

Faculty of Engineering

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70 The Faculty of Engineering

The University of Alberta's Faculty of Engineering has a long and illustrious history. Since 1908, when we offered our first engineering program, the Faculty of Engineering has been responding to the changing needs of the world around us. Today, the Faculty of Engineering at the University of Alberta is one of the largest and most diverse in Canada. We offer nine accredited undergraduate engineering programs, as well as a full range of graduate programs, to over 3,600 students from around the world.

The mission of the Faculty of Engineering, which has remained virtually unchanged since our inception, 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

We are proud of the role we play in educating future professional engineers. In Canada, engineering is a profession with a powerful and revered tradition of ethics, accountability, and service. The completion of a BSc degree in Engineering from the U of A is the first step on the road to becoming a professional engineer. Following a specified period of work experience, our graduates are able to register with their local professional engineering association, and practise engineering across Canada and around the world.

In their final term, all U of A students take part in "The Ritual of the Calling of an Engineer," or, the Iron Ring Ceremony. Written by Rudyard Kipling specifically for the first Canadian Iron Ring Ceremony in 1925, "The Ritual of the Calling of an Engineer," is the obligation and traditional ceremony meant to symbolize and enforce the ethics of professional engineers. This ceremony is purely Canadian, and the iron ring, worn on the little finger of the working hand, is the unique identifier of a Canadian engineer.

Faculty Awards and Accomplishments

Talented, successful teachers and researchers are key to our success as a Faculty. It is through the efforts of our professors that we are able to maintain our position on the leading edge of discovery and dissemination of engineering knowledge. Some awards and accomplishments of our faculty in the past year include

- Two NSERC Steacie Fellowships
- Martha Cook Piper Research Award
- Canadian Institute of Mining, Metallurgy and Petroleum Engineering
- Canadian Society of Chemical Engineering's RS Jane Memorial Lecture Award
- Seven Natural Sciences and Engineering Research Council Industrial Chairs and Senior Fellowships
- Two Fellows of the Canadian Society for Civil Engineers
- Fellow of the Institute of Electrical and Electronics Engineers
- Institute of Electrical and Electronics Engineers' WRG Baker Prize Paper Award
- Two Killam Annual Professorship Awards
- McCalla Research Professorship
- Syncrude/ASTech Oil Sands Research Prize
- Canadian Council of Professional Engineers Medal for Distinction in Engineering Education

Student Awards and Accomplishments

The Faculty of Engineering builds on the strengths of our students. High-quality programs, outstanding faculty, and top-notch facilities means that we have been able to attract exceptional students who are realizing their full potential. Some recent student awards and accomplishments include

- CD Howe Foundation Award for the top male first-year engineering student in Canada. Over the past four years our students have won six of the eight awards. No other university has ever won both male and female awards in the same year; the U of A won both awards in 1997 and again in 1998.
- Canadian Engineering Memorial Foundation Scholarship Award
- Governor General Bronze Medal
- Nortel Award for Leadership and Innovation awarded to our Discover 'E' Science Camp program.
- The SAE Aero Design Group placed first in the technical presentation event. As well, the Autonomous Robotic Vehicle Project Group placed second in their design group competition.
- Students in the Faculty of Engineering received over \$1 million in scholarships in the past year.

71 The Professors

Members of the Faculty

Officers of the Faculty

Professor and Dean
DT Lynch, PhD, PEng

Associate Deans
KC Porteous, PhD, PEng
SK Dew, PhD, PEng

Administrative Officers
T Buckle, BA
ME Compton, BA
RM Green, MA
LE Swanson, MSc

Chemical and Materials Engineering

Professor and Chair
S Wanke, PhD, PEng

University Professor
JH Masliyah, PhD, PEng, FRSC,
FCAE (NSERC Senior Industrial
Research Chair in Oil Sands
with Syncrude Canada Ltd)

Professors Emeriti
N Berkowitz, PhD, PEng
SA Bradford, PhD, PEng
IG Dalla Lana, PhD, PEng
DG Fisher, PhD, PEng
W Nader, Dr Phil
FD Otto, PhD, PEng, FCAE
JT Ryan, PhD
RK Wood, PhD, PEng

Professors
KT Chuang, PhD
RL Eadie, PhD, PEng
TH Etsell, PhD
MR Gray, PhD, PEng (NSERC/
Syncrude Senior Industrial
Research Chair in Advanced
Upgrading of Bitumen)
RE Hayes, PhD, PEng
H Henein, PhD
DG Ivey, PhD, PEng
SM Kresta, PhD, PEng
DT Lynch, PhD, PEng
AE Mather, PhD, PEng
DJ McCutcheon, BSc, PEng
(Industrial Professor, Safety
and Loss Management)
K Nandakumar, PhD, PEng
BM Patchett, PhD, PEng
KC Porteous, PhD, PEng
M Rao, PhD
SL Shah, PhD, PEng (NSERC/
ASRA/Matrikon Senior
Industrial Research Chair in
Computer Process Control)
ML Wayman, PhD, PEng
MC Williams, PhD
Z Xu, PhD

Associate Professors
JAW Elliott, PhD, PEng
JF Forbes, PhD, PEng
J Luo, PhD
U Sundararaj, PhD, PEng
A Yeung, PhD

Assistant Professors
W Chen, PhD, (NOVA/NSERC
Junior Industrial Research
Chair in Welding and
Corrosion)
PYK Choi, PhD, PEng
B Huang, PhD
D-Y Li, PhD
Q Liu, PhD, PEng
S Liu, PhD, PEng
WC McCaffrey, PhD, PEng
ES Meadows, PhD

Faculty Service Officers
A Afacan, BSc, PEng
DA Sharp, MSc

Administrative Officer
S McFadyen, BSc

Civil and Environmental Engineering

Professor and Chair
TM Hruyde, PhD, PEng

University Professors
Emeriti
JG MacGregor, PhD, PEng, FRSC,
FCAE
NR Morgenstern, PhD, PEng,
FRSC, FCAE

Professors Emeriti
PF Adams, PhD, PEng, FCAE
KO Anderson, MSc, PEng
JJ Baker, MScE, PEng
K Barron, PhD, PEng
RG Bentsen, PhD
PH Bouthillier, MSc, PEng
SP Dozzi, MEng, PEng
PM Dranchuk, MSc, PEng
Z Eisenstein, PhD, PEng
SM Farouq Ali, PhD, PEng
DL Flock, PhD, PEng
EL Fowler, MSc, PEng
WH Griffin, MSc, PEng
DJL Kennedy, PhD, PEng
GL Kulak, PhD, PEng
EO Lilge, MSc, PEng
J Longworth, MSc, PEng
DW Murray, PhD, PEng
TH Patching, BSc, PEng
LR Pliitt, MSc, PEng
WW Preston, BSc
N Rajaratnam, PhD, PEng
JD Scott, PhD, PEng
SH Simmonds, PhD, PEng
S Tepley, PhD, PEng
S Thomson, PhD, PEng
J Warwaruk, PhD, PEng
WA Weir, BSc, PEng
JM Whiting, PhD, PEng
GT Wormsbecker, BSc, PEng

Professors
SM AbouRizk, PhD, PEng
(Alberta Construction
Industry/NSERC Senior
Industrial Research Chair in
Construction Engineering and
Management)
DH-K Chan, PhD, PEng
J-J Cheng, PhD, PEng (CW Carry
Chair in Steel Structures)

DM Cruden, PhD, PGeol (Joint
Appointment with Geology)
AE Elwi, PhD, PEng
FE Hicks PhD, PEng
CD Martin, PhD, PEng
AE Peterson, MSc, PEng
M Polikar, PhD, PEng
PK Robertson, PhD, PEng
DM Rogowsky, PhD, PEng
DC Sego, PhD, PEng
DW Smith, PhD, PEng
PM Steffler, PhD, PEng
J Szymanski, PhD, PEng

Associate Professors
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ST Ariaratnam, PhD, PEng
KW Biggar, PhD, PEng
CV Deutsch, PhD, PEng
RG Driver, PhD, PEng
S Frimpong, PhD, PEng
TY Gan, PhD
WB Kindzierski, PhD, PEng
ES Kuru, PhD
MR Loewen, PhD, PEng
DD Tannant, PhD, PEng

Assistant Professors
RWI Brachman, PhD, PEng
ID Buchanan, PhD, PEng
RJ Chalaturnyk, PhD, PEng
QT Doan, PhD, PEng
GY Grondin, PhD, PEng
SE Guigard, PhD
B Lepski, PhD, PEng
A Robinson, PhD, PEng
HR Soleymani, PhD, PEng
T Yu, PhD
DZ Zhu, PhD, PEng

Faculty Service Officers
DA Booth, BSc, PEng
GS Hoye, PhD

Administrative Officer
L Padgham, BSc

**Director, Construction
Research Institute of
Canada (CRIC)**
CA Lenzion, BSc, PEng

Electrical and Computer Engineering

Professor and Chair
CE Capjack, PhD, PEng

University Professor
Emeritus
GB Walker, PhD, PEng

Professors Emeriti
KE Bollinger, MSc, PEng
GS Christensen, PhD, PEng
FS Chute, PhD, PEng
GD Cormack, PhD, PEng
CG Englefield, PhD
PA Goud, PhD, PEng
V Gourishankar, PhD, PEng
PJR Harding, MSc, PEng
CR James, PhD, PEng
DH Kelly, PhD, PEng
RW King, BSc, PEng
YJ Kingma, Jr, PEng
RI MacDonald, PhD, PEng

AA Offenberger, PhD
RE Phillips, BSc, PEng
RE Rink, PhD, PEng
AM Robinson, PhD, PEng
HG Schmidt-Weinmar, PhD
PR Smy, PhD, DSc, PEng
KA Stromsroe, PhD, PEng
JF Vaneldik, PhD, PEng
WAG Voss, PhD

Professors
NC Beaulieu, PhD, PEng (iCORE
Chair in Broadband Wireless
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MJ Brett, PhD, PEng (Micralyne/
NSERC Senior Industrial
Research Chair in Thin Film
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SK Dew, PhD, PEng
NG Durdle, PhD, PEng
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Industrial Research Chair in
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I Filanovsky, PhD, PEng
WD Grover, PhD, PEng
DO Koval, PhD, PEng
WA Krzymien, PhD, PEng
RPW Lawson, PhD, PEng
JN McMullin, PhD
Q-HM Meng, PhD
J Miller, PhD
B Nowrouzian, PhD, PEng
W Pedrycz, PhD, PEng
D Routledge, PhD, PEng
JC Salmon, PhD
HJJ Seguin, PhD, PEng
G Succi, PhD, PEng
WR Tinga, PhD, PEng
J Tulip, PhD
FE Vermeulen, PhD, PEng
WW Xu, PhD, PEng

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IJ Fair, PhD, PEng
HJ Marquez, PhD
X Sun, PhD

Assistant Professors
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AY Elezabi, PhD
DG Elliott, PhD, PEng
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X Liu, PhD
MK Mandal, PhD
P Musilek, PhD
M Reformat, PhD
YY Tsui, PD
Q Zhao, PhD, PEng

Administrative Officer
TJ Garneau, BSc, PEng

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Professor and Acting Chair
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DR Budney, PhD, PEng
KC Cheng, PhD
JR Colbourne, PhD, PEng
A Craggs, PhD, PEng
G Ford, DSc, PEng
JB Haddow, PhD
JS Kennedy, PhD, PEng
GSH Lock, PhD, PEng
DJ Marsden, PhD, PEng
CM Rodkiewicz, PhD

GW Sadler, MSc, PEng
JC Sprague, PhD, PEng
FH Vitovec, Dr TechSci, PEng

Professors
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F Ellyin, PhD, PEng (NOVA/
NSERC Senior Industrial
Research Chair in Advanced
Pipeline Materials)
MG Faulkner, PhD, PEng
WH Finlay, PhD, PEng
PC Flynn, PhD, PEng (Ernest E
and Gertrude Poole Chair in
Management for Engineers)
TW Forest, PhD, PEng
KR Fyfe, PhD, PEng
TR Heidrick, PhD, PEng (Ernest
E. and Gertrude Poole
Professor in Technology
Management)
LW Kostliuk, PhD, PEng
AW Lipsett, PhD, PEng
A Mioduchowski, PhD, PEng
P Schiavone, PhD
LW Sigurdson, PhD, PEng
JD Whittaker, PhD, PEng
DJ Wilson, PhD, PEng
M Zuo, PhD, PEng

Associate Professors
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RW Toogood, PhD, PEng
JW Yokota, PhD

Assistant Professors
A Bhattacharya, PhD
B Fleck, PhD, PEng
SV Karapetrovic, PhD, PEng
WA Moussa, PhD, PEng
DW Raboud, PhD, PEng
C Ru, PhD
XD Wang, PhD
Z Xia, PhD, PEng

Faculty Service Officer
MY Ackerman, MSc, PEng

Administrative Officer
SG Hobden, BA, MEd

**Sessional Lecturer in
Engineering**
BR Touchings, LLB

Engineering Co-op Centre

Professor and Director
KC Porteous, PhD, PEng

**Assistant Director and
Coordinator**
CJ Ottosen, BEd

Administrative Officers
L Allisen, Coordinator
C Bjornson, BA, Coordinator/
Systems Administrator
C DiCurzio, BCom, Coordinator
CM Ens, BCom, Coordinator
JL Esdale, BEd, Coordinator
RC Kully, BEd, Coordinator
BJ Strang, BA, Coordinator
LJ Szekely, BEd, Coordinator

Additional Members of Faculty Council

**President and Vice-
Chancellor**
RW Fraser, PhD

Registrar of the University
BJ Silzer, MEd

Professors
JJ Leonard, PhD, PEng
(Agricultural, Food, and
Nutritional Sciences)
GH Cliff, PhD (Mathematical
Sciences)
R Greiner, PhD (Computing
Science)
RB Jordan, PhD (Chemistry)
H Northcott, PhD (Sociology)
LY Yuan, PhD (Computing
Science)

Assistant Professor
R Lederer, MDes (Art and
Design)

APEGGA Representative
VSV Rajan, PhD, PEng

**Representatives from
Engineering Students**
C Stobbs (Undergraduate)
J Brindle (Undergraduate)
M Hirji (Undergraduate)
K Brown (Graduate)
C Linghede (Graduate)

72 General Information

72.1 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.

72.1.1 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 §150). 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 §154.10 for further details.

72.2 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. 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 §74.4 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 Centre 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. Visa students (student visitors) are not eligible for the Cooperative Education program.

72.3 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 the chemistry of a process 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 advanced materials, biotechnology, engineering management, environmental engineering, petroleum and natural gas, polymers or process control. The computer process control option (described below) is unique to the University of Alberta.

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.

72.3.1 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.

72.3.2 Elective Patterns in Chemical Engineering

In addition to the required courses, Chemical Engineering programs offer considerable flexibility through electives to develop interdisciplinary interests or to study certain fields in depth.

A brief description of some fields in which electives may be chosen follows:

- (1) **Advanced Materials and Polymers:** Advances in current technology are supported by new materials with unique properties, fabricated from metals, ceramics, semiconductors, and synthetic organic polymers. Developing these new materials involves a broad spectrum of basic science and engineering disciplines. Chemical Engineering students who select electives in the advanced materials program will be able to contribute significantly to this interdisciplinary field. As an alternative, students can focus on polymer materials, wherein the molecules are engineered to achieve unique properties. Chain-like polymer molecules are designed for end uses such as plastics, rubbers, fibres, films, and in combination with other materials to form composites. The chemical engineer, with a solid background in chemistry, is ideally suited for specialization in this area of materials engineering.
- (2) **Biotechnology:** Advances in molecular biology have given rise to important new biotechnology industries, which produce a range of products for medical, agricultural, food, and chemical applications. Chemical engineers work on the design, development, and operation of product and separation processes. Students can pursue specialization in biotechnology by supplementing their chemistry training with courses in the life sciences and biochemical engineering. This program also provides the necessary background for graduate study in engineering aspects of biotechnology.
- (3) **Process Control:** Industrial plants, although designed for steady-state operation, often do not operate in this manner due to planned changes in process conditions or unexpected disturbances, such as changes in raw materials. Process control addresses the development of control systems ranging from schemes that use simple instruments to sophisticated distributed digital computer systems that keep industrial units operating at the desired conditions. An introduction to some of the more advanced concepts in process control is available by selecting one or more of the appropriate elective courses given by the Department. Students interested in a career in the control and instrumentation field should consider the "Computer Process Control Option" described in §72.3.1.
- (4) **Environmental Engineering:** Because of the need to protect the quality of our environment, many chemical engineers are involved in developing technically and economically feasible solutions to environmental pollution problems. Chemical Engineering electives, and courses offered by the Departments of Civil and Environmental Engineering and Mechanical Engineering and by faculties outside Engineering, help students become aware of environmental technology and also serve as appropriate background for those who want to specialize in the environmental field.

(5) **Engineering Management:** Chemical engineers are frequently employed in positions with a primary function of technical management. For engineers involved in production or design, many tasks involve establishing optimal operating conditions. The Department elective course in optimization, taken with courses offered by the Department of Mechanical Engineering in the operations management area, provides pertinent background material for students interested in technical management.

By choosing proper electives, students may, depending on their academic standing, be able to select courses that may be applied for advance credit toward a Master of Business Administration (MBA) or Master of Arts (MA) in Economics.

(6) **Oil and Natural Gas:** Chemical Engineering graduates are often employed in industries that produce, process and refine natural gas, petroleum, and oil sands. The Department offers electives in natural gas processing and properties of heavy oils and petroleum. Elective courses, concerned with petroleum production, are offered by the School of Mining and Petroleum Engineering.

72.4 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.

72.4.1 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.

72.4.2 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.

72.5 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 engineering 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 Division of Computer Engineering (a division of the Department of Electrical and Computer Engineering) headed by the Director of Computer Engineering.

72.5.1 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 Division of Computer Engineering within the Department of Electrical and Computer Engineering headed by the Director of Computer Engineering.

72.6 Electrical Engineering

Electrical engineering encompasses the study and understanding of all aspects of electrical phenomena in nature, and the application of the knowledge so gained to the benefit and betterment of society.

The fundamentals of electricity and magnetism, and the laws governing electric circuits, are explored in the introductory courses, branching into the specific areas of electrical engineering in the third and fourth years of study. There is plenty of opportunity for practical experience throughout the program. Laboratory experiments form an integral part of many courses, and various design projects are offered in the final year of study.

Students should contact the Department of Electrical and Computer Engineering for advice regarding selecting appropriate elective courses.

72.6.1 Elective Patterns in Electrical Engineering

Biomedical Engineering

The biomedical stream provides an introduction to the basic concepts of this field including human anatomy and physiology, biological systems modelling, medical instrumentation and imaging. See §72.12 for more information.

Electric Power Engineering

Power engineers use a background in mathematics, circuit analysis, control systems, electric machines, reliability, and computer software and hardware to design and maintain power-related devices and systems.

Communications

Communications addresses the transmission of information from one point to another, using wires, coaxial cable, fibre-optics, or radio. Designing communications systems requires knowledge in such areas as network theory and statistical analysis, while designing elements that make up these systems draws heavily on digital and analog circuit design, signal processing and filtering, and electronics.

Control Systems

The control of physical systems is an interdisciplinary subject that cuts across many specialized engineering fields. This versatile area ranks as one of the most promising fields, and its growth potentials are unlimited.

Senior undergraduate students in Electrical or Computer Engineering wanting to specialize in this area can select one or more elective courses given by the Department of Electrical and Computer Engineering in control systems, microprocessor design, and software engineering. They can also take courses in process control offered by the Department of Chemical and Materials Engineering, and courses in robotics and computer vision offered by the Departments of Electrical and Computer Engineering and Computing Science.

Digital Systems Engineering

Digital systems engineers design hardware systems for a range of applications, including process control, robotics, digital signal processing, computers, communications, instrumentation, and analog/digital conversion. The electives that make up the digital systems stream deal with low-level

hardware design issues such as microprocessor system design, digital system design, and analog/digital electronics.

Electronics

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 communications, digital, control, and power systems.

Electronics includes the study of solid state devices, integrated circuits (including fabrication technology), digital and analog circuits, VLSI, and computer-aided design. Electronics engineers use these devices and techniques to design and analyze systems that can be used in various applications from radio frequency or microwave systems to solving instrumentation problems. Electronics engineers require a broad background in all aspects of electrical engineering, with special expertise in circuit analysis techniques and a thorough understanding of electronic components and their uses.

72.7 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.

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 7.0 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.

72.8 Materials Engineering

Materials engineering has evolved from dealing only with metals and alloys to being concerned with the production and engineering applications of metallic and non-metallic materials (polymers, ceramics, composites and electronic materials). 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 applying 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 and rod mills of the metals industry 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 balance of lectures and laboratory sessions emphasizing underlying principles and their engineering applications. The program deals with mineral processing, extractive metallurgy, physical metallurgy, ceramics, polymers, composites and various aspects of the behavior of materials in service including failure, wear, and corrosion. With the technical electives it is possible for the student to go into more depth in particular areas of interest. With a quota of only 25 students, the class size is smaller than many other disciplines.

72.9 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 technical 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.

72.9.1 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.

72.10 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.

72.11 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.

72.12 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.

While the University of Alberta does not offer a formal undergraduate degree program in biomedical engineering, there are biomedical streams in both Mechanical and Electrical Engineering. To help students understand and prepare for employment in this area, a series of undergraduate technical electives is available in areas such as physiology, medical instrumentation, medical imaging, modelling of biological systems and biomechanics. In addition, an enhanced graduate program is offered jointly by the Universities of Alberta and Calgary.

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

72.13 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.

72.14 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.

72.15 Industrial Safety and Loss Management Courses

Safety, risk, and loss management principles applicable to all industries 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.

72.16 Arrangements with Other Institutions

72.16.1 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 Community 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.

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

A transfer student may obtain credit for a full year of the Engineering program at either the University of Calgary or the University of Alberta by completing courses at a transfer institution equivalent to the following:

Course Type	University of Calgary	University of Alberta
Two Chemistry Courses	ENGG 201 CHEM 209	CHEM 103 CHEM 105
Three Engineering Physics Courses	PHYS 269 ENGG 203 ENGG 249	PHYS 130 ENGG 130 ENPH 131
Two Calculus Courses	AMAT 217 AMAT 219	MATH 100 MATH 101
One Linear Algebra Course	MATH 221	MATH 102
One Computing Course	ENGG 233	ENCMP 100 (see Note 1 below)
Introduction to Engineering/Writing	ENGG 215 (see Note 2 below)	ENGG 100, ENGG 101, and ENGL 199 (see Note 2 below)
One Elective	As chosen by the student in accordance with the regulations of the Faculty involved (see Note 3 below)	As chosen by the student in accordance with the regulations of the Faculty involved (see Note 3 below)

Notes

- (1) Students transferring to the University of Calgary will not be granted credit for ENCMP 100. Students transferring to the University of Alberta will be given credit to take the place of ENGG 233.
- (2) Students transferring to the University of Alberta will receive credit for ENGG 100, ENGG 101 and ENGL 199. Students transferring to the University of Calgary will receive credit for a Complementary Studies elective.
- (3) A student may wish to take a Complementary Studies course or
 - a. for transfer to the University of Calgary—(University of Calgary PHYS 259 equivalent) Electricity and Magnetism

Note: Students entering Year 2 at the University of Calgary who wish to transfer directly into the Department of Electrical, Mechanical, or Geomatics Engineering must have the equivalent of PHYS 259.
 - b. for transfer to the University of Alberta—(University of Alberta MATH 102 equivalent), Applied Linear Algebra

Note: Students transferring to the Civil, Mining and Petroleum Engineering program at the University of Alberta cannot obtain transfer credit for PHYS 259.
- (4) Students transferring from Engineering at the University of Alberta to Engineering at the University of Calgary are assured full course-by-course credit for all required courses with a grade of 5.0 or higher.
- (5) Students transferring from Engineering at the University of Calgary to Engineering at the University of Alberta are assured full course-by-course credit for all required courses with a grade of C- or higher.

72.16.3 Transfer from Alberta Technical Institutes

Students from Alberta Institutes of Technology (e.g., NAIT, SAIT) should refer to the *Alberta Transfer Guide* for information on potential transfer credit.

72.16.4 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.

72.16.5 BSc Program in Agricultural Engineering

The University of Saskatchewan offers a four-year program leading to the BSc in Agricultural Engineering. Students wanting to transfer to the Agricultural Engineering program at the University of Saskatchewan following one year of engineering at the University of Alberta should write to Head, Agricultural Engineering Department, College of Engineering, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0.

72.16.6 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.

72.16.7 Exchange Program with the Technical University of Berlin

Students in the Faculty of Engineering at the University of Alberta may participate in an exchange program with the Technische Universität Berlin (TUB). Students may attend TUB for one year as part of their BSc program in Engineering. Students must have demonstrated superior academic ability and be fluent in German. Programs are available in various engineering disciplines. Consult the Associate Dean (Student Services), Faculty of Engineering, for more information.

72.17 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).

The TEC-ED program which allowed members of the Alberta Society of Engineering Technologists (ASET) to register as special students has been discontinued. Contact the Faculty for more information on its replacement.

72.18 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.

72.19 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 specialty.

73 Faculty Regulations

73.1 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 §15.6.

73.2 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 §§74.3 and 74.4. 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 §14.2.5 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.

73.3 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.

There are 590 entry places in the first year and 710 entry places in the second year of the Engineering program. The second-year entry places are shown below for the individual disciplines. The number of entry spaces within each discipline allocated to the cooperative education program is reviewed annually and is subject to change. The bracketed numbers give some indication of the co-op admissions in each discipline over the past few years.

Chemical	90	(60)
Civil	110	(36)
Civil-Environmental	30	(30)
Computer	115	(45)
Electrical (including Engineering Physics)	145	(32)
Mechanical	145	(45)
Materials	25	(6)
Mining	20	(5)
Petroleum	30	(7)

Entry to a specialized program is based on the student's academic performance in the first, or qualifying, year. All students in the qualifying year, and new applicants to the Faculty with previous postsecondary education, must submit a Second Year Engineering Program Selection Form (PSF) by the document deadline noted in §12. Forms are provided to qualifying year students in ENGG 101. Program Selection Forms are mailed to other applicants by the Registrar's Office on application. All applicants with previous postsecondary education must submit a PSF. Applicants who do not have sufficient transfer credit for a second-year program (to be determined by the Faculty) may be considered for a qualifying year.

A student entering the Faculty directly from high school, or with fewer than 15 units of transfer credit, must normally qualify for a specialized program in not more than four terms (two years); those with 15 units or more of transfer credit must qualify in not more than two terms (one year). 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 who are offered admission to one of the specialized programs must register in the Fall and/or Winter Term immediately following; otherwise they must re-apply and again compete for a space in these programs.

(2) Engineering Graduation Average

- The Engineering Graduation Average (EGA) is based on the final four academic terms. If the course load in these terms totals less than 70 units, additional terms will be included in the calculation of the EGA as required to reach a total of at least 70 units. The 70 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.
- Requirements to Graduate:** To graduate, a student must
 - pass all courses required by the specific program;
 - have an Engineering Graduation Average of 5.0 or greater;
 - be in satisfactory academic standing, i.e., have a Fall/Winter GPA of 5.0 or greater.

A student who is otherwise eligible to graduate but has an EGA of less than 5.0 and/or a Fall/Winter GPA in the range 4.5 to 4.9 is permitted to return for one additional term to take courses as specified by the Dean. If the student's EGA and Fall/Winter GPA following this term are not both 5.0 or greater, the student will not qualify for a degree and will not be allowed to continue in the Faculty.

- (3) **Time Limit for Completion of Degree:** All students must complete their degree requirements within six calendar years from the time of their initial admission to a specialized degree program in Engineering, (except students from the Alberta Society of Engineering Technologists TEC-ED program) (see §72.17). Students admitted from the TEC-ED program have a degree time limit of four years.

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 §73.3(5)b, but must meet the degree time limit as specified in §73.3(3). A course load less than that required to maintain full time status, as defined in §261, 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 units in Fall/Winter, excluding the 2.0 units for ENGG 100/101.

(5) **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 §74.3 and 74.4. Evaluation is on the basis of the Fall/Winter GPA or Spring/Summer GPA (see §23.4(7)).

- a. **Satisfactory Standing:** Fall/Winter or Spring/Summer GPA of 5.0 or greater. Promotion, repeating any failed course(s).
- b. **Marginal Standing-Academic Warning:** Fall/Winter or Spring/Summer GPA of 4.5 to 4.9 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) Previously on academic warning on two or more occasions.
 - ii) Previously required to withdraw and previously on academic warning.
 - iii) 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 5.0 while carrying a minimum course load of 14 units.

- c. **Unsatisfactory Standing-Required to Withdraw:** Fall/Winter or Spring/Summer GPA less than 4.5. Student must withdraw.
 - d. **Probation:** Students who have been required to withdraw and who have successfully appealed that decision will be placed on probation.
- (6) **Work Experience Credit:** Work Experience (WKEXP) courses in the cooperative education program are graded on a Pass/Fail basis. A student receiving a grade of Fail is normally required to withdraw from the cooperative program and the Faculty of Engineering.

(7) **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.

(8) **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.

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 §73.3(5)b.

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

(10) **Reexaminations:** See §23.5.5.

(11) 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 §§74.2, 74.3, or 74.4 as appropriate. In the case of Faculty and Department awards, a full course load is defined as at least 35 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 7.5 or greater, calculated on a course load of not less than 35 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 7.5 or greater, and
- ii) carried at least 70 units in the final four academic terms.

(12) 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 make his/her decision known to the Dean in writing 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: Letters are mailed to the student's mailing address of record as maintained by the Registrar's Office and are deemed to be delivered when mailed. An unsuccessful appeal within the Faculty may be carried to the General Faculties Council Academic Appeals Committee. See §23.8.

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 §73.3(12)a.

A copy of the Faculty of Engineering Regulations regarding appeals may be obtained from the Faculty Office, 5-1 Mechanical Engineering.

74 Programs of Study

74.1 Faculty Requirements for All BSc in Engineering Programs

Course requirements for Engineering programs are listed in §74.2 (First-Year) and §§74.3 through 74.4 (Second-Year and beyond). All Engineering programs include ENGG 400, MATH 201, MATH 209, one of ENGG 310 or 401, and an ITS elective as described in §74.6.1.

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).

74.2 First-Year Program

Students registering for first-year courses should consult the *Registration Procedures* booklet. Students interested in an equivalent curriculum given in French should consult §154.10.

Term 1	Term 2
CHEM 103 (3-1s-3/2)	CHEM 105 (3-0-3/2)
ENGG 100 (1-0-0)	ENCMP 100 (3-0-1.5)
ENGG 130 (3-0-2)	ENGG 101 (1-0-0)
MATH 100 (3-0-2)	EN PH 131 (3-1s-3/2)
PHYS 130 (3-0-3/2)	MATH 101 (3-0-1)
Complementary Studies Elective (3-0-0)	MATH 102 (3-0-1)

Notes

- (1) The Complementary Studies Elective listed in the first term should be selected from any 100-level course with a 3 weight (one term) from the following subject areas (see §201 for course descriptions): Anthropologie, Anthropology, Art and Design (ART H only), Canadian Studies (200-level), Christian Theology, Classics, Comparative Literature, Etudes de la religion, Family Studies, Linguistics, Philosophie, Philosophy, Political Science, Psychologie, Psychology, Religious Studies, Science Politique, Slavic and East European Studies, Sociologie, and Sociology. See §74.6.
- (2) Students accepted into the Honors Mathematics stream replace MATH 100, 101, and 102 with MATH 117, 118, and 127 (see §72.14).

74.3 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 information on Complementary Studies Electives see §74.6.

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

Chemical	Year 2	Year 3	Year 4
	<p>Term 3 CH E 200 (1-0-0) CH E 243 (3-1s-0) CH E 265 (3-0-3) or MATE 252 (3-0-3/2) CHEM 261 (3-0-3) ENGL 199 (3-0-0) or Complementary Studies Elective (3-0-0) MATH 209 (3-0-1) Complementary Studies Elective (3-0-0)</p> <p>Term 4 MATE 252 (3-0-3/2) or CH E 265 (3-0-3) E E 239 (3-0-3/2) MATH 201 (3-0-1) STAT 235 (3-0-2) Complementary Studies Elective (3-0-0) or ENGL 199 (3-0-0) ITS Elective (3-0-0) (See §74.6.1)</p>	<p>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) Technical Elective (3-0-0)</p> <p>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 310 (3-0-0) or ENGG 401 (3-0-0)</p>	<p>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 481 (1-0-0) Technical Elective (3-1s-0)</p> <p>Term 8 CH E 454 (1-0-4) CH E 465 (4-0-4) CH E 483 (1-0-0) ENGG 400 (1-0-0) Tech Elective (3-1s-0) Tech Elective (3-1s-0) Note: See §74.5.1 for restrictions on the five technical electives.</p>
Chemical: Computer Process Control Option	<p>Term 3 CH E 200 (1-0-0) CH E 243 (3-1s-0) CHEM 261 (3-0-3) E E 240 (3-1s-3/2) MATE 252 (3-0-3/2) MATH 209 (3-0-1) Tech Elective (3-1s-0) or MATH 201 (3-0-1)</p> <p>Term 4 CH E 265 (3-0-3) E E 250 (3-1s-3/2) ENGL 199 (3-0-0) MATH 201 (3-0-1) or Tech Elective (3-1s-0) STAT 235 (3-0-2) Tech Elective (3-1s-0)</p>	<p>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) ITS Elective (3-0-0) (See §74.6.1) Complementary Studies Elective (3-0-0)</p> <p>Term 6 CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (2-0-4) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) Tech Elective (3-1s-0)</p>	<p>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 481 (1-0-0) Tech Elective (3-1s-0) Complementary Studies Elective (3-0-0)</p> <p>Term 8 CH E 454 (1-0-4) CH E 465 (4-0-4) CH E 483 (1-0-0) CH E 562 (3-0-3/2) CH E 564 (3-0-3/2) ENGG 400 (1-0-0) Notes: (1) MATH 201 must be taken in either Term 3 or 4. (2) See §74.5.2 for restrictions on the technical electives.</p>
Chemical: Oil Sands Elective	<p>Term 3 CH E 200 (1-0-0) CH E 243 (3-1s-0) CHEM 265 (3-0-3) or MATE 252 (3-0-3/2) CHEM 261 (3-0-3) ENGL 199 (3-0-0) or Complementary Studies Elective (3-0-0) MATH 209 (3-0-1) Complementary Studies Elective (3-0-0)</p> <p>Term 4 MATE 252 (3-0-3/2) or CH E 265 (3-0-3) E E 239 (3-0-3/2) MATH 201 (3-0-1) ITS Elective (3-0-0) (See §74.6.1) STAT 235 (3-0-2) Complementary Studies Elective (3-0-0) or ENGL 199 (3-0-0)</p>	<p>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) Tech Elective (3-0-0)</p> <p>Term 6 CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (2-0-4) ENGG 310 (3-0-0) or ENGG 401 (3-0-0)</p>	<p>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 481 (1-0-0) CH E 552 (3-1s-3/3)</p> <p>Term 8 CH E 435 (4-0-4) CH E 454 (1-0-4) CH E 483 (1-0-0) CH E 534 (3-1s-3/3) CH E 537 (3-1s-3/3) ENGG 400 (1-0-0) Note: See §74.5.3 for restrictions on the technical electives.</p>

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

Civil	Year 2	Year 3	Year 4
	<p>Term 3 CIV E 265 (2-0-3) CIV E 270 (3-0-3) EAS 210 (3-0-3) MATH 209 (3-0-1) MATE 252 (3-0-3/2)</p> <p>Term 4 CIV E 221 (3-0-3/2) CIV E 250 (3-0-2) CIV E 251 (2 weeks)* CIV E 290 (3-0-0) CIV E 295 (3-0-2) MATH 201 (3-0-1) *Held in Spring/Summer (Spring Term)</p>	<p>Term 5 CIV E 330 (3-1s-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) ENGL 199 (3-0-0)</p> <p>Term 6 CIV E 303 (3-0-3/2) CIV E 312 (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)</p>	<p>Term 7 Tech Elective (See Note 1) Tech Elective (See Note 1) Tech Elective (See Note 1) One of E E 239, MEC E 250 or CH E 243 Complementary Studies Elective (3-0-0) (See Note 2)</p> <p>Term 8 CIV E 490 (1-2s-0) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGG 400 (1-0-0) ENGG 420 (3-0-0) ITS Elective (3-0-0) (See \$74.6.1) Tech Elective (See Note 1) Tech Elective (See Note 1) Notes: (1) See \$74.5.3 for restrictions on the technical electives. (2) See \$74.6 for restrictions on Complementary Studies Electives.</p>
Computer	Year 2	Year 3	Year 4
	<p>Term 3 CMPUT 115 (3-0-3) E E 240 (3-1s-3/2) E E 280 (3-0-3/2) ENGL 199 (3-0-0) MATH 209 (3-0-1) ITS Elective (3-0-0) (See \$74.6.1)</p> <p>Term 4 CMPUT 272 (3-1s-3) E E 231 (3-1s-0) E E 250 (3-1s-3/2) E E 380 (3-0-3/2) MATH 201 (3-0-1) PHYS 230 (3-0-3/2)</p>	<p>Term 5 CMPUT 201 (3-0-3) CMPUT 204 (3-0-1) E E 335 (3-1s-0) E E 340 (3-1s-3/2) E E 387 (3-1s-0) E E 480 (3-0-3/2)</p> <p>Term 6 CMPE 300 (3-0-3/2) CMPE 382 (3-0-0) E E 317 (3-0-0) E E 350 (3-1s-3/2) Tech Elective (3-0-0) Complementary Studies Elective (3-0-0)</p>	<p>Term 7 CMPE 401 (3-0-3/2) CMPUT 379 (3-0-3) E E 338 (3-0-3/2) E E 390 (3-0-0) Tech Elective (3-0-0) Tech Elective (3-0-0)</p> <p>Term 8 E E 462 (3-0-3/2) E E 582 (1-0-6) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGG 400 (1-0-0) Tech Elective (3-0-0) Tech Elective (3-0-0) Complementary Studies Elective (3-0-0) Notes: (1) See \$74.5.4 for restrictions on the five technical electives. (2) If timetabling problems arise, the ITS Elective may be taken in a later term and a Complementary Studies Elective should be taken in Term 3.</p>
Computer: Software Option	Year 2	Year 3	Year 4
	<p>Term 3 CMPUT 115 (3-0-3) E E 240 (3-1s-3/2) E E 280 (3-0-3/2) ENGL 199 (3-0-0) MATH 209 (3-0-1) ITS Elective (3-0-0) (See \$74.6.1)</p> <p>Term 4 CMPE 210 (3-0-3) E E 231 (3-1s-0) E E 380 (3-0-3/2) MATH 201 (3-0-1) PHYS 230 (3-0-3/2) CMPUT 272 (3-1s-3)</p>	<p>Term 5 CMPE 300 (3-0-3/2) CMPUT 204 (3-0-1) CMPUT 291 (3-0-3) E E 335 (3-1s-0) E E 340 (3-1s-3/2) E E 387 (3-1s-0)</p> <p>Term 6 CMPE 310 (2-0-3) CMPUT 304 (3-0-0) CMPUT 379 (3-0-3) CMPE 401 (3-0-3/2) E E 338 (3-0-3/2) Complementary Studies Elective (3-0-0)</p>	<p>Term 7 CMPE 410 (2-0-3) CMPE 510 (3-0-0) CMPE 382 (3-0-0) CMPUT 313 (3-0-3) Tech Elective (3-0-0) Complementary Studies Elective (3-0-0)</p> <p>Term 8 CMPE 520 (3-0-0) CMPUT 301 (3-0-3) CMPUT 422 (3-0-3) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGG 400 (1-0-0) Tech Elective (3-0-0) Tech Elective (3-0-0) Notes: (1) See \$74.5.4.1 for restrictions on the three technical electives. (2) If timetabling problems arise, the ITS Elective may be taken in a later term and a Complementary Studies Elective should be taken in Term 3.</p>

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

Electrical	Year 2	Year 3	Year 4
	<p>Term 3 E E 240 (3-1s-3/2) E E 280 (3-0-3/2) MATH 201 (3-0-1) MATH 209 (3-0-1) MEC E 250 (3-1s-0) ITS Elective (3-0-0) (See \$74.6.1)</p> <p>Term 4 CH E 243 (3-1s-0) E E 231 (3-1s-0) E E 250 (3-1s-3/2) ENGL 199 (3-0-0) MATH 309 (3-0-0) PHYS 230 (3-0-3/2)</p>	<p>Term 5 E E 315 (3-1s-0) E E 330 (3-0-0) E E 335 (3-1s-0) E E 340 (3-1s-3/2) E E 380 (3-0-3/2) E E 387 (3-1s-0)</p> <p>Term 6 E E 332 (3-0-3/2) E E 338 (3-0-3/2) E E 350 (3-1s-3/2) E E 357 (3-0-3/2) E E 390 (3-0-0) ENGG 402 (3-0-0) or other Complementary Studies Elective (3-0-0)</p>	<p>Term 7 E E 401 (1-0-6) or E E 582 (1-0-6) Complementary Studies Elective (3-0-0) Tech Elective Tech Elective Tech Elective Tech Elective</p> <p>Term 8 ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGG 400 (1-0-0) Tech Elective Tech Elective Tech Elective Tech Elective Tech Elective</p> <p>Notes: (1) See \$74.5.5 for restrictions on the nine technical electives. (2) If timetabling problems arise, the ITS Elective may be taken in a later term and a Complementary Studies Elective should be taken in Term 3.</p>
Engineering Physics	<p>Term 3 E E 240 (3-1s-3/2) MATE 251 (3-0-0) MATH 201 (3-0-1) MATH 209 (3-0-1) PHYS 281 (3-0-0) PHYS 292 (0-0-3) ITS Elective (3-0-0) (See \$74.6.1)</p> <p>Term 4 E E 231 (3-1s-0) E E 250 (3-1s-3/2) ENGL 199 (3-0-0) PHYS 211 (3-0-0) PHYS 244 (3-0-0) PHYS 271 (3-0-0) PHYS 292 (0-0-3)</p>	<p>Term 5 E E 335 (3-1s-0) E E 340 (3-1s-3/2) MATH 311 (3-0-0) PHYS 311 (3-0-0) Complementary Studies Elective (3-0-0) one of PHYS 362 (3-0-0) or Complementary Studies Elective (3-0-0)</p> <p>Term 6 E E 323 (3-1s-0) E E 350 (3-1s-3/2) PHYS 372 (3-0-0) PHYS 381 (3-0-0) PHYS 397 (0-0-6) one of E E 332 (3-0-3/2); E E 380 (3-0-3/2); E E 390 (3-0-0)</p>	<p>Term 7 E E 338 (3-0-3/2) E E 494 (0-1s-0) E E 570 (3-0-3) PHYS 415 (3-0-0) PHYS 481 (3-0-0) Tech Elective (3-0-0) one of PHYS 362 (3-0-0) or Complementary Studies Elective (3-0-0)</p> <p>Term 8 E E 462 (3-0-3/2) E E 495 (0-0-6) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGG 400 (1-0-0) Tech Elective (3-0-0) Tech Elective (3-0-0) Tech Elective (3-0-0)</p> <p>Notes: (1) See \$74.5.6 for restrictions on the four technical electives. (2) Students may take an extra course per term if their GPA is at least 7.0. (3) PHYS 362 may be offered every second year and must be taken when available. (4) If timetabling problems arise, the ITS Elective may be taken in a later term and a Complementary Studies Elective should be taken in Term 3.</p>
Materials	<p>Term 3 CH E 200 (1-0-0) CH E 243 (3-1-0) CHEM 261 (3-0-3) E E 239 (3-0-3/2) ENGL 199 (3-0-0) or Complementary Studies Elective (3-0-0) MATE 252 (3-0-3/2) MATH 209 (3-0-1)</p> <p>Term 4 CH E 265 (3-0-3) CIV E 270 (3-0-3) MATH 201 (3-0-1) MATE 256 (3-1s-3/2) ITS Elective (3-0-0) (See \$74.6.1) Complementary Studies Elective (3-0-0) or ENGL 199 (3-0-0)</p>	<p>Term 5 CH E 312 (3-1s-0) CH E 374 (3-1s-0) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) or Tech Elective MATE 340 (3-0-0) MATE 357 (3-0-3) STAT 235 (3-0-2)</p> <p>Term 6 CH E 314 (3-1s-0) MATE 331 (3-0-3/2) MATE 332 (3-0-3/2) MATE 343 (2-0-3) or MATE 365 (3-0-3) MATE 345 (3-0-0) MATE 358 (3-0-3/2)</p>	<p>Term 7 CH E 481 (1-0-0) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) or Tech Elective (3-0-0) MATE 430 (3-0-3/2) MATE 448 (0-1s-0) MATE 452 (3-0-3) MATE 467 (3-1s-0) MATE 480 (3-0-0)</p> <p>Term 8 CH E 446 (3-1s-3/3) CH E 483 (1-0-0) ENGG 400 (1-0-0) MATE 440 (3-0-0) MATE 443 (2-1-3) or MATE 465 (1-0-6) Tech Elective Tech Elective</p> <p>Notes: (1) See \$74.5.7 for restrictions on three technical electives. (2) ENGG 310 or ENGG 401 must be taken in either Term 5 or Term 7.</p>

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

	Year 2	Year 3	Year 4
Mechanical	<p>Term 3 CIV E 270 (3-0-3) ENGL 199 (3-0-0) MATH 209 (3-0-1) MEC E 200 (0-2-0) MEC E 250 (3-1s-0) MEC E 265 (2-0-3) PHYS 230 (3-0-3/2)</p> <p>Term 4 CH E 243 (3-1s-0) E E 239 (3-0-3/2) MATH 201 (3-0-1) MEC E 260 (2-0-3) MATE 252 (3-0-3/2) STAT 235 (3-0-2)</p>	<p>Term 5 MATH 300 (3-0-0) MEC E 300 (3-0-0) MEC E 301 (1-0-3) MEC E 330 (3-0-1) MEC E 380 (3-0-0) MEC E 390 (3-0-1)</p> <p>Term 6 ENGG 310 (3-0-0) or ENGG 401 (3-0-0) MEC E 303 (1-0-3) MEC E 340 (3-0-0) MEC E 360 (3-0-3/2) MEC E 362 (3-0-3/2) MEC E 370 (3-1s-0)</p>	<p>Term 7 MEC E 430 (3-0-0) or MEC E 480 (3-0-0) MEC E 451 (3-0-1) MEC E 463 (3-0-2) MEC E 465 (1-0-4) Tech Elective (3-0-0) Tech Elective (3-0-0)</p> <p>Term 8 CH E 448 (3-1s-3/3) or E E 469 (3-0-3/2) ENGG 400 (1-0-0) MEC E 463 (3-0-2) MEC E 465 (1-0-4) ITS Elective (3-0-0) (See \$74.6.1) Tech Elective (3-0-0) Tech Elective (3-0-0) Note: See \$74.5.8 for restrictions on the four technical electives.</p>
Mining	<p>Term 3 CIV E 265 (2-0-3) EAS 210 (3-0-3) E E 239 (3-0-3/2) MATH 209 (3-0-1) MIN E 295 (3-0-3/2) STAT 235 (3-0-2)</p> <p>Term 4 CH E 243 (3-1s-0) CIV E 250 (3-0-2) CIV E 251 (2 weeks)* CIV E 270 (3-0-3) ENGL 199 (3-0-0) MATH 201 (3-0-1) MIN E 310 (3-0-3) *Held in Spring/Summer (Spring Term)</p>	<p>Term 5 CH E 312 (3-1s-0) CIV E 381 (3-0-3) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) MIN E 323 (3-0-3) MIN E 325 (3-0-3) MIN E 428 (0-1s-0)**</p> <p>Term 6 ITS Elective (3-0-0) (See \$74.6.1) MATE 331 (3-0-3/2) MIN E 324 (3-0-0) MIN E 330 (3-3s/2-0) MP E 322 (3-1s-0) Elective (3-0-0) (See \$74.5.9) **Held prior to start of Terms 5 or 7</p>	<p>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) MIN E 428 (0-1s-0)** Complementary Studies Elective (3-0-0) (See \$74.6) Elective (3-0-0) (See \$74.5.9)</p> <p>Term 8 ENGG 400 (1-0-0) MATE 408 (3-0-0) 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)</p>
Petroleum	<p>Term 3 EAS 210 (3-0-3) E E 239 (3-0-3/2) ENGL 199 (3-0-0) MATE 252 (3-0-3/2) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) Complementary Studies Elective (3-0-0) (See \$74.6)</p> <p>Term 4 CH E 243 (3-1s-0) CIV E 270 (3-0-3) MATH 201 (3-0-1) MATH 209 (3-0-1) PET E 295 (3-0-3/2) STAT 235 (3-0-2)</p>	<p>Term 5 CH E 312 (3-1s-0) CH E 374 (3-1s-0) CHEM 271 (3-0-3) PET E 362 (3-0-3/2) PET E 364 (3-1s-0) PET E 465 (3-1s-0)</p> <p>Term 6 EAS 222 (3-0-3) MP E 322 (3-1s-0) PET E 366 (3-0-0) PET E 368 (3-0-3/2) Elective (3-0-0) (See \$74.5.10) Elective (3-0-0) (See \$74.5.10)</p>	<p>Term 7 CH E 314 (3-1-4/4) ENGG 404 (3-3s/2-0) PET E 444 (3-0-0) PET E 471 (3-0-0) PET E 473 (3-0-3/2) PET E 484 (2-0-3) PET E 488 (0-1s-0)</p> <p>Term 8 ENGG 400 (1-0-0) PET E 475 (3-0-3/2) PET E 477 (3-0-0) PET E 489 (1-0-0) PET E 496 (1-6s-0) ITS Elective (3-0-0) (See \$74.6.1) Elective (3-0-0) (See \$74.5.10)</p>

74.4 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 information on Complementary Studies Electives see \$74.6.

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

Chemical Plan I	Year 2	Year 3	Year 4	Year 5
	<p>Fall Term 3 CH E 200 (1-0-0) CH E 243 (3-1s-0) CH E 265 (3-0-3) or MATE 252 (3-0-3/2) CHEM 261 (3-0-3) ENGG 299 (1-1s-0) ENGL 199 (3-0-0) or Complementary Studies Elective (3-0-0) MATH 209 (3-0-1) Complementary Studies Elective (3-0-0)</p> <p>Winter Term 4 CH E 265 (3-0-3) or MATE 252 (3-0-3/2) E E 239 (3-0-3/2) MATH 201 (3-0-1) ITS Elective (3-0-0) (See \$74.6.1) STAT 235 (3-0-2) Complementary Studies Elective (3-0-0) or ENGL 199 (3-0-0)</p> <p>Summer WKEXP 901</p>	<p>Fall WKEXP 902</p> <p>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) Tech Elective (3-0-0)</p> <p>Summer Term 6 CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (2-0-4) ENGG 310 (3-0-0) or ENGG 401 (3-0-0)</p>	<p>Fall WKEXP 903</p> <p>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 481 (1-0-0) Tech Elective (3-1s-0)</p> <p>Summer WKEXP 904</p>	<p>Fall WKEXP 905</p> <p>Winter Term 8 CH E 454 (1-0-4) CH E 465 (4-0-4) CH E 483 (1-0-0) ENGG 400 (1-0-0) Tech Elective (3-1s-0) Tech Elective (3-1s-0) Note: See \$74.5.1 for restrictions on the five technical electives.</p>
Chemical Plan II	<p>Fall Term 3 CH E 200 (1-0-0) CH E 243 (3-1s-0) CH E 265 (3-0-3) or MATE 252 (3-0-3/2) CHEM 261 (3-0-3) ENGG 299 (1-1s-0) ENGL 199 (3-0-0) or Complementary Studies Elective (3-0-0) MATH 209 (3-0-1) Complementary Studies Elective (3-0-0)</p> <p>Winter WKEXP 901</p> <p>Summer Term 4 MATE 252 (3-0-3/2) or CH E 265 (3-0-3) E E 239 (3-0-3/2) MATH 201 (3-0-1) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) STAT 235 (3-0-2) Complementary Studies Elective (3-0-0) or ENGL 199 (3-0-0)</p>	<p>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) Tech Elective (3-0-0)</p> <p>Winter WKEXP 902</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (2-0-4) ITS Elective (3-0-0) (See \$74.6.1)</p> <p>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 481 (1-0-0) Tech Elective (3-1s-0)</p> <p>Summer WKEXP 904</p>	<p>Fall WKEXP 905</p> <p>Winter Term 8 CH E 454 (1-0-4) CH E 465 (4-0-4) CH E 483 (1-0-0) ENGG 400 (1-0-0) Tech Elective (3-1s-0) Tech Elective (3-1s-0) Note: See \$74.5.1 for restrictions on the five technical electives.</p>
Chemical: Computer Process Control	<p>Fall Term 3 CH E 200 (1-0-0) CH E 243 (3-1s-0) CHEM 261 (3-0-3) E E 240 (3-1s-3/2) ENGG 299 (1-1s-0) MATE 252 (3-0-3/2) MATH 209 (3-0-1) Tech Elective (3-1s-0) or MATH 201 (3-0-1)</p> <p>Winter Term 4 CH E 265 (3-0-3) E E 250 (3-1s-3/2) ENGL 199 (3-0-0) MATH 201 (3-0-1) or Tech Elective (3-1s-0) STAT 235 (3-0-2) Tech Elective (3-1s-0)</p> <p>Summer WKEXP 901</p>	<p>Fall WKEXP 902</p> <p>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) ITS Elective (3-0-0) (See \$74.6.1) Complementary Studies Elective (3-0-0)</p> <p>Summer Term 6 CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (2-0-4) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) Technical Elective (3-1s-0)</p>	<p>Fall WKEXP 903</p> <p>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 481 (1-0-0) Tech Elective (3-1s-0) Complementary Studies Elective (3-0-0)</p> <p>Summer WKEXP 904</p>	<p>Fall WKEXP 905</p> <p>Winter Term 8 CH E 454 (1-0-4) CH E 465 (4-0-4) CH E 483 (1-0-0) CH E 562 (3-0-3/2) CH E 564 (3-0-3/2) ENGG 400 (1-0-0) Notes: (1) MATH 201 must be taken in either Term 3 or 4. (2) See \$74.5.2 for restrictions on technical electives.</p>

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

Chemical: Oil Sands Elective	Year 2	Year 3	Year 4	Year 5
	<p>Fall Term 3 CH E 200 (1-0-0) CH E 243 (3-1s-0) CHEM 265 (3-0-3) or MATE 252 (3-0-3/2) CHEM 261 (3-0-3) ENGG 299 (1-1s-0) ENGL 199 (3-0-0) or Complementary Studies Elective (3-0-0) MATH 209 (3-0-1) Complementary Studies Elective (3-0-0)</p> <p>Winter WKEXP 901</p> <p>Summer Term 4 MATE 252 (3-0-3/2) or CH E 265 (3-0-3) E E 239 (3-0-3/2) MATH 201 (3-0-1) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) STAT 235 (3-0-2) Complementary Studies Elective (3-0-0) or ENGL 199 (3-0-0)</p>	<p>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) Tech Elective (3-0-0)</p> <p>Winter WKEXP 902</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 CH E 314 (3-1s-0) CH E 318 (3-0-2) CH E 345 (3-1s-0) CH E 358 (2-0-4) ITS Elective (3-0-0) (See \$74.6.1)</p> <p>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 481 (1-0-0) CH E 522 (3-1s-3/3)</p> <p>Summer WKEXP 904</p>	<p>Fall WKEXP 905</p> <p>Winter Term 8 CH E 435 (4-0-4) CH E 454 (1-0-4) CH E 483 (1-0-0) CH E 534 (3-1s-3/3) CH E 537 (3-1s-3/3) ENGG 400 (1-0-0) Note: See \$74.5.3 for restrictions on the technical electives.</p>
Civil	Year 2	Year 3	Year 4	Year 5
	<p>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) MATE 252 (3-0-3/2) MATH 209 (3-0-1)</p> <p>Winter Term 4 CIV E 221 (3-0-3/2) CIV E 250 (3-0-2) CIV E 251 (2 weeks*) CIV E 290 (3-0-0) CIV E 295 (3-0-2) MATH 201 (3-0-1) *Held in Spring/Summer (Spring Term)</p> <p>Summer WKEXP 901</p>	<p>Fall WKEXP 902</p> <p>Winter Term 5 CIV E 312 (3-0-0) CIV E 321 (3-0-3/2) CIV E 330 (3-1s-0) CIV E 372 (3-2s-0) CIV E 391 (3-0-3) CIV E 395 (3-0-2/2)</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 CIV E 303 (3-0-3/2) CIV E 331 (3-0-3/2) CIV E 374 (3-0-3) CIV E 381 (3-0-3) CIV E 398 (3-1s-0) ENGL 199 (3-0-0)</p> <p>Winter WKEXP 904</p> <p>Summer WKEXP 905</p>	<p>Fall Term 7 Tech Elective (See Note 1) Tech Elective (See Note 1) Tech Elective (See Note 1) One of E E 239, MEC E 250 or CH E 243 Complementary Studies Elective (3-0-0) (See Note 2)</p> <p>Winter Term 8 CIV E 490 (1-2s-0) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGG 400 (1-0-0) ENGG 420 (3-0-0) ITS Elective (3-0-0) (See \$74.6.1) Tech Elective (See Note 1) Tech Elective (See Note 1) Notes: (1) See \$74.5.3 for restrictions on the technical electives. (2) See \$74.6 for restrictions on the complementary studies electives.</p>
Civil: Environmental Engineering Option	Year 2	Year 3	Year 4	Year 5
	<p>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)</p> <p>Winter Term 4 BIOL 107 (3-0-3) CIV E 250 (3-0-2) CIV E 295 (3-0-2) CIV E 251 (2 weeks*) ENV E 222 (3-0-3/2) MATH 201 (3-0-1) *Held in Spring/Summer (Spring Term)</p> <p>Summer WKEXP 901</p>	<p>Fall WKEXP 902</p> <p>Winter Term 5 CIV E 290 (3-0-0) CIV E 330 (3-1s-0) CIV E 372 (3-2s-0) CIV E 395 (3-0-2/2) ENV E 302 (2-1s-0) ENV E 351 (3-0-3/2)</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 CH E 243 (3-1s-0) CIV E 331 (3-0-3/2) CIV E 398 (3-1s-0) ENV E 320 (3-0-3/2) ENV E 322 (3-0-0) One of E E 239, MEC E 250 or MATE 252</p> <p>Winter WKEXP 904</p> <p>Summer WKEXP 905</p>	<p>Fall Term 7 CIV E 303 (3-0-3/2) CIV E 381 (3-0-3) ENV E 400 (3-0-0) ENV E 421 (3-0-3/2) ENV E 471 (3-0-3/2) Complementary Studies Elective (3-0-0) (See Note)</p> <p>Winter Term 8 ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGG 400 (1-0-0) ENV E 432 (3-0-0) ENV E 434 (3-0-0) ENV E 440 (3-0-3) LAW 559 (3-0-0) ITS Elective (3-0-0) (See \$74.6.1) Note: See \$74.6 for restrictions on complementary electives.</p>

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

Computer	Year 2	Year 3	Year 4	Year 5
	<p>Fall Term 3 CMPUT 115 (3-0-3) E E 240 (3-1s-3/2) E E 280 (3-0-3/2) ENGG 299 (1-1s-0) ENGL 199 (3-0-0) MATH 209 (3-0-1) ITS Elective (3-0-0) (See §74.6.1)</p> <p>Winter Term 4 CMPUT 272 (3-1s-3) E E 231 (3-1s-0) E E 250 (3-1s-3/2) E E 380 (3-0-3/2) MATH 201 (3-0-1) PHYS 230 (3-0-3/2)</p> <p>Summer WKEXP 901</p>	<p>Fall Term 5 CMPUT 201 (3-0-3) CMPUT 204 (3-0-1) E E 335 (3-1s-0) E E 340 (3-1s-3/2) E E 387 (3-1s-0) E E 480 (3-0-3/2)</p> <p>Winter WKEXP 902</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 CMPE 401 (3-0-3/2) CMPUT 379 (3-0-3) E E 350 (3-1s-3/2) E E 390 (3-0-0) Tech Elective (3-0-0) Tech Elective (3-0-0)</p> <p>Winter Term 7 CMPE 300 (3-0-3/2) CMPE 382 (3-0-0) E E 317 (3-0-0) E E 338 (3-0-3/2) Tech Elective (3-0-0) Complementary Studies Elective (3-0-0)</p> <p>Summer WKEXP 904</p>	<p>Fall WKEXP 905</p> <p>Winter Term 8 E E 462 (3-0-3/2) E E 582 (1-0-6) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGG 400 (1-0-0) Tech Elective (3-0-0) Tech Elective (3-0-0) Complementary Studies Elective (3-0-0)</p> <p>Notes: (1) See §74.5.4 for restrictions on the five technical electives. (2) If timetabling problems arise, the ITS Elective may be taken in a later term and a Complementary Studies Elective should be taken in Term 3.</p>
Electrical	Year 2	Year 3	Year 4	Year 5
	<p>Fall Term 3 E E 240 (3-1s-3/2) E E 280 (3-0-3/2) ENGG 299 (1-1s-0) MATH 201 (3-0-1) MATH 209 (3-0-1) MEC E 250 (3-1s-0) ITS Elective (3-0-0) (See §74.6.1)</p> <p>Winter Term 4 CH E 243 (3-1s-0) E E 231 (3-1s-0) E E 250 (3-1s-3/2) ENGL 199 (3-0-0) MATH 309 (3-0-0) PHYS 230 (3-0-3/2)</p> <p>Summer WKEXP 901</p>	<p>Fall Term 5 E E 315 (3-1s-0) E E 330 (3-0-0) E E 335 (3-1s-0) E E 340 (3-1s-3/2) E E 380 (3-0-3/2) E E 387 (3-1s-0)</p> <p>Winter WKEXP 902</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 E E 332 (3-0-3/2) E E 338 (3-0-3/2) E E 350 (3-1s-3/2) E E 357 (3-0-3/2) E E 390 (3-0-0) ENGG 402 (3-0-0) or other Complementary Studies Elective (3-0-0)</p> <p>Winter Term 7 E E 401 (1-0-6) or E E 582 (1-0-6) Complementary Studies Elective (3-0-0) Tech Elective Tech Elective Tech Elective Tech Elective</p> <p>Summer WKEXP 904</p>	<p>Fall WKEXP 905</p> <p>Winter Term 8 ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGG 400 (1-0-0) Tech Elective Tech Elective Tech Elective Tech Elective</p> <p>Notes: (1) See §74.5.5 for restrictions on the nine technical electives. (2) If timetabling problems arise, the ITS Elective may be taken in a later term and a Complementary Studies Elective should be taken in Term 3.</p>
Materials	Year 2	Year 3	Year 4	Year 5
	<p>Fall Term 3 CH E 200 (1-0-0) CH E 243 (3-1-0) CHEM 261 (3-0-3) E E 239 (3-0-3/2) ENGG 299 (1-1s-0) ENGL 199 (3-0-0) or Complementary Studies Elective (3-0-0) MATE 252 (3-0-3/2) MATH 209 (3-0-1)</p> <p>Winter Term 4 CH E 265 (3-0-3) CIV E 270 (3-0-3) MATH 201 (3-0-1) MATE 256 (3-1s-3/2) ITS Elective (3-0-0) (See §74.6.1) Complementary Studies Elective (3-0-0) or ENGL 199 (3-0-0)</p> <p>Summer WKEXP 901</p>	<p>Fall Term 5 CH E 312 (3-1s-0) CH E 374 (3-1s-0) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) or Tech Elective MATE 340 (3-0-0) MATE 357 (3-0-3) STAT 235 (3-0-2)</p> <p>Winter WKEXP 902</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 CH E 481 (1-0-0) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) or Tech Elective (3-0-0) MATE 430 (3-0-3/2) MATE 448 (0-1s-0) MATE 452 (3-0-3) MATE 467 (3-1s-0) MATE 480 (3-0-0)</p> <p>Winter Term 7 CH E 314 (3-1s-0) MATE 331 (3-0-3/2) MATE 332 (3-0-3/2) MATE 345 (3-0-0) MATE 358 (3-0-3/2) MATE 343 (2-0-3) or MATE 365 (3-0-3)</p> <p>Summer WKEXP 904</p>	<p>Fall WKEXP 905</p> <p>Winter Term 8 CH E 446 (3-1s-3/3) CH E 483 (1-0-0) ENGG 400 (1-0-0) MATE 440 (3-0-0) MATE 443 (2-1-3) or MATE 465 (1-0-6) Tech Elective Tech Elective</p> <p>Notes: (1) See §74.5.7 for restrictions on three technical electives. (2) ENGG 310 or ENGG 401 must be taken in either Term 5 or Term 6.</p>

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

	Year 2	Year 3	Year 4	Year 5
Mechanical	<p>Fall Term 3 CIV E 270 (3-0-3) ENGG 299 (1-1s-0) ENGL 199 (3-0-1) MATH 209 (3-0-1) MEC E 250 (3-1s-0) MEC E 265 (2-0-3) PHYS 230 (3-0-3/2)</p> <p>Winter Term 4 CH E 243 (3-1s-0) E E 239 (3-0-3/2) MATH 201 (3-0-1) MATE 252 (3-0-3/2) MEC E 200 (0-2-0) MEC E 260 (2-0-3) STAT 235 (3-0-2)</p> <p>Summer WKEXP 901</p>	<p>Fall WKEXP 902</p> <p>Winter Term 5 MATH 300 (3-0-0) MEC E 300 (3-0-0) MEC E 301 (1-0-3) MEC E 330 (3-0-1) MEC E 380 (3-0-0) MEC E 390 (3-0-1)</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 ENGG 310 (3-0-0) or ENGG 401 (3-0-0) MEC E 303 (1-0-3) MEC E 340 (3-0-0) MEC E 360 (3-0-3/2) MEC E 362 (3-0-3/2) MEC E 370 (3-1s-0)</p> <p>Winter WKEXP 904</p> <p>Summer WKEXP 905</p>	<p>Fall Term 7 MEC E 430 (3-0-0) or MEC E 480 (3-0-0) MEC E 451 (3-0-1) MEC E 463 (3-0-2) MEC E 465 (1-0-4) Tech Elective (3-0-0) Tech Elective (3-0-0)</p> <p>Winter Term 8 E E 469 (3-0-3/2) or CH E 448 (3-1s-3/3) ENGG 400 (1-0-0) MEC E 465 (1-0-4) ITS Elective (3-0-0) (See \$74.6.1) Tech Elective (3-0-0) Tech Elective (3-0-0) Complementary Elective (3-0-0) Note: See \$74.5.8 for restrictions on the four technical electives.</p>
Mining	<p>Fall Term 3 CIV E 265 (2-0-3) EAS 210 (3-0-3) E E 239 (3-0-3/2) ENGG 299 (1-1s-0) MATH 209 (3-0-1) MIN E 295 (3-0-3/2) STAT 235 (3-0-2)</p> <p>Winter Term 4 CH E 243 (3-1s-0) CIV E 250 (3-0-2) CIV E 251 (2 weeks)* CIV E 270 (3-0-3) ENGL 199 (3-0-0) MATH 201 (3-0-1) MIN E 310 (3-0-3)</p> <p>Summer WKEXP 901 *Held in Spring/Summer Spring Term.</p>	<p>Fall WKEXP 902</p> <p>Winter Term 5 ITS Elective (3-0-0) (See \$74.6.1) MATE 331 (3-0-3/2) MIN E 324 (3-0-0) MIN E 330 (3-3/2s-0) MP E 322 (3-1s-0) Elective (3-0-0) (See \$74.5.9)</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 CH E 312 (3-1s-0) CIV E 381 (3-0-3) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) MIN E 323 (3-0-3) MIN E 325 (3-0-3) MIN E 428 (0-1s-0)**</p> <p>Winter WKEXP 904</p> <p>Summer WKEXP 905 **Held prior to start of Terms 6 or 7.</p>	<p>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) MIN E 428 (0-1s-0) Complementary Studies Elective (3-0-0) (See \$74.6) Elective (3-0-0) (See \$74.5.9)</p> <p>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) MATE 408 (3-0-0)</p>
Petroleum	<p>Fall Term 3 EAS 210 (3-0-3) E E 239 (3-0-3/2) ENGG 299 (1-1s-0) ENGG 310 (3-0-0) or ENGG 401 (3-0-0) ENGL 199 (3-0-0) MATE 252 (3-0-3/2) Complementary Studies Elective (3-0-0) (See \$74.6)</p> <p>Winter Term 4 CH E 243 (3-1s-0) CIV E 270 (3-0-3) MATH 201 (3-0-1) MATH 209 (3-0-1) PET E 295 (3-0-3/2) STAT 235 (3-0-2)</p> <p>Summer WKEXP 901</p>	<p>Fall WKEXP 902</p> <p>Winter Term 5 EAS 222 (3-0-3) MPE 322 (3-0-0) PET E 366 (3-0-0) PET E 368 (3-0-3/2) Elective (3-0-0) (See \$74.5.10) Elective (3-0-0) (See \$74.5.10)</p> <p>Summer WKEXP 903</p>	<p>Fall Term 6 CH E 312 (3-1s-0) CH E 374 (3-1s-0) CHEM 271 (3-0-3) PET E 362 (3-0-3/2) PET E 364 (3-1s-0) PET E 465 (3-1s-0)</p> <p>Winter WKEXP 904</p> <p>Summer WKEXP 905</p>	<p>Fall Term 7 CH E 314 (3-1-4/4) ENGG 404 (3-3s/2-0) PET E 444 (3-0-0) PET E 471 (3-0-0) PET E 473 (3-0-3/2) PET E 484 (2-0-3) PET E 488 (0-1s-0)</p> <p>Winter Term 8 ENGG 400 (1-0-0) PET E 475 (3-0-3/2) PET E 477 (3-0-0) PET E 489 (1-0-0) PET E 496 (1-6s-0) ITS Elective (3-0-0) (See \$74.6.1) Elective (3-0-0) (See \$74.5.10)</p>

74.5 Technical Electives

74.5.1 Chemical

- (1) Of the four single-term technical electives, two must be Engineering Science and/or Engineering Design courses, and one elective must be an approved Science course.
- (2) In addition to required courses, programs in Chemical Engineering offer considerable flexibility through electives to develop interdisciplinary interests or to study certain fields in depth. Subject only to feasibility of scheduling and course availability, a student may choose from technical elective courses offered by the Department or courses offered by other Departments.

A complete list of approved technical electives is available from the Department of Chemical and Materials Engineering.

74.5.2 Chemical: Computer Process Control Option

The four technical electives must follow one of two program streams:

- (1) Signal processing: MATH 309, E E 335 and E E 338, and either CMPUT 115 or a departmentally approved computing course.
- (2) Computer Systems: E E 280 and E E 380, either CMPUT 115 or a departmentally approved computing course, and one more departmentally approved technical elective.

74.5.3 Chemical: Oilsands Option

The technical elective must be chosen from an approved list of courses which is available from the Department of Chemical and Materials Engineering.

74.5.4 Civil

Five technical electives are required. At least three must be selected from (1) and at least one from (2). In special cases, one technical elective may be taken from another program but prior written approval from the Department of Civil and Environmental Engineering must be obtained.

(1) CIV E 406, 421, 431, 474, 481

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

74.5.5 Computer

Of the five single-term technical electives, one elective must be a 300- or 400-level Computing Science course, and two electives must be from the group of courses CH E 243, MATE 353 and MEC E 250. The remaining two technical electives must be selected from the Computer Engineering technical elective list.

Complete list of Computer Engineering Technical Electives:

CMPUT 291, 304, 313, 325, 366, 391, 411, 415, 422, 425, 466, 474, 485

E E 483, 514, 539, 552, 563, 570, 571, 572, 586, 588, 589, 598, 599

EE BE 512, 540

CMPE 498, 499

Other courses including 600-level courses may be taken with Departmental approval.

74.5.5.1 Computer Engineering: Software Option

Two technical electives must be chosen from CH E 243, MAT E 353, MEC E 250. A third technical elective must be chosen from the courses in the Computer Engineering technical elective list, excluding those which are required in this option.

74.5.6 Electrical

- (1) The nine technical electives must include one of the six program streams:
 - a. **Communications Stream:** E E 316, 588 and two of E E 586, 589, 685 and four of E E 445, 480, 539, 570, 571, 582, 591, 597 plus one more E E approved technical elective including courses not taken from the list above.
 - b. **Controls Stream:** E E 561, 566 and three of E E 539, 562, 563, 564, 565 and two of E E 445, 480, 582 plus two more E E approved technical electives including courses not taken from list above.
 - c. **Digital Stream:** E E 480, 552, 570, 582 and one of E E 539 or 483 and two of E E 445, 571, 572; CMPE 382; CMPUT 115, 204; EE BE 540; plus two more E E approved technical electives including courses not taken from list above.
 - d. **Electronics Stream:** E E 316, 570, 571, 572 and three of E E 480, 483, 530, 550, 552, 597, 641, and two of E E 445, 514, 524, 531, 539, 561, 582, 591, EE BE 512.
 - e. **Power Stream:** E E 521, 525, 531 and four of E E 445, 513, 514, 524, 527, 528, 529, 530, 545 plus two more E E approved technical electives including courses not taken from list above.
 - f. **Biomedical Stream:** BME 210, 310, 513, EE BE 512 and 540; one of E E 316, 323, 480, 550; and one of BME 529, 553, E E 563, 565; and two more approved Electrical Engineering technical electives.

Notes

- (1) When E E 582 is taken as a substitute for E E 401, it will not count as one of the nine technical electives. Students who elect to take E E 582 in addition to E E 401 are strongly advised against registering for both in the same term.
 - (2) E E 563 is offered every second year, alternating with E E 565.
- (2) Complete list of Electrical Engineering approved Technical Electives: BME 210, 310, 513, 529, 553
E E 316, 323, 445, 480, 483, and all 500-level Electrical Engineering courses. 600-level courses may be taken with the approval of the Department.
EE BE 512, 540
CMPUT 115, 204, 272, 366, 466
In addition to this list, other courses may be taken with Departmental approval.

Note: Undergraduate students should be aware that they can take technical elective courses as extra to their BSc degree. It may be possible to use these extra courses as partial credit toward a graduate degree.

- (3) At least two technical electives must have a lab component and the total lab hours must be at least 9/2.

74.5.7 Engineering Physics

The four technical electives must be chosen, with Departmental consent, such that the electives include at least 9.2 units of Engineering Science and Design.

74.5.8 Materials

The three technical electives must be chosen from the approved list of courses. Students may choose to develop a technical interest within elements of the discipline or to develop interdisciplinary interests in business, materials design (with Mechanical Engineering), polymers (with Chemical Engineering or Chemistry), biomaterials, etc. Department approval is required for all elective courses.

74.5.9 Mechanical

- (1) Four technical electives must be chosen from the following:

ACCTG 300

B LAW 301

BME 210, 310, 513, 530, 553

CH E 555

EAS 210

E E 280, 445, (250, 330, 380 and 480 may be taken with approval of the

Department of Electrical and Computer Engineering), E E 528, 563

EE BE 512, 540

ENGG 402, 404, 406, 420

FIN 301

MARK 301

MATH 311

MATE 256, 345, 357, 358, 411, 462

MEC E 364, 409, 412, 430, 439, 443, 469, 480, 513, 535, 537, 539, 541,

542, 553, 563, 565, 567, 569, 582, 583

MEC E 514 or E E 514

MEC E 555 or E E 565

MGTSC 352 or CIV E 592

ORG A 301, 321

PET E 362, 364, 366, 444, 465, 473

PH BE 221

PHYSL 161

- (2) Biomedical Engineering Elective Stream

Students wishing to specialize in the area of biomedical engineering should choose their four technical electives from the following courses: BME 210, 310, 513, 530, 553, EE BE 512, 540, MEC E 409, 469, 535, 563, PH BE 221, PHYSL 161. In particular either BME 210, 310 and two other electives, or PHYSL 161 (full-year course), BME 310 and one other elective are especially recommended.

Note that admission to PHYSL 161 for engineering students is on a space-available basis only. Also note that some of these courses may not be offered every year. See department for details.

- (3) Business and Management Elective Stream

Students wishing to obtain an introduction to business and management principles should take ENGG 401 instead of ENGG 310, 405 as their ITS elective, and ECON 204 as their complementary studies elective in Term 7. In addition, they can choose their technical electives from the following:

a. **Within the Faculty of Engineering:** CIV E 592, E E 514, ENGG 402, 420, MEC E 412, 513, 514. Note that some of these courses may not be offered every year. See department for details.

b. **Within the Faculty of Business:** ACCTG 300, BLAW 301, FIN 301, MARK 301, MGTSC 352, ORG A 301, 321. Note that admission to FIN 301, MARK 301, ORG A 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 514 and MEC E 514, and for one of CIV E 592 and MGTSC 352.

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

74.5.10 Mining

Electives must be chosen from an approved list prepared by the School of Mining and Petroleum Engineering. This list includes courses offered by the School, the Faculty of Engineering, and the Faculties of Arts, Science, and Business. School approval is required for all elective courses.

74.5.11 Petroleum

Electives must be chosen from an approved list prepared by the School of Mining and Petroleum Engineering. This list includes courses offered by the School, the Faculty of Engineering, and the Faculty of Arts, Science, and Business. School approval is required for all elective courses.

Engineering, Computing (ENCMP) (offered jointly with the Faculty of Science)
 Engineering, General (ENGG)
 Engineering, Management (ENG M)
 Engineering, Physics (EN PH) (offered jointly with the Faculty of Science)
 Environmental Engineering (ENV E)
 Materials Engineering (MATE)
 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)

74.6 Complementary Studies Electives

The Canadian Engineering Accreditation Board requires engineering programs to have a complementary studies component composed of courses that expose students to the thought processes and practices in arts, communication, engineering economics, humanities and management. The complementary studies elective courses within each engineering program may be selected from any of the following subject areas: Anthropology, Art and Design (ART H only), Business (not Management Information System courses, also see §72.13), Canadian Studies, Canadien-Français, Christian Theology, Classics, Comparative Literature, Economics, Engineering (ENGG 401, 402, 403, 405 and 420 only), English, Etudes de Religion, History, Interdisciplinary Studies (Departmental approval required), Linguistics, Philosophie, Philosophy, Political Science, Psychologie, Psychology, Religious Studies, Rural Economy, Science Politique, Slavic and East European Studies, Sociologie, Sociology, Women's Studies, and Writing. Courses from other subject areas may be acceptable with approval of an advisor. Complementary studies courses must be graded (not pass-fail), three lecture-hour courses with a written component. Courses outside Business and Engineering must also include a final exam. Courses that teach the application of a particular skill (such as courses in physical education and music) are not eligible as complementary studies electives.

Foreign-language courses may not be taken by qualifying year students. Under certain circumstances language courses may be taken by students after their qualifying year. Students wanting to take foreign language courses as Complementary Studies Electives must obtain prior department approval. Students may only register in courses appropriate to their level of proficiency. Beginner-level language courses are only accepted as complementary studies electives if the student has no prior experience in that language and where equivalent 30-level matriculation courses do not exist. Students who are familiar with a foreign language must receive an assessment of their level of proficiency and register appropriately: introductory or beginner-level courses are not accepted as complementary studies electives if prior knowledge of the language exists. Students with matriculation-level credit in a language must select courses appropriate to their ability.

74.6.1 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: ENGG 403, ENGG 405, HIST 391, INT D 200, SOC 366 or SOC 363.

75 Courses

75.1 Course Listings

Faculty of Engineering courses are listed in §201, Course Listings, under the following subject headings:

Bioresource Engineering (BIOEN) (offered by the Faculty of Agriculture, Forestry, and Home Economics)
 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/Biomedical Engineering (EE BE)

75.2 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.