

GEOLOGICAL ENGINEERING

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Geological Engineering is a broad and creative field of engineering which combines practical application of geological principles, concepts and techniques with engineering investigation, analysis and design, providing reliable and sustainable engineered solutions to human needs.

Geological Engineering at Queen's University prepares students for the creative problem solving, analysis, interpretation and decision making necessary to tackle engineering challenges related to:

- Design and application of advanced surface and subsurface investigation, field and lab data interpretation, advanced analysis and geological modelling in aid of engineering design;
- Environmental engineering including subsurface water resource exploration and protection, ground contaminant remediation, sustainable mine/urban/industrial waste management/engineering;
- Geotechnical engineering and construction on, with or through earth materials (rock and soil) including tunnels, caverns, mines, transportation infrastructure, foundations, dams, waste storage;
- Geo-hazard assessment and risk mitigation including landslides, subsidence, earthquakes and floods;
- Mineral and energy resource exploration, evaluation, development and sustainable management, including environmental protection and remediation before, during and after geo-resource extraction;
- Applied Geophysics (eg. Seismics, electro-magnetics, gravity, laser, radar, etc) for remote probing (from the ground or from space) and visualization of the subsurface environment to facilitate geotechnical, geo-hazard, geo-environmental or geo-resource engineering.

The academic plan provides an enhanced understanding of the geological model associated with a particular challenge from the list above allowing in-depth assessment and understanding of the engineering properties of earth

materials, including natural variability within and between different environments, sensitivity of these materials to genesis and tectonic history, the changes to earth materials with time within an engineering context, and the impacts on the reliability and sustainability of design solutions.

The Geological Engineering plan offers a common second year curriculum, to provide students with a foundation in geological sciences, math and physics in addition to broad introductory exposure to a variety of geo-engineering problems and design approaches. The extensive and well-rounded core program offered in third and fourth year is augmented by a number of technical elective choices. This allows each student to gain in-depth specialization by taking several courses in an area of interest, geotechnical engineering, geo-environmental engineering, including mineral and energy exploration, or geophysics. Alternatively, a student can choose to build a breadth of knowledge across the discipline of Geological Engineering.

Geological Engineering Curriculum

It is recommended that students consult the academic advisor at least once in each year of their plan, to ensure that they are taking the required number of Technical Electives and Complementary Studies courses to fulfill the academic plan requirements as well as those of the Canadian Engineering Accreditation Board. Students need to plan ahead to ensure that they take courses in the appropriate years along with the necessary prerequisites.

Revisions to the Geological Engineering plan are ongoing. There are separate sections for the Classes of 2017, 2018, and 2019. Please refer to the appropriate calendar for your year of graduation.

The Technical Elective (TE) List is given at the end of this section. Complementary Studies (CE) are discussed at the end of each year calendar entry. For the classes of 2018 and 2019, students may take elective courses (4 TE and 3 CE) in any of the elective slots available in the 3rd and 4th years of the plan. For the class of 2017, a total of 5 TE and 3 CE are required.

Field Work

Field work is an essential part of Geological Engineering training, both to gain field skills and to understand the sources and nature of the data to be used for analysis and design. Field trips and field projects are offered in each year of study because the Department wishes to provide the best experience-based education possible. Employers and alumni from the Department are universally enthusiastic about the



value of this component of the Geological Engineering plan. In accordance with University policies, students will receive specialized instruction in field safety.

A field skills course, with trips around the Kingston area, is undertaken during the fall term of second year. A two-week Geological Engineering field school is held in the spring immediately following final exams. Students are expected to take this course at the end of their second year. This course requires teams of students to design and carry out geological and engineering site investigations related to specific geological engineering problems. Core field courses in fourth year deal either with engineering and design issues related to geo-environmental, geotechnical and resource management issues within the mineral industry, or with engineering site investigation design using applied geophysics.

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 is provided on the departmental web page (<http://www.queensu.ca/geol/undergrad/field-trips> (<http://www.queensu.ca/geol/undergrad/field-trips/>)).

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.

Students may incur additional field trip costs for courses they elect to take as a part of their degree. Students should consult with course instructors regarding these costs before registering in courses with a field trip component.

- Geological Engineering, B.A.Sc. (Class of 2022) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/geological-engineering/geological-engineering-basc-class-2022/>)
- Geological Engineering, B.A.Sc. (Class of 2023) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/geological-engineering/geological-engineering-basc-class-2023/>)
- Geological Engineering, B.A.Sc. (Class of 2024) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/geological-engineering/geological-engineering-basc-class-2024/>)
- Geological Engineering: Technical Electives (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/geological-engineering/geological-engineering-technical-electives/>)

Courses

GEOE 207 History of Life Units: 3.50

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 throughout all key divisions of the Geological Time Scale used by Geological Engineers and Scientists. 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 four three-hour laboratories.

Offering Faculty: Faculty of Arts and Science

GEOE 212 Introduction To Minerology 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.

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

Offering Faculty: Faculty of Arts and Science

GEOE 221 Geological Engineering Field Methods Units: 5.00

The engineering 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 and interpretations recorded in maps, sections, and reports throughout the course.

NOTE: Field trips and laboratories are 4 hours per week. Please consult the Departmental website for more information regarding estimated field trip costs.

Field component will not be until April/May 2021 due to Covid 19.

NOTE: Field trips and laboratories are 4 hours per week. Please consult the Departmental website for more information regarding estimated field trip costs.

Requirements: APSC 151

Offering Faculty: Faculty of Arts and Science

GEOE 226 Geology For Civil Engineers Units: 3.00

A study of geological materials and selected geological processes of concern to civil engineers. Topics include geologic structures, glacial deposits, groundwater, coastal processes and permafrost. (0/32/0/4/0)~ COURSE DELETED IN 2009/10 ~

Offering Faculty: Faculty of Arts and Science

GEOE 232 Mineralogy Units: 4.50

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.

Requirements: APSC 151 and registered in BSC

Offering Faculty: Faculty of Arts and Science

GEOE 235 Gen & Char Solid Earth Mtls Units: 4.00

Macroscopic and microscopic characterization of igneous, sedimentary and metamorphic rocks. Processes by which rocks are formed and transformed, and influence of genesis on shape, distribution, and rock-mass character of rock bodies. Engineering implications and consequences of rock-forming processes for mineral exploration and production, fossil-fuel exploration and production, and engineering site investigation.

Requirements: GEOE 232, or permission of the instructor

Offering Faculty: Faculty of Arts and Science

GEOE 238 Surficial Proc Sed & Strat Units: 4.00

An examination of the genetic link between surficial geological processes and the sedimentary record produced by these processes and environments. Topics include origin of sedimentary rocks and their sedimentary structures, depositional environments, stratigraphic successions and stratigraphic principles, with a focus on their application to sedimentary basins, hydrocarbon genesis and the interaction of natural processes with human society.

Requirements: APSC 151 and registered in BSC

Offering Faculty: Faculty of Arts and Science

GEOE 249 Geophysical Char Of The Earth Units: 3.50

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.

Requirements: APSC 111 and APSC 151 and APSC

Offering Faculty: Faculty of Arts and Science

GEOE 262 Aspects Mineral Deposits Units: 3.75

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.

Requirements: APSC 151 or equivalent

Offering Faculty: Faculty of Arts and Science

GEOE 281 Introduction to Geological Engineering Units: 4.00

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.

Requirements: PREREQ: APSC 151 and registered in BSCE or BASC. COREQ: GEOE 221 or permission of the instructor.

Offering Faculty: Faculty of Arts and Science

GEOE 282 Earth Systems: Resources & Environment Units: 3.50

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: GEOE 232 and GEOE 221, or permission of the instructor

Offering Faculty: Faculty of Arts and Science

**GEOE 291 Technical Communication I Units: 1.00**

This course provides instruction and practice in effective technical writing and oral presentation. The topics include amongst other things task definition, document structure and outlining. Many of the exercises will be linked to required oral and written communication tasks in other core courses. Open to Geological Engineering students only. (0/0/12/0/0)~ COURSE DELETED IN 2009/10) ~

Requirements: GEOL281

Offering Faculty: Faculty of Arts and Science

GEOE 292 Technical Communication II Units: 1.00

This course provides advanced instruction and practice in effective technical writing and oral presentation. Most exercises will be linked to required oral and written communication tasks in other courses. Open to Geological Engineering students only. (0/0/12/0/0)~ COURSE DELETED IN 2009/10 ~

Requirements: GEOL291

Offering Faculty: Faculty of Arts and Science

GEOE 300 Geological Engineering Field School Units: 4.00

An intensive one-week course taken at the end of August before the start of third year. Teams of students design and implement a geological engineering field investigation program to produce and interpret geological field maps. NOTE: The cost of accommodation, transportation and food will be borne by the student. Please consult the Departmental website for more information regarding estimated field trip costs.

Requirements: GEOE 221, 235, 238, 281

Offering Faculty: Faculty of Arts and Science

GEOE 301 Field Studies in Geology 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: The course runs during the week of Canadian Thanksgiving. Students are responsible for the cost of transportation, accommodation and food during the trip. Please see the Departmental web page for more information.

Requirements: GEOE 238, Cor: GEOE 321, 337, 368

Offering Faculty: Faculty of Arts and Science

GEOE 313 Geomechanics and Engineering Geology Units: 3.50

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.

Requirements: PREREQUISITES: APSC 151, APSC 174, CIVL 230, CIVL 340, and GEOE 359 (or CIVL 222), or permission of the instructor. EXCLUSIONS: GEOE 413

Offering Faculty: Fac of Engineering Appl Sci

GEOE 319 Applied Geophysics Units: 4.50

Geophysical tools and methods (including gravity, magnetic, electrical, and seismic) applied to engineering problems, including resource exploration and site investigation. Design of field programs using these methods including consideration of physical principles, instrumentation, field procedures and data interpretation.

Requirements: GEOE 249 and MTHE 223 (or MTHE 232), or permission of the instructor

Offering Faculty: Faculty of Arts and Science

GEOE 321 Analysis Of Rock Structures Units: 4.00

Characterization and analysis of rock deformation and fracture at all scales. Topics include geometric, kinematic and dynamic analysis of rock structure, mechanics of rock deformation (stress and strain), geologic mapping and map interpretation with applications to earth resource exploration and exploitation, mining, geohazards and geotechnical engineering. Introduction to geotectonics with examination of selected tectonic associations. Required full-day field trip.

Requirements: GEOE 300 or permission of the instructor

Offering Faculty: Faculty of Arts and Science

GEOE 333 Terrain Evaluation Units: 4.50

.An introduction to the principles of geomorphology relevant to site investigation and analysis for Geological Sciences and Geological Engineering. An emphasis is made on the evaluation of terrain features using analog and digital imagery using traditional and digital (GIS) methods and on terrain analysis using computational methods, generation of surface models from LiDAR and imagery, and integration into simulations. Applications include engineering investigation of geohazards, earth resources and infrastructure engineering.

Requirements: APSC 151 or permission of the

Offering Faculty: Faculty of Arts and Science

GEOE 337 Paleontology Units: 3.75

Review of the major groups of invertebrate fossils, emphasizing functional morphology, and geological significance. Introduction to paleoecology and biostratigraphy. Course includes a required paleontological field trip.

Requirements: GEOE 238 or permission of the instructor.

Offering Faculty: Faculty of Arts and Science

GEOE 340 Problems In Geological Engineering Units: 3.00

Each student investigates a problem in geological engineering that is not covered in any of the available courses, and submits a written report on the topic. This course is open to students only if a suitable faculty member is available.

Requirements: Completion of 2nd year Geological Engineering and permission of designated instructor

Offering Faculty: Faculty of Arts and Science

GEOE 341 Special Topics in Applied Geology Units: 3.00

This course provides intensive coverage of a special topic in applied geology and will be offered periodically in conjunction with visiting faculty and professionals. Consult the department homepage for opportunities

Requirements: Completion of 2nd year Geological Engineering and permission of designated instructor

Offering Faculty: Faculty of Arts and Science

GEOE 343 Applied Hydrogeology Units: 3.50

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 and movement in an engineering geology context. Flow system analysis, with a focus on designing extraction schemes. During the required field activities, students investigate a groundwater problem by taking measurements to be reduced and interpreted in report form.

Requirements: Completion of 2nd year Geology

Offering Faculty: Faculty of Arts and Science

GEOE 345 Site Investigation & Geological Engineering Design Units: 4.00

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.

Requirements: Completion of 2nd year Geology

Offering Faculty: Faculty of Arts and Science

GEOE 350 Sedimentary Geology Field School Units: 4.50

An intensive two-week field school consisting of practical exercises utilizing sedimentology, sequence stratigraphy, and paleobiology to interpret terrigenous clastic, carbonate, and evaporite successions. Held prior to the Fall semester. Students should consult with course instructors regarding estimated field trip costs. (0/29/0/14/11)~ COURSE DELETED IN 2009/10 ~

Offering Faculty: Faculty of Arts and Science

GEOE 352 Topics in Mineralogy Units: 3.50

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. Consult geol.queensu.ca/currentcourses for more information.

Requirements: PreReq: GEOE 352 452

Offering Faculty: Faculty of Arts and Science

GEOE 359 Applied Quantitative Analysis in Geological Engineering Units: 3.50

The theory and use of numerical computational procedures to solve geo-engineering problems. The utility, significance and widespread applicability of analytical and numerical techniques will be illustrated in the evaluation and solution of practical problems. Methods for: solution of simultaneous linear equations, curve fitting, solution of the algebraic eigenvalue problem, interpolation, least-squares, error propagation and geostatistics are included.

Requirements: Prerequisite: GEOE 249, MTHE 225 (or MTHE 232), APSC174 and APSC 143 or permission of instructor Must be registered in BASC.

Offering Faculty: Faculty of Arts and Science

**GEOE 362 Resource Engineering Units: 4.50**

Characterization of major ore deposit types using petrological, geochemical and geophysical engineering sciences, including tectonic setting, age, rock composition, geometry, mineralogy and textures, geochemical and geophysical signatures of mineral deposits. Design involves evaluation of ore deposit models and exploration programs, including ore processing and environmental issues. Laboratory work integrates investigation of mineral deposit's samples to determine paragenetic sequences, estimation of ore grade and evaluation of issues related to ore processing and site contamination.

Requirements: Prerequisite: GEOE 221 and GEOE 235 and GEOE321 and GEOE365, or permission of instructor. Must be registered in a BSCE or BASC program.

Offering Faculty: Faculty of Arts and Science

GEOE 365 Geochemical Characterization Of The Earth Units: 4.00

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: APSC 131, APSC 132, GEOE 235

Offering Faculty: Faculty of Arts and Science

GEOE 368 Carbonate Sedimentology Units: 4.50

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. Required extended field trip during term.

Requirements: GEOE 238

Offering Faculty: Faculty of Arts and Science

GEOE 401 Field Studies in Geology II Units: 1.50

A multi-day field trip that uses stratigraphic, sedimentological, paleontological, and structural data to interpret shallow-and deep-marine rock successions in a paleoenvironmental and tectonic context. Enrollment is limited. NOTE: The course runs during the week of Canadian Thanksgiving. Students are responsible for the cost of transportation, accommodation and food during the trip. Please see the Departmental web page for more information.

Requirements: Prerequisite: (A minimum GPA of 2.90 in GEOE 221, GEOE 238 and GEOE 321) or permission of the Department.

Offering Faculty: Faculty of Arts and Science

GEOE 410 Geological Engineering Field School Units: 4.00

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.

Requirements: Completion of 3rd year Geological Engineering

Offering Faculty: Faculty of Arts and Science

GEOE 413 Rock Engineering Design Units: 3.50

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.

Requirements: GEOE 281 and GEOE 300 and GEOE 321 and GEOE359, or permission of the instructor

Offering Faculty: Faculty of Arts and Science

GEOE 414 Foundations of the Oil and Gas Industry Units: 3.50

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. (0/0/0/30/12)

Offering Faculty: Fac of Engineering Appl Sci

GEOE 418 Petroleum Geology Units: 4.50

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 design problem and presentation.

Requirements: GEOE 238 or GEOL 238 and GEOE

Offering Faculty: Faculty of Arts and Science

GEOE 419 Engineering Geophysics Field School Units: 4.00

This nine day, intensive, tri-university field course focuses on field and laboratory techniques using a wide array of geophysical site investigation and exploration methods. Lectures are used to review basic instrument theory, and to teach the principles of exploration program design. The course culminates in an exercise to design and implement an integrated geophysical site investigation. Course takes place before start of 4th year. Students should consult with departmental website regarding estimated field trip costs.

Requirements: Completion of 3rd year Geological Engineering, or permission of the Queen's University instructor

Offering Faculty: Faculty of Arts and Science

GEOE 431 Metamorphic Petrology Units: 3.50

Physical and chemical principles of metamorphism and metasomatism. Metamorphic reactions, isograds, zones, and facies in relation to rock deformation, magmatism, tectonics, and ore genesis. Thermobarometry. Laboratory study of metamorphic rocks using the petrographic microscope. (0/14/0/19/9)~ COURSE DELETED IN 2008/09 ~

Offering Faculty: Faculty of Arts and Science

GEOE 439 Advanced Applied Geophysics Units: 3.00

Advanced theory and techniques for acquisition, processing and interpretation of geophysical data. Students solve a geophysical problem mineral exploration, near-surface prospecting and site investigation. Processing will use both available and student designed software.

Requirements: MTHE 232 (or MTHE 225) and GEOE249 and GEOE319

Offering Faculty: Faculty of Arts and Science

GEOE 441 Special Topics in Applied Geology Units: 3.00

This course provides intensive coverage of a special advanced topic in applied geology and will be offered periodically and may be presented by faculty or by visiting professionals or as an advanced independent study. Consult the department homepage for opportunities.

Requirements: Completion of 3rd year Geologi

Offering Faculty: Faculty of Arts and Science

GEOE 446 Engineering Design Project I Units: 4.00

Student teams research, prepare a design work plan and carry out a "Phase I" 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. Design meetings are recorded in the form of minutes submitted to the course Management Board and time sheets are submitted. Engineering project work plans are presented and defended to a committee comprising faculty and external engineers. Evaluation is based on the presentation and the team-written preliminary design report. These reports form the basis for more in depth design work in GEOE 447 in the winter. Students must register in both GEOE 446 and 447.

Requirements: Completion of 3rd year Geological Engineering

Offering Faculty: Faculty of Arts and Science

**GEOE 447 Engineering Design Project II Units: 5.50**

Student teams carry out design work, including detailed analysis, synthesis, and presentation for the open-ended engineering projects proposed and initiated in GEOE 446. Projects adhere to current national and/or provincial regulations as appropriate, 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. Students must register in both GEOE 446 and 447.

Requirements: GEOE 446

Offering Faculty: Faculty of Arts and Science

GEOE 452 Instrumental Techniques Applied to the Study of Solids Units: 3.00

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. This course may not be offered every year.

Requirements: PreReq: GEOE 352 452

Offering Faculty: Faculty of Arts and Science

GEOE 462 Advanced Petrogenesis and Metallogenesis Units: 4.50

Application of the fundamental principles of igneous petrology, geochemistry and fluid-rock interaction to metallogeny and ore genesis. Training in ore microscopy and mineral paragenesis with mineral chemistry and lithochemical data for selected case studies. Lectures, critical reading, discussion sections, laboratory work and seminars will provide an understanding of ore forming processes.

Requirements: Prerequisite: GEOE 263 and GEOE365, or permission of the instructor. Must be registered in BSCE or BASC.

Offering Faculty: Faculty of Arts and Science

GEOE 463 Spatial Information Management in the Geosciences Units: 3.50

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.

Requirements: GEOE 333 or permission of instructor

Offering Faculty: Faculty of Arts and Science

GEOE 464 Visualization in Geosciences Units: 1.50

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. Virtual worlds.

Requirements: GEOE 463

Offering Faculty: Faculty of Arts and Science

GEOE 466 Isotopes & The Environment Units: 4.00

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.

Requirements: GEOE 365 or permission of the instructor

Offering Faculty: Faculty of Arts and Science

GEOE 475 Exploration and Environmental Geochemistry Units: 4.50

Principles of rock-water interaction and element migration in the near surface environment applied to environmental and exploration geochemistry. Students learn field and analytical techniques, evaluate and interpret geochemical data, and design solutions related to geochemical hazards to human health, environmental impacts of mining, and formulation of strategies for detecting mineral deposits.

Requirements: GEOE 465

Offering Faculty: Faculty of Arts and Science

GEOE 478 Terrigenous Sedimentology Units: 3.50

Detailed examination of depositional processes and external controls on the facies organization and sequence stratigraphy of fluvial, coastal, shelf, and deep-marine environments. Introduction to sedimentary basin types.

Requirements: GEOE 238 or permission of the instructor

Offering Faculty: Faculty of Arts and Science

GEOE 479 Appl Geoph: Field&ElecMag Meth Units: 3.50

Advanced theory and practical considerations for static potential and time-varying electromagnetic fields as applied to near-surface prospecting and site-investigation. Implications of wide-ranging physical responses for technique selection and design, implementation, modelling and interpretation of an extended Earth system. Potential theory, rock physical properties, diffusive electromagnetic signals in the Earth, boundary-value problems, frequency and time-domain field systems, design limitations and advantages. (7/15/0/10/10)~ COURSE DELETED IN 2009/10 ~

Requirements: (MATH227 AND MATH338) OR (MATH227 AND GEOL319) OR (MATH227 AND MATH334) OR (MATH227 AND GEOL319)

Offering Faculty: Faculty of Arts and Science

GEOE 481 Advanced Structural Analysis Units: 3.50

Applications of the principles of rock deformation to the fabric analysis of rocks in the optimization of strategies for open-ended resource exploration, resource engineering and geotechnical engineering problems. Emphasis is on fracture, fault, and vein analysis; structures in fold and thrust belts; and studies of superposed deformation and their impact on effective and economical mineral resource development. Offered next in 2014/15, and every second year thereafter.

Requirements: GEOE 321 or permission of the instructor.

Offering Faculty: Faculty of Arts and Science

GEOE 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.

Requirements: Completion of 3rd year Geological Engineering or permission of the instructor

Offering Faculty: Faculty of Arts and Science

GEOE 489 Appl Geoph: Seismic Methods Units: 3.50

Characterization, processing and interpretation of exploration seismic digital data for the oil and gas, and mineral industries. Vector waves; Green functions and diffraction; attenuation, anisotropy and poroelasticity of earth materials; geometrical rays; resolution limits and survey design; processing sequence design, data optimization, depth-model building of earth systems. Theory and practice of pre and post-stack migration, limitations and advantages; examples of partially and fully processed data, consequences of different processing design decisions. (5/0/0/30/7)~ COURSE DELETED IN 2009/10 ~

Requirements: (MATH227 AND MATH334) OR (MATH227 AND GEOL319) OR (MATH227 AND MATH338) OR (MATH227 AND GEOL319)

Offering Faculty: Faculty of Arts and Science