological, paleontological, and structural data to interpret shall-and-deep-marine rock successions in paleoenvironmental and tectonic context. Enrollment is limited. Course runs during the week of Canadian Thanksgiving.

NOTE Multiday Field Trip (Quebec City, Quebec): estimated cost \$630.

Learning Hours: 61 (1 Lecture, 30 Practicum, 15 Group Learning, 15 Private Study)

Requirements: Prerequisite (A minimum GPA of 2.90 in GEOL 221; GEOL 238; GEOL 321) or permission of the Department. Corequisite GEOL 488. Exclusion GEOL 402. Note Visit the Department of Geological Science and Geological Engineering website for more information about this course.

Offering Faculty: Faculty of Arts and Science

GEOL 402 Problems in North American Geology Units: 1.50

The self-directed detailed study of some aspect of the geological evolution of eastern North America. The topic will complement the knowledge gained in GEOL 488.

NOTE This course is intended to provide an option for students in lieu of GEOL 401.

Learning Hours: 60 (10 Individual Instruction, 50 Private Study)

Requirements: Prerequisite (A minimum GPA of 2.90 or a 'PASS' (obtained in Winter 2020) in GEOL 221; GEOL 238; GEOL 321) or permission of the Department. Corequisite (GEOL 488 and permission of the Department). Exclusion GEOL 401; GEOL 368 (prior to 2013); GEOL 488 (prior to 2013).

Offering Faculty: Faculty of Arts and Science

GEOL 418 Petroleum Geology Units: 3.00

The origin, migration and accumulation of petroleum resources, emphasizing typical reservoir styles, potential reservoir lithologies, methods of exploration and basic concepts of formation evaluation. Concepts and applications equip students with the basic principles necessary to undertake petroleum industry exploration and production. Laboratory exercises include a major exploration problem and presentation. Offered in 2009-2010 and in alternate years thereafter.

NOTE This course may not be offered every year. Please see Departmental website.

Learning Hours: 129 (36 Lecture, 33 Laboratory, 60 Private Study)

Requirements: Prerequisite GEOL 238 or permission of the Department. Corequisite GEOL 321.

Offering Faculty: Faculty of Arts and Science

GEOL 419 Geophysics Field School Units: 3.00

This 12-day, intensive field course focuses on field and laboratory techniques using a wide array of geophysical site investigation and exploration methods. Review lectures on instrument theory and principles of exploration program design. The course culminates in an exercise to design and implement an integrated geophysical site investigation. NOTE Please contact the Department for more information. Estimated cost \$800.

Learning Hours: 120 (8 Lecture, 12 Group Learning, 60 Practicum, 40 Private Study)

Requirements: Prerequisite GEOL 319 or permission of the Department. Note Visit the Department of Geological Science and Geological Engineering website for more information about this course.

Offering Faculty: Faculty of Arts and Science

GEOL 438 Topics in Sedimentary and Petroleum Geology Units: 3.00

A course on a topic in the field of sedimentary geology, sedimentary geochemistry, basin analysis and/or petroleum geology.

NOTE Consult the Chair of Undergraduate Studies for details of specific course offerings each academic year.

Requirements: Prerequisite Level 3 or above and registration in a GEOL Major or Specialization Plan.

Offering Faculty: Faculty of Arts and Science

GEOL 439 Advanced Applied Geophysics Units: 3.00

Advanced theory and techniques for acquisition, processing and interpretation of geophysical data. Solve a problem from idea, strategy, data acquisition, processing, to interpretation and deliverables. Design projects exploit seismic, gravity, magnetic, EM methods, in oil/gas/mineral exploration, near-surface prospecting and site investigation.

Learning Hours: 128 (21 Lecture, 24 Group Learning, 35 Individual Instruction, 24 Off-Campus Activity, 24 Private Study)

Requirements: Prerequisite (GEOL 249 and GEOL 319) or permission of the Department.

Offering Faculty: Faculty of Arts and Science



GEOL 452 Instrumental Techniques Applied to Geochemical Studies Units: 3.00

The theory and practical aspects of the techniques of sample preparation, X-ray powder diffraction, scanning electron microscopy, acid decomposition and digestion, column separation, liquid elemental and isotopic analysis are studied. Other techniques including Mossbauer, infra-red spectroscopy, and synchrotron methods will also be covered. An extensive term project is required where the student employs these techniques to hands-on study of a geological material in the analytical laboratories of Geological Sciences and Geological Engineering.

Learning Hours: 120 (24 Lecture, 36 Laboratory, 60 Private Study)

Requirements: Prerequisite GEOL 232/3.0 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 462 Advanced Petrogenesis and Metallogenesis Units: 3.00

Igneous petrology, geochemistry and fluid-rock interaction applied to metallogeny and ore genesis. Case studies in mineral chemistry and geochemistry. Lectures, critical reading, laboratory work and seminars will provide an advanced understanding of the major ore-forming processes in a geodynamic setting and applications to mineral exploration.

Learning Hours: 120 (24 Lecture, 12 Seminar, 36 Laboratory, 48 Private Study)

Requirements: Prerequisite (GEOL 362 and GEOL 365) or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 463 Spatial Information Management in the Geosciences Units: 3.00

An introduction to spatial information management focusing on methods to support and extend geological mapping, mineral and petroleum exploration, and engineering site investigation. Computers and computation, GIS software and theory, spatial simulation and analysis, databases and data management, and design of effective decision support solutions.

NOTE This course may not be offered every year. Please see Departmental website.

Learning Hours: 112 (33 Lecture, 24 Laboratory, 55 Practicum)

Requirements: Prerequisite GPHY 243 or GEOL 333 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 464 Visualization in the Geosciences Units: 3.00

An introduction to 3D visualization of natural sciences data with a focus on methods relevant to geological engineering, mineral exploration, and geoscience research. Perception, representation, and analytical methods. Design tools and data integration methods. Temporal analysis of natural sciences data. LiDAR data analysis. Global and local models.

Learning Hours: 129 (24 Lecture, 8 Seminar, 27 Laboratory, 48 Practicum, 22 Private Study)

Requirements: Prerequisite GEOL 463 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 466 Isotopes and the Environment Units: 3.00

This course is designed to expose advanced students in the fields of biology, chemistry, geography or geology to the principles of stable isotope and radiogenic isotope systematics in natural processes. Emphasis will be placed on the use of isotopes in tracing elemental cycles, biological cycles and hydrologic cycles and how some isotopes can be used to place constraints on the timing of specific events in these cycles.

NOTE This course may not be offered every year. Please see Departmental website.

Learning Hours: 120 (36 Lecture, 12 Seminar, 12 Laboratory, 60 Private Study)

Requirements: Prerequisite CHEM 112 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 472 Economic Analysis Methods in Geological Engineering Units: 3.00

Cost, risk, and return characteristics of mineral exploration; introduction to economic evaluation; cash flow and time value concepts; discounted cash flow methods; mining taxation considerations; sensitivity and risk analysis techniques; exploration economics and strategies; evaluation of exploration projects; exploration planning issues.

Requirements: Prerequisite GEOL 235 and permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 475 Exploration and Environmental Geochemistry Units: 3.00

Rock-water interaction and element migration in near surface environments applied to environmental and exploration problems. Students learn field and analytical techniques, evaluate and interpret geochemical data, and design solutions related to geochemical hazards to human health, environmental impact of mining, and detection of mineral deposits.

Learning Hours: 129 (30 Lecture, 6 Seminar, 33 Laboratory, 60 Private Study)

Requirements: Prerequisite GEOL 365 or permission of the Department. Exclusion GEOL 485.

Offering Faculty: Faculty of Arts and Science

GEOL 478 Clastic Sedimentology Units: 3.00

An advanced sedimentology course discussing depositional processes, facies models, and sequence stratigraphy of fluvial, coastal, shelf, and deep-marine environments. A strong focus on the clastic depositional environments and translation of these environments and processes into the geological record. Topics addressed include, generation and transport of clastic sediment, identification of depositional environments from the sedimentary record, and field and analytical methods used within sedimentology research.

Learning Hours: 130 (48 Lecture, 10 Seminar, 36 Laboratory, 36 Private Study)

Requirements: Prerequisite GEOL 238/3.0 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 481 Advanced Structural Analysis Units: 3.00

Applications of the principles of brittle and ductile deformation to the fabric analysis of rocks in the optimization of strategies for open-ended resource exploration, resource engineering, continental tectonics studies, and geotechnical engineering problems. Emphasis is on fracture, fault, and vein analysis; structures in fold and thrust belts and continental collision zones; and studies of superposed deformation and their impact on effective and economical mineral resource development.

NOTE This course may not be offered every year. Please visit Departmental website.

Learning Hours: 120 (24 Lecture, 24 Laboratory, 12 Tutorial, 60 Private Study)

Requirements: Prerequisite GEOL 321 or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 488 Geology of North America Units: 3.00

An advanced course discussing the principles of earth evolution as exemplified by North America. The holistic approach illustrates the way in which geodynamics, geochemistry, sedimentation, paleo-biology and oceanography are used to unravel the history of the continent.

Learning Hours: 120 (36 Lecture, 36 Seminar, 48 Private Study)

Requirements: Prerequisite (GEOL 107 and GEOL 235 and GEOL 238 and GEOL 249 and GEOL 300 and GEOL 321 and GEOL 365) or permission of the Department. Note GEOL 321 may be taken concurrently with permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 543 Research and Thesis Units: 6.00

Directed, independent research on geological problems. The thesis may be based on data or material collected during summer fieldwork or in the fall/winter around Kingston, on laboratory research, or using published data. Monthly tutorials will cover various aspects of literature review, writing skills and oral presentations. A seminar concerning the thesis topic will be presented at the end of Winter term.

NOTE An electronic copy of the final thesis, formatted to the supervisor's satisfaction, must be uploaded to Qspace. The supervisor may require one hardcopy.

Learning Hours: 258 (6 Lecture, 12 Seminar, 48 Individual Instruction, 192 Private Study)

Requirements: Prerequisite Level 4 or above and registration in a (GEOL Major or Specialization Plan) and a (GPA of 3.30 (obtained in any term) or a 'Pass' (obtained in Winter 2020) in 36.0 units in GEOL) and permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOL 594 Independent Study Units: 3.00

Exceptionally qualified students entering their third- or fourth-year may take a program of independent study provided it has been approved by the Department or Departments principally involved. The Department may approve an independent study program without permitting it to be counted toward a concentration in that Department. It is, consequently, the responsibility of students taking such programs to ensure that the concentration requirements for their degree will be met.

NOTE Requests for such a program must be received one month before the start of the first term in which the student intends to undertake the program.

NOTE Also offered at Bader College, UK.

Requirements: Prerequisite Permission of the Department or Departments principally involved.

Offering Faculty: Faculty of Arts and Science



GEOL 595 Independent Study Units: 6.00

Exceptionally qualified students entering their third- or fourth-year may take a program of independent study provided it has been approved by the Department or Departments principally involved. The Department may approve an independent study program without permitting it to be counted toward a concentration in that Department. It is, consequently, the responsibility of students taking such programs to ensure that the concentration requirements for their degree will be met.

NOTE Requests for such a program must be received one month before the start of the first term in which the student intends to undertake the program.

Requirements: Prerequisite Permission of the Department or Departments principally involved.

Offering Faculty: Faculty of Arts and Science