TA opportunities
Department of Geological Sciences and Geological Engineering
Fall 2021 / Winter 2022

The descriptions below refer to courses for which Teaching Assistantships are required.
The prefix GEOE indicates Geological Engineering; GEOL is Geological Science; GEOL/E is combined Geological Science and Geological Engineering; APSC is Applied Science. Courses are numbered according to year level (100s are first-year, 200s are 2nd-year, etc.).

Introductory Courses

Earth Systems Engineering
APSC 151
Roles: TA, Senior TA
An introduction to the complex Earth System (the solid earth, hydrosphere, atmosphere, and biosphere) and our interactions with it. The science behind our exploration and understanding of our planet and its ongoing evolution is explored in combination with the engineering geology of geo-materials, geo-resources, geo-dynamics and geo-risk. The connection between the Earth System and human activity is explored in depth, including local and global-scale impacts of engineering works, geopolitics, and resource issues. Examples of the terrestrial sources of geo-materials used in engineering activities are highlighted along with the technical, social, economic and environmental challenges associated with their life cycle including sustainability, contamination, biodiversity loss, social impact and climate change.

Gemstones: Their Art, History and Science
GEOL 102
Role: Marker
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 (24L;12T;36O;48P)

The Dynamic Earth
GEOL 104
Role: TA
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.

Environmental Geology and Natural Hazards
GEOL 106
Roles: Marker, Head TA
The relationship between humankind 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, and of public perception of and response to geological risk.

History of Life
GEOL 107 / GEOE 207
Roles: TA, Marker, Head TA
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.

Structure and Petrology Courses

Geological Field Methods
GEOL 221 / GEOE 221
Roles: TA, Head TA
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.

Mineralogy
GEOL 232 / GEOE 232
Roles: TA, Head TA
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.

Igneous and Metamorphic Petrology
GEOL 235 / GEOE 235
Role: TA
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. PREREQUISITE GEOL 232.

Geological Aspects of Mineral Deposits
GEOE 262
Role: TA
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.

Analysis of Rock Structures
GEOL 321 / GEOE 321
Role: TA
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.

Petrology Applied to Ore Deposits
GEOL 362 / GEOE 362
Role: TA
Characterization of major ore deposit types using petrological, geochemical and geophysical engineering sciences. Tectonic setting, age, rock composition, geometry, mineralogy and textures, geochemical and geophysical signatures. Metallogenic epochs and provinces. Design and evaluation of ore deposit models and exploration programs, including ore processing and environmental issues. Laboratory work integrates techniques of ore microscopy to determine paragenetic sequences, estimation of ore grade and evaluation of issues related to ore processing and site contamination.

Advanced Petrogenesis and Metallogenesis
GEOL 462 / GEOE 462
Role: TA
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.

Sedimentology, Stratigraphy, and Paleontology Courses

Surficial Processes, Sedimentation and Stratigraphy
GEOL 238 / GEOE 238
Role: TA
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.

Paleontology
GEOL 337 / GEOE 337
Role: TA
Review of the major groups of invertebrate fossils, emphasizing functional morphology, paleoecology, evolution, and geological significance.

Carbonate Sedimentology
GEOL 368 / GEOE 368
Role: TA
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.

Foundations of the Oil and Gas Industry
GEOE 414 / CHEE 414
Role: TA
Fundamentals of the oil and gas industry covering Chemical Engineering and Geological Engineering practice, and implications of Canadian and world political forces together with business practices are covered. Industry needs for exploration, recovery, processing, business expansion and policy issues will be addressed through case studies, in conjunction with examination of suitable business models.

Geophysics and Remote Sensing Courses

Geophysical Characterization of the Earth
GEOL 249 / GEOE 249
Role: Marker
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.

Applied Geophysics
GEOL 319 / GEOE 319
Role: TA
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.

Terrain Evaluation
GEOL 333 / GEOE 333
Role: TA
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.

Applications of Quantitative Analysis
GEOL 359 / GEOE 359
Role: TA
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.

Spatial Information Management in the Geosciences
GEOL 463 / GEOE 463
Role: TA
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.

Geochemistry and Hydrogeology Courses

Oceanography
GEOL 200
Role: Marker
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.

Hydrogeology
GEOL 343 / GEOE 343
Role: TA
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.

Geochemical Characterization of Earth Processes
GEOL 365 / GEOE 365
Role: TA
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 practicum involving problems, laboratory experience and field experience will be part of the course.

Instrumental Techniques Applied to the Study of Solids
GEOL 452
Role: TA
The theory and practical aspects of the techniques of X-ray powder diffraction and scanning electron microscopy are studied. Other techniques including Mossbauer, infra-red spectroscopy, and nuclear magnetic resonance spectroscopy will also be covered. An extensive term project is required where the student employs these techniques to study a material of their choice.

Isotopes and the Environment
GEOL 466
Role: TA
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.

Exploration and Environmental Geochemistry
GEOL 475 / GEOE 475
Role: TA
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.

Geological Engineering Courses

Introduction to Geological Engineering
GEOE 281
Role: TA
Introduction to all of the integrated fields of Geological Engineering and the essence of engineering design in an earth-systems context. Focus is on geological engineering properties and processes and their impact on design, with a particular focus on scale dependency, natural variability and risk-assessment. Introductory geotechnical engineering, applied geophysics, resource engineering, hydrogeology and geo-environmental engineering is highlighted with emphasis on the following: mining related site investigation and design, tunnelling, infrastructure development, natural-hazard mitigation and environmental remediation and resource exploration and management. A one day field trip is required.

Geomechanics
GEOE 313
Role: TA
Application of geomechanical principles to rock characterization, engineering analysis and design problems related to surface and underground construction in rock and surface slope stability. Presentation and discussion of geomechanics theory, including stress, strain, strength of materials and post yield behaviour, and analysis tools with application to typical rock engineering problems and to case

histories involving empirical, analytical and numerical solutions. Emphasis on the inherent variability of geomaterials at the lab and field scale and implications for design.

Site Investigation
GEOE 345
Role: TA
The course involves a team approach to tackling current geological engineering problems and developing innovative design solutions. Critical site investigation and site selection decisions are proposed, undertaken and tested with consideration of "downstream" engineering issues and constraints. The course relies on student consultation with guest participants, most of whom are practicing professional engineers. Additionally, topics such as professional liability and ethics, equity, environmental legislation, and the Occupational Health and Safety Act are presented and discussed. Formalized engineering design tools including FMEA, QRA will be utilized. Course includes a major geological engineering design project involving technical concepts, key elements of project management and communication of proposed design solutions.

Rock Engineering Design – NOT OFFERED IN 2021-22
GEOE 413
Role: TA
Rigorous application of geomechanics and rock engineering principles to open-ended design problems related to surface and underground excavation, construction and geo-hazard mitigation. Student-led projects will compliment presentation and discussion of design methodologies and case histories are followed up by related analysis and design problems incorporating industry standard software. Emphasis on the inherent variability of geomaterials and implications for integrated site-investigation planning, quantitative risk assessment, design decision-making and performance-monitoring. A field excursion will be included.

Project-based Courses

Engineering Design Project I & II - Full Year
GEOE 446 & GEOE 447
Role: TA
FALL - GEOE 446: Student teams research, prepare a design work plan and carry out a "Phase 1" engineering investigation for a major, open-ended geological engineering project, in consultation with a Management Board comprising geological engineering faculty. Work plans adhere to current national and/or provincial regulations as appropriate, and include scope definition, development of a range of technical solutions to the engineering problem, cost analyses and project scheduling tasks. Time sheets and minutes from design meetings are submitted to the course Management Board. Engineering project work plans are presented and defended to a committee comprising faculty and external engineers. Evaluation is based on the presentation and preliminary design report.
WINTER - GEOE 447: Student teams carry out design work, including detailed analysis, synthesis, and presentation for the open-ended engineering projects initiated in GEOE 446. Projects adhere to current national and provincial regulations, and include further development of engineering solutions while controlling project schedule, budget and critical path design objectives. Data are obtained from industrial sources, government documents, engineering reports, the appropriate literature, and field studies and

testing. Design projects, including methodologies, budgeting and technical components will be defended in class to a committee. Evaluation is based on two presentations and the team-written design report.

Research and Thesis - Full Year
GEOL 543
Role: TA
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.

Field Schools

Geological Field School
GEOL 300 / GEOE 300
Role: TA
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.

Advanced Geological Sciences Field School – NOT OFFERED 2021-22
GEOL 400 Role: TA
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.

Geological Engineering Field School – NOT OFFERED 2021-22
GEOE 410
Role: TA
A one-week intensive field course with associated discussions and project work during the term. Design and application of field data collection methods in exploration and mining projects, underground and surface mine works and for site remediation. The key geological engineering and design issues associated with each project are examined, from preliminary engineering design through engineering control of construction through long-term monitoring and maintenance. Students evaluate current design issues and develop engineering design solutions which are presented in the form of engineering reports and presentations.

Geophysics Field School – NOT OFFERED 2021-22
GEOL 419 / GEOE 419
Role: TA
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.