

# GEOENGINEERING

## Overview of the Collaborative Program

GeoEngineering is a Collaborative Program linking Graduate and research programs in the Departments of Civil Engineering, Geological Sciences and Geological Engineering and Mining Engineering at Queen's with Civil Engineering at the Royal Military College of Canada. This program is associated with the GeoEngineering Centre at Queen's - RMC. Students enter this program having first enrolled in one of the four constituent programs. The collaborative program is designed to provide shared learning experiences with interdisciplinary content, and is available to doctoral students as well as both research and coursework masters students associated with those four constituent programs. On graduation, students choosing to participate in this program are identified as having specialized training in GeoEngineering.

GeoEngineers are involved with the engineering of earth and rock structures such as those associated with foundations, slopes, deep excavations, tunnels, solid waste landfills, and contaminated ground. The effective solution of many of these problems requires a multidisciplinary approach, featuring the application of engineering mechanics and applied mathematics, materials science, geology, hydrogeology and geochemistry. GeoEngineers are normally drawn from traditional fields such as Civil, Mining and Geological Engineering, though they may also come from other disciplines such as Applied Mathematics, Chemistry, Geology and Physics.

## Areas of GeoEngineering Research Strength

- 1. Hydrogeology:** The hydrogeology group focuses on the behaviour and remediation of contaminants in groundwater, with specific applications in fractured rock, fractured clay, and unconsolidated porous media. Investigations of regional groundwater flow and the sustainable use of groundwater resources are also conducted. Extensive use is made of compositional numerical simulation, laboratory experimentation, and field characterization methods (Bernard Kueper, Kent Novakowski, Vicki Remenda)
- 2. Geotechnical Engineering:** Geotechnical Engineering involves the application of soil mechanics, rock mechanics and engineering geology to solve soil and rock engineering problems such as design of foundations, slopes, excavations, dams, tunnels and other Civil, Mining and Environmental engineering works involving the mechanical response of the ground and the water within it. Research work being undertaken includes studies on shallow and deep foundations, tunnels and deep excavations, pipes, culverts and other buried infrastructure, and Geotechnical Earthquake Engineering (Richard Bathurst, Richard Brachman, Mark Diederichs, Jean Hutchinson, Steve McKinnon, Ian Moore, Gerald Raymond, Kerry Rowe, Andy Take)
- 3. Geoenvironmental Engineering:** Geoenvironmental Engineering is the multidisciplinary application of Geotechnical engineering, Hydrogeology and Geochemistry to solve modern-day environmental problems related to soil and water pollution. The group has expertise in solid waste landfills, subsurface NAPL contamination and remediation, geochemistry of mine tailings, and Geosynthetic barrier systems (Richard Bathurst, Richard Brachman, Jean Hutchinson, Heather Jamieson, Bernard Kueper, Kent Novakowski, Vicki Remenda, Kerry Rowe)
- 4. Geomechanics:** Geomechanics involves the response of in-situ earth materials to the presence or application of deforming forces. It embraces the fundamentals of soil mechanics, rock mechanics, material science and structural geology. Geomechanics Engineering involves the application of these disciplines to the interpretation of geometry and distribution of ore bodies and hydrocarbon resources, the assessment of hazards associated with geological structure, earth stresses and deforming geomaterials. It also involves the design of surface and underground openings to account for the influence of natural and induced stresses. Research work being undertaken includes the study of issues related to rock mass strength and yield response, site investigation, the design of surface and underground works for mining and tunneling, long term stability of abandoned mine workings, the design of underground support, the numerical simulation of soil and rock response to stress and to blasting, the study of mining induced seismicity, and risk management related to worker and public exposure to hazards related to Geomechanics (James Archibald, Richard Brachman, Mark Diederichs, Jean Hutchinson, Steve McKinnon, Ian Moore, Kerry Rowe, Andy Take)
- 5. Geosynthetics:** Geosynthetics are planar, polymeric materials used in contact with soil/rock and/or any other Geotechnical material in civil engineering applications. They include geotextiles, geogrids, geomembranes, Geosynthetic clay liners, geonets, geopipes, geofoams, prefabricated vertical drains and other products placed in contact with soil to separate, filter, reinforce, protect,



drain or resist drainage in a range of Geotechnical and Geoenvironmental applications. Research work being undertaken includes studies on reinforcement to enhance the stability of walls, foundations, tunnels and embankments, on the use of geomembranes and Geosynthetic clay liners to limit contaminant migration from municipal and hazardous waste landfills and as barrier systems for hydrocarbon contaminated soils, and on new and repaired pipes and manholes (James Archibald, Richard Bathurst, Richard Brachman, Ian Moore, Gerald Raymond, Kerry Rowe)

6. **Geochemistry:** Geochemistry involves understanding the chemical composition and interaction of earth materials such as natural and contaminated waters, sediments and rocks. Research in geochemistry includes studies of the long-term stability of mine waste including kimberlitic tailings, acid rock drainage and arsenic-rich gold mine tailings, subsurface NAPL contamination and migration, and groundwater tracer migration studies (Heather Jamieson, Bernard Kueper, Vicki Remenda)

## Facilities

Researchers in the GeoEngineering Centre at Queen's - RMC enjoy high levels of support from NSERC, the Department of National Defense, the Canada Foundation for Innovation, the Ontario Innovation Trust, other Canadian and US Government agencies, as well as industrial funding. In addition to providing opportunities for scores of graduate student projects, this funding has permitted the development of world-class research infrastructure. Details are available on the Department websites, as well as at [www.geoeng.ca](http://www.geoeng.ca) (<http://www.geoeng.ca/>).

## Courses and Programs of Study

Course details are given under the constituent Departments (Civil Engineering, Geological Sciences and Geological Engineering and Mining Engineering at Queen's with Civil Engineering at the Royal Military College of Canada). All students undertake the GeoEngineering Seminar Course GENG 840 Geoengineering Seminar. Website: <http://www.geoeng.ca/info-for-students/program-information.html>

Other courses are GENG 842 Spec Topics Geoengineering II, and courses offered by the four constituent departments:

Code	Title	Units
CIVL 840	Advanced Soil Mechanics	3.00
CIVL 842	Foundation Engineering	3.00
CIVL 844	Geotechnical analysis 1: Elasticity	1.50
CIVL 847	Geosynthetics In Geotech. Engr	3.00
CIVL 848	Landfill Design	3.00
CIVL 880	Subsurface Contamination	3.00

CIVL 881	Fractured Rock Flow/Transport	3.00
CIVL 882	Groundwater Modeling Technique	3.00
CIVL 888	Groundwater Flow & Transport	3.00
GEOL 840	Problems In Geology	3.00
MINE 818	Rock Mechanics	3.00
MINE 820	Topics In Drilling & Blasting	3.00
MINE 821	Hydrometallurgy and electrometallurgy: Theory and practice	3.00
MINE 828	Seismicity in Mines	3.00
RMC-CE 531		
RMC-CE 535		
RMC-CE 539		
RMC-CE 588		

## Faculty

Archibald, J.F., Bathurst, R.J., Brachman, R.W.I., Diederichs, M.S., Hutchinson, D.J., Jamieson, H.E., Kueper, B.H., McKinnon, S.D. (Chair in Mine Design), Moore, I.D. (Canada Research Chair in Infrastructure Engineering), Novakowski, K.S., Remenda, V.H., Rowe, R.K. (Vice-Principal, Research), Siemens G.A., Take, W. A.

## Courses

### GENG 840 GeoEngineering Seminar

Illustrate all areas of GeoEngineering research and practice; emphasis on breadth and interdisciplinary aspects; preparation, delivery and audience participation in oral presentations; the course links students from departments participating in the Collaborative Graduate Program in GeoEngineering; opportunities are provided to develop and refine presentation skills, to give and receive constructive criticism, and to pose and respond to questions. Instructors: GeoEngineering faculty, Invited lecturers.

### GENG 842 Special Topics in Geoengineering II

A course unit will be composed of two modules on various topics in GeoEngineering and Applied Geoscience. Each module will consist of a workshop or short course as approved by the GeoEngineering Graduate Coordinator. The unit will be completed within two years. Specific modules to be available during each academic year will be announced in September or, in exceptional circumstances, as opportunities arise. I.D. Moore Term: F, W, S as modules are available.

### GENG 843 Special Topics in Geoengineering III

Current topics of interest to geoenvironmental students, as well as other engineering and nonengineering students, will be presented. Fall, Winter, Summer (when lecture is available).

Faculty and visiting instructors (managed by I.D. Moore,  
GeoEngineering Graduate Coordinator)

**GENG 844 GeoEngineering Short Course- I**

The course will be a one or two day short course on various topics in GeoEngineering and Applied Geoscience, as approved by the GeoEngineering Graduate Coordinator. Specific short courses will be available during each academic year as announced in September or as opportunities arise. (1.5 credit units)

**GENG 845 GeoEngineering Short Course- II**

The course will be a one or two day short course on various topics in GeoEngineering and Applied Geoscience, as approved by the GeoEngineering Graduate Coordinator. Specific short courses will be available during each academic year as announced in September or as opportunities arise. (1.5 credit units)