

MINING ENGINEERING

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The mineral industry deals with the excavation and processing of ore to obtain the mineral products required by contemporary society. To meet industrial requirements, the curriculum of Mining Engineering provides three closely associated options: Mining Engineering, Mineral Processing and Environmental Engineering and Mine-Mechanical Engineering. The Mining Engineering Option, in addition to the fundamentals of mining, includes elements of earthworks and excavation for both surface and underground. In the Mineral Processing and Environmental Engineering option, the subjects addressed include the design, operation and control of ore treatment plants and the environmental control systems required by government regulations. The Mine-Mechanical option produces mining engineers who understand the design, modification, automation, use and maintenance of heavy and specialized equipment in the mining industry.

Options available:

- Mining Option
- Mineral Processing Option
- Mechanical Option

Programs

- Mining Engineering, B.A.Sc. (Class of 2022) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mining/mining-engineering-basc-class-2022/>)
- Mining Engineering, B.A.Sc. (Class of 2023) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mining/mining-engineering-basc-class-2023/>)
- Mining Engineering, B.A.Sc. (Class of 2024) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mining/mining-engineering-basc-class-2024/>)

- Mining Engineering: Electives (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mining/mining-engineering-electives/>)

Courses

MINE 101 Cdn Primary Industry Global Ec Units: 3.00

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 102 Engineer & Large Organizations Units: 3.00

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 103 Industry & Innovations Since45 Units: 3.00

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 201 Introduction to Mining and Mineral Processing Units: 4.00

This course presents an overview of all aspects of mining from exploration, financing, development and mining operations. Underground and open pit mining are contrasted. Mineral processing systems for the production of gold, diamonds, copper, nickel, zinc and iron will be studied. Topics include decision-making process related to world market commodity pricing, mine planning and design, mining equipment, blasting and environmental considerations. Concepts of sustainability from economic, social and environmental perspective will be explored. Case studies, a major field trip and related assessment will be used to illustrate principles taught and how they are applied in a practical situation.

Requirements: Registered in a MINE-M-BAS

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 211 The Canadian Mineral Industry Units: 2.50

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 212 The Canadian Mineral Industry Units: 3.50

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 216 Computing In Mining Units: 3.00

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

**MINE 220 Explosives Technology Units: 4.50**

This course covers the properties of explosives and the basis for the selection of explosives for specific applications. It includes an introduction to the theory of detonation (ideal and non ideal), sensitivity, performance and numerical modelling of detonation, and the description of modern commercial explosives including typical compositions, mixing, priming and handling. Specific problems related to the use of explosives such as desensitization, sympathetic detonation, gas and dust explosions, as well as the technology associated with initiation methods are also discussed. (0/18/0/36/0) ~ COURSE DELETED IN 2008/09 ~

Requirements: Must be registered in BASC

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 222 Mineral Processing Systems Units: 3.00

Requirements: Must be registered in BASC

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 244 Underground Mining Units: 3.00

A study of underground mining technology with special reference to economic optimization in both design and production. Conventional and up to date mining methods are reviewed. Developments and trends in mining methods are closely analyzed. Mine design is studied in relation to ore reserves, tonnage and grade distribution, equipment with emphasis on the growing importance of maintenance on underground machinery and capacities of various production units. Development and production costs associated with mining are an inherent aspect of this course. The problems and possibilities of existing and evolving mining techniques are reviewed.

Requirements: Prerequisites: MINE 201 and re

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 267 Applied Chemistry for Mining Units: 3.50

This course provides an overview of the chemistry of inorganic and organic compounds used in the practice of mining and mineral processing including hydro- and pyro-extractive methods. Chemistry and chemical interactions for selected reagent formulations used in blasting, flotation/flocculation, leaching/precipitation, solvent extraction/electrowinning and pollution control technologies are outlined with relevant stoichiometry. Mineral stability and its relevance to metal extraction is discussed. Unary, binary and ternary phase diagrams are explored. The properties of solutions of interest are reviewed.

Requirements: APSC 131 and registered in BASC

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 268 Analytical Methods in Mining Units: 1.00

This course exposes the students to the analytical techniques utilized in the mining and the mineral processing industries. The first part of each laboratory includes the principles of the analytical technique while the second part is concerned with the practical use of the technique. The analytical techniques are typical of those of analytical groups in most mining companies. The techniques studied include: sampling, digestion, Atomic Absorption Spectroscopy, Induction Coupled Plasma Spectroscopy, X-Ray Diffraction and fire assay. Safety in handling of hazardous chemicals is emphasized with a review of selected Material Safety Data Sheets and industry standards.

Requirements: PREREQUISITE: APSC 131 and registered in a BSCE or BASC Academic Program. COREQUISITE: MINE 267

Offering Faculty: Fac of Engineering Appl Sci

MINE 272 Applied Data Science Units: 4.50

This course presents a comprehensive overview of the key elements of data science for engineers. Topics include data cleaning, organization and manipulation, data collection, visualization and noise filtering. Data analysis techniques including regression, decision trees, feature selection, clustering and classification are covered. Emphasis is on spatial analysis and visualization, as well as the analysis of time series. An introduction to advanced topics such as deep learning, big data management and analysis is provided. The focus is on the practical application of data science in the engineering context to make predictions and decisions based on the statistical inference of data.

Requirements: APSC 143 or CISC 101, and CHEE 209 or MTHE 367, or permission of the department

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 301 Intro To Recycling Units: 3.00

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 310 Adv. Survey - Mining Engineers Units: 2.75

Requirements: (CIVL211 AND MINE326) OR (CIVL211 AND MINE467)

Offering Term: N

Offering Faculty: Fac of Engineering Appl Sci

MINE 321 Drilling & Blasting Units: 4.50

This course deals with the principles of commercial explosives technology and the application of blasting in mining and construction. The planning, design, economic considerations and trends of drilling and blasting practices in the different segments of the mining and construction industries are considered. Topics covered are detonation theory, performance and sensitivity of explosives, fragmentation prediction measurement and control, vibrations from blasting, air blast, damage and special blasting techniques used in perimeter blasting and blast design methods.

Requirements: Prerequisite: MTHE 367 or CHEE

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 324 Hydraulics/Mining Applications Units: 3.50

The fluid mechanics basic to fluid hydraulic systems used in the mineral industry are introduced. Topics covered include properties of fluids, fluid statics and its application to mining. Hydrodynamic studies include the energy balance and Bernoulli's equation, energy losses in incompressible flow, the momentum equation and its application, and flow and pressure measuring devices. Flow in closed conduits, including series and parallel pipeline systems and pipe networks, is studied in detail and open channel flow is introduced. Applications include industrial pumps, sump design, hydraulic structures, underground mine dewatering systems, open pit mine drainage systems, and mine backfill and mine tailings transportation.

Requirements: Prerequisite: MTHE225, MECH230, or CHEE 210 or the permission of the instructor

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 325 Applied Rock Mechanics Units: 4.50

This course deals with the principles of solid mechanics as applied to geologic materials in order to examine the effects of stress, strain and other factors on the geomechanical responses of such materials to these influences. Topics covered include rheological behaviour of rocks, stress measurement and prediction, and measurement procedures for determination of rock strength and other characteristic parameters. Failure theories are discussed and used to describe fracture development and design considerations for underground and surface mine structures. Analytical techniques based on empirical knowledge and supported by available theory and engineering practice are presented, including, for example: slope stability, underground structure and rock foundation design; the influences of ground water, rockbursts and backfill support on structural stability of excavations; and discussion of potential hazards associated with each. The operation and design of instrumentation used for rock mechanics studies are also discussed. (only offered in 2018-2019 & 2019-2020, same course as MINE 325)

Requirements: CIVL230 and MINE201 or permission

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 326 Operations Research Units: 4.50

The course deals with the application of operations research methods in engineering with emphasis on mining applications. Topics covered are linear programming, optimization methods, transportation and network models, discrete optimization, non linear optimization, decision tree methods, simulation and elements of geostatistics as applied to mining. Lab sessions also deal with forecasting techniques, regression analysis, dispatch problems, planning and scheduling.

Requirements: APSC143

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

**MINE 330 Mineral Industry Economics Units: 3.50**

This course for students in Mining Engineering and allied disciplines will apply basic principles of economic evaluation learned in APSCI 221 to the minerals industry. Topics covered include: the project definition and economic evaluation process; economic analysis tools and techniques; taxation; inflation; cost estimation; the nature of mineral supply and demand; mineral commodity markets and pricing; uncertainty and risks associated with the mining industry, their analysis and incorporation into the evaluation process. Assignments, examples, and tutorials reflect a variety of situations and challenges faced in the evaluation of exploration and mine development opportunities, as well as important applications to mining and mineral processing design and decision-making.

Requirements: APSC 221

Offering Faculty: Fac of Engineering Appl Sci

MINE 331 Methods Of Mineral Separation Units: 4.50

Mineral separation processes of a physical and physicochemical nature are studied with laboratory sessions. Topics include size reduction, classification, flotation, flocculation, gravity concentration, magnetic, electrostatic separations and dewatering. Surface phenomena involving fine particle processing, reagent classifications, flotation machines and circuits, plant practice in ore flotation are discussed. The laboratory practice includes a design project on flotation circuit analysis and sizing. Assignments will be completed based on field trip observations.

Requirements: Prerequisite: MINE 201 or GEOE 281, MINE 267 or GEOE 365 or CHEE 221 or permission of the instructor

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 332 Flotation Units: 4.50

Requirements: Must be registered in BASC

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 333 Review Of Flotation Units: 4.50

Requirements: Must be registered in BASC

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 334 Intro. To Financial Analysis Units: 1.00

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 335 Mineral Processing Units: 3.00

Mineral separation processes of a physical and physicochemical nature are studied. Topics include size reduction, classification, flotation, flocculation, gravity concentration, magnetic, electrostatic separations and dewatering. Surface phenomena involving fine particle processing, reagent classifications, flotation machines and circuits, plant practice in ore flotation are discussed. Quantitative understanding of various topics is aided through problem solving in class and assignments on mass balancing, kinetic analysis and circuit sizing.

Offering Faculty: Fac of Engineering Appl Sci

MINE 339 Mine Ventilation Units: 4.50

Hydraulics of air flow through mine openings and ducts is studied, leading to mine ventilation design calculations and ventilation network analysis. Topics related to the design of mine ventilation systems include: statutory regulations and engineering design criteria, ventilation circuit design, natural ventilation, testing, application and selection of mine ventilation fans, auxiliary ventilation design, psychrometry, mine air heating and cooling, dust and fume control, and ventilation economics. Health hazards of mine gases, dust and radiation are reviewed, together with statutory requirements for air quality. Procedures for conducting air quantity and quality surveys are also taught. Ventilation Laboratory: Modern laboratory instruments are used to determine the characteristics of air hydraulics, to investigate fan selection procedures and to conduct mine circuit designs. Experiments are also performed to evaluate dust and fume contents of the air and to measure radon gas and daughter products. Air flow measuring techniques to determine air flow characteristics of mine openings are studied.

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 340 Operations Research Units: 3.75

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 341 Open Pit Mining Units: 4.50

This course presents technologies and techniques employed in open pit mining with a focus on strategic and operations planning considerations. Topics of study include: pit design, application of algorithms for economic pit limit analysis, equipment selection, production scheduling, material control and reconciliation, remote sensing and geomatics applications, mine waste management, emerging trends in open pit mining, and mine safety. Regulatory controls and best practices in design are stressed for all stages of the mine life cycle. Environmental impacts of design decisions and mitigating strategies are explored. The use of software at various stages of the design and planning process is introduced and a strategic design project completed using commercial software applications.

Requirements: APSC 221 and MINE 201

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 344 Underground Mining Units: 4.00

The fluid mechanics basic to fluid hydraulic systems used in the mineral industry are introduced. Topics covered include properties of fluids, fluid statics and its application to mining. Hydrodynamic studies include the energy balance and Bernoulli's equation, energy losses in incompressible flow, the momentum equation and its application, and flow and pressure measuring devices. Flow in closed conduits, including series and parallel pipeline systems and pipe networks, is studied in detail and open channel flow is introduced. Applications include industrial pumps, sump design, hydraulic structures, underground mine dewatering systems, open pit mine drainage systems, and mine backfill and mine tailings transportation. (0/12/0/30/0)~ COURSE DELETED IN 2009/10 ~

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 350 Operations Research Units: 3.00

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 422 Mining And Sustainability Units: 4.00

This course describes the evolution of policies, operational procedures and management systems related to sustainability and the social, economic, environmental, ethical, and technical design challenges facing the mining industry. Themes examined will include: international and national performance expectations, standards and regulations; operational and management responses; social and environmental impact risk assessment; stakeholder engagement; impact mitigation planning and risk management systems; performance monitoring, evaluation and reporting; agreement making and benefit sharing. Students will be introduced to a range of complex situations with significant sustainability implications that need to be addressed responsibly during the life cycle of a mine, such as land acquisition, population and livelihood displacement, cultural heritage and habitat preservation, water use, waste disposal, mining-community relationships, mine closure and its community and environmental implications.

Requirements: Must be registered in BASC

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 431 Life-Cycle Assessment for Green Technologies Units: 3.50

Life-cycle assessment (LCA) is an ISO standardized framework (ISO 14040/44) for comprehensively examining and assessing the environmental impacts associated with industrial products and systems. It has been widely used by businesses and governments to support decision-making for product design and development, ecolabelling, public policy and planning, and environmental impact assessment for new technology. This course introduces the concepts and procedures of LCA, and critically reviews empirical LCA studies at both the product and systems levels, with a special focus on material cycles (mining, processing, metallurgy, metals, manufacturing, end-use, and recycling). Case-study-based learning activities are incorporated to explore the appropriate use and limitations of LCA databases and software as a tool for sustainability assessment. Topics include: systems thinking of sustainability and sustainable development; greenhouse gas (GHG) and carbon footprint accounting; the ISO LCA framework and its requirements; methods of life-cycle inventory analysis; methods of life-cycle impact assessment; interpretation of LCA results; uncertainty and sensitivity in LCA; LCA applications in assessing low-carbon technologies and products; life-cycle cost analysis; social life-cycle assessment; life-cycle management and its contribution to the circular economy and SDGs.

Requirements: MINE 431 Pre-reqs

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

**MINE 434 Project Report Units: 4.00**

In this course, the student is exposed to research in the mining, mineral processing and metal extraction industries. The work is performed under the supervision of a Faculty member. Standing is based on the work done, the ability of individuals to meet project deliverables according to the schedule provided, and individual written and oral presentations made. The deliverables include a research proposal, a research plan and literature review, an oral seminar presentation and a final report in the form of a technical paper. The deliverables can be based on research performed during the fall and winter terms, as an extension of a summer employment research project, or literature-derived research information. Emphasis is placed on the critical treatment of the data obtained to produce useful conclusions.

Requirements: Registered in the BASC with completion of all 2nd and 3rd courses in MINE and or permission of the department

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 439 Environmental Health Eng. Units: 4.50

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 440 Operations Research (With Lab) Units: 3.75

Offering Faculty: Fac of Engineering Appl Sci

MINE 445 Open Pit Mine Design Units: 5.50

The material of MINE 341 is applied to the design of an open pit mine. Special attention is given to the selection of equipment and the use of computers in strategic and detailed mine planning and scheduling. The course uses commercial mine planning software to enable small groups of students (2-4) to complete mine designs starting with topography maps, drill information, and mineral inventory block models. Several real deposit databases are used including gold, copper, copper/molybdenum, copper/zinc. The deposits are evaluated, feasibility assessed, and production decisions discussed.

Requirements: (MINE341 AND MINE326) OR (MINE441 AND MINE326) OR (MINE441 AND MINE467) OR (MINE341 AND MINE467) OR (MINE441 AND MINE326) OR (MINE441 AND MINE467)

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 447 Econs. Of The Mineral Industry Units: 3.00

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 448 Underground Design Units: 5.50

This course provides an opportunity to apply a knowledge of basics to the design of an underground mine. Initial design information may range from diamond-drill assay data to a partially or completely designed mine. The problem of design or renovation entails ground stability, ventilation, systems analysis, equipment selection, maintenance, etc, with safety and economics as the basic criteria for design.

Requirements: Prereq: APSC 221, MINE 344, MINE 339, MINE 225 or MINE 325, MINE 467 AND MINE 469 or permission of the instructor

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 451 Chemical Extraction Of Metals Units: 4.00

The recovery and recycling of metals by both hydrometallurgical and pyrometallurgical techniques is discussed. The thermodynamic and kinetic aspects of the solutions utilized in these processes are reviewed. The major unit operations of the hydrometallurgical and pyrometallurgical processes are studied. For hydrometallurgy, the unit operations are; ion exchange, solvent extraction, cementation, purification, precipitation, electrowinning and electrorefining. Particular emphasis will be placed on the recovery of gold. For pyrometallurgy the unit operations are; roasting, agglomeration, calcination, smelting, converting, refining and electrolysis. In the course, the importance of environmental stewardship in metal extraction is stressed.

Requirements: MINE 331 or permission of the instructor

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 452 Bus. Org. For Mineral Industry Units: 3.00

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 453 Pyrometallurgy Units: 4.00

Requirements: Must be registered in BASC

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 454 Hydrometallurgy Units: 3.00

Requirements: Must be registered in BASC

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 455 Design, Analysis and Operation of Mineral Processes Units: 4.50

Engineering elements of a mineral processing project are examined from the concept stage to process design. Flowsheet evaluation, process equipment selection and layout, capital and operating costs, operating and control strategies are considered for real problems.

Requirements: MINE331

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 456 Cont Mining @ Mats Handling Units: 3.50**Offering Term:** F**Offering Faculty:** Fac of Engineering Appl Sci**MINE 458 Process Investigations Units: 4.00**

Projects may involve design of new processes, re-design of existing processes, process simulation and process innovation. Oral presentations and a formal report are required at the end of the term.

Requirements: MINE455**Offering Term:** W**Offering Faculty:** Fac of Engineering Appl Sci**MINE 459 Risk and Reliability Analysis for Industrial Asset Management, Health & Safety Units: 4.00**

This course covers the analytical techniques and tools which form the foundations required for application of the ISO 55000 series of standards for effective life-cycle management of physical assets, as well as the ISO 45000:2018 standard for occupational health and safety management systems. The course uses risk analysis as the primary lens to investigate and evaluate a broad range of industrial challenges, ranging from equipment reliability and maintenance planning strategies, through to identification and mitigation of workplace health and safety hazards. Methodologies covered include Failure Mode, Effects, and Criticality Analysis (FMECA), Reliability Centred Maintenance (RCM), Hazards and Operability Analysis (HAZOP), and Internal Responsibility Systems (IRS) for Safety Management. The role of legislation and regulations is addressed. Selected topics in industrial hygiene, including exposure limits, are also surveyed. Examples and case studies from a variety of industry sectors are used.

Requirements: Must be registered in BASC**Offering Term:** W**Offering Faculty:** Fac of Engineering Appl Sci**MINE 460 Special Topics In Mining Engr Units: 4.50**

This course will change from year to year as subjects of special interest to mining engineers arise, or as special staff are available.

Requirements: Must be registered in BASC**Offering Term:** F**Offering Faculty:** Fac of Engineering Appl Sci**MINE 462 Occ Hlth/Safety In Mining Prac Units: 3.50**

Affirms a societal rationale and framework for due diligence in health, safety and environment (HS&E). Considers the five principal categories of workplace environmental factors that may lead to ill health / death, and introduces the principles (strategies and techniques) of exposure assessment (relative to both regulatory and professional standards) and control, as part of the Anticipation-Recognition-Evaluation-Communication-Control sequence. Enables the student to resolve, by means of memorandum, a specific topical occupational health issue. In addition to providing the basic tools for undertaking occupational health risk assessment / management, reviews fundamental chemical (non-toxicological) hazards and risk parameters.

Requirements: PREREQUISITES: Completion of 3rd year Mining Engineering or permission of the instructor.**Offering Term:** W**Offering Faculty:** Fac of Engineering Appl Sci**MINE 463 Management & Human Relations Units: 3.00****Offering Term:** W**Offering Faculty:** Fac of Engineering Appl Sci**MINE 465 Mining & The Environment Units: 3.00****Offering Term:** W**Offering Faculty:** Fac of Engineering Appl Sci**MINE 467 Geostatistics and Orebody Modelling Units: 4.50**

This course introduces those principals of geostatistics used in evaluating grade distribution in orebodies from drillhole data. Basic concepts of spatial distributions, sampling, distance weighted averages, and variograms are covered. Cases from practice will be employed to illustrate concepts. Use of commercially available software to carry out geostatistical calculations and graphical representation will be made. Utilizing these techniques, students will develop a block model of ore grade distribution for an orebody and then apply this model to a mine pre-feasibility study in a subsequent course.

Requirements: PREREQUISITES: MINE 326, or GEOE 359, or permission of the instructor. Must be registered in a BASC Academic Program.**Offering Term:** F**Offering Faculty:** Fac of Engineering Appl Sci**MINE 468 Gold Extraction Units: 4.50****Requirements:** Must be registered in BASC**Offering Term:** W**Offering Faculty:** Fac of Engineering Appl Sci

**MINE 471 Mine-Mechanical Design Project Units: 5.50**

This course involves a design project with emphasis on the mechanical aspects of mine or plant design and operation. Typical topics include mobile equipment, materials handling, automation, equipment redesign and systems integration.

Requirements: Must be registered in BASC

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 472 Mining Systems, Automation, and Robotics Units: 3.50

In order to address issues related to safety, productivity, and remote operations, the world's mineral resources industry has been gradually shifting towards the increased use of automated systems and robotically enhanced machines. It is important, therefore, that graduate engineers understand how these new technologies work so as to improve and make best use of them. This online course introduces senior students to the fundamental tools and techniques of automation and robotics as applied to modern mining practice. Enrolment is open to students from a range of engineering disciplines. This course provides an introduction to the basics of systems control, examples of how methods of automatic control can be applied to mining equipment and associated industrial vehicles, as well as to the fundamentals of sensing and navigation as applied to the design of robotic mobile equipment.

Requirements: ELEC443 or MECH350 or MTHE332

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 800 Mining Systems and Processes Units: 3.00

This course provides an overview of mining systems and processes and is intended to be presented to graduate students and professionals interested in the mining industry. The course is given in modules by faculty and spans a range of topics from mining to mineral processing with emphasis being placed on mining methods, methods of rock breakage, review of ground stability, ventilation, materials handling, mineral beneficiation, economic and environmental assessments, and corporate social responsibility.

Offering Faculty: Fac of Engineering Appl Sci

MINE 801 Community Aspects of Mineral Resource Development Units: 3.00

This course provides students with a thorough understanding of community issues associated with mineral resource development. It provides context and examples to demonstrate how the industry response to these issues has changed over time. The business case for a disciplined approach to community engagement and relationship building is outlined. It introduces the topics of community development, community engagement, and indigenous issues which are further explored in subsequent courses.

Offering Faculty: Fac of Engineering Appl Sci

MINE 803 Community Engagement and Mining Units: 3.00

This course extends the exploration of a range of community development and community engagement domains, techniques and skills, relating to social technique, participatory approach to community development planning and programming; the use of partnerships as a vehicle for participatory development; social impact assessment; community engagement planning; program monitoring and evaluation. It expands and reinforces the participant's understanding of how the application of professional approaches and methods can assist communities and companies to build sustainable, organized relationships and structures within the broader context of mining and development practice, locally, nationally, and globally.

Offering Faculty: Fac of Engineering Appl Sci

MINE 804 Mining Projects and Indigenous Peoples Units: 3.00

This course examines the social, political and economic relationships that exist between Indigenous Peoples and external parties in the development of commercial mining operations. The course will review specific social, political and economic issues arising from the engagement of Indigenous Peoples with the minerals industry, and the skill sets and knowledge base that are critical to negotiating positive relationships between Indigenous Peoples and mining companies.

Offering Faculty: Fac of Engineering Appl Sci

MINE 812 Underground Mining Units: 3.00

This course provides a comprehensive discourse of all aspects of underground mining. It is designed to provide engineers with full knowledge to develop strategic and tactical mine planning and to incorporate all aspects of underground mining, including method selection, design, planning, scheduling, development and production. Classification methodologies are introduced to permit selection of a mining method based on orebody characteristics. The program includes description and application of underground mining methods, equipment selection and basic requirements. Layout and design of underground mine development and production and related equipment requirements are presented. Support services, including ground control, ventilation, dewatering, backfill, compressed air are introduced.

Offering Faculty: Fac of Engineering Appl Sci

MINE 814 Advanced Ventilation and Environmental Mine Engineering Units: 3.00

The development of basic airflow models and complex ventilation networks are discussed in depth, and practical design studies using computerized techniques are developed. Topics related to ventilation calculation and design include: mine regulations and engineering design criteria, basic and complex circuit evaluation and design, natural ventilation, fan selection, auxiliary ventilation design, ventilation surveys and ventilation economics. The total environment of mines and air quality control are studied in detail, and include mine gases, mine dust, heat control and radiation hazard and control in mines. Three term-hours, fall term; lectures. E.M. de Souza

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 817 Advanced Explosives Technology Units: 3.00

Detonation theory and its applications. Topics include: Detonation theory, equations of state, experimental techniques for measuring explosive properties, initiation and sensitivity, shaped charges, metal working with explosives, commercial explosives, metal loaded explosives, dust explosions, pressure desensitization, numerical methods. Three term-hours, winter term; lectures. P. Katsabanis

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 818 Rock Mechanics Units: 3.00

Theories and application of rock mechanics principles in underground and open pit mine design are discussed. General areas of concentration include assessment of elastic for rock; the determination and influence of in-situ stress on excavation stability; evaluation of ground movement, subsidence and convergence; review of rock slope stability factors and mitigation techniques for stabilization; and assessment of contemporary and innovative measures for ground support provision in underground mines.

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 819 Numerical modelling in mining geomechanics Units: 3.00

This course introduces numerical modelling methods used in mining geomechanics. The basic theory and use of finite difference, finite element, boundary element continuum and discrete particle discontinuum codes will be reviewed with the objective of providing an understanding of the mathematical basis for each method, and their major differences. The emphasis will be on building and interpreting models

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 820 Topics In Drilling & Blasting Units: 3.00

Rock failure in blasting. Topics include fragmentation, influence of joints and rock structure, theory of fracturing and crack propagation, cratering, blasting-induced vibrations and damage, wall control techniques, numerical methods. Three term- hours, fall term; lectures. P. Katsabanis

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 821 Hydrometallurgy and electrometallurgy: Theory and practice Units: 3.00

This lecture- and seminar-based course covers the advanced topics about hydrometallurgy and electrometallurgy. The course involves the theory of leaching, solid liquid separation, solvent extraction and ion exchange, chemical precipitation and electrometallurgy. In addition, several process options and flowsheets for the recovery of selected base metals (copper, zinc and nickel) and gold will be presented. Each student will perform a literature survey, write a report and present on a topic of interest.

Offering Term: FWS

Offering Faculty: Fac of Engineering Appl Sci

**MINE 828 Seismicity in Mines Units: 3.00**

This course provides a broad overview of seismicity in mines, ranging from its causes, source mechanisms, waveform analysis, influence of geological factors including stresses, monitoring systems, analysis of seismic data, and applications of seismic data analysis in mining geomechanics and mine design. Familiarity with principles of rock mechanics and structural geology are assumed for the course.

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 832 Flotation Science & Technology Units: 3.00

Roles and applications of flotation in the mining industry, tailings management, recycling and environmental clean-up are discussed. The topics include both interfacial aspects such as wettability, electrical double layer theories, dispersion/coagulation/flocculation, reagent interactions, as well as the engineering aspects such as sampling/mass balancing, kinetics and circuit design. Primary examples of technologies related to processing of sulphide ores, non-sulphides, salts, coals and tar sands are covered. The course includes laboratory sessions on selected topics.

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 834 Advanced Geostatistics for Modelling Uncertainty in the Earth Sciences Units: 3.00

This course introduces the theory and practice of advanced geostatistics to characterize the uncertainty in spatially distributed attributes in the Earth Sciences. The course presents tools and modelling workflows, including multi-Gaussian simulation, indicator simulation, and multiple-point statistics. Multivariate techniques will also be reviewed, and examples will be provided in a mining context. The audience is engineers and geoscientists from all relevant engineering and applied science disciplines who have an interest in models of Earth systems.

Offering Faculty: Fac of Engineering Appl Sci

MINE 835 Applied Machine Learning Units: 3.00

This course introduces the theory and practice of machine learning for graduate engineering students. The course presents tools for analysis and prediction using machine learning techniques, including regression, support vector machines, hidden Markov models, ensemble methods, supervised and unsupervised learning. The course will be focused on the fundamentals of these techniques, the advantage, disadvantage and usage context of each technique, and their application in the engineering field. Engineering examples for each topic will be provided. **PREREQUISITE:** Students must have taken a probability and statistics course (e.g. MTHE 367 or equivalent).

Offering Faculty: Fac of Engineering Appl Sci

MINE 836 Mineral Process & Environment Units: 3.00

The objective of this course is to provide an introduction to mineral processing unit operations with regards to final product production. Process selection criteria will be highlighted including economics, efficiency, and geographic location. Environmental issues associated with producing metals from a variety of ore types will be examined including tailings treatment/impoundment methods and pyrometallurgical and hydrometallurgical refining techniques. Three term-hours, fall and/or spring term, lectures. S. Kelebek

Offering Term: N

Offering Faculty: Fac of Engineering Appl Sci

MINE 838 Project Decision-making in Extractive Metallurgy Units: 3.00

The goal of this course is to provide an opportunity for students to use information from their undergraduate courses to make decisions on projects of the type that they may face in their future careers. The course will analyze actual project case histories in mining and process metallurgy and evaluate them from technical, economic, and risk perspectives. The objective of each case will be to confront the student and/or group with a decision point similar to that faced in the actual situation. The students will work individually and/or in small groups in an interactive tutorial setting to develop each case for class presentation. There will also be opportunities for interaction with invited experts from industry. The course will show students how to use the key evaluation tools for objective project and process decision-making in mining and process metallurgy.

Offering Faculty: Faculty of Arts and Science

MINE 839 Advanced Pyrometallurgy Units: 3.00

In this course, pyrometallurgical technologies for metals extraction are discussed and evaluated. This includes basic thermodynamics, solution thermodynamics and alternative standard states. Models of metallurgical solutions are examined. Stability diagrams are utilized to understand processes and predominance area diagrams are used to explain roasting. Current research areas in pyrometallurgy are discussed with emphasis on energy and the environment.

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

MINE 851 Risk Analysis for Industrial Asset Management, Health and Safety Units: 3.00

This course covers the analytical techniques and tools which form the foundations required for effective life-cycle management of physical assets, as well as for occupational health and safety management systems. The course uses risk analysis as the primary lens to investigate and evaluate a broad range of industrial challenges, ranging from equipment reliability and maintenance planning strategies, through to identification and mitigation of workplace health and safety hazards. Selected topics in industrial hygiene, including exposure limits, are surveyed. Methodologies covered include Failure Mode, Effects, and Criticality Analysis (FMECA), Reliability Centred Maintenance (RCM), and Internal Responsibility Systems (IRS) for Safety Management.

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 852 Mine Mechanization and Automation Units: 3.00

Objectives, constraints, and methodologies for mechanization and automation. Modelling and simulation of mining processes and equipment. Equipment monitoring. Production monitoring. Navigation and automatic guidance of mobile equipment, including inertial navigation and GPS. Dispatching and scheduling systems. Mine-wide communications systems. SCADA (Supervisory control and data acquisition) systems. Teleoperation and Telerobotics technologies. Machine design in the context of mechanization and automation; reliability and maintainability. Technology transfer issues. Case studies of both surface and underground mines. Three term hours, fall and winter term; lectures. L.K. Daneshmend

Offering Term: W

Offering Faculty: Fac of Engineering Appl Sci

MINE 860 Selected Topics in Mining Engineering Units: 3.00

This course is intended for students at both the Masters and Doctoral levels who already have a good background in fundamental topics related to their research or course-based programs of study, and who are interested in broadening their exposure to other subject areas of mining engineering that are not offered through existing graduate courses. Topics will focus on either mining, mineral processing or mine-mechanical-related areas of mining engineering, and will be presented through lectures, seminar presentations, open classroom discussion and self-directed independent study. The specific course content to be taught to students will be posted in writing at the beginning of each term in which this course will be given, and the deliverable will be presented publicly at the end of the term, and will take the form of a lecture, bibliographic review, proof of concept or other deemed appropriate by the supervisor. Marking for the course will be assessed on the basis of student assignments, written reports and classroom presentations.

Offering Faculty: School of Graduate Studies

MINE 865 Directed Research Units: 3.00

This course is intended for students at both the Masters and Doctoral levels who already have a good background in fundamental topics related to their research or course-based programs of study. The course is created by a professor in agreement with a student to explore an area of common interest that may have the potential of adding to the student's research thesis topic. The course deliverable may consist of a final report, a lecture, a short research project, a paper, a prototype, or a computer code.

Offering Faculty: Fac of Engineering Appl Sci

MINE 881 Mining Systems Units: 3.00

This course reviews the processes involved in a mining operation in the context of efficiencies in the use of resources, energy and water. The engineering design stages and unit operations are discussed from a systems perspective. Case studies illustrate factors for success and failure of projects. This course is exclusively online.
EXCLUSIONS: MNTC305/MINE-800.

Offering Faculty: Fac of Engineering Appl Sci

MINE 882 Advanced Mineral Economics Units: 3.00

Mineral economics spans theory, industry knowledge, government policies, finance and investment. Students will explore topics in foundational economic theories, regulation of the industry, tools and applications, feasibility assessment and disclosure, project evaluation, and changes needed in tools and practices to better integrate sustainability. This course is exclusively online.

Offering Faculty: Fac of Engineering Appl Sci



MINE 885 Mineral Processing Units: 3.00

: This course presents the unit operations in mineral processing, and discusses process selection criteria, considering new available technologies. Equipment selection, efficiencies, and performance are analyzed in light of product requirements for subsequent metallurgical operations. Techno-economic and environmental aspects are discussed.

Offering Faculty: Fac of Engineering Appl Sci

MINE 897 Graduate Seminar Units: 6.00

Each student is required to make a presentation concerning his project or research at least once per calendar year. For those students who may only be enrolled in part-time studies, or who may be completing their degree requirements off campus, this requirement may be met through submission of electronic media presentation, which can be viewed, by staff and students, during a regularly scheduled seminar session. This is a non-credit course which each student must pass successfully. J. F. Archibald

Offering Faculty: Fac of Engineering Appl Sci

MINE 898 Master's Project Units: 3.00

Offering Term: FWS

Offering Faculty: Fac of Engineering Appl Sci

MINE 899 Master's Thesis Research Units: 6.00

Offering Term: FWS

Offering Faculty: Fac of Engineering Appl Sci

MINE 999 Ph. D. Thesis Research Units: 6.00

Offering Term: FWS

Offering Faculty: Fac of Engineering Appl Sci