Faculty of Engineering

80 The Faculty of Engineering

Since 1908, the Faculty of Engineering has been responding to the evolving needs of the engineering profession through innovative programs and exceptional teaching. With over 6,000 students from 65 countries, the Faculty of Engineering at the University of Alberta is one of the largest and most diverse in North America. The Faculty offers nine accredited undergraduate engineering programs, as well as a full range of graduate programs.

The mission of the Faculty of Engineering is

- to produce engineering graduates of choice for employers and postgraduate schools and to produce graduates who can carry out forefront engineering design and research
- to produce nationally and internationally recognized engineering research
- to provide high-quality service to the engineering profession and the external community

The Engineering Profession

Engineering is a creative profession with a powerful and respected tradition of accountability and service. The completion of a BSc degree in Engineering from the U of A is your first step on the road to becoming a professional engineer. As a graduate, you may register with a professional engineering association, and following a period of recognized work experience, practice engineering around the world.

Faculty Awards and Accomplishments

Talented, successful teachers and researchers are key to the success of this Faculty. It is through the efforts of Engineering professors that the Faculty is able to maintain its position on the leading edge of discovery and dissemination of engineering knowledge. Our vibrant community of scholars conducts fundamental and applied research, collaborating extensively with industry and leading international partners in a wide range of fields ranging from oil sands technologies to nanotechnology. With over one million square feet of new teaching and research space, and more than $50M in annual external research funding, our faculty create exceptional opportunities for learning, interdisciplinary research and professional growth. Recent awards and accomplishments of the Faculty include:

- One Canada Excellence Research Chair, Canada's most prestigious federal research chair
- Society for Teaching and Learning in Higher Education 3M Canada Teaching Fellowship – Canada's highest honour for undergraduate teaching

- Two Society for Teaching and Learning in Higher Education 3M Canada Teaching Fellowships – Canada's highest honour for undergraduate teaching
- Two Canadian Council of Professional Engineers Medals for Distinction in Engineering Education
- 12 Rutherford Awards for Teaching Excellence
- Numerous APEGA Awards including: Excellence in Education, Centennial Leadership, Project Achievement, Early Accomplishment, and Environmental Excellence Awards
- Multiple ASTech Science & Technology, Community, and Technology Leadership Awards
- One Order of Canada
- 16 NSERC Industrial Research Chairs, the highest total of any faculty in Canada
- 17 Canada Research Chairs
- 11 Petro-Canada Young Innovator Awards

Student Opportunities, Awards and Accomplishments

The Faculty of Engineering builds on the strengths of our students. High-quality programs, outstanding faculty, and world-class facilities means that we are able to attract exceptional students who realize their full potential by participating in creative and engaging activities in- and outside the classroom. Students in our research-learning environment have the ability to participate in leading-edge, extra-curricular research, with funding available from Faculty, University, and national research award programs. The Faculty of Engineering is home to an incredibly active student body, which provides opportunities to participate in student governance and intercollegiate design projects that compete on both national and international levels. The Faculty has one of Canada's largest Engineering Co-op programs with approximately 1,500 participants. Students in Co-op get real world engineering experience through paid work placements. Some recent student awards and accomplishments include:

- Undergraduate students in the Faculty receive over $1.5 million in scholarships annually (including the CD Howe Foundation Awards for the top first-year male and female engineering students in Canada and Canadian Engineering Memorial Foundation Scholarship Awards).
- Graduate students in the Faculty receive over $6 million in scholarships annually
- Our Discover E Engineering and Science Camp program has won the Google RISE Award, the Actua Award for Leadership and Innovation and the ASTech Foundation Award for Science & Technology Public Awareness
- 35 students in the Faculty of Engineering are varsity level athletes

81 The Professors

Members of the Faculty

Officers of the Faculty

Professor and Dean
DT Lynch, PhD, PEng, FCAE

Associate Deans
T Joseph, PhD, PEng
SK Dew, PhD, PEng

Faculty Service Officer
E Flaim, PhD

Administrative Officers
ME Compton, BA
RC Harper, BA
R Matthias, BA

Biomedical Engineering

Professor and Chair
R Burrell, PhD (Canada Research Chair in Nanostructured Biomaterials)

Professors Emeriti
PS Allen, PhD
DJ Griffiths, PhD
TR Overton, PhD
RE Snyder, PhD

Professors
C Beaulieu, PhD
MA Gorassini, PhD
AH Wilman, PhD

Associate Professors
RB Thompson, PhD

Assistant Professor
N Malykhin, PhD

Faculty Service Officer
C Hanstock, PhD

Chemical and Materials Engineering

Professor and Chair
JF Forbes, PhD, PEng

University Professor Emeritus
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Professors Emeriti
KT Chuang, PhD
IG Dalla Lana, PhD, PEng
RL Eadie, PhD, PEng
DG Fisher, PhD, PEng
AE Mather, PhD, PEng
K Nandakumar, PhD, PEng, FCAE
FD Otto, PhD, PEng, FCAE
BM Patchett, PhD, PEng
SL Shah, PhD, PEng (NSERC/ Matrikon/Suncor/Senior Industrial Research Chair in Computer Process Control)
SE Wanke, PhD, PEng
ML Wayman, PhD, PEng
MC Williams, PhD
RK Wood, PhD, PEng

Professors
R Burrell, PhD (Canada Research Chair in Nanostructured Biomaterials)
K Cadien, PhD, PEng (Canada Research Chair in Nanofabrication and Ingenuity Scholar in Nanofabrication)
W Chen, PhD, PEng
PYK Choi, PhD, PEng
J Cocchio, MBA, PEng (Industrial Professor of Engineering Safety and Risk Management)
A de Klerk, PhD, PEng
JAW Elliott, PhD, PEng (Canada Research Chair in Interfacial Thermodynamics)
TH Etsell, PhD, PEng
MR Gray, PhD, PEng, FCAE (Scientific Director, The Centre for Oil Sands Innovation, NSERC-Imperial Oil Industrial Research Chair and Canada Research Chair in Oil Sands Upgrading)
R Gupta, PhD, PEng
RE Hayes, PhD, PEng
H Henein, PhD, PEng, FCAE, FCIM
B Huang, PhD, PEng (NSERC Senior Industrial Research Chair in Control of Oil Sands Processes)
DG Ivey, PhD, PEng
SM Kresta, PhD, PEng
S Kuznicki, PhD (NSERC/NOVA Chemicals/Senior Industrial Research Chair in New Microporous Molecular Sieves, Alberta Ingenuity Scholar in Separation Technology)
D-Y Li, PhD, PEng
L Li, PhD
Qi Liu, PhD, PEng (Ron Nolan/ Hatch Professor in Sustainable Energy and Mineral Process Technologies)
Qingxia Liu, PhD, PEng
J Luo, PhD, PEng (Canada Research Chair in Alternative Fuel Cells)
DT Lynch, PhD, PEng, FCAE
WC McCaffrey, PhD, PEng
P Mendez, PhD, PEng (Welco-Beales/Industry Chair in Welding and Joining)
D Mitlin, PhD, PEng
C Montemagno, PhD (Canada Research Chair in Intelligent Nanosystems)
W Pick, MSc, PEng (Industrial Professor of Chemical Process Design)
KC Porteous, PhD, PEng
JM Shaw, PhD, PEng (NSERC/ Petroleum Industry Senior Industrial Research Chair in Petroleum Thermodynamics)
J Soares, PhD, PEng, FCIC (Canada Research Chair in Advanced Polymer Reaction Engineering)
T Thundat, PhD (Canada Excellence Research Chair in Oil Sands Molecular Engineering)
H Uludag, PhD, PEng
G Winkel PEng (Program Director of Safety & Risk Management)
Z Xu, PhD, PEng, FCAE (Teck Cominco Professor, NSERC/ Oilsands Industry Senior Industrial Research Chair in Oil Sands Engineering and Canada Research Chair in Mineral Processing)
A Yeung, PhD, PEng (NSERC/ Imperial Oil Associate Industrial Research Chair in Non-Aqueous Bitumen Extraction)

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N Semagina, PhD, PEng

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Administrative Officer
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Professors Emeriti
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MY Boluk, PhD, PEng (Nanofibre Chair in Forest Products)
RJ Chalaturnyk, PhD, PEng
DH-K Chan, PhD, PEng
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D McCartney, PhD, PEng
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DZ Zhu, PhD, PEng

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MK Mandal, PhD, PEng
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M Lipsett, PhD, PEng
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S Mitra, PhD, PEng
WA Moussa, PhD, PEng
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A McDonald, PhD, PEng
P Mertiny, PhD, PEng
P Mousavi, PhD, PEng
D Nobes, PhD, PEng
DW Raboud, PhD, PEng
M Secanell, PhD, PEng
T Tang, PhD, PEng (Canada Research Chair in Nano-biomolecular Hybrid Materials)
R Vehring, PhD, PEng (George Ford Chair in Materials Engineering), PEng

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S Ghaemi, PhD
Aloke Kumar, PhD
R Long, PhD
A Martin, PhD
J Olfert, PhD, PEng
D Sameoto, PhD, PEng
A Vette, PhD

Administrative Officer
G Thomas, MEng, PEng
K Edwards, BA, BEd, MEd

Sessional Lecturer in Engineering
BR Touchings, BA, LLB

Engineering Co-op Department

Associate Professor and Director
T Joseph, PhD, PEng

Assistant Director
S Concini, BSc, PEng

Administrative Officers
C Bjornson, BA, Coordinator
RC Kully, BEd, Coordinator
L Lewington, Coordinator
MT Marks, BCom, Coordinator
A Rumsby, Coordinator
S Sayler, BA, Coordinator
R Sisson, Coordinator
BJ Strang, BA, Coordinator
LJ Szekely, BEd, Coordinator
K Vande Vyvere, BA, Coordinator

Additional Members of Faculty Council

President and Vice-Chancellor
IV Samarasekera, O.C., PhD, PEng, FRSC, FCAE

Registrar of the University
LM Collins

Professors
G Forth, PhD (Anthropology)
N Harris, PhD (Earth and Atmospheric Science)
B Rostron, PhD (Earth and Atmospheric Science)

Associate Professors
H Bruce, PhD (Agricultural, Food and Nutritional Science)
H Graves, PhD (English and Film Studies)
M Salavatipour (Computing Science)

Assistant Professors
E Rivard, PhD (Chemistry)

APEGGA Representative
VSV Rajan, PhD, PEng

Representatives from Engineering Students
C Gee (Undergraduate)
W Liang (Undergraduate)
A Marshall (Undergraduate)
Z Lei (Graduate)
M Marefatallah (Graduate)

82 General Information

82.1 BSc Engineering

The Faculty of Engineering offers undergraduate programs leading to BSc degrees in Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Engineering Physics, Materials Engineering, Mechanical Engineering, Mining Engineering, and Petroleum Engineering.

All engineering students follow a common curriculum in their first year and take courses in Chemistry, Mathematics, Physics, Computing, Humanities, Engineering Mechanics, and Introduction to the Engineering Profession. In March of the first year, students choose among the various engineering disciplines offered and also between the traditional and cooperative education streams. The disciplines and education streams are described in the following sections.

The second-year program includes courses such as Mathematics and English, common to all departments, as well as courses specific to the chosen discipline. As students progress through the program, courses become more specialized. Also, exposure to basic business concepts is important to an engineering education. Programs for all disciplines include courses in engineering economics, and several engineering management and business electives are available.

Enrolment in all Engineering programs is limited.

82.1.1 Engineering Instruction in French

In conjunction with Faculté Saint-Jean, most of the first-year curriculum can be taken in French on the Faculté Saint-Jean campus (see §180). Academic conditions and content of the courses are equivalent to their English counterparts. Note that only a few second-year and higher level courses for Engineering programs are available in French. See §184.10 for further details.

82.2 Cooperative Education Program

The Faculty of Engineering offers two types of degree programs: the traditional program and the cooperative education program. Students in the traditional program attend classes from September to April over four years (eight academic terms) to obtain their degree. In the cooperative education program, students complement their academic studies with five four-month terms of paid work experience. The academic requirements for both programs are identical. Because of the work experience component, Co-op students complete the last six academic terms over four years, so a degree with the Cooperative Program designation requires five years.

The Cooperative Program is offered in all Engineering programs except Engineering Physics and the Biomedical Options in Civil Engineering and Electrical Engineering. Programs normally include one fall work term (September to December), one winter work term (January to April) and three summer work terms (May to August). See §84.4 for the sequence of academic and work terms. Because of the year-round nature of the Cooperative Program, Co-op students are considered full-time students of the University of Alberta for the full 12 months of any academic year (July 1 to June 30).

Students accepted into the Co-op Program must successfully complete the following six courses and the regular requirements for an Engineering degree within their specialization: ENGG 299, WKEXP 901, WKEXP 902, WKEXP 903, WKEXP 904, and WKEXP 905.

Because work experience is required, the Engineering Co-op Department in the Faculty helps students find suitable employment. Most jobs are in Alberta, but some jobs are elsewhere in Canada or overseas. The ultimate responsibility for obtaining work-term employment is the student's. Co-op students pay a modest administrative fee for each work term. A limited number of visa students (student visitors) may be admitted to the Cooperative Education program.

82.3 Biomedical Engineering

Biomedical engineering is concerned with the application of engineering and the basic sciences to the solution of problems arising in medicine and biology. In its application to human physiology, biomedical engineering involves the understanding of body processes, the diagnosis of different body conditions and the rehabilitation of bodily functions. The tremendous complexity and variety of problems associated with the aforementioned areas require the involvement of engineers of all backgrounds.

Although the Department of Biomedical Engineering does not offer an undergraduate degree, offering only the MSc and PhD degrees, there are formal undergraduate biomedical engineering options and elective sequences in the Departments of Chemical and Materials Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, and Mechanical Engineering. To help students understand and prepare for employment in this area, a series of undergraduate electives is available in areas such as physiology, medical instrumentation, medical imaging, modelling of biological systems, biomaterials and biomechanics. At the graduate level, there are programs in these departments as well as the Department of Biomedical Engineering which is in both the Faculty of Engineering and the Faculty of Medicine and Dentistry. This latter program is offered jointly by the Universities of Alberta and Calgary.

For further information contact the Chair, Department of Biomedical Engineering, Faculty of Engineering and Faculty of Medicine and Dentistry, or a Faculty advisor in any Engineering department.

82.4 Chemical Engineering

Chemical engineers design the complex plants needed to convert a laboratory or pilot-scale experiment into an industrial operation capable of producing tons of material daily. Chemical engineers supervise the construction of these plants, and are also involved in running and maintaining them. These activities call for a thorough understanding of chemistry, physics, mathematics and many other skills.

The chemical engineer must understand the physics and mathematics behind the problems of heat and mass flow when large quantities of reacting material must be heated or cooled, and moved from one section of the plant to another. He or she must understand the properties of the materials available to build the plant; how they tolerate high pressures and temperatures; and how they resist corrosion and wear. In the design and operation of biotechnology or environmental protection processes, the chemical engineer also needs to understand basic biological principles.

Students study the fundamentals of chemistry, physics, and mathematics, then learn engineering science and design. Selecting appropriate electives allows students to specialize in oil sands engineering, nanoscale engineering, mineral processing and extractive metallurgy, and polymer materials. See §§82.4.4 and 84.5.1 for more details.

Graduates are equipped to embark on careers in the chemical, petrochemical, food processing, forest products, pharmaceutical, and semiconductors industries, or work for a government agency.

82.4.1 Computer Process Control Option in Chemical Engineering

With increased use of distributed digital computer control systems in the process industries and microprocessor-based analyzers and instruments, a need exists for process engineers with a background in areas that have traditionally been in the domain of the electrical engineer and computing scientist. This program, which retains all the core chemical engineering courses, provides the necessary background for engineering positions concerned with applying computers to the control of process systems.

Enrolment is limited.

82.4.2 Biomedical Option in Chemical Engineering

The application of engineering principles to biomedical sciences has been gaining significant momentum since the 1980s. Exploring a biomedical problem from an engineering perspective provides unique solutions to biomedical problems. Utilizing established chemical engineering principles, such as thermodynamics, mass transfer and reactor design, enables significant advances in human health and facilitates establishment of an industrial activity based on bioengineering principles. The Biomedical Option retains all of the core courses of the Chemical Engineering program. It then adds courses specific to the biomedical sciences to provide students with the necessary background for employment in the biomedical field. See §82.3 for more details. Enrolment is limited.

82.4.3 Oil Sands Engineering Elective Pattern in Chemical Engineering

With over 1.7 trillion barrels of oil in place, the oilsands of Alberta are an enormous resource to supply Canada's energy needs and support oil exports for many years in the future. Extracting the bitumen and upgrading it to synthetic crude oil presents exciting engineering challenges, including increasing yield and energy efficiency, reducing environmental impact and improving the quality of the oil product. The Oilsands Engineering Program retains all of the core courses of the Chemical Engineering program. It then adds courses specific to

the oilsands to provide students with the necessary background for employment in the industry.

Enrolment is limited.

82.4.4 Elective Streams in Chemical Engineering

In addition to the required courses, students in Chemical Engineering may study certain fields in depth by choosing appropriate program elective courses. The following lists elective streams that are currently available in Chemical Engineering:

Note: The following elective streams apply to Chemical Engineering Traditional Program and Co-op Plan II. Due to course scheduling difficulties, these elective streams do not apply to Co-op Plan I.

(1) **Mineral Processing and Extractive Metallurgy:** This Elective Stream is offered in collaboration with Materials Engineering. Metallic and non-metallic materials such as gold, copper, iron (steel) and ceramics are extracted from mineral resources. Mineral processing and extractive metallurgy is therefore an important engineering field that contributes to Canada's economy. The Mineral Processing and Extractive Metallurgy Elective Stream will introduce students to the fundamental theories of mineral processing, hydrometallurgy, electrometallurgy and pyrometallurgy, and current practices of unit operations of these processes. The graduates from this elective pattern will be able to find employment in Canadian resource sectors, especially in oil sands, coal, base metal, precious metal, potash and diamond ore processing industries. The recommended courses for this elective stream are CME 421, 422 and 472.

(2) **Nanoscale Engineering:** The Nanoscale Engineering Elective Stream consists of 4 courses which are taken in the four program elective slots available in the Chemical Engineering program. The recommended courses for this stream are: MAT E 211 and three of CH E 487, CH E 583, CH E 584 and MAT E 495. These courses expose Chemical Engineering students to topics in which understanding of the small-scale structures of materials are necessary for understanding the macroscopic processes associated with these nanostructures. It also provides the students with an introduction to the tools available for probing the properties of these nanostructures.

(3) **Polymer Materials:** This Elective Stream is offered in collaboration with Materials Engineering. The Polymer Materials Elective Stream is designed for students who are interested in acquiring a basic knowledge in the field of polymers: structure-property relationships, polymerization reactions and polymer processing so that upon completion of the Stream, they will have the knowledge to embark on graduate level research in polymer science and engineering and will be employable by polymer manufacturers and polymer processing industry. The recommended courses for this elective stream are CME 482, 484 and 485.

82.5 Civil Engineering

Civil engineers apply science in planning, designing, constructing, operating, or managing airports, buildings, bridges, harbors, highways, flood control structures, transit systems, water supply and distribution systems, waste collection and storm drainage, and other public works. Today, civil engineers are asked to meet the challenges of pollution, deteriorating urban infrastructure, traffic congestion, energy needs, urban development, and community planning.

Civil engineering offers an unlimited range of career opportunities to satisfy individual interests, aptitudes, and goals. Civil engineers can specialize in one field or a combination of many technical specialties. They can direct their efforts into planning, design, construction, research, teaching, sales, or management.

The University of Alberta curriculum provides the preparation required for a career in civil engineering. All students take a core program that provides the basis for professional practice in the Civil Engineering disciplines of construction, environmental, geotechnical, structural, surveying, transportation, and water resources. Students then select elective courses in the fourth year to permit some specialization in these disciplines.

82.5.1 Disciplines in Civil Engineering

Construction Engineering

Construction engineers combine engineering and management disciplines to plan and execute projects. They apply their knowledge of construction methods and equipment to ensure that work is completed on time, within budget, safely, and in accordance with design specifications. Construction engineers lead a team of financial planners, technicians, tradespeople, and professional engineers from other disciplines.

Environmental Engineering

Environmental engineers incorporate principles of chemistry, biology, microbiology, mathematics, chemical engineering, and civil engineering to provide technological solutions to environmental problems such as water pollution control, providing safe drinking water, disposal and recycling of solid wastes, and hazardous waste. In addition, environmental engineers are concerned about the provisions of municipal services such as sewers, water mains, and solid waste collection.

Geotechnical Engineering

Geotechnical engineers analyze, in the field and in the laboratory, the properties of soils and rock that support and affect the behavior of structures, pavement, and underground facilities. They evaluate potential settlement of buildings, stability of slopes and fills, analysis of landslides, groundwater seepage, and effects of earthquakes. Geotechnical engineers and structural engineers design the construction of dams, foundations of buildings, and tunnels.

Structural Engineering

Structural engineers plan and design various structures, including buildings, bridges, storage tanks, containment facilities, and towers. They analyze the forces that each structure must resist, select the appropriate construction materials (concrete, steel, timber, or other materials) and proportion all members and connections to produce a safe and economical structure. Structural engineers also plan and supervise the construction of these structures.

Surveying Engineering

Surveying engineers make precise measurements of the earth's surface to obtain reliable information for locating and designing engineering projects. They use data from satellites, aerial and terrestrial photogrammetry, and computer-processed satellite imagery. Their maps give accurate information for building highways and dams, boring tunnels, plotting flood control and irrigation projects, and for all other areas of civil engineering.

Transportation Engineering

Transportation engineers plan and design the safe and efficient movement of people and goods. They construct and manage all types of transportation facilities.

Water Resources Engineering

Water resources engineers use their expertise in areas such as hydraulics, hydrology, fluid mechanics, coastal and river engineering, water resources management and planning, and mathematics and computer analysis to solve problems associated with the control and use of water. This includes flood control and protection, water distribution and wastewater collection systems, hydroelectric power development, road and pipeline river crossings, irrigation, drainage, coastal and bank erosion protection, and marine and river navigation facilities.

82.5.2 Environmental Engineering Option in Civil Engineering

Interest in design, construction, operation, and maintenance of developments with minimal effect on public and environmental health for all aspects of the biosphere is a major component of engineering. The ability to incorporate the principles of chemistry, biology, microbiology, mathematics, chemical engineering, and civil engineering to provide project analysis, technological solutions, risk assessment, impact minimization, and environmental management are the essentials of environmental engineering. The most common areas of interest are safe drinking water provision, water pollution control, solid and hazardous wastes disposal and recycling, and air quality control in industrial and municipal environments. Environmental engineers are also involved in providing municipal components such as water mains, sewers, storm sewers, and solid waste collection.

Enrolment is limited.

82.5.3 Biomedical Engineering Option in Civil Engineering

This option is intended to provide students with the background necessary to start their career in Civil Engineering with a good basic understanding of the Biomedical Engineering disciplines. Core courses in the Civil Engineering Program (surveying, construction engineering and management, transportation engineering and engineering law) are replaced by fundamental courses in biology and medicine. This option is intended to better prepare students for graduate studies in biomedical engineering and for employment in the health care industry, especially in the area of biomechanical engineering, bone engineering and biological processes. The curriculum has also provided necessary requirements to allow successful students to apply to the MD program.

82.6 Computer Engineering

Computer engineering is concerned with the design of computer systems for their many applications.

A computer system consists of hardware and software components, and the computer engineer must be knowledgeable in the design of both. The Computer Engineering program provides the fundamentals of hardware design through courses in electrical circuits, electronics, digital systems, computer organization, and microcomputer systems. The fundamentals of software design are provided through courses in data structures, algorithm design, operating systems, and software engineering. Students also take courses in the key application areas of computers, namely control systems and communication systems. Students may take several elective courses in Electrical Engineering and Computing Science.

Computer engineers are uniquely equipped in being educated to design computer systems where the hardware and software components are closely coupled, and where both components are critical to the design's success. The background of our graduates is sufficiently broad that they are able to pursue careers in related areas, ranging from software design and systems analysis to electronics design.

Computer engineering draws on material from the two disciplines of electrical and computing science. Because of this, the Computer Engineering program is offered jointly by the Department of Electrical and Computer Engineering and the Department of Computing Science. The program is administered by the Department of Electrical and Computer Engineering.

82.6.1 Software Option in Computer Engineering

This option is concerned with the systematic and comprehensive development of software systems. The rapidly growing complexity of such systems along with their stringent requirements such as to their reliability, security, user-friendliness, maintainability, testability, portability, interoperability and cost effectiveness is a challenge to the software industry. To prepare for this challenging and rewarding reality, the software option provides a balanced curriculum including the theoretical and applied foundations in computing, mathematics, physical science, the engineering sciences and current technology.

Computer engineers in the software field specify, describe, and analyze digital systems bridging the gaps between the digital world and real world. They develop small (such as remote control software) and large (e.g., the Internet) software systems. Starting from user requirements, they use sound engineering practices to construct, test, and maintain software artifacts. Programming is a relatively small phase of the overall project lifecycle.

The Software Option provides students with comprehensive foundations for this rapidly evolving field by dwelling on engineering design principles, the discrete and continuous mathematics, logic and the theory of software. It incorporates the best practices of the software industry. The course material is tightly coupled with practical exercises and experiments, using up-to-date industrial software development tools.

The Software Option is offered jointly by the Department of Electrical and Computer Engineering and the Department of Computing Science. The option is administered by the Department of Electrical and Computer Engineering.

82.6.2 Nanoscale System Design Option in Computer Engineering

This option provides an introduction to the processes involved in the fabrication of nanoscale integrated circuits and to the computer aided design (CAD) tools necessary for the engineering of large scale systems on a chip. By selecting this option, students will learn about fault tolerance in nanoscale systems and gain an understanding of quantum phenomena in systems design.

The option retains most of the core elements of the traditional Computer Engineering Program and contains a number of new offerings in the form of program electives. Changes from the Traditional Computer Engineering Program occur only after second year.

82.7 Electrical Engineering

Electrical engineering is the application of knowledge of electrical systems and phenomena for the benefit of society. The Electrical Engineering program builds an understanding of theoretical concepts early in the program and then gives students the tools to develop more in-depth knowledge in their fields of interest. Introductory courses explore the fundamentals of electricity and magnetism, the laws governing analog electric circuits, and introduce digital circuitry. In the third and fourth years of study, students are able to investigate specific areas of electrical engineering, while maintaining a broad outlook. Practical experience is integral to the program. Laboratory experiments form a required element of many courses while in the final year of study students must complete a capstone design project.

82.7.1 Areas of Study

Students are required to choose electives as part of the program. These courses allow students to study the following technical areas in greater depth.

Students should contact the Department of Electrical and Computer Engineering for advice regarding the selection of appropriate elective courses in their areas of interest.

Biomedical Engineering

Biomedical Engineering is the application of the principles of engineering to the solution of problems in medicine and biology. Applications of electrical engineering include bioelectromagnetism, physiological monitoring and related instrumentation, medical imaging and information systems. See §§82.7.2 and 82.3 for more information.

Communications Engineering

Communications engineering involves the movement of information from one point to another in analog or digital form, including transmitting, routing, receiving and processing these signals.

Control Systems Engineering

Control Systems Engineering is an interdisciplinary subject that cuts across many specialized engineering fields. Control system engineers are essential to the design of systems such as robotics, space vehicles, oil refineries, paper-making machines, power systems and automobiles.

Digital Systems Engineering

Digital systems engineers design hardware systems for a broad range of applications including process control, robotics, digital signal processing, computers, communications, instrumentation and data acquisition.

Electronic Materials and Nanotechnology

Electronic materials are central to many applications including electronic and photonic devices and biotechnology. Topics include growth of thin films and microfabrication of functional devices. Of increasing importance is nanotechnology, the science and engineering of materials and structures at the molecular level.

Electronics Engineering

Electronics is an area of electrical engineering that may be applied to all fields of technology. It overlaps other areas of electrical engineering such as digital, control, communications and power systems.

Electromagnetics and Photonics

Electromagnetic phenomena form the basis of electrical engineering. Further study of electromagnetics can aid understanding of systems such as photonics, microwaves, plasma processing, power distribution, lasers and wireless transmission.

Power Engineering

Power Engineering covers the generation, transmission, distribution and application of electrical power. It includes power systems, power electronics, motors generators and motor drives.

82.7.2 Biomedical Option in Electrical Engineering

This option is intended to provide a more intensive specialization in the biomedical engineering field than is possible by choosing only the relevant program electives. Core courses in the Electrical Engineering Program are replaced by fundamental courses in medicine and biology. This option is intended to better prepare students for graduate studies in biomedical engineering and for employment in the health-care industry. It also provides the necessary academic qualifications to allow successful students to make application into the MD Program. See §§82.7.1, 82.3 and 15.9.9 for more information.

82.7.3 Nanoengineering Option in Electrical Engineering

This option provides an introduction to the principles of electronics, electromagnetics and photonics as they apply at the nanoscale level. By selecting this option, students will learn about the processes involved in the fabrication of nanoscale structures and become familiar with the computer aided design (CAD) tools necessary for analyzing phenomena at these very high levels of miniaturization.

The Option retains most of the core elements of the traditional Electrical Engineering Program and contains a number of offerings in the form of program electives. Changes from the Traditional Electrical Engineering Program occur only after second year.

82.8 Engineering Physics

The Engineering Physics program, offered in cooperation with the Department of Physics, leads to the degree of BSc in Engineering Physics. It is more fundamental than the Electrical Engineering program and provides students

with an extensive background in mathematics and physics. Within the program is the Nanoengineering Option which focuses on aspects of the emerging field of nanotechnology and provides a more interdisciplinary perspective appropriate to that field.

Students who want to take Engineering Physics must have a high standing in mathematics and physics and normally are required to have a minimum GPA of 3.0 in the first year. Exceptions to this rule may be made by the Chair of the Department of Electrical and Computer Engineering.

In this program, the core material consists of courses in the basic sciences and electrical engineering. This provides a basis for more intensive studies in a number of specialized areas in Electrical Engineering. These areas are covered by elective courses chosen to meet the student's requirements. Some of these areas are lasers, plasmas, communications, microelectronics, microwave, and high vacuum.

82.8.1 Nanoengineering Option

The emerging field of nanotechnology crosses many disciplines, including engineering, biology, chemistry, and physics. Structures and devices engineered on the scale of less than 100nm will have significant impact on how we create materials, process information, sense the environment, use energy, manufacture goods and practice medicine. The Nanoengineering Option provides broad skills suitable for entry to the nanotechnology professions, combining core Electrical Engineering and Physics courses with additional instruction in biochemistry and chemistry, and specialized instruction in nanoelectronics, nanobioengineering, and nanofabrication.

82.9 Materials Engineering

Materials Engineering is the discipline in Engineering in which materials are engineered and designed for their function in society. This is done by selecting the scale of the material from molecular or atomic, to nano, micro and macro and by choosing the class of material from soft to hard to composites while integrating this knowledge through the processing, structure, properties and performance of materials. It is concerned with the production and engineering applications of metallic and non-metallic materials (polymers, ceramics, composites, electronic materials and biomaterials). Materials engineers develop, modify, and use processes to convert raw materials to useful engineering materials with specified desirable properties. The discipline therefore includes aspects of materials production, materials processing and materials applications and design. Materials engineering embraces physics, chemistry and mechanics to understand processing and applications of materials. Graduates of the program find employment in all sectors of the materials cycle. The primary sector is raw materials processing and includes such industries as mineral processing, aluminium smelting and steel making. The next sector is manufacturing and extends from the rolling of the metals to the materials aspects of manufacturing various engineered products in the aerospace, automotive, electronics, photonics, and petrochemical industries. The final sector includes the service industries with such specialities as corrosion, wear, fracture mechanics and failure investigation. This sector would also include the recycling industries.

The undergraduate Materials Engineering program, the only one of its kind in the prairie provinces, includes a set of core materials engineering courses emphasizing underlying principles and their engineering applications. With the program electives it is possible for the students to go into more depth in particular areas of interest, e.g., biomaterials, functional materials, mineral processing and extractive metallurgy, polymer materials and structural materials.

82.9.1 Biomedical Option in Materials Engineering

The utilization of novel materials for biomedical purposes has been finding increased acceptance. Novel materials specifically engineered for medical performance provide unique solutions to biomedical problems. Utilizing novel metallic alloys, molecularly designed polymers, and tailored composites has enabled significant progress in health care and medical diagnostics. The Biomedical Option retains all of the core courses of the Materials Engineering program. It then adds courses specific to the biomedical sciences to provide students with the necessary background for employment in the biomedical field. Enrolment is limited.

82.9.2 Nano and Functional Materials Option

All nanotechnological developments are built on two things, either they involve materials with dimensions in the nanometer scale (nanomaterials), and/or they involve structures with dimensions in the nanometer scale (nanostructures). At nanometre scale the structure-property relationships in materials tend to change, i.e., the properties of these materials depend on the dimensions of the materials and quantum mechanical effects start to dominate. Since the Materials Engineering program is focused on the processing and manufacturing of materials and the materials' structure-property relationships, Materials Engineering is a natural home for nanotechnology, thus the Nano and Functional Materials Option in the Materials Engineering program.

Students entering this option will be exposed to the exciting and emerging field of nano and functional materials. Subject areas covered include electronic, optical and magnetic materials, nanomaterials and their applications, nanostructured molecular sieves, nano and functional materials processing and fabrication. Employment opportunities exist in several sectors of Canadian industry, such as microelectronic/optoelectronic device fabrication, MEMS processing and fuel cell development.

82.9.3 Elective Streams in Materials Engineering

(1) **Mineral Processing and Extractive Metallurgy:** Metallic and non-metallic materials such as gold, copper, iron (steel) and ceramics are extracted from mineral resources. Mineral processing and extractive metallurgy is therefore an integral part of materials engineering and an important engineering field that contributes to Canada's economy. The Mineral Processing and Extractive Metallurgy elective stream will introduce students to the fundamental theories of mineral processing, hydrometallurgy, electrometallurgy and pyrometallurgy, and current practices of unit operations of these processes. The graduates from this elective stream will be able to find employment in Canadian resource sectors, especially in oil sands, coal, base metal, precious metal, potash and diamond ore processing industries. The recommended courses for this elective stream are CME 421 to be taken in Term 7 (Term 6 for Co-op students), CME 422 and 472 in Term 8. It is also recommended that students take either MAT E 470 or CH E 446 as the fourth program elective.

(2) **Polymer Materials:** The polymer materials elective stream is designed for students who are interested in acquiring a basic knowledge in the field of polymers: structure-property relationships, polymerization reactions and polymer processing so that upon completion of the option, they will have the knowledge to embark on graduate level research in polymer science and engineering and will be employable by polymer manufacturers and polymer processing industry. The recommended courses for this elective stream are CH E 345 and CME 482 to be taken in Term 7 (Term 6 for Co-op students), CME 484 and 485 in Term 8.

(3) **Structural Materials:** Students completing this elective stream will be proficient in the traditional areas of metallurgical and materials engineering, i.e., physical metallurgy and materials processing. Employment opportunities exist in several sectors of Canadian industry including, but not restricted to, primary metal extraction, steel processing, oil and gas, automotive and consulting. The recommended courses for this elective stream are MAT E 470 to be taken in Term 7 (Term 6 for Co-op students), CME 472, MAT E 473 and 474 in Term 8. Students interested in this elective stream will need to take the ITS Elective in either Term 6 (Co-op students) or Term 7 (traditional students) to make room for the extra program elective in Term 8.

82.10 Mechanical Engineering

Mechanical engineering covers a diverse range of engineering fields with five major areas of study: solid mechanics and dynamics, fluid mechanics, thermodynamics, mechanical design, and engineering management. Examples of more specialized areas of work are acoustics, aerodynamics, biomechanical engineering, combustion engines, energy conversion systems, environmental engineering, material science including fracture and fatigue, robotics and vehicle design.

The undergraduate program initially exposes students to a wide range of topics covering the fundamentals. Advanced courses and electives provide more specialized knowledge and emphasize applications. Many courses include experimental laboratories to give students hands-on experience with current engineering and measurement equipment. Throughout the program, several courses are devoted to mechanical engineering design. Working on individual and group projects, students apply engineering principles to challenging design projects and develop communication skills through oral and written presentations as well as preparation of drawings for fabrication in the department's machine shop. Computers are used extensively in the program; students are involved in programming and in using engineering analysis and design packages.

82.10.1 Areas of Study

Solid Mechanics and Dynamics

Mechanical engineers are involved in the design of structures and mechanical components to safely withstand normal working stresses. Many structures and machines are also subjected to additional stresses caused by vibrations, for example, due to the imbalance in a compressor or engine, and

these effects can be critical for their safe use. Stress analysis predicts the internal loads in a component and allows the designer to select materials and shapes suitable for the service the component will experience. Traditional materials such as steel and aluminium as well as recently developed materials such as ceramics and fibre-reinforced composites are considered to optimize the component's performance.

Fluid Mechanics

Fluid mechanics is concerned with the motions of liquids and gases and the machinery that causes that motion (e.g., pumps) or uses it (e.g., windmills). Applications include acoustics, aerodynamics, meteorology, pollutant dispersion, pumps, fans, turbines, pipelines, and lubrication. Mechanical engineers with a specialization in fluid mechanics, design, and improve a wide range of fluids-related equipment as well as investigate concerns related to the flow of water and air in the environment. Another major area of work for mechanical engineers with a fluid mechanics background is in the aerodynamics industry designing everything from wings to jet engines.

Thermodynamics

Applied thermodynamics is the study of energy conversion from one form to another. A typical application is electricity production. Energy from the combustion of fuels like coal, oil, or natural gas is used to heat a fluid such as air or water, and then the fluid is expanded through machinery to produce mechanical work and drive a generator. The electricity produced is an easily transported form of energy that can be used at locations remote to the original energy source. Mechanical engineers with a specialization in thermodynamics design and improve power plants, engines, heat exchangers, and other forms of equipment. Specific examples include heating, ventilation and air conditioning systems for living space and industrial processes, use of alternate fuels in engines, and reducing pollution from internal combustion engines.

Design

The design process starts with recognizing a need for a new product, device, or industrial process and then carries on to defining the problem to be solved, gathering necessary information, performing the required analysis and optimization, building prototypes, and evaluating different concepts. There is usually no single correct solution for a given design problem as different designs may all solve the same problem. Some designs are better than others, as they may be lighter or more efficient or cost less, so that by constant refinement and iteration throughout the design process, acceptable designs can be made.

Engineering Management

Many engineering graduates spend a significant part of their career as managers of plants, companies, or other engineers. Engineering management bridges the gap between engineering and management. These engineers deal with areas such as management of engineering processes, engineering economics, operations management, quality improvement, quality control, and the use of computers in business.

82.10.2 Biomedical Option in Mechanical Engineering

Applications of mechanical engineering to biomedical problems range from understanding the intricacies of fluid flows in the heart and lungs to the design of artificial joints, implants, orthopedic devices, and medical equipment and instrumentation. Exciting opportunities exist for innovative solutions to numerous health care problems by applying knowledge contained within the discipline of mechanical engineering. Such solutions typically require interdisciplinary teams for which the broad background in fundamentals obtained in mechanical engineering is an asset. Examples include the ever-increasing use of mechanical systems to assist or replace various portions of the anatomy, and the application of system modeling and design methods in areas from diagnosis to aids for rehabilitation.

For students considering a career in this expanding area, the Department of Mechanical Engineering offers two choices within its program. Both include all the broad core of mechanical engineering studies which are enhanced by the biomedical options. Both provide a good preparation for graduate studies in the biomedical engineering field. The first, which is available to all students, replaces the elective courses in the regular program with a stream of essential introductory courses in biomedical engineering and a course in biomechanics.

The second is a degree option, for a limited group of students in the cooperative engineering program, that includes a number of additional required courses and a four month clinical placement at a hospital or research institute. The overall length of the program is the same as for the regular co-op programs in the department. The additional courses are specified to provide a well-rounded introduction to biomedical engineering and biomechanics. Electives can be chosen from an approved list of courses to suit the interest of the individual student. Students completing this option will be granted a degree in Mechanical Engineering (Biomedical). With a suitable choice of electives (supplemented by at most two additional courses), students will also be qualified to apply to the Faculty of Medicine and Dentistry at the University of Alberta.

82.11 Mining Engineering

Mining engineers deal with the application of science and technology in the planning, design, development, optimization, operation and management of surface and underground mining and mineral exploration projects. A particularly important challenge that faces mining engineers in today's environment is to design and implement mining systems to extract minerals with sound environmental technology while maximizing the return on investors' capital. The major employers of mining engineers include surface and underground mining companies, mineral exploration companies, equipment manufacturers and dealerships, consulting companies, and teaching and research institutions.

The Mining Engineering curriculum at the University of Alberta covers the following core areas of study: ore reserve modelling and grade control, computerized mine planning and design using commercial software packages, mineral economics, mine production engineering, rock and soil mechanics, rock fragmentation, mine ventilation, mine environmental technology, surface and underground mining technology, mine survey, and economic and structural geology. The curriculum is designed to prepare prospective mining engineers with the tools to succeed in a variety of career opportunities including ore reserve analyst, mine planning engineer, mine production engineer, mineral economist, mine systems engineer, mine maintenance engineer, mine geotechnical engineer, mine reclamation engineer and mine manager.

Ore reserve analysts apply geometric, statistical, probabilistic and geostatistical methods for ore reserve modelling and grade control required for investment decisions, mine planning, design and production. Mine planning engineers use analytical and computer-aided design tools to design and optimize surface and underground mine layouts for efficient extraction processes. Mine production engineers supervise labor and mine equipment to achieve short and long range production targets using efficient and safe operating standards. Mineral economists apply the principles of mathematics, economics and finance in evaluating the economic potential of mining projects, analysis of investment risk and uncertainty and commodity markets analysis and pricing

Mine systems engineers apply operation research techniques for efficient unit mining operations in the development-production networks. Mine maintenance engineers design and implement preventive, breakdown and repair maintenance programs for the efficient and safe use of mine equipment in production. Mine geotechnical engineers design and implement programs to ensure the stability of underground mine openings, surface mine slopes, and waste and tailings dumps. Mine reclamation engineers design and monitor reclamation of landscapes after mine closure. Mine managers use management and engineering principles to manage the overall mining operations to meet short- and long-term goals.

82.12 Petroleum Engineering

Working in the upstream sector of the oil and natural gas (O and NG) industry, petroleum engineers are responsible for the technical and economic analysis leading to the appraisal, development, and production of O and NG reserves. Petroleum engineers apply scientific principles to the challenge of drilling wells into underground formations, and to provide safe and efficient production of O and NG reserves. They appraise the value of the resource and manage the reservoir to maximize returns. Petroleum engineering encompasses skills from a broad array of scientific disciplines, including geology and chemical, civil, and mechanical engineering.

Most graduates find work in the Canadian O and NG industry, while some choose to work overseas. Others work in areas where their training has given them appropriate skills, such as in underground contaminant flow. Our undergraduate degree program is the only accredited petroleum engineering program in Canada.

82.13 Business Course Electives for Engineering Students

The Faculty of Engineering has an agreement with the Faculty of Business to permit a limited number of Engineering students to take Business courses. Areas include accounting, finance, industrial relations, and management science. Interested students should contact their Program Advisor for referral to the Engineering–Business Advisor.

82.14 Honors Mathematics Courses

Students with exceptionally high interest and ability in mathematics may replace certain engineering mathematics courses with honors mathematics courses. These students would follow the honors calculus sequence MATH 117, 118, and 217, instead of MATH 100, 101, and 209. Students should contact the Honors Chair of the Department of Mathematics for an interview and approval to register immediately after receiving notification of their admission to the first-year Engineering program.

82.15 Engineering Safety and Risk Management Courses

Safety, risk, and loss management principles applicable to all engineering activities are covered in ENGG 404 and ENGG 406. These courses provide a basic understanding of the integrated practices of reducing risks to people, environment, assets, and production. The key role of Engineering and Business graduates in this expanding field is explored, including emphasis on the proactive team approach.

82.16 Arrangements with Other Institutions

82.16.1 Engineering Transfer Programs at Alberta Colleges

Students may complete their first year of Engineering at any of the following Alberta postsecondary institutions: Grande Prairie Regional College, Keyano College (Fort McMurray), University of Lethbridge, Medicine Hat College, Grant MacEwan College (Edmonton), Mount Royal College (Calgary), and Red Deer College. Students who complete the Engineering Transfer Program at one of these institutions may apply to enter second-year Engineering at the University of Alberta and will be considered for program placement on an equal basis with continuing University of Alberta Engineering students.

82.16.2 Transfer Credit Agreement Between the University of Alberta and the University of Calgary Faculties of Engineering

The first year engineering programs at the University of Alberta and the University of Calgary are similar but not identical. The first year program requirements at the two universities, effective with the 2002–2003 academic year, are indicated below. Where there is a course entry for both the University of Alberta and the University of Calgary, these courses are equivalent and qualify for transfer credit. Students who completed the first year program at the University of Calgary prior to the 2002–2003 academic year and are interested in a transfer to the University of Alberta should consult the Faculty of Engineering concerning transfer credit.

First Year Program Requirements	University of Alberta	University of Calgary
Two Chemistry Courses	CHEM 103 CHEM 105	ENGG 201 CHEM 209
Engineering Statics (See Note 1)	ENGG 130	
Engineering Dynamics (See Note 1)	EN PH 131	
Engineering Statics/Dynamics (See Note 1)	-	ENGG 205
Two Calculus Courses	MATH 100 MATH 101	AMAT 217 AMAT 219
Linear Algebra	MATH 102	MATH 221
Physics (Waves and Optics) (See Note 2)	PHYS 130	-
Physics (Electricity and Magnetism) (See Note 3)	-	PHYS 259
Computing	ENCMP 100	ENGG 233
Orientation To The Engineering Profession: 2 Courses	ENGG 100 ENGG 101	- -
Design and Communications (See Note 4)	- -	ENGG 251 ENGG 253
Complementary Studies Elective (See Note 5)	Yes	Yes

Notes

(1) The University of Calgary offers a second Engineering Statics/Dynamics course in second year ENGG 349. ENGG 205 and ENGG 349 at the University of Calgary is equivalent to ENGG 130 and EN PH 131 at the University of Alberta.

(2) The University of Calgary offers an equivalent course, PHYS 369, as part of the second year program.

(3) The University of Alberta offers an equivalent course, PHYS 230, as part of the second year program. Students entering the Civil, Mining, Computer Process Control option in Chemical and Petroleum Engineering programs at the University of Alberta cannot receive degree credit for PHYS 259 from the University of Calgary or PHYS 230 from the University of Alberta.

(4) The University of Alberta offers no directly equivalent courses. Students completing ENGG 251/253 at the University of Calgary will only receive transfer credit for ENGG 100/101.

(5) Complementary studies electives in first year are courses selected from the humanities (excluding languages) or social sciences. English courses are acceptable.

82.16.3 Transfer from Alberta Technical Institutes

Students from Alberta Institutes of Technology (e.g., NAIT, SAIT) should refer to the Alberta Transfer Guide and the Faculty of Engineering website for information on admission policies and potential transfer credit.

82.16.4 Geomatics Engineering at the University of Calgary

The University of Calgary offers a four-year program leading to a BSc in Geomatics Engineering. After appropriate practical experience, a graduate may register as a Professional Surveying engineer and/or a Provincial and/or Canada Lands Surveyor.

A student interested in a career in geomatics (surveying) may take the first year of Engineering at the University of Alberta. On successful completion of the first-year program, students would be admitted to the second year of Geomatics Engineering at the University of Calgary. For information regarding Geomatics Engineering at the University of Calgary, please write the Dean, Faculty of Engineering, University of Calgary, Calgary, Alberta T2N 1N4.

82.16.5 BSc Program in Agricultural Engineering Bioresource Engineering

The University of Saskatchewan offers a four-year program leading to the Bachelor of Science in Engineering (BE) with Agricultural and Bioresource Engineering as a field of specialization. Students wanting to transfer to the Agricultural and Bioresource Engineering program at the University of Saskatchewan following one year of engineering at the University of Alberta may be eligible to receive scholarship funds from the University of Alberta (MacHardy-Stephanson Fund) to support their transfer. For additional information about the program, contact the Head, Agricultural and Bioresource Engineering, College of Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, S7N 5A9 or access the website: www.engr.usask.ca/dept/age/

82.16.6 Exchange Program with École Polytechnique

Students in the Faculty of Engineering at the University of Alberta may participate in an exchange program whereby one year of their studies is completed at École Polytechnique in Montréal. École Polytechnique, affiliated with the University of Montréal, is one of the premier schools of engineering in Canada and is the largest French-language school of engineering in the country. Students must have demonstrated superior academic ability and be fluent in French. The exchange normally takes place in a student's third year. Exchange programs are available in all engineering programs except Petroleum Engineering. Please consult the Associate Dean (Student Services), Faculty of Engineering, for more information.

82.17 Special Students

Students with a BSc in Engineering or a Science specialization (e.g., Mathematics, Physics, Chemistry, Computing Science, Geology), may register as special students in the Faculty. For further information regarding admissibility, see §12.2(7).

82.18 Graduate Studies

The U of A's flourishing research programs indicate a commitment to scholarship, pursuit of knowledge, and the application of that knowledge to the solution of contemporary problems. There are graduate programs in many fields of engineering leading to the degrees of Master of Science (MSc), Master of Engineering (MEng), and Doctor of Philosophy (PhD). A combined Master of Business Administration/Master of Engineering (MBA/MEng) degree program is also available. For more information on Graduate Studies, contact the individual Engineering departments.

82.19 Professional Associations and Technical Societies

All Engineering programs listed in the Calendar are accredited by the Canadian Engineering Accreditation Board of the Canadian Council of Professional Engineers. Therefore, graduation from the Faculty of Engineering can lead to registration as a professional engineer in the provincial associations of professional engineers, in accordance with their individual policies.

The practice of engineering throughout Canada is regulated by professional associations in each province. The right to practise and accept professional responsibility is limited to those registered with the professional organization in the province concerned. In Alberta, this is the Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA). Members of the Engineering Students' Society are automatically student members of the Association. Graduates are encouraged to join the Association as Engineers in Training. Four years of acceptable experience following graduation are necessary for registration as a professional engineer.

The practising engineer keeps abreast of technological developments through membership in one of several technical societies. Student branches of these societies (CSAE; SChE; CSCE; IEEE; CSME; CIM; ISA; SPE; SAE; SME; ASHRAE) have active chapters on campus. Engineering students are encouraged to join the society closest to their specially.

83 Faculty Regulations

83.1 Admission and Registration

General University admission requirements are set out in §§13 and 14. Specific admission information for the Faculty of Engineering is detailed in §15.7.

83.2 Residence Requirements

A student proceeding toward a BSc degree in Engineering is expected to complete at least half of the credits required through courses offered by the University of Alberta (either "on" or "off" campus in Fall/Winter or Spring/Summer). Normally, at least half of these "University of Alberta" courses will be courses from Terms 5 through 8, as shown in §§84.3 and 84.4. Credits obtained by special assessment at the University of Alberta may be included in the count of courses used to satisfy the residence requirements. (See §14.2.4 Credit by Special Assessment.)

Where a student has been accepted as a transfer student from another accredited engineering program at a Canadian university and has the equivalent of six full terms of transfer credit, reducing the residence requirement to one academic year consisting of two full terms may be considered.

83.3 Academic Regulations

(1) **Admissions:** The Faculty of Engineering admits students into a first- or qualifying-year program and into specialized programs at the second-year level. All admissions are on a competitive basis.

Admissions into the first or qualifying year program include students who are coming directly from high school and students with less than 30.0 engineering units of postsecondary transfer credit. On an annual basis, the minimum high school average for students entering directly from high school is reviewed and may be adjusted to reflect demand and space availability. This average is calculated across the five required admission subjects (Alberta Grade 12 Chemistry 30, English 30-1, Mathematics 30-1, Mathematics 31 and Physics 30 or their equivalent), and for the past several years it has been 80.0% or above. All high school students who meet the minimum average are admitted to the first or qualifying year program.

There is a maximum number of students which can be accommodated in the first or qualifying year program. Spaces available after all eligible applicants from high school have been admitted are offered to students with postsecondary transfer credit. Factors in selecting students from this group for admission are academic performance and the specific courses which earn transfer credit.

The Faculty offers a number of engineering degree program choices as indicated below:

Chemical
Chemical Process Control Option
Chemical Biomedical Option
Civil
Civil Environmental Option
Civil Biomedical Option*
Computer
Computer Software Option
Computer Nanoscale System Design Option
Electrical
Electrical Biomedical Option*
Electrical Nanoengineering Option
Engineering Physics*
Engineering Physics Nanoengineering Option*
Mechanical
Mechanical Biomedical Option**
Materials
Materials Biomedical Option
Materials Nano and Functional Materials Option
Mining
Petroleum

Most of these programs are offered in both the Traditional and Co-op formats except as indicated by the asterisks - *Traditional only, **Co-op only. All of the specialized or discipline specific programs start in second year and each has a limited number of spaces. On an annual basis the Faculty reviews the number of spaces in all disciplines and may change the number of spaces in specific degree programs to reflect student demand and the market demand for these disciplines subject to the availability of Faculty resources.

Students admitted to the qualifying year must normally qualify for a specialized program in not more than two terms (one year). Students entering directly from high school or with less than 15.0 units of transfer credit may, subject to space availability, be allowed an additional two terms (one year) to qualify. Students entering with 15.0 or more units of transfer credit must qualify in not more than two terms (one year).In order to qualify, a student must be in satisfactory standing after Fall/Winter and have credit in at least 30.0 units (excluding ENGG 100/101) of courses transferable to a specialized program. A student who is offered admission to a specialized program after two terms has qualified and may not continue as a qualifying student. Students who fail to qualify within the indicated number of terms are required to withdraw and are not normally readmitted to the Faculty.

Students are admitted to a specialized program based first of all on academic performance in the first or qualifying year and secondly on their program preferences. These preferences are communicated by completing a Program Selection Form (PSF). All students in the qualifying year, and new applicants, must complete the PSF which is accessed through the Faculty web site. All applicants with previous postsecondary education must submit a PSF. Applicants who do not have sufficient transfer credit for admission to a second year program (to be determined by the Faculty) may be considered for a qualifying year.

Students who are offered admission to one of the specialized programs must register in the Fall and/or Winter Term immediately following; otherwise they must reapply and again compete for a space in these programs.

Spaces in each specialized program are reserved for students who do not have an undergraduate engineering degree. Students who already hold an undergraduate engineering degree are not eligible for admission to a second undergraduate program in the Faculty. Study of a different engineering discipline can be done through registration as a Special Student or registration in a graduate program.

(2) **Engineering Graduation Average**

a. The Engineering Graduation Average (EGA) is based on the final four academic terms. If the course load in these terms totals less than 70.0 units, additional terms will be included in the calculation of the EGA as required to reach a total of at least 70.0 units. The 70.0 units include courses designated as extra to degree. Grades for courses taken in Spring/Summer are not included in the EGA unless this is a scheduled term within the student's degree program.

b. **Requirements to Graduate:** To graduate, a student must
   i) pass all courses required by the specific program;
   ii) have an Engineering Graduation Average of 2.0 or greater;
   iii) be in satisfactory academic standing, i.e., have a Fall/Winter GPA of 2.0 or greater.

A student who is otherwise eligible to graduate but has an EGA of less than 2.0 and/or a Fall/Winter GPA in the range 1.7 to 1.9 is permitted to return for one additional term provided this term falls within the 72 month degree time limit as specified in §83.3(3). Courses to be taken during this additional term are specified by the Dean. If the student's EGA and Fall/

Winter GPA following this term are not both 2.0 or greater, the student will not qualify for a degree and will not be allowed to continue in the Faculty.

The preceding paragraph also applies to any student who has completed all course requirements and chooses to return for an extra term. The courses which the student takes in this subsequent term are to be specified by the Dean.

(3) **Time Limit for Completion of Degree:** All students must complete their degree requirements within 72 months from the time of their initial admission to a specialized degree program in Engineering.

The time measurement starts at the beginning of the term following a student's initial admission to a specialized degree program in Engineering. This time limit includes all time during which a student is not in attendance either by personal choice or as a result of suspension or a requirement to withdraw. When a student encounters special circumstances that necessitate an absence from the University for an extended period of time, the student may apply to the Faculty for an extension to the degree time limit. Such an application must be made prior to the absence or at the earliest opportunity. Extensions are not granted for cases where a student has spent time on withdrawal or suspension.

(4) **Course Load**

a. Students in specialized degree programs are not required to meet any minimum course load requirement except as noted in §83.3(6)b. but must meet the degree time limit as specified in §83.3(3). A course load less than that required to maintain full time status, as defined in §240, may have scholarship eligibility, income tax and student loan implications.

b. Students in their qualifying year may not normally take a course load with fewer than 37.0 units in Fall/Winter, excluding the 2.0 units for ENGG 100/101.

(5) **Courses Outside of Degree Requirements**

Courses which are taken in addition to a student's degree requirements are designated "Not for Degree Credit" or "Extra to Degree". Since GPA calculations include the grades earned in these non degree courses, students musts obtain prior written approval from their Department before registering in such courses unless it is a requirement imposed by the Faculty. Only students whose GPA in the immediately preceding term is 2.5 or above will receive approval from their Department. These courses must be at the 200-level or above. Not all courses will be considered. See www.engineering.ualberta.ca for more information. Students who have registered in courses outside their degree program without formal approval will be withdrawn from these courses and are responsible for any associated fees.

(6) **Promotion:** A student's progress is evaluated on completion of academic studies for Fall/Winter and on completion of any academic term occurring in Spring/Summer that is a scheduled term within the student's degree program. Scheduled terms are those shown in §§84.3 and 84.4. Evaluation is on the basis of the Fall/Winter GPA or Spring/Summer GPA [see §23.4(5)]. A student registered in Co-op Work Experience for the Winter Term and simultaneously registered in one or more courses is considered to have completed their academic studies for Fall/Winter after the Fall Term.

a. **Satisfactory Standing:** Fall/Winter or Spring/Summer GPA of 2.0 or greater. Promotion, repeating any failed course(s).

b. **Marginal Standing-Academic Warning:** Fall/Winter or Spring/Summer GPA of 1.7 to 1.9 inclusive. Proceed to next term on academic warning, repeating any failed course(s) and other courses as specified by the Dean, unless one of the following conditions applies, in which case the student must withdraw:
   i) occurs immediately upon completion of the qualifying year [also see §83.3(1) with respect to students who entered directly from high school or with less than 15.0 units of transfer credit].
   ii) previously on academic warning on two or more occasions.
   iii) previously required to withdraw and previously on academic warning.
   iv) already on academic warning or probation.

Students on academic warning or probation will be evaluated at the end of each term. Spring/Summer is not considered a term unless it is a scheduled term within the student's degree program. To clear academic warning or probation, a student must achieve an engineering term average of at least 2.0 while carrying a minimum course load of 14.0 units.

c. **Unsatisfactory Standing-Required to Withdraw:** Fall/Winter or Spring/Summer GPA less than 1.7. Student must withdraw.

Students who meet all Fresh Start admission criteria (§220.5) and were registered in the first qualifying year (students directly from high school or with less than 15.0 engineering units of transfer credit) may be recommended to Fresh Start. Such a recommendation is dependent on the student's agreement that by entering Fresh Start he/she will not be eligible for readmission to the Faculty of Engineering and must apply to another Faculty.

(7) **Work Experience Credit:** Work Experience (WKEXP) courses in the cooperative education program are graded on a Pass/Fail (Credit/No Credit) basis. A student receiving a grade of Fail/No Credit is normally required to withdraw from the cooperative program and the Faculty of Engineering.

(8) **Deficiencies from a Previous Term:** Where a student is deficient in credits in a course (or courses) from a previous term, through failure or otherwise, that student must normally clear that deficiency the next time the course (or courses) is (are) offered.

Where the deficiency is the result of failure or withdrawal from an elective course, another course may be substituted if Faculty approval is first received to do so.

(9) **Readmission after a Requirement to Withdraw:** A student required to withdraw must stay out for two terms before being eligible for readmission. In this context, Spring/Summer is not counted as a term unless it is a scheduled term within the student's degree program.

If a student receives a suspension for academic misconduct which overlaps the period of withdrawal resulting from poor academic performance, the periods of withdrawal and suspension will run sequentially. The total length of the required absence is to be equal to the period of the suspension plus the period of withdrawal for academic reasons.

All students are readmitted on probation and must take all the previously failed courses and other courses as specified by the Dean. For students in the co-op program, readmission must coincide with the start of an academic term. A student required to withdraw a second time is not normally readmitted to the Faculty of Engineering.

The requirements to clear probation are explained in §83.3(6)b.

(10) **Withdrawal from Courses:** (See §11 Academic Schedule for deadline dates.)

(11) **Missed Term and Final Exams:** Refer to §23.3. There are no deferred term exams for courses offered in the Faculty of Engineering. In instances where a student has a documented reason for missing a term exam(s) and at the discretion of the instructor, the value of a missed term exam(s) can be added to the value of the final exam. A missed term exam(s) is considered assigned term work which has not been completed in determining eligibility for a deferred final exam.

(12) **Transfer Credit:** Students planning to earn transfer credit for a course(s) taken elsewhere should obtain Department and Faculty approval in the form of a Letter of Permission prior to taking the course(s). The Faculty is under no obligation to grant transfer credit without such preapproval. Letters of Permission are not given to students who have been required to withdraw until they have been readmitted. Students returning for a second qualifying year who have successfully completed a qualifying year course(s) which was (were) not taken or not passed in their first qualifying year will automatically receive credit for such courses and cannot retake them.

(13) **Reexaminations:** See §23.5.5.

(14) **Academic Awards and Recognition**

a. **Awards and Scholarships**

Information about awards and scholarships is available in the University of Alberta Awards Publication. A number of scholarship competitions are open to high school students who plan to study Engineering at the University. Students who are continuing in the Faculty may apply for various awards. In addition, a number of awards are made by Faculty or Department nomination. Awards and scholarships are awarded after the second, fourth, sixth, and eighth academic terms and require a student to carry a full course load. For University-wide award competitions, this is the course load calculated from §§84.2, 84.3, or §84.4 as appropriate. In the case of Faculty and Department awards, a full course load is defined as at least 35.0 units. Because of their course load requirements co-op students are not eligible for awards in the third year of their program.

b. **First-Class Standing**

First-class standing is awarded following the second, fourth, sixth, and eighth academic terms based on a GPA of 3.5 or greater, calculated on a course load of not less than 35.0 units in the two preceding academic terms.

c. **Graduation "With Distinction"**

To graduate "With Distinction," a student must have
   i) an Engineering Graduation Average of 3.5 or greater, and
   ii) carried at least 70.0 units in the final four academic terms.

(15) **Communication with Students Re Academic and Discipline Matters:** Pursuant to §20.3, the Faculty of Engineering will communicate all academic standing decisions and all decisions relating to charges under the Code of Student Behaviour electronically. The decision letter will be an electronic document attached to an e-mail forwarded to the student's campus e-mail address which includes the ualberta.ca extension or available through Bear Tracks.

(16) **Appeals**

a. **Academic Standing:** A student wanting to appeal an academic standing decision must first attempt to resolve the issue with the Faculty of Engineering, Associate Dean (Student and Co-op Services). If the matter remains unresolved, the student may then appeal to the Faculty of Engineering Academic Appeals Committee. To do so, the student must provide a written letter of appeal addressed to the Dean which outlines the basis for the appeal. The letter of appeal must be received by the Dean within 28 calendar days from the decision date. This is the date of the letter in which the student was first advised of the academic standing decision. The 28 days include mailing time and all time spent in attempting to resolve the matter with the Associate Dean (Student and Co-op Services).

Note: An unsuccessful appeal within the Faculty or any conditions imposed as part of the appeal decision within the Faculty may be carried to the General Faculties Council Academic Appeals Committee. See §23.8. The appeal of any conditions in an appeal decision by the Faculty must occur within the timelines set out for any appeal to the General Faculties Council Academic Appeals Committee. The consequences resulting from a subsequent failure to meet the conditions are not appealable.

b. **Grievances Concerning Grades:** The assignment of marks and grades is the initial responsibility of an instructor. Any grievances concerning grades should first be discussed with the instructor. If the problem is not resolved, the student should talk with the Chair of the Department where the course is taught.

For courses taught in the Faculty of Engineering, final recourse is to the Faculty of Engineering Academic Appeals Committee. To appeal to this committee, the student must submit the appeal in writing to the Dean within 60 calendar days after the final examination period.

c. **Work Term Status:** Faculty initiated withdrawal from a work term, denial of work term or disciplinary decisions related to a work term are appealable to the GFC Practice Review Board (see Calendar §23.8.2). Failure of a work term which results from lack of performance and/or termination of employment by the employer is an academic standing decision and is appealable as described in §83.3(16)a..

A copy of the Faculty of Engineering Regulations regarding appeals may be obtained from the Faculty Office, E6-050 Engineering Teaching and Learning Complex.

83.4 Calculators in Examinations

Instructors must specify in the syllabus for each course, the course policy with respect to calculators in examinations. The policy choices are:

(1) no calculators

(2) approved non-programmable calculators

(3) approved programmable calculators or approved non-programmable calculators

A list of acceptable calculators in the non-programmable and programmable categories is available from the Faculty and Department offices. Only approved calculators may be taken into an exam. Approved calculators must bear a sticker that identifies it as to type and acceptability. Students must bring their calculator(s) to the Faculty or Department office to have the appropriate sticker affixed.

84 Programs of Study

84.1 Faculty Requirements for all BSc in Engineering Programs

Course requirements for Engineering programs are listed in §§84.2 (First-Year) and 84.3 through §84.4 (Second-Year and beyond). All Engineering programs include ENGG 400, MATH 201, 209, one of ENG M 310 or 401, and an ITS elective as described in §84.6.1.

All engineering programs must also include at least three units at the 200-level in each of at least three of the following five areas: (1) Strength of Materials, (2) Thermodynamics, (3) Materials Science, (4) Fundamental Electrical Engineering, and (5) Engineering Mechanics (Dynamics).

84.2 First-Year Program

Students registering for first-year courses should consult the Registration and Courses menu at www.registrarsoffice.ualberta.ca for detailed registration procedures. Students interested in an equivalent curriculum given in French should consult §184.10.

Term 1

CHEM 103 (3-1s-3/2)
ENGG 100 (1-0-0)
ENGG 130 (3-0-2)
MATH 100 (3-0-1)
PHYS 130 (3-0-3/2)
Complementary Studies Elective (3-0-0)

Term 2

CHEM 105 (3-0-3/2)
ENCMP 100 (3-0-1.5)
ENGG 101 (1-0-0)
EN PH 131 (3-1s-3/2)
MATH 101 (3-0-1)
MATH 102 (3-0-1)

Notes

(1) The Complementary Studies Elective listed in the first term should be selected from courses identified in §84.6. List 1 is recommended for First Year students.

(2) Students accepted into the Honors Mathematics stream replace MATH 100 and 101 with MATH 117 and 118 (see §82.14).

84.2.1 Math and Applied Sciences Centre (MASC)

MASC, a department of University Student Services, offers mathematics preparation for students entering the Faculty of Engineering. Although all students can benefit from these courses, they are particularly recommended for students who scored less than 80% in Mathematics in 30/31 or who have been away from the study of mathematics for three years or more. Further information can be found at www.ualberta.ca/~masc.

84.3 Required Courses and Suggested Course Sequence for Traditional Programs

The required program of studies leading to the various BSc in Engineering degrees (traditional programs) are noted below. While all courses listed below are compulsory, the sequencing of courses may differ. All programs require Departmental approval.

Engineering Chart 1 details a suggested course sequence for each Engineering degree program by year and term. Course numbers are followed by the hours of instruction in parentheses. The first number indicates lecture hours, the second number seminar hours, and the third number laboratory hours. Laboratory hours often appear as two numbers separated by a slash, which indicates hours and weeks (e.g., the expression 3/2 means 3 hours of laboratory every second week).

Note: For further descriptions of the requirements on the Program Electives, see §84.5. For information on Complementary Studies Electives, Impact of Technology on Society (ITS) Electives and English Electives see §84.6.

Engineering Chart 1 Required Courses and Suggested Course Sequence for Traditional Programs

Chemical

Year 2		Year 3		Year 4	
Term 3 CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) CME 265 (3-0-3) English Elective (3-0-0) MATH 209 (3-0-1) Complementary Studies Elective (3-0-0)	**Term 4** ECE 209 (3-0-3/2) MAT E 202 (3-0-3/2) MATH 201 (3-0-1) STAT 235 (3-0-1.5) Complementary Studies Elective (3-0-0) ITS Elective (3-0-0)	**Term 5** CH E 312 (3-1s-0) CH E 343 (3-1s-0) CH E 351 (2-0-3) CH E 374 (3-1s-0) Program Elective (3-0-0)	**Term 6** CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (3-0-4) ENG M 310 (3-0-0) or 401 (3-0-0)	**Term 7** CH E 416 (3-0-2) CH E 445 (3-1s-0) CH E 446 (3-1s-3/3) CH E 464 (3-0-3) CME 481 (1-0-0) Program Elective (3-1s-0)	**Term 8** CH E 454 (1-0-4) CH E 465 (4-0-4) CME 483 (1-0-0) ENGG 400 (1-0-0) Program Elective (3-1s-0) Program Elective (3-1s-0)

Notes
(1) See §84.5.1 for restrictions on the four program electives.
(2) Students who are interested in taking Nanoscale Engineering, Mineral Processing and Extractive Metallurgy, or Polymer Materials Elective Streams should consult the Department for course schedules.

Chemical: Biomedical Option

Year 2		Year 3		Year 4	
Term 3 BIOL 107 (3-1s-3) CH E 243 (3-1s-0) CME 200 (1 day) CME 265 (3-0-3) CHEM 261 (3-0-3) English Elective (3-0-0) MATH 209 (3-0-1)	**Term 4** BIOCH 200, BIOL 201, or CELL 201 (3-0-0) ECE 209 (3-0-3/2) MAT E 202 (3-0-3/2) MATH 201 (3-0-1) STAT 235 (3-0-1.5) ITS Elective (3-0-0)	**Term 5** BME 320 (3-0-0) CH E 312 (3-1s-0) CH E 343 (3-1s-0) CH E 351 (2-0-3) CH E 374 (3-1s-0)	**Term 6** BME 321 (3-0-0) CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (3-0-4) ENG M 310 (3-0-0) or 401 (3-0-0)	**Term 7** CH E 446 (3-1s-3/3) CH E 464 (3-0-3) CH E 416 (3-0-2) CME 481 (1-0-0) PHIL 386 (3-0-0) Complementary Studies Elective (3-0-0)	**Term 8** CH E 454 (1-0-4) CH E 465 (4-0-4) CME 483 (1-0-0) ENGG 400 (1-0-0) Program Elective (3-1s-0) Program Elective (3-1s-0)

Notes
(1) Students who are interested in applying for admission into the Faculty of Medicine and Dentistry MD program should refer to §84.5.1.1.
(2) WKEXP 906 is required for this program. WKEXP 906 can be taken after Term 4, 6 or 8.
(3) See §84.5.1.1 for restrictions on the two program electives.

Chemical: Computer Process Control Option

Year 2		Year 3		Year 4	
Term 3 CHEM 261 (3-0-3) CME 200 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) Complementary Studies Elective (3-0-0)	**Term 4** CH E 243 (3-1s-0) CME 265 (3-0-3) English Elective (3-0-0) MATH 201 (3-0-1) STAT 235 (3-0-1.5) Complementary Studies Elective (3-0-0)	**Term 5** CH E 312 (3-1s-0) CH E 343 (3-1s-0) CH E 351 (2-0-3) CH E 374 (3-1s-0) CH E 446 (3-1s-3/3)	**Term 6** CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (3-0-4) CH E 472 (3-1s-3/3) ENG M 310 (3-0-0) or 401 (3-0-0)	**Term 7** CH E 416 (3-0-2) CH E 464 (3-0-3) CME 481 (1-0-0) ITS Elective (3-0-0) Program Elective (3-1s-0) Program Elective (3-1s-0)	**Term 8** CH E 454 (1-0-4) CH E 465 (4-0-4) CH E 573 (3-0-3/2) CH E 576 (3-0-3/2) CME 483 (1-0-0) ENGG 400 (1-0-0)

Notes
(1) MATH 201 must be taken in either Term 3 or 4.
(2) See §84.5.1.2 for restrictions on the program electives.

Chemical: Oil Sands Elective

Year 2		Year 3		Year 4	
Term 3 CH E 243 (3-1s-0) CME 200 (1 day) CME 265 (3-0-3) CHEM 261 (3-0-3) English Elective (3-0-0) MATH 209 (3-0-1) Complementary Studies Elective (3-0-0)	**Term 4** MAT E 202 (3-0-3/2) ECE 209 (3-0-3/2) MATH 201 (3-0-1) STAT 235 (3-0-1.5) Complementary Studies Elective (3-0-0) ITS Elective (3-0-0)	**Term 5** CH E 312 (3-1s-0) CH E 343 (3-1s-0) CH E 351 (2-0-3) CH E 374 (3-1s-0) ENG M 310 (3-0-0) or 401 (3-0-0)	**Term 6** CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (3-0-4) CH E 522 (3-1s-0)	**Term 7** CH E 416 (3-0-2) CH E 445 (3-1s-0) CH E 446 (3-1s-3/3) CH E 464 (3-0-3) CME 481 (1-0-2) Program Elective (3-0-0)	**Term 8** CH E 435 (4-0-4) CH E 454 (1-0-4) CH E 534 (3-1s-3/3) CME 483 (1-0-0) ENGG 400 (1-0-0) Program Elective (3-0-0)

Note: See §84.5.1.3 for restrictions on the program electives.

Civil

Year 2		Year 3		Year 4	
Term 3 CIV E 265 (2-0-3) CIV E 270 (3-0-3) EAS 210 (3-0-3) MATH 209 (3-0-1) MAT E 202 (3-0-3/2)	**Term 4** CIV E 221 (3-0-3/2) CIV E 240 (1-2s-0) CIV E 250 (3-0-3) CIV E 251 (1 week)* CIV E 290 (3-0-0) CIV E 295 (3-0-2) MATH 201 (3-0-1) *Held in Spring/Summer (Spring Term)	**Term 5** CIV E 330 (3-ls-0) CIV E 372 (3-2s-0) CIV E 391 (3-0-3) CIV E 395 (3-0-2/2) CIV E 398 (3-1s-0) English Elective (3-0-0)	**Term 6** CIV E 303 (3-0-3/2) CIV E 315 (3-0-2) CIV E 321 (3-0-3/2) CIV E 331 (3-0-3/2) CIV E 374 (3-0-3) CIV E 381 (3-0-3)	**Term 7** Program Elective (See Note) Program Elective (See Note) Program Elective (See Note) One of ECE 209, MEC E 250 or CH E 243 Complementary Studies Elective (3-0-0)	**Term 8** ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) ENGG 420 (3-0-0) Program Elective (See Note) Program Elective (See Note) ITS Elective (3-0-0)

Note: See §84.5.2 for restrictions on the program electives.

Engineering Chart 1 Required Courses and Suggested Course Sequence for Traditional Programs (cont'd)

Civil: Biomedical Engineering Option

Year 2		Year 3		Year 4	
Term 3 CHEM 261 (3-0-3) CIV E 265 (2-0-3) CIV E 270 (3-0-3) EAS 210 (3-0-3) MATH 209 (3-0-1) MAT E 202 (3-0-3/2)	**Term 4** BIOL 107 (3-1s-3) CIV E 221 (3-0-3/2) CIV E 240 (1-2s-0) CIV E 290 (3-0-0) CIV E 295 (3-0-2) MATH 201 (3-0-1)	**Term 5** BME 320 (3-0-0) CIV E 330 (3-1s-0) CIV E 372 (3-2s-0) CIV E 395 (3-0-2/2) CIV E 398 (3-1s-0) English Elective	**Term 6** BME 321 (3-0-0) CIV E 321 (3-0-3/2) CIV E 331 (3-0-3/2) CIV E 374 (3-0-3) CIV E 381 (3-0-3) ENV E 351 (3-0-3/2)	**Term 7** BIOCH 200 (3-0-0) One of ECE 209, MEC E 250 or CH E 243 ENG M 310 (3-0-0) or 401 (3-0-0) Complementary Studies Elective (3-0-0) ITS Elective (3-0-0) Program Elective (See Note)	**Term 8** BME 410 (3-0-0) CIV E 459 (3-0-3) ENGG 400 (1-0-0) MEC E 485 (3-0-0) Program Elective (See Note) Program Elective (See Note)

Note: See §84.5.2.1 for restrictions on the program electives and information for students interested in applying for admission into the Faculty of Medicine and Dentistry MD program.

Civil: Environmental Engineering Option

Year 2		Year 3		Year 4	
Term 3 CIV E 265 (2-0-3) CIV E 270 (3-0-3) EAS 210 (3-0-3) ENV E 220 (3-0-3/2) MATH 209 (3-0-1)	**Term 4** CIV E 240 (1-2s-0) CIV E 250 (3-0-3) CIV E 251 (1 week)* CIV E 290 (3-0-0) CIV E 295 (3-0-2) ENV E 222 (3-0-3/2) MATH 201 (3-0-1) *Held in Spring/Summer (Spring Term)	**Term 5** CH E 243 (3-1s-0) CIV E 330 (3-1s-0) CIV E 372 (3-2s-0) CIV E 395 (3-0-2/2) ENV E 322 (3-0-0) ENV E 324 (3-0-3/2)	**Term 6** CIV E 331 (3-0-3/2) CIV E 381 (3-0-3) ENV E 302 (2-1s-0) ENV E 351 (3-0-3/2) Complementary Studies Elective (3-0-0)	**Term 7** CIV E 374 (3-0-3) ENV E 320 (3-0-3/2) ENV E 421 (3-0-3/2) ENV E 423 (3-0-0) ENV E 432 (3-0-0) One of CIV E 524 (3-0-0), CIV E 526 (3-0-0), CIV E 558 (3-0-0), ENV E 400 (3-0-0) or ENV E 401 (3-0-0)* *All courses may not be offered every year.	**Winter Term 8** ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) ENV E 434 (3-0-0) ENV E 440 (3-0-3) LAW 399 (3-0-0) ITS Elective (3-0-0) One of ECE 209, MEC E 250 or MAT E 202

Computer

Year 2		Year 3		Year 4	
Term 3 CMPUT 274 (3-0-3) ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) MATH 201 (3-0-1) MATH 209 (3-0-1) English Elective	**Term 4** CMPUT 272 (3-1s-3) CMPUT 275 (3-0-3) ECE 203 (3-1s-3/2) ECE 212 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2)	**Term 5** ECE 302 (3-1s-3/2) ECE 311 (3-0-0) ECE 325 (3-0-3/2) ECE 340 (3-0-3/2) Group I Program Elective ENG M 310 (3-0-0) or 401 (3-0-0)	**Term 6** CMPUT 291 (3-0-3) CMPUT 379 (3-0-3) ECE 315 (3-0-3/2) ECE 487 (3-0-0) Complementary Studies Elective (3-0-0) ITS Elective (3-0-0)	**Term 7** CMPUT 301 (3-0-3) ECE 304 (3-1s-3/2) ECE 342 (3-1s-0) Group I Program Elective Group II Program Elective Complementary Studies Elective (3-0-0)	**Term 8** ECE 410 (3-0-3/2) ECE 420 (3-0-3/2) ECE 492 (1-0-6) ENGG 400 (1-0-0) Group II Program Elective Group II Program Elective Group II Program Elective

Note: See §84.5.3 for restrictions on the six program electives.

Computer: Nanoscale System Design Option

Year 2		Year 3		Year 4	
Term 3 CMPUT 274 (3-0-3) ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) MATH 201 (3-0-1) MATH 209 (3-0-1) English Elective	**Term 4** CMPUT 272 (3-1s-3) CMPUT 275 (3-0-3) ECE 203 (3-1s-3/2) ECE 212 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2)	**Term 5** ECE 302 (3-1s-3/2) ECE 311 (3-0-0) ECE 325 (3-0-3/2) Complementary Studies Elective (3-0-0) ENG M 310 (3-0-0) or 401 (3-0-0) Group I Program Elective	**Term 6** CMPUT 291 (3-0-3) ECE 315 (3-0-3/2) ECE 412 (3-0-0) ECE 450 (3-0-3/2) ECE 475 (3-0-0) ITS Elective (3-0-0)	**Term 7** CMPUT 301 (3-0-3) ECE 304 (3-1s-3/2) ECE 342 (3-1s-0) Group I Program Elective Group II Program Elective Complementary Studies Elective (3-0-0)	**Term 8** ECE 403 (3-0-3/2) ECE 410 (3-0-3/2) ECE 457 (3-0-2) ECE 492 (1-0-6) ENGG 400 (1-0-0) Group II Program Elective Group II Program Elective

Note: See §84.5.3.1 for restrictions on the program electives.

Electrical

Year 2		Year 3		Year 4	
Term 3 ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) MATH 201 (3-0-1) MATH 209 (3-0-1) Group I Program Elective English Elective (3-0-0)	**Term 4** ECE 203 (3-1s-3/2) ECE 212 (3-0-3/2) ECE 220 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2) Complementary Studies Elective	**Term 5** ECE 302 (3-1s-3/2) ECE 312 (3-0-3/2) ECE 330 (3-0-0) ECE 340 (3-0-3/2) ECE 370 (3-1s-0) MATH 309 (3-0-0)	**Term 6** ECE 303 (3-1s-3/2) ECE 332 (3-0-3/2) ECE 342 (3-1s-0) ECE 360 (3-0-3/2) ECE 380 (3-0-3/2) Group II Program Elective	**Term 7** ECE 490 (1-0-3) Group I Program Elective Group II Program Elective Group II Program Elective Group II Program Elective Complementary Studies Elective (3-0-0)	**Term 8** ECE 491 (1-0-3) ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) Group II Program Elective Group II Program Elective Group II Program Elective ITS Elective (3-0-0)

Note: See §84.5.4 for restrictions on the nine program electives.

Electrical: Biomedical Engineering Option

Year 2		Year 3		Year 4	
Term 3 ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) MATH 201 (3-0-1) MATH 209 (3-0-1) Group I Program Elective English Elective (3-0-0)	**Term 4** ECE 203 (3-1s-3/2) ECE 212 (3-0-3/2) ECE 220 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2) Complementary Studies Elective (3-0-0)	**Term 5** BIOL 107 (3-1s-3) ECE 302 (3-1s-3/2) ECE 312 (3-0-3/2) ECE 340 (3-0-3/2) ECE 370 (3-1s-0) MATH 309 (3-0-0)	**Term 6** ECE 303 (3-1s-3/2) ECE 342 (3-1s-0) ECE 360 (3-0-3/2) ECE 380 (3-0-3/2) Group I Program Elective Complementary Studies Elective (3-0-0)	**Term 7** ECE 405 (3-0-0) ECE 440 (3-0-3/2) ECE 490 (1-0-3) Group II Program Elective PHYSL 210A ITS Elective (3-0-0)	**Term 8** ECE 491 (1-0-3) Group II Program Elective Group II Program Elective Group II Program Elective ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) PHYSL 210B

Note: See §84.5.4.1 for restrictions on the program electives and information for students interested in applying for admission into the Faculty of Medicine and Dentistry MD program

Engineering Chart 1 Required Courses and Suggested Course Sequence for Traditional Programs (cont'd)

Electrical: Nanoengineering Option

Year 2		Year 3		Year 4	
Term 3 ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) MATH 201 (3-0-1) MATH 209 (3-0-1) Group I Program Elective English Elective (3-0-0)	**Term 4** ECE 203 (3-1s-3/2) ECE 212 (3-0-3/2) ECE 220 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2) Group I Program Elective	**Term 5** ECE 302 (3-1s-3/2) ECE 312 (3-0-3/2) ECE 340 (3-0-3/2) ECE 370 (3-1s-0) MATH 309 (3-0-0) ITS Elective (3-0-0)	**Term 6** ECE 303 (3-1s-3/2) ECE 341 (3-1s-0) ECE 342 (3-1s-0) ECE 360 (3-0-3/2) ECE 450 (3-0-3/2) ECE 456 (3-0-0)	**Term 7** ECE 457 (3-0-2) ECE 471 (3-0-3/2) ECE 490 (1-0-3) Complementary Studies Elective (3-0-0) Group II Program Elective Group II Program Elective	**Term 8** ECE 475 (3-0-0) ECE 491 (1-0-3) ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) Complementary Studies Elective (3-0-0) Group II Program Elective Group II Program Elective

Note: See §84.5.4.2 for restrictions on the program electives

Engineering Physics

Year 2		Year 3		Year 4	
Term 3 ECE 201 (1 day) ECE 202 (3-1s-3/2) MAT E 201 (3-0-0) MATH 201 (3-0-1) MATH 209 (3-0-1) PHYS 281 (3-0-0) PHYS 292 (0-0-3) English Elective (3-0-0)	**Term 4** CH E 243 (3-1s-0) ECE 203 (3-1s-3/2) ECE 240 (3-1s-0) PHYS 244 (3-0-0) PHYS 271 (3-0-0) PHYS 292 (0-0-3) ITS Elective	**Term 5** ECE 210 (3-0-3/2) ECE 302 (3-1s-3/2) ECE 340 (3-0-3/2) ECE 471 (3-0-0) MATH 311 (3-0-0) PHYS 381 (3-0-0)	**Term 6** ECE 220 (3-0-3/2) ECE 303 (3-1s-3/2) ECE 341 (3-1s-0) PHYS 311 (3-0-0) PHYS 372 (3-0-0) PHYS 397 (0-0-6)	**Term 7** ECE 494 (1-0-3) PHYS 415 (3-0-0) PHYS 481 (3-0-0) Program Elective Program Elective Program Elective Complementary Studies Elective (3-0-0)	**Term 8** ECE 360 (3-0-3/2) ECE 495 (1-0-6) ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) Program Elective Program Elective Complementary Studies Elective (3-0-0)

Notes
(1) See §84.5.5 for restrictions on the five program electives.
(2) Students may take an extra course per term if their GPA is at least 3.3.

Engineering Physics: Nanoengineering Option

Year 2		Year 3		Year 4	
Term 3 ECE 201 (1 day) ECE 202 (3-1s-3/2) MAT E 201 (3-0-0) MATH 201 (3-0-1) MATH 209 (3-0-1) PHYS 281 (3-0-0) PHYS 292 (0-0-3) English Elective (3-0-0)	**Term 4** CH E 243 (3-1s-0) ECE 203 (3-1s-3/2) ECE 240 (3-1s-0) PHYS 244 (3-0-0) PHYS 271 (3-0-0) PHYS 292 (0-0-3) ITS Elective	**Term 5** ECE 210 (3-0-3/2) ECE 302 (3-1s-3/2) ECE 457 (3-0-2) ECE 471 (3-0-0) MATH 311 (3-0-0) PHYS 381 (3-0-0)	**Term 6** ECE 303 (3-1s-3/2) ECE 341 (3-1s-0) ECE 360 (3-0-3/2) ECE 456 (3-0-0) PHYS 311 (3-0-0) PHYS 372 (3-0-0)	**Term 7** CHEM 261 (3-0-3) Complementary Studies Elective (3-0-0) ECE 494 (1-0-3) PHYS 415 (3-0-0) PHYS 481 (3-0-0) Program Elective Program Elective	**Term 8** BIOCH 200 (3-0-0) ECE 455 (3-0-0) ECE 495 (1-0-6) ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) Program Elective Complementary Studies Elective (3-0-0)

Notes
(1) See §84.5.5.1 for restrictions on the program electives.
(2) Students may take an extra course per term if their GPA is at least 3.3

Materials

Year 2		Year 3		Year 4	
Term 3 CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) STAT 235 (3-0-1.5)	**Term 4** CIV E 270 (3-0-3) CME 265 (3-0-3) English Elective (3-0-0) MATH 201 (3-0-1) MAT E 211 (3-1s-3/4) MAT E 221 (3-1s-0)	**Term 5** CH E 312 (3-1s-0) CH E 374 (3-1s-0) Complementary Studies Elective (3-0-0) MAT E 335 (3-1s-0) MAT E 301 (3-0-0) MAT E 361 (1-1s-3/2)	**Term 6** Complementary Studies Elective (3-0-0) ENG M 310 (3-0-0) or 401 (3-0-0) MAT E 336 (3-1s-0) MAT E 341 (3-1s-0) MAT E 351 (3-1s-0) MAT E 362 (1-1s-3/2)	**Term 7** CH E 314 (3-1s-0) CME 481 (1-0-0) MAT E 464 (3-0-3) ITS Elective (3-0-0) Program Elective (3-0-0) Program Elective (3-0-0)	**Term 8** CME 483 (1-0-0) ENGG 400 (1-0-0) MAT E 461 (1-1s-4) MAT E 465 (2-1s-3) Program Elective (3-0-0) Program Elective (3-0-0) Program Elective (3-0-0)

Notes
(1) See §84.5.6 for restrictions on the five program electives.
(2) Students who are interested in Structural Materials, Mineral Processing and Extractive Metallurgy or Polymer Materials Elective Streams should consult the Department for course schedules.

Materials: Biomedical Option

Year 2		Year 3		Year 4	
Term 3 CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) STAT 235 (3-0-1.5)	**Term 4** CIV E 270 (3-0-3) CME 265 (3-0-3) English Elective (3-0-0) MATH 201 (3-0-1) MAT E 211 (3-1s-3/4) MAT E 221 (3-1s-0)	**Term 5** BIOL 107 (3-1s-3) CH E 312 (3-1s-0) Complementary Studies Elective (3-0-0) MAT E 301 (3-0-0) MAT E 335 (3-1s-0) MAT E 361 (1-1s-3/2)	**Term 6** BIOCH 200, or BIOL 201, or CELL 201 (3-0-0) ENG M 310 (3-0-0) or 401 (3-0-0) MAT E 336 (3-1s-0) MAT E 341 (3-1s-0) MAT E 351 (3-1s-0) MAT E 362 (1-1s-3/2)	**Term 7** BME 320 (3-0-0) CH E 314 (3-1s-0) CH E 374 (3-1s-0) CME 481 (1-0-0) MAT E 464 (3-0-3) PHIL 386 (3-0-0)	**Term 8** BME 321 (3-0-0) CH E 582 (3-1s-0) or MAT E 495 (3-1s-0) CME 483 (1-0-0) ENGG 400 (1-0-0) MAT E 461 (1-1s-4) MAT E 465 (2-1s-3) ITS Elective (3-0-0)

Notes
(1) Students who are interested in applying for admission into the Faculty of Medicine and Dentistry MD program should refer to §84.5.6.1.
(2) WKEXP 906 is required for this program. WKEXP 906 can be taken after Term 4, 6 or 8.

Engineering Chart 1 Required Courses and Suggested Course Sequence for Traditional Programs (cont'd)

Materials: Nano and Functional Materials Option

Year 2		Year 3		Year 4	
Term 3 CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) STAT 235 (3-0-1.5)	**Term 4** CIV E 270 (3-0-3) CME 265 (3-0-3) English Elective (3-0-0) MATH 201 (3-0-1) MAT E 211 (3-1s-3/4) MAT E 221 (3-1s-0)	**Term 5** CH E 312 (3-1s-0) CH E 374 (3-1s-0) MAT E 335 (3-1s-0) MAT E 301 (3-0-0) MAT E 361 (1-1-3/2) MAT E 390 (3-0-0)	**Term 6** Complementary Studies Elective (3-0-0) ENG M 310 (3-0-0) or 401 (3-0-0) MAT E 336 (3-1s-0) MAT E 341 (3-1s-0) MAT E 351 (3-1s-0) MAT E 362 (1-1s-3/2)	**Term 7** CH E 314 (3-1s-0) CME 481 (1-0-0) ECE 457 (3-0-2) MAT E 464 (3-0-3) MAT E 491 (3-1s-0) Complementary Studies Elective (3-0-0)	**Term 8** CME 458 (2-0-3) or MAT E 495 (3-1s-0) CME 483 (1-0-0) ENGG 400 (1-0-0) MAT E 461 (1-1s-4) MAT E 465 (2-1s-3) MAT E 494 (3-0-3/2) ITS Elective (3-0-0)

Mechanical

Year 2		Year 3		Year 4	
Term 3 CIV E 270 (3-0-3) MATH 209 (3-0-1) MEC E 230 (3-1s-0) **Course Group 2A** CH E 243 (3-1s-0) MEC E 200 (1-2s-0) MEC E 250 (3-1s-0) **or** **Course Group 2B** MEC E 260 (2-0-3) MEC E 265 (2-0-3)	**Term 4** ECE 209 (3-0-3/2) MATH 201 (3-0-1) MAT E 202 (3-0-3/2) STAT 235 (3-0-1.5) **Course Group 2A** CH E 243 (3-1s-0) MEC E 200 (1-2s-0) MEC E 250 (3-1s-0) **or** **Course Group 2B** MEC E 260 (2-0-3) MEC E 265 (2-0-3)	**Term 5** **Course Group 3A** MATH 300 (3-0-0) MEC E 300 (3-1s-0) MEC E 301 (1-0-3) MEC E 331 (3-0-1) MEC E 371 (3-1s-0) MEC E 380 (3-1s-0) **or** **Course Group 3B** ENG M 310 (3-0-0) or 401 (3-0-0) English Elective (3-0-0) MEC E 340 (3-0-0) MEC E 360 (3-0-3/2) MEC E 362 (3-0-3/2) MEC E 390 (3-0-1)	**Term 6** **Course Group 3A** MATH 300 (3-0-0) MEC E 300 (3-1s-0) MEC E 301 (1-0-3) MEC E 331 (3-0-1) MEC E 371 (3-1s-0) MEC E 380 (3-1s-0) **or** **Course Group 3B** ENG M 310 (3-0-0) or 401 (3-0-0) English Elective (3-0-0) MEC E 340 (3-0-0) MEC E 360 (3-0-3/2) MEC E 362 (3-0-3/2) MEC E 390 (3-0-1)	**Term 7** Program Elective (3-0-0) Program Elective (3-0-0) **Course Group 4A** MEC E 430 (3-0-0) or 480 (3-0-0) MEC E 463 (3-0-2) Program Elective (3-0-0) Complementary Studies Elective (3-0-0) **or** **Course Group 4B** MEC E 403 (1-0-3) MEC E 451 (3-0-1) MEC E 460 (2-1s-4) ITS Elective (3-0-0)	**Term 8** CH E 448 (3-1s-3/3) or ECE 362 (3-0-3/2) or MEC E 420 (3-0-3/2) ENGG 400 (1-0-0) Program Elective (3-0-0) **Course Group 4A** MEC E 430 (3-0-0) or 480 (3-0-0) MEC E 463 (3-0-2) Program Elective (3-0-0) Complementary Studies Elective (3-0-0) **or** **Course Group 4B** MEC E 403 (1-0-3) MEC E 451 (3-0-1) MEC E 460 (2-1s-4) ITS Elective (3-0-0)

Notes
(1) See §84.5.7 for restrictions on the four program electives.
(2) In each year, students take either (Group A in Fall, Group B in Winter) or (Group B in Fall, Group A in Winter).

Mining

Year 2		Year 3		Year 4	
Term 3 CIV E 265 (2-0-3) EAS 210 (3-0-3) ECE 209 (3-0-3/2) MATH 209 (3-0-1) MIN E 295 (3-0-3/2) STAT 235 (3-0-1.5)	**Term 4** CH E 243 (3-1s-0) CIV E 250 (3-0-3) CIV E 251 (1 week)* CIV E 270 (3-0-3) MATH 201 (3-0-1) MIN E 310 (3-0-3) ITS Elective (3-0-0) *Held in Spring/Summer (Spring Term)	**Term 5** CIV E 330 (3-1s-0) or CH E 312 (3-1s-0) ENG M 310 (3-0-0) or 401 (3-0-0) MIN E 323 (3-0-3) MIN E 325 (3-0-3) Program Elective (3-0-0) (See §84.5.8)	**Term 6** CIV E 381 (3-0-3) MIN E 324 (3-0-0) MIN E 330 (3-3s/2-0) English Elective (3-0-0) Complementary Studies Elective (3-0-0) (See §84.6)	**Term 7** CME 421 (3-0-3/2) ENGG 404 (3-3s/2-0) MIN E 402 (1-0-6) MIN E 413 (3-0-3/2) MIN E 414 (3-0-3/2) Program Elective (3-0-0) (See §84.5.8)	**Term 8** ENGG 400 (1-0-0) MIN E 403 (1-0-6) MIN E 407 (3-0-3/2) MIN E 408 (2-0-2) MIN E 420 (3-0-0) MIN E 422 (2-1s-0)

Petroleum

Year 2		Year 3		Year 4	
Term 3 CH E 243 (3-1s-0) EAS 210 (3-0-3) ECE 209 (3-0-3/2) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) English Elective (3-0-0)	**Term 4** CH E 312 (3-1s-0) CIV E 270 (3-0-3) MATH 201 (3-0-1) PET E 275 (3-0-3/2) STAT 235 (3-0-1.5) Complementary Studies (3-0-0)	**Term 5** CHEM 371 (3-0-3) ENG M 310 (3-0-0) or 401 (3-0-0) PET E 364 (3-1s-3/2) PET E 373 (3-0-3/2) Program Elective (3-0-0) (See §84.5.9) Complementary Studies (3-0-0)	**Term 6** CH E 374 (3-1s-0) EAS 222 (3-0-3) PET E 365 (3-1s-0) PET E 366 (3-0-0) Program Elective (3-0-0) (See §84.5.9)	**Term 7** CH E 314 (3-1s-0) ENGG 404 (3-3s/2-0) PET E 444 (3-0-0) PET E 475 (3-0-3/2) PET E 476 (3-0-0) PET E 484 (3-0-0)	**Term 8** ENGG 400 (1-0-0) PET E 471 (3-0-0) PET E 477 (3-0-0) PET E 478 (3-0-0) PET E 496 (1-6s-0) ITS Elective (3-0-0)

84.4 Required Courses and Suggested Course Sequence for Co-op Programs

The required program of studies leading to the various BSc in Engineering degrees (Cooperative Education programs) are noted below. While all courses listed below are compulsory, the sequencing of courses may differ. All programs require Departmental approval.

Engineering Chart 2 details a suggested course sequence for each Engineering degree program by year and term. Course numbers are followed by the hours of instruction in parentheses. The first number indicates lecture hours, the second number seminar hours, and the third number laboratory hours. Laboratory hours often appear as two numbers separated by a slash, which indicates hours and weeks (e.g., the expression 3/2 means 3 hours of laboratory every second week).

Note: For further descriptions of the requirements on the Program Electives, see §84.5. For information on Complementary Studies Electives, Impact of Technology on Society (ITS) Electives and English Electives, see §84.6.

Engineering Chart 2 Required Courses and Suggested Course Sequence for Co-op Programs

Chemical Plan I

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CH E 243 (3-1s-0) CME 200 (1 day) CHEM 261 (3-0-3) ENGG 299 (1-1s-0) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) English Elective (3-0-0) Complementary Studies Elective(3-0-0) **Winter Term 4** CME 265 (3-0-3) ECE 209 (3-0-3/2) MATH 201 (3-0-1) ITS Elective (3-0-0) STAT 235 (3-0-1.5) Complementary Studies Elective(3-0-0) **Summer** WKEXP 901	**Fall** WKEXP 902 **Winter Term 5** CH E 312 (3-1s-0) CH E 343 (3-1s-0) CH E 351 (2-0-3) CH E 374 (3-1s-0) Program Elective (3-0-0) **Summer Term 6** CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (3-0-4) ENG M 310 (3-0-0) or 401 (3-0-0)	**Fall** WKEXP 903 **Winter Term 7** CH E 416 (3-0-2) CH E 445 (3-1s-0) CH E 446 (3-1s-3/3) CH E 464 (3-0-3) CME 481 (1-0-0) Program Elective (3-1s-0) **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** CH E 454 (1-0-4) CH E 465 (4-0-4) CME 483 (1-0-0) ENGG 400 (1-0-0) Program Elective (3-1s-0) Program Elective (3-1s-0)

Note: See §84.5.1 for restrictions on the four program electives.

Chemical Plan II

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) CME 265 (3-0-3) ENGG 299 (1-1s-0) English Elective (3-0-0) MATH 209 (3-0-1) Complementary Studies Elective(3-0-0) **Winter** WKEXP 901 **Summer Term 4** ECE 209 (3-0-3/2) MAT E 202 (3-0-3/2) MATH 201 (3-0-1) ENG M 310 (3-0-0) or 401 (3-0-0) STAT 235 (3-0-1.5) Complementary Studies Elective(3-0-0)	**Fall Term 5** CH E 312 (3-1s-0) CH E 343 (3-1s-0) CH E 351 (2-0-3) CH E 374 (3-1s-0) Program Elective (3-0-0) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (3-0-4) ITS Elective (3-0-0) **Winter Term 7** CH E 416 (3-0-2) CH E 445 (3-1s-0) CH E 446 (3-1s-3/3) CH E 464 (3-0-3) CME 481 (1-0-0) Program Elective (3-1s-0) **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** CH E 454 (1-0-4) CH E 465 (4-0-4) CME 483 (1-0-0) ENGG 400 (1-0-0) Program Elective (3-1s-0) Program Elective (3-1s-0)

Notes
(1) See §84.5.1 for restrictions on the four program electives.
(2) Students who are interested in taking the Nanoscale Engineering, Mineral Processing and Extractive Metallurgy, or Polymer Materials Elective Streams should consult the Department for course schedules.

Chemical Plan II: Biomedical Option

Year 2	Year 3	Year 4	Year 5
Fall Term 3 BIOL 107 (3-1s-3) CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) CME 265 (3-0-3) ENGG 299 (1-1s-0) English Elective (3-0-0) MATH 209 (3-0-1) **Winter** WKEXP 901 **Summer Term 4** ECE 209 (3-0-3/2) ENG M 310 (3-0-0) or 401 (3-0-0) MAT E 202 (3-0-3/2) MATH 201 (3-0-1) STAT 235 (3-0-1.5) Complementary Studies Elective(3-0-0)	**Fall Term 5** BIOCH 200, BIOL 201, or CELL 201(3-0-0) CH E 312 (3-1s-0) CH E 343 (3-1s-0) CH E 351 (2-0-3) CH E 374 (3-1s-0) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** BME 320 (3-0-0) CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (3-0-4) PHIL 386 (3-0-0) **Winter Term 7** BME 321 (3-0-0) CH E 416 (3-0-2) CH E 446 (3-1s-3/3) CH E 464 (3-0-3) CME 481 (1-0-0) ITS Elective (3-0-0) **Summer** WKEXP 904	**Fall** WKEXP 906 **Winter Term 8** CH E 454 (1-0-4) CH E 465 (4-0-4) CME 483 (1-0-0) ENGG 400 (1-0-0) Program Elective (3-1s-0) Program Elective (3-1s-0)

Notes
(1) Students who are interested in applying for admission into the Faculty of Medicine and Dentistry MD program should refer to §84.5.1.1.
(2) See §84.5.1.1 for restrictions on the two program electives.

Engineering Chart 2 Required Courses and Suggested Course Sequence for Co-op Programs (cont'd)

Chemical: Computer Process Control Option

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CHEM 261 (3-0-3) CME 200 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) ENGG 299 (1-1s-0) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) Complementary Studies Elective(3-0-0) **Winter Term 4** CH E 243 (3-1s-0) CME 265 (3-0-3) MATH 201 (3-0-1) STAT 235 (3-0-1.5) English Elective (3-0-0) ITS Elective (3-0-0) **Summer** WKEXP 901	**Fall** WKEXP 902 **Winter Term 5** CH E 312 (3-1s-0) CH E 343 (3-1s-0) CH E 351 (2-0-3) CH E 374 (3-1s-0) CH E 446 (3-1s-3/3) Complementary Studies Elective(3-0-0) **Summer Term 6** CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (3-0-4) ENG M 310 (3-0-0) or ENG M 401(3-0-0)	**Fall** WKEXP 903 **Winter Term 7** CH E 416 (3-0-2) CH E 464 (3-0-3) CH E 472 (3-1s-3/3) CME 481 (1-0-0) Program Elective (3-1s-0) Program Elective (3-1s-0) **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** CH E 454 (1-0-4) CH E 465 (4-0-4) CH E 573 (3-0-3/2) CH E 576 (3-0-3/2) CME 483 (1-0-0) ENGG 400 (1-0-0)

Notes
(1) MATH 201 must be taken in either Term 3 or 4.
(2) See §84.5.1.2 for restrictions on the program electives.

Chemical: Oil Sands Elective

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) CME 265 (3-0-3) ENGG 299 (1-1s-0) MATH 209 (3-0-1) English Elective (3-0-0) Complementary Studies Elective(3-0-0) **Winter** WKEXP 901 **Summer Term 4** ECE 209 (3-0-3/2) ENG M 310 (3-0-0) or 401 (3-0-0) MAT E 202 (3-0-3/2) MATH 201 (3-0-1) STAT 235 (3-0-1.5) Complementary Studies Elective(3-0-0)	**Fall Term 5** CH E 312 (3-1s-0) CH E 343 (3-1s-0) CH E 351 (2-0-3) CH E 374 (3-1s-0) Program Elective (3-0-0) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (3-0-4) ITS Elective (3-0-0) **Winter Term 7** CH E 416 (3-0-2) CH E 445 (3-1s-0) CH E 446 (3-1s-3/3) CH E 464 (3-0-3) CH E 522 (3-1s-3/3) CME 481 (1-0-0) **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** CH E 435 (4-0-4) CH E 454 (1-0-4) CH E 534 (3-1s-3/3) CME 483 (1-0-0) ENGG 400 (1-0-0) Program Elective (3-1s-0)

Note: See §84.5.1.3 for restrictions on the program electives.

Civil

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CIV E 265 (2-0-3) CIV E 270 (3-0-3) ENGG 299 (1-1s-0) EAS 210 (3-0-3) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) **Winter Term 4** CIV E 221 (3-0-3/2) CIV E 240 (1-2s-0) CIV E 250 (3-0-3) CIV E 251 (1 week)* CIV E 290 (3-0-0) CIV E 295 (3-0-2) MATH 201 (3-0-1) *Held in Spring/Summer (Spring Term) **Summer** WKEXP 901	**Fall** WKEXP 902 **Winter Term 5** CIV E 303 (3-0-3/2) CIV E 315 (3-0-2) CIV E 321 (3-0-3/2) CIV E 330 (3-1s-0) CIV E 372 (3-2s-0) CIV E 395 (3-0-3/2) **Summer** WKEXP 903	**Fall Term 6** CIV E 331 (3-0-3/2) CIV E 374 (3-0-3) CIV E 381 (3-0-3) CIV E 391 (3-0-3) CIV E 398 (3-1s-0) English Elective (3-0-0) **Winter** WKEXP 904 **Summer** WKEXP 905	**Fall Term 7** Program Elective (See Note) Program Elective (See Note) Program Elective (See Note) One of ECE 209, MEC E 250 or CH E 243 Complementary Studies Elective(3-0-0) **Winter Term 8** ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) ENGG 420 (3-0-0) Program Elective (See Note) Program Elective (See Note) ITS Elective (3-0-0)

Note: See §84.5.2 for restrictions on the program electives.

Engineering Chart 2 Required Courses and Suggested Course Sequence for Co-op Programs (cont'd)

Civil: Environmental Engineering Option

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CIV E 265 (2-0-3) CIV E 270 (3-0-3) ENGG 299 (1-1s-0) ENV E 220 (3-0-3/2) EAS 210 (3-0-3) MATH 209 (3-0-1) **Winter Term 4** CIV E 240 (1-2s-0) CIV E 250 (3-0-3) CIV E 251 (1 week)* CIV E 290 (3-0-0) CIV E 295 (3-0-2) ENV E 222 (3-0-3/2) MATH 201 (3-0-1) *Held in Spring/Summer (Spring Term) **Summer** WKEXP 901	**Fall** WKEXP 902 **Winter Term 5** CIV E 330 (3-1s-0) CIV E 395 (3-0-2/2) ENV E 302 (2-1s-0) ENV E 351 (3-0-3/2) Complementary Studies Elective(3-0-0) **Summer** WKEXP 903	**Fall Term 6** CH E 243 (3-1s-0) CIV E 331 (3-0-3/2) CIV E 372 (3-2s-0) CIV E 381 (3-0-3) ENV E 322 (3-0-0) ENV E 324 (3-0-3/2) **Winter** WKEXP 904 **Summer** WKEXP 905	**Fall Term 7** CIV E 374 (3-0-3) ENV E 320 (3-0-3/2) ENV E 421 (3-0-3/2) ENV E 423 (3-0-0) ENV E 432 (3-0-0) One of CIV E 524 (3-0-0), CIV E 526 (3-0-0), CIV E 558 (3-0-0), ENV E 400 (3-0-0), or ENV E 401 (3-0-0)* *All courses may not be offered every year. **Winter Term 8** ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) ENV E 434 (3-0-0) ENV E 440 (3-0-3) LAW 399 (3-0-0) One of ECE 209, MEC E 250 or MAT E 202 ITS Elective (3-0-0)

Computer

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CMPUT 274 (3-0-3) ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) ENGG 299 (1-1s-0) MATH 201 (3-0-1) MATH 209 (3-0-1) English Elective (3-0-0) **Winter Term 4** CMPUT 272 (3-1s-3) CMPUT 275 (3-0-3) ECE 203 (3-1s-3/2) ECE 212 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2) **Summer** WKEXP 901	**Fall Term 5** ECE 302 (3-1s-3/2) ECE 311 (3-0-0) ECE 325 (3-0-3/2) ECE 340 (3-0-3/2) Group I Program Elective ITS Elective **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** CMPUT 301 (3-0-3) CMPUT 379 (3-0-3) ECE 304 (3-1s-3/2) ECE 342 (3-1s-0) Complementary Studies Elective (3-0-0) Group II Program Elective **Winter Term 7** CMPUT 291 (3-0-3) ECE 315 (3-0-3/2) ECE 410 (3-0-3/2) ECE 420 (3-0-3/2) Group I Program Elective Group II Program Elective **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** ECE 487 (3-0-0) ECE 492 (1-0-6) ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) Group II Program Elective Group II Program Elective Complementary Studies Elective (3-0-0)

Note: See §84.5.3 for restrictions on the six program electives.

Computer: Nanoscale System Design Option

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CMPUT 274 (3-0-3) ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) ENGG 299 (1-1s-0) MATH 201 (3-0-1) MATH 209 (3-0-1) English Elective (3-0-0) **Winter Term 4** CMPUT 272 (3-1s-3) CMPUT 275 (3-0-3) ECE 203 (3-1s-3/2) ECE 212 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2) **Summer** WKEXP 901	**Fall Term 5** ECE 302 (3-1s-3/2) ECE 311 (3-0-0) ECE 325 (3-0-3/2) Complementary Studies Elective (3-0-0) ITS Elective (3-0-0) Group I Program Elective **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** CMPUT 291 (3-0-3) CMPUT 301 (3-0-3) ECE 304 (3-1s-3/2) ECE 342 (3-1s-0) Group II Program Elective ENG M 310 (3-0-0) or 401 (3-0-0) **Winter Term 7** ECE 315 (3-0-3/2) ECE 403 (3-0-3/2) ECE 410 (3-0-3/2) ECE 450 (3-0-3/2) ECE 475 (3-0-0) Complementary Studies Elective (3-0-0) **Summer** WKEXP 904	**Fall Term 7** WKEXP 905 **Winter Term 8** ECE 412 (3-0-0) ECE 457 (3-0-2) ECE 492 (1-0-6) ENGG 400 (1-0-0) Group I Program Elective Group II Program Elective Group II Program Elective

Note: See §84.5.3.1 for restrictions on the program electives.

Engineering Chart 2 Required Courses and Suggested Course Sequence for Co-op Programs (cont'd)

Computer: Software Option

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CMPUT 274 (3-0-3) ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) ENGG 299 (1-1s-0) MATH 201 (3-0-1) MATH 209 (3-0-1) English Elective (3-0-0) **Winter Term 4** CMPUT 272 (3-1s-3) CMPUT 275 (3-0-3) ECE 212 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2) ITS Elective (3-0-0) **Summer** WKEXP 901	**Fall Term 5** ECE 311 (3-0-0) ECE 321 (2-0-3) ECE 325 (3-0-3/2) STAT 235 (3-0-1.5) Group I Program Elective Complementary Studies Elective (3-0-0) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** CMPUT 291 (3-0-3) CMPUT 301 (3-0-3) CMPUT 379 (3-0-3) ECE 322 (3-0-3/2) Group I Program Elective Group II Program Elective **Winter Term 7** ECE 315 (3-0-3/2) ECE 421 (2-0-3) ECE 422 (3-0-0) Group II Program Elective Group II Program Elective Complementary Studies Elective (3-0-0) **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** ECE 420 (3-0-3/2) ECE 487 (3-0-0) ECE 493 (1-0-6) ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) Group II Program Elective Group II Program Elective

Notes
(1) See §84.5.3.2 for restrictions on the five program electives.
(2) At the discretion of the Office of the Dean, students may be transferred to a traditional (non-coop) degree.

Electrical

Year 2	Year 3	Year 4	Year 5
Fall Term 3 ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) ENGG 299 (1-1s-0) MATH 201 (3-0-1) MATH 209 (3-0-1) Group I Program Elective English Elective (3-0-0) **Winter Term 4** ECE 203 (3-1s-3/2) ECE 212 (3-0-3/2) ECE 220 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2) Complementary Studies Elective (3-0-0) **Summer** WKEXP 901	**Fall Term 5** ECE 302 (3-1s-3/2) ECE 312 (3-0-3/2) ECE 330 (3-0-0) ECE 340 (3-0-3/2) ECE 370 (3-1s-0) MATH 309 (3-0-0) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** ECE 342 (3-1s-0) ECE 360 (3-0-3/2) ECE 490 (1-0-3) Group I Program Elective Group II Program Elective Complementary Studies Elective (3-0-0) **Winter Term 7** ECE 303 (3-1s-3/2) ECE 332 (3-0-3/2) ECE 380 (3-0-3/2) ECE 491 (1-0-3) Group II Program Elective Group II Program Elective **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) Group II Program Elective Group II Program Elective Group II Program Elective Group II Program Elective ITS Elective (3-0-0)

Note: See §84.5.4 for restrictions on the nine program electives.

Electrical: Nanoengineering Option

Year 2	Year 3	Year 4	Year 5
Fall Term 3 ECE 201 (1 day) ECE 202 (3-1s-3/2) ECE 210 (3-0-3/2) ENGG 299 (1-1s-0) MATH 201 (3-0-1) MATH 209 (3-0-1) Group I Program Elective English Elective (3-0-0) **Winter Term 4** ECE 203 (3-1s-3/2) ECE 212 (3-0-3/2) ECE 220 (3-0-3/2) ECE 240 (3-1s-0) PHYS 230 (3-0-3/2) Group I Program Elective **Summer** WKEXP 901	**Fall Term 5** ECE 302 (3-1s-3/2) ECE 312 (3-0-3/2) ECE 340 (3-0-3/2) ECE 370 (3-1s-0) MATH 309 (3-0-0) ITS Elective (3-0-0) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** ECE 360 (3-0-3/2) ECE 457 (3-0-2) ECE 471 (3-0-3/2) ECE 490 (1-0-3) Group II Program Elective Complementary Studies Elective (3-0-0) **Winter Term 7** ECE 303 (3-1s-3/2) ECE 341 (3-1s-0) ECE 342 (3-1s-0) ECE 456 (3-0-0) ECE 491 (1-0-3) Group II Program Elective **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** ECE 450 (3-0-3/2) ECE 475 (3-0-0) ENG M 310 (3-0-0) or 401 (3-0-0) ENGG 400 (1-0-0) Group II Program Elective Group II Program Elective Complementary Studies Elective (3-0-0)

Note: See §84.5.4.2 for restrictions on the program electives.

Engineering Chart 2 Required Courses and Suggested Course Sequence for Co-op Programs (cont'd)

Materials

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) ENGG 299 (1-1s-0) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) STAT 235 (3-0-1.5) **Winter Term 4** CIV E 270 (3-0-3) CME 265 (3-0-3) English Elective (3-0-0) MATH 201 (3-0-1) MAT E 211 (3-1s-3/4) MAT E 221 (3-1s-0) **Summer** WKEXP 901	**Fall Term 5** CH E 312 (3-1s-0) CH E 374 (3-1s-0) Complementary Studies Elective (3-0-0) MAT E 301 (3-0-0) MAT E 335 (3-1s-0) MAT E 361 (1-1s-3/2) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** CH E 314 (3-1s-0) CME 481 (1-0-0) ENG M 310 (3-0-0) or 401 (3-0-0) MAT E 464 (3-0-3) Program Elective (3-1s-0) Program Elective (3-0-0) **Winter Term 7** Complementary Studies Elective (3-0-0) ITS Elective (3-0-0) MAT E 341 (3-1s-0) MAT E 336 (3-1s-0) MAT E 351 (3-1s-0) MAT E 362 (1-1s-3/2) **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** CME 483 (1-0-0) ENGG 400 (1-0-0) MAT E 461 (1-1s-4) MAT E 465 (2-1s-3) Program Elective (3-0-0) Program Elective (3-0-0) Program Elective (3-0-0)

Notes
(1) See §84.5.6 for restrictions on the five program electives.
(2) Students who are in or are interested in Structural Materials, Mineral Processing and Extractive Metallurgy, or Polymer Materials Elective Streams should consult the Department for course schedules.

Materials: Biomedical Option

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) ENGG 299 (1-1s-0) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) STAT 235 (3-0-1.5) **Winter Term 4** CIV E 270 (3-0-3) CME 265 (3-0-3) English Elective (3-0-0) MATH 201 (3-0-1) MAT E 211 (3-1s-3/4) MAT E 221 (3-1s-0) **Summer** WKEXP 901	**Fall Term 5** BIOL 107 (3-1s-3) CH E 312 (3-1s-0) Complementary Studies Elective (3-0-0) MAT E 301 (3-0-0) MAT E 335 (3-1s-0) MAT E 361 (1-1s-3/2) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** BME 320 (3-0-0) CH E 314 (3-1s-0) CH E 374 (3-1s-0) CME 481 (1-0-0) ENG M 310 (3-0-0) or 401 (3-0-0) MAT E 464 (3-0-3) **Winter Term 7** BIOCH 200, or BIOL 201, CELL 201 (3-0-0) MAT E 341 (3-1s-0) MAT E 336 (3-1s-0) MAT E 351 (3-1s-0) MAT E 362 (1-1s-3/2) PHIL 386 (3-0-0) **Summer** WKEXP 904	**Fall** WKEXP 906 **Winter Term 8** BME 321 (3-0-0) CH E 582 (3-1s-0) or MAT E 495 (3-1s-0) CME 483 (1-0-0) ENGG 400 (1-0-0) MAT E 461 (1-1s-4) MAT E 465 (2-1s-3) ITS Elective (3-0-0)

Note: Students who are interested in applying for admission into the Faculty of Medicine and Dentistry MD program should refer to §84.5.6.1.

Materials: Nano and Functional Materials Option

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CH E 243 (3-1s-0) CHEM 261 (3-0-3) CME 200 (1 day) ENGG 299 (1-1s-0) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) STAT 235 (3-0-1.5) **Winter Term 4** CIV E 270 (3-0-3) CME 265 (3-0-3) English Elective (3-0-0) MATH 201 (3-0-1) MAT E 211 (3-1s-3/4) MAT E 221 (3-1s-0) **Summer** WKEXP 901	**Fall Term 5** CH E 312 (3-1s-0) CH E 374 (3-1s-0) MAT E 335 (3-1s-0) MAT E 301 (3-0-0) MAT E 361 (1-1s-3/2) MAT E 390 (3-0-0) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** CH E 314 (3-1s-0) CME 481 (1-0-0) ECE 457 (3-0-2) ENG M 310 (3-0-0) or 401 (3-0-0) MAT E 464 (3-0-3) MAT E 491 (3-1s-0) Complementary Studies Elective (3-0-0) **Winter Term 7** Complementary Studies Elective (3-0-0) MAT E 341 (3-1s-0) MAT E 336 (3-1s-0) MAT E 351 (3-1s-0) MAT E 362 (1-1s-3/2) MAT E 495 (3-1s-0) or CME 458 (2-0-3) **Summer** WKEXP 904	**Fall** WKEXP 905 **Winter Term 8** CME 483 (1-0-0) ENGG 400 (1-0-0) MAT E 461 (1-1s-4) MAT E 465 (2-1s-3) MAT E 494 (3-0-3/2) ITS Elective (3-0-0)

Engineering Chart 2 Required Courses and Suggested Course Sequence for Co-op Programs (cont'd)

Mechanical Plan I

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CH E 243 (3-1s-0) CIV E 270 (3-0-3) ENGG 299 (1-1s-0) MATH 209 (3-0-1) MEC E 200 (1-2s-0) MEC E 230 (3-1s-0) MEC E 250 (3-1s-0) **Winter Term 4** ECE 209 (3-0-3/2) MATH 201 (3-0-1) MAT E 202 (3-0-3/2) MEC E 260 (2-0-3) MEC E 265 (2-0-3) STAT 235 (3-0-1.5) **Summer** WKEXP 901	**Fall** WKEXP 902 **Winter Term 5** **Course Group 3A** MATH 300 (3-0-0) MEC E 300 (3-0-0) MEC E 301 (1-0-3) MEC E 331 (3-0-1) MEC E 371 (3-1s-0) MEC E 380 (3-0-0) **or** **Course Group 3B** ENG M 310 (3-0-0) or 401 (3-0-0) English Elective (3-0-0) MEC E 340 (3-0-0) MEC E 360 (3-0-3/2) MEC E 362 (3-0-3/2) MEC E 390 (3-0-1) **Summer** WKEXP 903	**Fall Term 6** **Course Group 3A** MATH 300 (3-0-0) MEC E 300 (3-1s-0) MEC E 301 (1-0-3) MEC E 331 (3-0-1) MEC E 371 (3-1s-0) MEC E 380 (3-1s-0) **or** **Course Group 3B** ENG M 310 (3-0-0) or 401 (3-0-0) English Elective (3-0-0) MEC E 340 (3-0-0) MEC E 360 (3-0-3/2) MEC E 362 (3-0-3/2) MEC E 390 (3-0-1) **Winter** WKEXP 904 **Summer** WKEXP 905	**Fall Term 7** Program Elective (3-0-0) Program Elective (3-0-0) **Course Group 4A** MEC E 430 (3-0-0) or 480 (3-0-0) MEC E 463 (3-0-2) Program Elective (3-0-0) Complementary Studies Elective (3-0-0) **or** **Course Group 4B** MEC E 403 (1-0-3) MEC E 451 (3-0-1) MEC E 460 (2-1s-4) ITS Elective (3-0-0) **Winter Term 8** ENGG 400 (1-0-0) CH E 448 (3-1s-3/3) or ECE 362 (3-0-3/2) or MEC E 420 (3-0-3/2) Program Elective (3-0-0) **Course Group 4A** MEC E 430 (3-0-0) or 480 (3-0-0) MEC E 463 (3-0-2) Program Elective (3-0-0) Complementary Studies Elective (3-0-0) **or** **Course Group 4B** MEC E 403 (1-0-3) MEC E 451 (3-0-1) MEC E 460 (2-1s-4) ITS Elective (3-0-0)

Notes
(1) See §84.5.7 for restrictions on the four program electives.
(2) In Years 3, 4, and 5, students take either (Group A in Fall, Group B in Winter) or (Group B in Fall, Group A in Winter).

Mechanical Plan II

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CIV E 270 (3-0-3) ENGG 299 (1-1s-0) MATH 209 (3-0-1) MEC E 230 (3-1s-0) MEC E 260 (2-0-3) MEC E 265 (2-0-3) **Winter** WKEXP 901 **Summer Term 4** CH E 243 (3-1s-0) ECE 209 (3-0-3/2) MATH 201 (3-0-1) MAT E 202 (3-0-3/2) MEC E 200 (1-2s-0) MEC E 250 (3-1s-0) STAT 235 (3-0-1.5)	**Fall Term 5** **Course Group 3A** MATH 300 (3-0-0) MEC E 300 (3-0-0) MEC E 301 (1-0-3) MEC E 331 (3-0-1) MEC E 371 (3-1s-0) MEC E 380 (3-0-0) **Winter** WKEXP 902 **Summer** WKEXP 903	**Fall Term 6** **Course Group 3B** ENG M 310 (3-0-0) or 401 (3-0-0) English Elective (3-0-0) MEC E 340 (3-0-0) MEC E 360 (3-0-3/2) MEC E 362 (3-0-3/2) MEC E 390 (3-0-1) **Winter** WKEXP 904 **Summer** WKEXP 905	**Fall Term 7** Program Elective (3-0-0) Program Elective (3-0-0) **Course Group 4A** MEC E 430 (3-0-0) or 480 (3-0-0) MEC E 463 (3-0-2) Program Elective (3-0-0) Complementary Studies Elective (3-0-0) **or** **Course Group 4B** MEC E 403 (1-0-3) MEC E 451 (3-0-1) MEC E 460 (2-1s-4) ITS Elective (3-0-0) **Winter Term 8** ENGG 400 (1-0-0) CH E 448 (3-1s-3/3) or ECE 362 (3-0-3/2) or MEC E 420 (3-0-3/2) Program Elective (3-0-0) **Course Group 4A** MEC E 430 (3-0-0) or 480 (3-0-0) MEC E 463 (3-0-2) Program Elective (3-0-0) Complementary Studies Elective (3-0-0) **or** **Course Group 4B** MEC E 403 (1-0-3) MEC E 451 (3-0-1) MEC E 460 (2-1s-4) ITS Elective (3-0-0)

Notes
(1) See §84.5.7 for restrictions on the four program electives.
(2) In Year 5, students take either (Group A in Fall, Group B in Winter) or (Group B in Fall, Group A in Winter).

Engineering Chart 2 Required Courses and Suggested Course Sequence for Co-op Programs (cont'd)

Mechanical Plan III : Biomedical Option

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CIV E 270 (3-0-3) ENGG 299 (1-1s-0) MATH 209 (3-0-1) MEC E 230 (3-1s-0) **Course Group 2A** CH E 243 (3-1s-0) MEC E 200 (1-2s-0) MEC E 250 (3-1s-0) **or** **Course Group 2B** MEC E 260 (2-0-3) MEC E 265 (2-0-3) **Winter Term 4** ECE 209 (3-0-3/2) MATH 201 (3-0-1) MAT E 202 (3-0-3/2) STAT 235 (3-0-1.5) **Course Group 2B** MEC E 260 (2-0-3) MEC E 265 (2-0-3) **or** **Course Group 2A** CH E 243 (3-1s-0) MEC E 200 (1-2s-0) MEC E 250 (3-1s-0) **Summer** WKEXP 902	**Fall Term 5** BME 320 (3-0-0) ENG M 310 or 401 (3-0-0) MEC E 340 (3-0-0) MEC E 360 (3-0-3/2) MEC E 362 (3-0-3/2) MEC E 390 (3-0-1) **Winter Term 6** BME 321 (3-0-0) MATH 300 (3-0-0) MEC E 300 (3-0-0) MEC E 301 (1-0-3) MEC E 331 (3-0-1) MEC E 380 (3-0-0) **Summer** WKEXP 903	**Fall Term 7** Complementary Studies Elective (3-0-0) English Elective (3-0-0) MEC E 371 (3-1s-0) MEC E 468/563 (3-0-3) Program Elective (3-0-0) STAT 337 (3-0-2) **Winter** WKEXP 906 **Summer** WKEXP 904	**Fall Term 8** Program Elective (3-0-0) ITS Elective (3-0-0) **Course Group 4A** MEC E 430 (3-0-0) MEC E 463 (3-0-2) Program Elective (3-0-0) **or** **Course Group 4B** MEC E 403 (1-0-3) MEC E 451 (3-0-1) MEC E 460 (2-1s-4) **Winter Term 9** CH E 448 (3-1s-3/3) or ECE 362 (3-0-3/2) or MEC E 420 (3-0-3/2) ENGG 400 (1-0-0) MEC E 485 (3-0-0) PHIL 386 (3-0-0) **Course Group 4B** MEC E 403 (1-0-3) MEC E 451 (3-0-1) MEC E 460 (2-1s-4) **or** **Course Group 4A** MEC E 480 (3-0-0) MEC E 463 (3-0-2) Program Elective (3-0-0)

Notes
(1) See §84.5.7.1 for restrictions on the program electives.
(2) In Year 2 and Year 5, students take either (Group A in Fall and Group B in Winter) or (Group B in Fall and Group A in Winter)
(3) The order of WKEXP 904 and 906 may be switched. See the program advisor.
(4) Fall Term 8 and WKEXP 906 as indicated may be switched. See the program advisor.
(5) Students wishing to apply for admission to the Faculty of Medicine and Dentistry MD program should see §84.5.7.1.

Mining

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CIV E 265 (2-0-3) EAS 210 (3-0-3) ECE 209 (3-0-3/2) ENGG 299 (1-1s-0) MATH 209 (3-0-1) MIN E 295 (3-0-3/2) STAT 235 (3-0-1.5) **Winter Term 4** CH E 243 (3-1s-0) CIV E 250 (3-0-3) CIV E 251 (1 week)* CIV E 270 (3-0-3) MATH 201 (3-0-1) MIN E 310 (3-0-3) ITS Elective (3-0-0) **Summer** WKEXP 901 *Held in Spring/Summer (Spring Term)	**Fall** WKEXP 902 **Winter Term 5** CIV E 330 (3-1s-0) or CH E 312 (3-1s-0) MIN E 324 (3-0-0) MIN E 330 (3-3/2s-0) English Elective (3-0-0) Program Elective (3-0-0) (See §84.5.8) **Summer** WKEXP 903	**Fall Term 6** CIV E 381 (3-0-3) CME 421 (3-0-3/2) ENG M 310 (3-0-0) or 401 (3-0-0) MIN E 323 (3-0-3) MIN E 325 (3-0-3) **Winter** WKEXP 904 **Summer** WKEXP 905	**Fall Term 7** ENGG 404 (3-3s/2-0) MIN E 402 (1-0-6) MIN E 413 (3-0-3/2) MIN E 414 (3-0-3/2) Complementary Studies Elective (3-0-0) Program Elective (3-0-0) (See §84.5.8) **Winter Term 8** ENGG 400 (1-0-0) MIN E 403 (1-0-6) MIN E 407 (3-0-3/2) MIN E 408 (2-0-2) MIN E 420 (3-0-0) MIN E 422 (2-1s-0)

Petroleum

Year 2	Year 3	Year 4	Year 5
Fall Term 3 CH E 243 (3-1s-0) EAS 210 (3-0-3) ECE 209 (3-0-3/2) ENGG 299 (1-1s-0) MAT E 202 (3-0-3/2) MATH 209 (3-0-1) English Elective (3-0-0) **Winter Term 4** CH E 312 (3-1s-0) CIV E 270 (3-0-3) MATH 201 (3-0-1) PET E 275 (3-0-3/2) STAT 235 (3-0-1.5) Complementary Studies (3-0-0) **Summer** WKEXP 901	**Fall** WKEXP 902 **Winter Term 5** CH E 374 (3-1s-0) EAS 222 (3-0-3) PET E 366 (3-0-0) PET E 365 (3-1s-0) Program Elective (3-0-0) (See §84.5.9) **Summer** WKEXP 903	**Fall Term 6** CHEM 371 (3-0-3) ENG M 310 (3-0-0) or 401 (3-0-0) PET E 364 (3-1s-3/2) PET E 373 (3-0-3/2) Program Elective (3-0-0) (See §84.5.9) Complementary Studies (3-0-0) **Winter** WKEXP 904 **Summer** WKEXP 905	**Fall Term 7** CH E 314 (3-1s-0) ENGG 404 (3-3s/2-0) PET E 444 (3-0-0) PET E 475 (3-0-3/2) PET E 476 (3-0-0) PET E 484 (3-0-0) **Winter Term 8** ENGG 400 (1-0-0) PET E 471 (3-0-0) PET E 477 (3-0-0) PET E 478 (3-0-0) PET E 496 (1-6s-0) ITS Elective (3-0-0)

84.5 Program and Technical Electives

84.5.1 Chemical

Of the four single-term program electives,

(1) Exactly one must be a "Science" elective selected from: BIOL 107, 108; CHEM 211, 263; EAS 100, 210; PHYS 230, 244, 271.

(2) At least two must be Engineering Science and/or Engineering Design courses selected from:
BME 320, 321
CME 421, 422, (458, 459 see Note), 472, 482, 484, 485, 494, 496
CH E 420, 482, 484, 485, 487, 494, 496, 512, 522, 534, 572, 573, 576, 580, 582, 583, 584, 594, 596
CIV E 270, 321
ECE 203, 210, 212
ENGG 404, 406
ENG M 501
ENV E 302
MAT E 211, 221, 335, 336, 341, 345, 351, 390, 466, 471, 473, 474, 490, 491, 494, 495
MEC E 250, 443
MGTSC 405
MIN E 310
PET E 364, 365, 366, 368, 470, 473, 475
Note: CME 458 or 459 may only be taken with an appropriate project approved by the department.

(3) No more than one single-term program elective may be selected from the following approved list:
BIOCH 200
BIOL 201, 208, 381
BOT 340
CELL 201
CHEM 211, 213, 303, 333, 479, 495
EAS 201, 209
ENCS 455, 475
FOREN 355
MATH 225, 241, 300, 309, 311, 337, 371, 373, 374
MGTSC 405
MICRB 265, 311, 316
OM 352, 404, 422, 426
SOILS 210, 430, 440, 450
Note: Other courses may be taken as program electives with written permission from the Department.

(4) Nanoscale Engineering Elective Stream
One of the four program electives should be MAT E 211. The remaining three program electives can be selected from CH E 487, 583, 584 and MAT E 495.
Students interested in this elective stream should consult the Department for a course schedule.

(5) Mineral Processing and Extractive Metallurgy Elective Stream
Three of the four program electives should be CME 421, 422 and 472. The fourth program elective can be selected from the above lists (1), (2) and (3), and must be approved by the Department.
Students interested in this elective stream should consult the Department for a course schedule.

(6) Polymer Materials Elective Stream
Three of the four program electives should be CME 482, 484 and 485. The fourth program elective can be selected from the above lists (1), (2) and (3), and must be approved by the Department.
Students interested in this elective stream should consult the Department for a course schedule.

84.5.1.1 Chemical: Biomedical Option

The two single-term program electives must be selected from the following: CH E 484, 582, CME 458 or 459, MAT E 495 with appropriate project approved by department.

Admission requirements for the Doctor of Medicine (MD) degree program include a specific number of course units in various core subjects. This information can be found in §15.9.9II. Students in the Biomedical Option who plan to apply to the MD degree program must select their electives carefully to obtain the necessary credit for required subjects. It may also be necessary to take courses over and above those included in the Biomedical Option to meet the course unit requirements in all of the core subjects required for Medicine. Students in the Biomedical Option who plan to apply for admission to the MD degree program should contact their program advisor in the Fall term of second year for guidance on the selection of appropriate electives and any specific courses which would be in addition to those required for the engineering degree.

84.5.1.2 Chemical: Computer Process Control Option

The two single-term program electives must be selected from lists (1), (2) and (3) in §84.5.1. At least one of these electives must be Engineering Science and/or Engineering Design [from list (2)]. Other courses may be taken with written permission from the current Computer Process Control Advisor **prior** to enrollment.

84.5.1.3 Chemical: Oil Sands Elective

The two single-term program electives can be selected from lists (1), (2) and (3) in §84.5.1. At least one of these electives must be Engineering Science and/or Engineering Design [from list (2)]. Other courses may be taken with written permission from the current Oil Sands Advisor **prior** to enrollment.

84.5.2 Civil

Five program electives are required from (1) and (2). Three must be selected from (1) and two from (2).

(1) CIV E 406, 411, 431, 474, 481 and ENV E 421

(2) CIV E 409, 419, 429, 439, 479, 489

84.5.2.1 Civil: Biomedical Engineering Option

Three program electives are required, with one each selected from groups (1), (2) and (3).

(1) CIV E 431, 474, 481 and ENV E 421

(2) CIV E 429, 439, 479 and 489

(3) BIOL 207, BME 513, 553, CH E 484, CHEM 263, MEC E 563

Admission requirements for the Doctor of Medicine (MD) degree program include a specific number of course units in various core subjects. This information can be found in §15.9.9II. Students in the Biomedical Option who plan to apply to the MD degree program must select their electives carefully to obtain the necessary credit for required subjects. It may also be necessary to take courses over and above those included in the Biomedical Option to meet the course unit requirements in all of the core subjects required for Medicine. Students in the Biomedical Option who plan to apply for admission to the MD degree program should contact their program advisor in the Fall term of second year for guidance on the selection of appropriate electives and any specific courses which would be in addition to those required for the engineering degree.

84.5.3 Computer

Group I (Interdisciplinary) Electives
Two from CH E 243, MAT E 201 and MEC E 250 must be selected.
Group II Electives
The four program electives in this group must be selected from the following list:
CMPUT 250, 304, 307, 325, 350, 366, 391, 411, 415, 466
ECE 303, 321, 322, 362, 380, 402, 403, 405, one of 406 and 407, 412, 413, 421, 422, 440, 442, 449, 450, 455, 456, 475.
Other courses, including 500-level graduate ECE courses, may be taken with Departmental approval.

84.5.3.1 Computer Engineering: Nanoscale System Design Option

Group I (Interdisciplinary) Electives
Two from CH E 243, MAT E 201 and MEC E 250 must be selected.
Group II Electives
The three program electives in this group must be selected from the following list:
CMPUT 313, 379
ECE 340, 370, 380, one of 406 or 407, 422, 449, 452, 455, 456, 475
Other courses, including 500-level graduate ECE courses, may be taken with Departmental approval.

84.5.3.2 Computer Engineering: Software Option

Group I (Interdisciplinary) Electives
Two from CH E 243, MAT E 201 and MEC E 250 must be selected.
Group II Electives

The five program electives in this group must be selected from the following list:
CMPUT 250, 304, 307, 325, 350, 366, 391, 410, 411, 415, 466
ECE 362, 370, 380, 405, one of 406 or 407, 440, 449, 455
Other courses, including 500-level graduate ECE courses, may be taken with Departmental approval.

84.5.4 Electrical

Group I (Interdisciplinary) Electives
Two from CH E 243, MAT E 201 and MEC E 250 must be selected.
Group II Electives
Of the seven single-term program electives in this group, at least three must be from
ECE 304, 401, 402, 403, 410, 432, 433, 440, 442, 449, 450, 457, 460, 471, 475, 485
and at most two program electives may be chosen from the following list of courses:
BME 513
ECE 405, one of 408 or 409, 412, 413, 452, 487.
The other program electives may be chosen from the following list of courses:
ECE 341, 430, 434, 456, 458, 464, 472, 474, 476, 478, 486, 489
Other courses, including 500-level graduate ECE courses, may be taken with Departmental approval.
Total lab hours per week in the Group II Electives must be a minimum of 4.5 hours. The Lab hours in a graduate course may not count towards the minimum 4.5 hours/week.
Recommendations regarding selection of program electives in various areas of study in electrical engineering are available from the Department.

84.5.4.1 Electrical: Biomedical Option

Group I (Interdisciplinary) Electives
Two from CH E 243, MAT E 201 and MEC E 250 must be selected.
Group II Electives
Of the four program electives in this group, at least two must be from
ECE 304, 380, 401, 442, 450, 457, 460, 471, 476
and the remainder from
BIOCH 200
BME 513, 564
CHEM 261,263
ECE 330, 332, 430, 445, 452, 456, 458, 464, 475, 478
Admission requirements for the Doctor of Medicine (MD) degree program include a specific number of course units in various core subjects. This information can be found in §15.9.9II. Students in the Biomedical Option who plan to apply to the MD degree program must select their electives carefully to obtain the necessary credit for required subjects. It may also be necessary to take courses over and above those included in the Biomedical Option to meet the course unit requirements in all of the core subjects required for Medicine. Students in the Biomedical Option who plan to apply for admission to the MD degree program should contact their program advisor in the Fall term of second year for guidance on the selection of appropriate electives and any specific courses which would be in addition to those required for the engineering degree.

84.5.4.2 Electrical: Nanoengineering Option

Group I (Interdisciplinary) Electives
Two from CH E 243, MAT E 201 and MEC E 250 must be selected.
Group II Electives
Of the four single-term program electives in this group, at least two must be from
ECE 304, 452, 457, 458, 475
and the remainder from
BME 513, 553, 564
ECE 330, 332, 380, 401, 402, 403, 405, one of 408 or 409, 410, 430, 440, 449, 455, 460, 464, 472, 474, 476, 478.
Other courses, including 500-level graduate ECE courses, may be taken in lieu of those on the latter list with Departmental approval.
Total lab hours per week in the Group II Electives must be a minimum of 3.0 hours. The Lab hours in a graduate course may not count towards the minimum 3 hours/week.

84.5.5 Engineering Physics

Of the five program electives at least two must be from:
ECE 212, 380, 450, 452, 472, 476, 478
and the remainder from
ECE 304, 330, 332, 401, 402, 403, 405, 410, 432, 440, 442, 450, 455, 456, 457, 458, 460, 464, 474, 475, 485, 486, 489
BME 513, 564
Other courses from Faculty of Engineering and Faculty of Science (at the graduate or undergraduate level) can be substituted with Department approval.

84.5.5.1 Engineering Physics: Nanoengineering Option

Of the three program electives at least one must be from:
ECE 212, 220, 380, 450, 452, 472, 476, 478
and the remainder from
ECE 304, 330, 332, 401, 402, 403, 405, 410, 432, 440, 442, 449, 455, 456, 458, 460, 464, 474, 475, 485, 486, 489
BME 513, 564
MAT E 494, 495
Other courses from Faculty of Engineering and Faculty of Science (at the graduate or undergraduate level) can be substituted with Department approval.

84.5.6 Materials

(1) Students in the general Materials Engineering program are required to take five program electives from the following list of courses. At least three of the five must be CME and/or MAT E courses.
BIOCH 200
BIOL 107, 201
BME 410, 320, 321, 541
CELL 201
CME 421, 422, (458, 459 see Note 1), 472, 482, 484, 485, 494
CH E 343, 446, 482, 484, 485, 582
CHEM 211, 213, 263, 303, 333, 371, 373
CIV E 221, 321, 372, 374, 421
EAS 210, 224, 320
ECE 209, 457
ENGG 404, 406
ENG M 513, 514
ENV E 351
GEOPH 223
MAT E 390, 466, 470, 471, 473, 474, 490, 491, 494, 495
MATH 300
MEC E 250, 260, 360, 380
MGTSC 405
MIS 311
OM 352, 404, 422, 426
PHYS 230, 271
STAT 265, 335, 368, 378
Other courses may be taken as program electives with written permission from the Department.
Notes
(1) CME 458 or 459 may only be taken with an appropriate project approved by the Department.
(2) Other courses may be taken as program electives with written permission from the Department.

(2) Mineral Processing and Extractive Metallurgy Elective Stream
Three of the five program electives should be CME 421, 422 and 472. Of the remaining two program electives, one should be either CH E 446 or MAT E 470, and the other can be selected from list (1).
Students interested in this elective stream should consult the Department for a course schedule.

(3) Polymer Materials Elective Stream
Four of the five program electives should be CH E 345, CME 482, 484 and 485. The fifth program elective can be selected from list (1).
Students interested in this elective stream should consult the Department for a course schedule.

(4) Structural Materials Elective Stream
Four of the five program electives should be CME 472, MAT E 470, 473 and 474. The fifth program elective can be selected from list (1).
Students interested in this elective stream should consult the Department for a course schedule.

84.5.6.1 Materials: Biomedical Option

Admission requirements for the Doctor of Medicine (MD) degree program include a specific number of course units in various core subjects. This information can be found in §15.9.9II. Students in the Biomedical Option who plan to apply to the MD degree program must select their electives carefully to

obtain the necessary credit for required subjects. It may also be necessary to take courses over and above those included in the Biomedical Option to meet the course unit requirements in all of the core subjects required for Medicine. Students in the Biomedical Option who plan to apply for admission to the MD degree program should contact their program advisor in the Fall term of second year for guidance on the selection of appropriate electives and any specific courses which would be in addition to those required for the engineering degree.

84.5.7 Mechanical

(1) One program elective must be chosen from the following:
MEC E 467, 468, 539 or 563

(2) The remaining three program electives must be chosen from the following:
ACCTG 300, 311
B LAW 301, 422, 444
BME 320, 321, 410, 513, 553, 564, 583
CH E 582
ECE 405, 440, 449
ENGG 404, 406, 420
ENG M 402, 406, 501, 508, 510, 514, 516, 530, 540, 541, 558
FIN 301
MARK 301
MATH 311
MAT E 345, 495
MEC E 364, 409, 415, 430, 439, 443, 464, 466, 468, 469, 480, 485, 494/495, 537, 539, 541, 551, 553, 563, 564, 569
OM 352
PET E 275, 364, 365, 366, 444
SMO 301, 321

Other courses, including graduate-level ENG M and MEC E courses, may be taken with Department approval. Program elective courses (including transfer courses) must be at 300-level or above unless cleared in advance by the Department or specified for particular streams.

Note that some courses have prerequisites that must be satisfied.

(3) Biomedical Engineering Elective Stream

Students wishing to specialize in the area of biomedical engineering should choose their three program electives from the following courses: BME 320, 321, 410, 513, 553, 583, ECE 405, 440, MEC E 409, 469, 485. In particular, BME 320, 321, and MEC E 485 are especially recommended.

Note: Some of these courses may not be offered every year. See department for details.

(4) Business and Management Elective Stream

Students wishing to obtain an introduction to business and management principles should take ENG M 401 instead of ENG M 310, ENG M 405 as their ITS elective, and ECON 204 as their complementary studies elective in Term 8. In addition, they can choose their program electives from the following:

a. **Within the Faculty of Engineering:** E E 404, ENGG 402, 420, ENG M 501, 508, 510, 516, 530, 540, 541, 558. Note that some of these courses may not be offered every year. See department for details.

b. **Within the Faculty of Business:** ACCTG 300, B LAW 301, FIN 301, MARK 301, OM 352, SMO 301, 321. Note that admission to FIN 301, MARK 301, SMO 301, 321 is preferentially reserved for students within that Faculty, and is available to engineering students only on a space-available basis.

Credit will only be given for one of E E 404 and ENG M 515, and for one of CIV E 592 and OM 352.

Specific selection of electives should reflect the student's specific interests and needs.

(5) Aerospace Engineering Elective Stream

Students wishing to specialize in the area of aerospace engineering should choose their three program electives from the following courses: MEC E 439, 514, 520, 537, 539, 541, 569.

84.5.7.1 Mechanical (Biomedical Option)

(1) The three program electives may be chosen from the following in addition to courses listed in §84.5.7(2):
BIOCH 200
BIOL 107, 108, 207
CHEM 261, 263

Admission requirements for the Doctor of Medicine (MD) degree program include a specific number of course units in various core subjects. This information can be found in §15.9.9II. Students in the Biomedical Option who plan to apply to the MD degree program must select their electives carefully to obtain the necessary credit for required subjects. It may also be necessary to take courses over and above those included in the Biomedical Option to meet the course unit requirements in all of the core subjects required for Medicine. Students in the Biomedical Option who plan to apply for admission to the MD degree program should contact their program advisor in the Fall term of second year for guidance on the selection of appropriate electives and any specific courses which would be in addition to those required for the engineering degree.

84.5.8 Mining

The following courses are approved electives for the BSc program in Mining Engineering.

Courses not listed must be preapproved by the Mining Undergraduate Student Advisor. Preapproval forms can be obtained from the Department. Without a preapproval form in your file there is no guarantee you will be given credit for the course if it is not in this list.

CH E 374
CIV E 221, 303, 321, 331, 391, 431, 481
EAS 205, 221, 224
ECON 355, 365, 366
ENGG 406, 420
ENG M 501, 510, 514, 530
FIN 422
GEOPH 223, 224
MIN E 555
OM 422, 426
PHYS 230

Business Electives

The following courses are recommended program electives focus groups for the BSc program in Mining Engineering.

Mineral Processing: CME 422, 472
Geology: EAS 233, 421
Business: FIN 301, 413, 422; OM 352, 422, 426; SMO 301, 402

Note: Registration in more advanced business courses requires approval of the Faculty of Business.

84.5.9 Petroleum

The two program electives should be chosen from the following:
ACCTG 300
B LAW 301, 428
CH E 343, 522, 534
CIV E 265
CME 265
EAS 204, 205, 209, 323
ECON 355, 365, 366
ECE 341
ENGG 406, 420
ENG M 530
FIN 301, 422
GEOPH 224, 326
MAT E 345
MATH 253, 300, 311, 337, 436, 438
MEC E 340
OM 352, 422, 426
PET E 470
PHYS 230
SMO 301, 321, 402, 404, 412
STAT 361, 368

Credit will only be given for one of B LAW 301 and ENGG 420, and for one of EAS 204 and EAS 205. ACCTG 300 can be used as either a program or complementary elective.

Note: That some of these courses may have prerequisites. Other courses may be taken with Department approval.

84.6 Complementary Studies Electives

To better understand the role of Engineering within a broader social context, all programs require an element of complementary studies consisting of the humanities, social sciences, arts, management, engineering economics and communications. Aspects of these topics are covered in mandatory courses, but each program contains complementary studies electives so that students may explore areas of particular interest. Notwithstanding this, the Canadian Engineering Accreditation Board requires that programs include exposure

to the central thought processes of the humanities and social sciences. One Complementary Studies Elective must be taken from List 1, normally in the First Year of the program. Further Complementary Studies Electives must be at the 200-level or above and should be selected from List 2 (see §231 for course descriptions and prerequisites):

List 1 (First year)

ANTHR 101, 110, 150
CLASS 102, 103, 104, 110
ECON 101, 102, 204
ENGL 121, 122, 123, 124, 125*
HIST 110, 111, 112, 114, 115, 116
LING 100, 101
PHIL 120, 125
POL S 101
PSYCO 104
SOC 100

*A single ★3 ENGL course cannot satisfy both a Complementary Studies Elective and the English Elective requirements.

List 2 (Second and higher years)

ACCTG 300, 311
ANTHR 230
B LAW 301, 422, 428**, 432
CHRTC 350
CLASS 254, 255, 294, 376
ECON 204, 281, 282, 355, 365
ENGG 420
ENG M 402, 406
HECOL 211
HIST 260, 261, 396, 397, 398
INT D 257, 303
LA ST 210
LING 204, 205
MARK 301
OM 352
PHIL 205, 220, 250, 265, 325, 366, 375, 380
POL S 220, 221, 223, 266
PSYCO 258, 275
R SOC 355, 365
SMO 200, 301
SOC 212, 224, 225, 241, 242, 251, 301
WGS 201

**Not available to Civil (Environmental Engineering Option) students.

A second course from the ITS List (§84.6.1) may be taken as part of List 2. However, a single course cannot be used to satisfy both the ITS and Complementary Studies requirements. This list is updated annually. Courses that teach a language or the application of a particular skill (such as courses in physical education, music and art) do not meet the intent of the Accreditation Board with respect to complementary studies and are therefore not eligible.

84.6.1 Impact of Technology on Society (ITS) Elective

A specific requirement of the Canadian Engineering Accreditation Board is study of the impact of technology on society. To meet this requirement, students must take one of the following: ENG M 403, 405, HIST 115, 391, HGP 250, INT D 361, PHIL 265, 366, 375, STS 200, SOC 366 or 363.

84.6.2 English Electives

Most engineering programs require a single-term (3-0-0) English course. This is typically ENGL 199, but ENGL 121, 122, 123, 124 and 125 are also acceptable.

85 Courses

85.1 Course Listings

Faculty of Engineering courses are listed in §231, Course Listings, under the following subject headings:

Biomedical Engineering (BME)
Bioresource Engineering (BIOEN) (offered by the Faculty of Agricultural, Life and Environmental Sciences)
Chemical and Materials Engineering (CME)
Chemical Engineering (CH E)
Civil Engineering (CIV E)
Computer Engineering (CMPE) (offered jointly with the Faculty of Science)
Electrical Engineering (E E)
Electrical and Computer Engineering (ECE)
Electrical and Computer Engineering/Biomedical Engineering (EE BE)
Engineering, Computing (ENCMP)
Engineering, General (ENGG)
Engineering, Management (ENG M)
Engineering, Physics (EN PH) (offered jointly with the Faculty of Science)
Environmental Engineering (ENV E)
Materials Engineering (MAT E)
Mechanical Engineering (MEC E)
Mineral Engineering (MNL E)
Mining Engineering (MIN E)
Mining and Petroleum Engineering (MP E)
Petroleum Engineering (PET E)
Work Experience (WKEXP)

85.2 Registration in Engineering Courses by Students in Other Faculties

Although the Faculty of Engineering is a restricted enrolment Faculty, it is possible for students registered in other Faculties to enrol in a limited number of Engineering courses. However, students not registered in the Faculty of Engineering must obtain permission to enrol in Engineering courses. The appropriate Department Chair in the Faculty of Engineering is authorized to grant permission.

Note: This requirement does not apply to students in programs that include Engineering courses as a formal part of the program.