Faculty of Applied Science and Engineering

2012-2013 Calendar
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MESSAGE FROM THE DEAN

Welcome to the 2012-2013 academic year!

As an undergraduate student, you are part of a rich community of engineering leaders and innovators who are making real change in the world. In 2011-2012, Times Higher Education, and all international rankings, once again ranked UofT as the top school in Canada for Engineering and Technology.

The Faculty seeks to maintain both our high standing and our high standards for excellence, to accomplish this we approved our new Academic Plan in 2011 which will guide our activities for the next five years. Two major areas that have a direct impact on students are our goals in educating future engineers, and in student experience. As you pursue your degree with us, we hope that you will take advantage not only of the education you will receive from our internationally renowned scholars, but also of the co- and extra-curricular opportunities you will have.

This Calendar outlines the curriculum for each of our nine undergraduate programs, information on scholarships and financial aid, as well as policies and procedures for moving from session to session.

We know that you have much to consider as you pursue your studies with us and I recommend that you use not only the Calendar, but also our First Year, departmental undergraduate (for upper year students), and Registrar’s offices as resources in the months ahead. Through our capable staff you will have access to advice, guidance, counselling, and a wide range of other services should you require them.

Throughout the coming year we will be providing you with a wealth of information through various mediums such as our student e-newsletter, The Cannon Engineering student newspaper, the Engineering Society’s website, and on plasma screens throughout our buildings. We look for your feedback through surveys, your Engineering Society, and our semi-annual Dean’s Town Hall and appreciate suggestions that will help us improve your experience here with us.

My very best wishes for a rewarding year ahead.

Cristina Amon
Dean, Faculty of Applied Science & Engineering
IMPORTANT NOTICES

The Undergraduate Academic Calendar of the Faculty of Applied Science and Engineering is now published online. In the case of any discrepancy, the online version shall apply. Any post-publication corrections and/or updates to the Undergraduate Academic Calendar will be posted on the Registrar’s website at www.undergrad.engineering.utoronto.ca. Students are strongly advised to check back regularly to keep informed of changes.

The University reserves the right to change without notice any information contained in this Calendar, including any rule or regulation pertaining to the standards for admission, the requirements for the continuation of study in, or the requirements for the granting of degrees or diplomas in any or all of its programs. The publication of information in this Calendar does not bind the University to the provision of courses, programs, schedules of studies, or facilities as listed herein.

The University will not be liable for any interruption in, or cancellation of, any academic activities as set forth in this Calendar and related information where such interruption is caused by fire, strike, lock-out, inability to procure materials or trades, restrictive laws or governmental regulations, actions taken by faculty, staff or students of the University or by others, civil unrest or disobedience, or any other cause of any kind beyond the reasonable control of the University.

CHANGES IN PROGRAM OF STUDY AND/OR COURSES

The programs of study that our calendar lists and describes are available for the year(s) to which the calendar applies. They may not necessarily be available in later years. If the University or the Faculty must change the content of programs of study or withdraw them, all reasonable possible advance notice and alternative instruction will be given. The University will not, however, be liable for any loss, damages, or other expenses that such changes might cause.

For each program of study offered by the University through the Faculty, the courses necessary to complete the minimum requirements of the program will be made available annually. We must, however, reserve the right otherwise to change the content of courses, instructors and instructional assignments, enrolment limitations, pre-requisites and co-requisites, grading policies, requirements for promotion and timetables without prior notice.

REGULATIONS AND POLICIES

As members of the University of Toronto community, students assume certain responsibilities and are guaranteed certain rights and freedoms. The University has several policies that are approved by the Governing Council and which apply to all students. Each student must become familiar with the policies. The University will assume that he or she has done so. The rules and regulations of the Faculty are listed in this calendar. In applying to the Faculty, the student assumes certain responsibilities to the University and the Faculty and, if admitted and registered, shall be subject to all rules, regulations and policies cited in the calendar.

All University policies can be found at: www.governingcouncil.utoronto.ca/policies.htm

Those which are of particular importance to students are:
  - Policy on Access to Student Academic Records
  - Code of Behaviour on Academic Matters
  - Code of Student Conduct
  - Grading Practices Policy
  - Policy on Official Correspondence with Students

More information about students’ rights and responsibilities can be found at: http://life.utoronto.ca/get-help/rights-responsibilities.htm

ENROLMENT LIMITATIONS

The University makes every reasonable effort to plan and control enrolment to ensure that all of our students are qualified to complete the programs to which they are admitted, and to strike a practicable balance between enrolment and available instructional resources. Sometimes such a balance cannot be struck and the number of qualified students exceeds the instructional resources that we can reasonably make available while at the same time maintaining the quality of instruction. In such cases, we must reserve the right to limit enrolment in the programs, courses, or sections listed in the calendar, and to withdraw courses or sections for which enrolment or resources are insufficient. The University will not be liable for any loss, damages, or other expenses that such limitations or withdrawals might cause.

COPYRIGHT IN INSTRUCTIONAL SETTINGS

If a student wishes to tape-record, photograph, video-record or otherwise reproduce lecture presentations, course notes or other similar materials provided by instructors, he or she must obtain the instructor’s written consent beforehand. Otherwise all such reproduction is an infringement of copyright and is absolutely prohibited. In the case of private use by students with disabilities, the instructor’s consent will not be unreasonably withheld.

PERSON I.D. (STUDENT NUMBER)

Each student at the University is assigned a unique identification number. The number is confidential. The University, through the Policy on Access to Student Academic Records, strictly controls access to Person I.D. numbers. The University assumes and expects that students will protect the confidentiality of their Person I.D.’s.
FEES AND OTHER CHARGES
The University reserves the right to alter the fees and other charges described in the calendar.

NOTICE OF COLLECTION OF PERSONAL INFORMATION
The University of Toronto respects your privacy. Personal information that you provide to the University is collected pursuant to section 2(14) of the University of Toronto Act, 1971. It is collected for the purpose of administering admission, registration, academic programs, university-related student activities, activities of student societies, financial assistance and awards, graduation and university advancement, and for the purpose of statistical reporting to government agencies. At all times it will be protected in accordance with the Freedom of Information and Protection of Privacy Act. If you have questions, please refer to www.utoronto.ca/privacy or contact the University Freedom of Information and Protection of Privacy Coordinator at 416 946-7303, McMurrich Building, room 201, 12 Queen's Park Crescent West, Toronto, ON, MSS 1A8.
# Sessional Dates

## SUMMER SESSION (F/S) 2012

### T-Program Courses

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 7</td>
<td>Monday</td>
<td>First Year T-Program classes begin</td>
</tr>
<tr>
<td>June 11</td>
<td>Monday</td>
<td>Last day to drop F courses (T-Program) without academic penalty*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The request must be submitted to the First Year Office (GB170) by 4:00PM</td>
</tr>
<tr>
<td>June 22</td>
<td>Friday</td>
<td>First Year T-Program classes end</td>
</tr>
<tr>
<td>June 25 to June 29</td>
<td>Monday to Friday</td>
<td>Final examinations for First Year T-Program courses</td>
</tr>
</tbody>
</table>

(*) REFUND DATES

The last date to cancel a course or cancel your registration in a session with no academic penalty may not always coincide with the last date that you are eligible for a refund. Check the refund schedules for refund dates, which are available at www.fees.utoronto.ca.

### Engineering and Arts & Science Courses

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 10</td>
<td>Tuesday</td>
<td>First day for Engineering students to enrol in APSC Summer courses (6:00AM)</td>
</tr>
<tr>
<td>April 18</td>
<td>Wednesday</td>
<td>First day for Engineering students to enrol in Arts and Science (A&amp;S) courses (6:00AM)</td>
</tr>
<tr>
<td>April 26</td>
<td>Thursday</td>
<td>Last day to pay/defer fees</td>
</tr>
<tr>
<td>May 9</td>
<td>Wednesday</td>
<td>Courses removed for non-registered students</td>
</tr>
<tr>
<td>May 14</td>
<td>Monday</td>
<td>Classes begin in F and Y courses</td>
</tr>
<tr>
<td>May 21</td>
<td>Monday</td>
<td>Deadline to enrol in F and Y courses on SWS</td>
</tr>
<tr>
<td>May 21</td>
<td>Monday</td>
<td>Victoria Day: University closed</td>
</tr>
<tr>
<td>June 11</td>
<td>Monday</td>
<td>Last day to drop F courses without academic penalty*</td>
</tr>
<tr>
<td>June 20</td>
<td>Wednesday</td>
<td>Convocation ceremony for the conferring of the Bachelor of Applied Science and Engineering Science degrees (<a href="http://www.convocation.utoronto.ca">www.convocation.utoronto.ca</a>)</td>
</tr>
<tr>
<td>June 22</td>
<td>Friday</td>
<td>Classes end in F Session courses</td>
</tr>
<tr>
<td>June 25 to June 29</td>
<td>Monday to Friday</td>
<td>Final examinations for F courses</td>
</tr>
<tr>
<td>June 25 to June 29</td>
<td>Monday to Friday</td>
<td>Y Section Code Courses Break</td>
</tr>
<tr>
<td>July 2</td>
<td>Monday</td>
<td>Canada Day Holiday: University closed</td>
</tr>
<tr>
<td>July 3</td>
<td>Tuesday</td>
<td>Classes begin for S Session courses; Y courses resume</td>
</tr>
<tr>
<td>July 9</td>
<td>Monday</td>
<td>Deadline to enrol in S Session courses on SWS</td>
</tr>
<tr>
<td>July 22</td>
<td>Sunday</td>
<td>Last day to drop Y Session courses without academic penalty*</td>
</tr>
<tr>
<td>July 30</td>
<td>Monday</td>
<td>Last day to drop S Session courses without academic penalty*</td>
</tr>
<tr>
<td>August 6</td>
<td>Monday</td>
<td>Civic Holiday: University closed</td>
</tr>
<tr>
<td>August 13</td>
<td>Monday</td>
<td>Classes end in S and Y Session courses</td>
</tr>
<tr>
<td>August 14 to</td>
<td>Tuesday</td>
<td>Final examinations for S and Y courses</td>
</tr>
<tr>
<td>August 17</td>
<td>Friday</td>
<td></td>
</tr>
</tbody>
</table>

(*) REFUND DATES

The last date to cancel a course or cancel your registration in a session with no academic penalty may not always coincide with the last date that you are eligible for a refund. Check the refund schedules for refund dates, which are available at www.fees.utoronto.ca.
## FALL SESSION (F) 2012

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 7</td>
<td>Tuesday</td>
<td>First day for Engineering students to make changes to their personal timetable on SWS</td>
</tr>
<tr>
<td>August 14</td>
<td>Tuesday</td>
<td>First day for Engineering students to enrol in Arts and Science (A&amp;S) courses</td>
</tr>
<tr>
<td>August 15 &amp;</td>
<td>Wednesday</td>
<td>No Course Enrolment dates (A&amp;S)</td>
</tr>
<tr>
<td>September 6</td>
<td>Thursday</td>
<td></td>
</tr>
<tr>
<td>August 31</td>
<td>Friday</td>
<td>Last day to pay/defer fees</td>
</tr>
<tr>
<td>September 3</td>
<td>Monday</td>
<td>Labour Day: University closed</td>
</tr>
<tr>
<td>September 5</td>
<td>Monday</td>
<td>Orientation programs for First Year students begin</td>
</tr>
<tr>
<td>September 6</td>
<td>Thursday</td>
<td>Engineering lectures in F and Y Session courses begin</td>
</tr>
<tr>
<td>September 10</td>
<td>Monday</td>
<td>Courses removed for non-registered students</td>
</tr>
<tr>
<td>September 10</td>
<td>Monday</td>
<td>Arts and Science (A&amp;S) lectures in F and Y Session courses begin</td>
</tr>
<tr>
<td>September 14</td>
<td>Friday</td>
<td>eSIP &amp; PEY Registration Begins (<a href="http://www.engineeringcareers.utoronto.ca">www.engineeringcareers.utoronto.ca</a>)</td>
</tr>
<tr>
<td>September 21</td>
<td>Friday</td>
<td>Waitlist for Engineering courses turned off</td>
</tr>
<tr>
<td>September 23</td>
<td>Sunday</td>
<td>Last day for students to add or substitute any Fall Session (F) or Full Year (Y) courses on the SWS</td>
</tr>
<tr>
<td>September 24 to September 28</td>
<td>Monday to Friday</td>
<td>Late enrolment for Y Section code courses only (Registrar's Office only)</td>
</tr>
<tr>
<td>October 1</td>
<td>Monday</td>
<td>Last day for students to apply to re-enrol for 2012 Winter Session</td>
</tr>
<tr>
<td>October 8</td>
<td>Monday</td>
<td>Thanksgiving Day: University closed</td>
</tr>
<tr>
<td>October 19</td>
<td>Friday</td>
<td>Last day of lectures for first Fall Session Quarter courses; Last day to drop first Fall Session Quarter courses</td>
</tr>
<tr>
<td>October 22</td>
<td>Monday</td>
<td>Lectures begin for second Fall Session Quarter courses</td>
</tr>
<tr>
<td>October 22 to October 26</td>
<td>Monday to Friday</td>
<td>Exam period for first Fall Session Quarter courses. Please check with the respective department for details.</td>
</tr>
<tr>
<td>November 1</td>
<td>Thursday</td>
<td>Examination timetable for F Session courses posted (tentative)</td>
</tr>
<tr>
<td>November 4</td>
<td>Sunday</td>
<td>Last day for students to drop Fall Session courses without academic penalty including Fall Session courses taken in the Faculty of Arts and Science; Last day for students to transfer to part-time studies; Last day for students to withdraw from the Fall Session without academic penalty*</td>
</tr>
<tr>
<td>November</td>
<td>TBA</td>
<td>Fall Convocation ceremony for the conferring of the Bachelor of Applied Science and Engineering Science degrees. Please check (<a href="http://www.convocation.utoronto.ca">www.convocation.utoronto.ca</a>) for details</td>
</tr>
<tr>
<td>December 4</td>
<td>Tuesday</td>
<td>Last day of A&amp;S classes; Last day to apply for a late withdrawal (LWD) from an A&amp;S HSS/CS/Free Elective classes</td>
</tr>
<tr>
<td>December 5</td>
<td>Wednesday</td>
<td>Last day of lectures in Fall Session; All session work should be submitted by this date. Last day to drop second Fall Session Quarter courses</td>
</tr>
<tr>
<td>December 6</td>
<td>Thursday</td>
<td>APSC Study Day</td>
</tr>
<tr>
<td>December 7 to December 21</td>
<td>Friday to Friday</td>
<td>Fall Session examinations. Note: Examinations in courses offered by other Faculties may be held during other periods. APSC may hold exams on Saturdays and evenings during this period</td>
</tr>
<tr>
<td>December 24 to January 4</td>
<td>Wednesday to Friday</td>
<td>University closed; Winter Holidays</td>
</tr>
</tbody>
</table>

(*) REFUND DATES
### Sessional Dates

The last date to cancel a course or cancel your registration in a session with no academic penalty may not always coincide with the last date that you are eligible for a refund. Check the refund schedules for refund dates, which are available at www.fees.utoronto.ca.

#### WINTER SESSION (S) 2013

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 7</td>
<td>Monday</td>
<td>Lectures begin in S courses and resume in Y Session courses for Arts and Science</td>
</tr>
<tr>
<td>January 8</td>
<td>Tuesday</td>
<td>Lectures begin in S courses and resume in Y Session courses for Engineering</td>
</tr>
<tr>
<td>January 16</td>
<td>Monday</td>
<td>Lectures begin for T-Program courses</td>
</tr>
<tr>
<td>January 20</td>
<td>Sunday</td>
<td>Last day for students to add or substitute Winter Session courses</td>
</tr>
<tr>
<td>February 15</td>
<td>Friday</td>
<td>Last day of lectures for first Winter Session Quarter courses; Last day to drop first Winter Session Quarter courses</td>
</tr>
<tr>
<td>February 18</td>
<td>Monday</td>
<td>Last day to drop Y (full year) courses without academic penalty*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note: A student who is taking a full year core course will not be allowed to drop this course in the Winter Session if a recalculation of his or her Fall Session load shows that dropping the course will reduce the F Session course load to fewer than 2.5 credits</td>
</tr>
<tr>
<td>February 18</td>
<td>Monday</td>
<td>Family Day: University closed</td>
</tr>
<tr>
<td>February 19 to February 22</td>
<td>Tuesday Friday</td>
<td>Reading Week: No lectures, tutorials, or laboratories</td>
</tr>
<tr>
<td>February 25</td>
<td>Monday</td>
<td>Lectures begin for second Winter Session Quarter courses</td>
</tr>
<tr>
<td>February 25 to March 1</td>
<td>Monday Friday</td>
<td>Exam period for first Winter Session Quarter courses (tentative). Please check with the respective department for details.</td>
</tr>
<tr>
<td>March 1</td>
<td>Friday</td>
<td>Examination timetable for Winter and Y Session courses posted (tentative)</td>
</tr>
<tr>
<td>March 8</td>
<td>Friday</td>
<td>Last day for students to apply to re-enrol for 2013 Fall Session</td>
</tr>
<tr>
<td>March 10</td>
<td>Sunday</td>
<td>Last day for students to drop Winter Session courses without academic penalty, including Winter Session courses taken in the Faculty of Arts and Science. Last day for students to transfer to part-time studies. Last day for students to withdraw from Winter Session without academic penalty*</td>
</tr>
<tr>
<td>March 29</td>
<td>Friday</td>
<td>Good Friday: University closed</td>
</tr>
<tr>
<td>April 5</td>
<td>Friday</td>
<td>(Arts and Science only) End of classes for Winter and Y Session courses in the Faculty of Arts and Science. Last day to apply for late withdrawal (LWD) from Arts and Science HSS/CS/Free Elective courses</td>
</tr>
<tr>
<td>April 15</td>
<td>Monday</td>
<td>Last day for lectures in Winter Session; All session work should be submitted by this date; Last day to drop second Winter Session Quarter courses</td>
</tr>
<tr>
<td>April 16</td>
<td>Tuesday</td>
<td>APSC Study Day</td>
</tr>
<tr>
<td>April 17 to April 30</td>
<td>Wednesday Tuesday</td>
<td>Winter and Y Session examinations (April 30 is reserved for examinations postponed by general emergency)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note: Examinations in courses offered by other Faculties may be held outside of this period</td>
</tr>
<tr>
<td>April 10 to April 30</td>
<td>Wednesday Tuesday</td>
<td>Winter and Y session examination period for Arts and Science courses</td>
</tr>
<tr>
<td>May 17</td>
<td>Friday</td>
<td>Application deadline for transfer between Engineering programs</td>
</tr>
<tr>
<td>May 20</td>
<td>Monday</td>
<td>Victoria Day: University closed</td>
</tr>
</tbody>
</table>

(*) REFUND DATES

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### SUMMER SESSION 2013 (TENTATIVE)

**First Year Engineering Courses**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>May 6</td>
<td>Monday</td>
<td>First Year Engineering classes begin</td>
</tr>
<tr>
<td>June 21</td>
<td>Friday</td>
<td>First Year Engineering classes end</td>
</tr>
<tr>
<td>June 24 to</td>
<td>Monday</td>
<td>Final examinations for First Year Engineering courses</td>
</tr>
<tr>
<td>June 28</td>
<td>Friday</td>
<td></td>
</tr>
</tbody>
</table>
THE FACULTY OF APPLIED SCIENCE AND ENGINEERING

ADMINISTRATIVE OFFICERS

OFFICE OF THE DEAN
Vice Dean, Undergraduate: Susan McCahan, B.S., M.S., Ph.D., FAAAA, P.Eng.
Vice Dean, Research: Stewart Aitchison, B.Sc., Ph.D., F.Inst.P.,
Associate Dean, Cross-Disciplinary Programs: Bryan W. Karney, B.A.Sc., M.Eng., Ph.D., FAAAA, P.Eng.
Chair, First Year: Kim Pressnail, B.A.Sc., M.A.Sc., Ph.D., LL.B.
Director, Office of the Dean: Christinada Rocha-Seeley, B.A.(Hon), M.L.I.S.
Assistant Dean, Academic HR & Diversity: Lisa Simpson-Camilleri, B.A.

OFFICE OF THE REGISTRAR
Faculty Registrar: Barbara McCann, M.Ed.
Associate Registrar, Student Services and Records: Khuong Doan, B.Sc.
Associate Registrar, Director of Administrative Information Systems: Dan Pettigrew, B.A.Sc.
Associate Registrar, Director of Admissions and Academic Scheduling: Thomas Nault, B.Sc., M.Ed.
Assistant Registrar, Scholarships and Financial Aid: Pierina Filippone

ENGINEERING COMPUTING FACILITIES
Director: Phil Poulos, B.Sc., M.Sc.

ENGINEERING CAREER CENTRE
Director: Jose Pereira

ADVANCEMENT OFFICE
Executive Director: Jim Dawson, B.Mus., A.M., D.M.A.

AN OVERVIEW

Founded in 1873, the Faculty of Applied Science and Engineering community includes over 4,900 undergraduate and over 1,600 graduate students, about 230 professors, 245 staff and has more than 40,000 alumni. Our graduates have pursued careers in all engineering fields throughout Canada and the world. They contribute towards resource industries, manufacturing, transportation, communications, as well as law, finance and health care systems. Skule™ alumni are employed by governments, in private enterprise, and throughout our educational system. Many have become leaders in major corporations, businesses and develop new companies as technological entrepreneurs.

PROGRAMS OF STUDY

The Faculty offers a wide range of undergraduate and post-graduate studies in engineering. Students will qualify for the Bachelor of Applied Science degree (B.A.Sc.) in any one of the following programs:

- Chemical Engineering
- Industrial Engineering
- Civil Engineering
- Materials Engineering
- Computer Engineering
- Mechanical Engineering
- Electrical Engineering
- Lassonde Mineral Engineering

Students enrolled in Engineering Science will qualify for the Bachelor of Applied Science in Engineering Science (B.A.Sc. in Engineering Science) in one of the following Majors:

- Aerospace Engineering
- Engineering Mathematics, Statistics & Finance
- Biomedical Systems Engineering
- Infrastructure Engineering
- Electrical and Computer Engineering
- Nanoengineering Physics
- Energy Systems Engineering
- Engineering Physics

Curricula for all programs of study are set out in detail in Curriculum and Programs section of this calendar.

FACULTY STRUCTURE

Most of Engineering's undergraduate students' teaching is provided by our 230 professors across the Faculty's five Departments and two Institutes: the Departments of Chemical Engineering and Applied Chemistry, Civil Engineering, Electrical and Computer Engineering, Mechanical and Industrial Engineering, Materials Science and Engineering, the University of Toronto Institute for Aerospace Studies and the Institute of Biomaterials and Biomedical Engineering. The Faculty is fortunate to be part of a great University that provides access to a vast range of resources. The Departments of Computer Science, English, Geology, Mathematics, Philosophy and Physics, all in the Faculty of Arts and Science, make important contributions to the Engineering curriculum. The Engineering Alumni Association to which all graduates belong, supports the ongoing work of the Faculty, and, through
representative membership on the Faculty Council, participates in governance. The buildings of the Faculty are located primarily at the southern end of the University’s St. George Campus. The Faculty’s decanal offices are located in the Bahen Centre for Information Technology, University of Toronto, 44 St. George Street. Students seeking information about any aspect of study in the Faculty are encouraged to visit the Office of the Registrar, located in the Galbraith Building room 157, 35 St. George Street.

ENGINEERING SOCIETY

Every Engineering undergraduate is a member of the Engineering Society. Founded in 1885, the Society is the oldest formal Engineering organization in Canada. Together with its constituent “course clubs” (one for each program), the Society plans and operates many student activities and services. It is the focal point for the traditional Skule™ spirit that exists among Engineering students; the envy of other groups in the University. This sense of spirit and community continues throughout our graduates’ professional careers. The Society operates the Engineering stores, where students purchase most of their school supplies and instruments. Additionally, the Society deals with matters of policy relating to student academic affairs and has representation on Faculty Council and its Standing Committees.

ENGINEERING COMPUTING FACILITY

The Engineering Computing Facility (ECF) provides a variety of computing services for teaching, learning and research within the Faculty, as well as offering support for departmental computers and computer communication throughout the Faculty. ECF has networks of distributed computing systems accessible from hundreds of terminals. Every undergraduate student in the Faculty is entitled to an ECF account. The intention is to have the computing system used as often as the student requires it in his or her studies, just as one might use a library or other communal resource. Normally, students access their ECF accounts through terminals on campus. While students are not required to have their own computers, it is recognized that many do, and facilities are provided to transfer data to and from the ECF systems so that personal and University computers can complement each other. This data transfer can be via any network. There are also ECF (UNIX & WINDOWS) stations available which can transfer data to and from a user's diskette or USB memory stick so that those without remote access can carry data to and from home. There are two major components to ECF: general UNIX and WINDOWS environments. The general purpose UNIX machines consist of 172 PCs that run LINUX. All of these systems are interconnected with Ethernet and share files (using NFS). They are also connected to the campus backbone network, and thereby, to the Internet. This provides students with electronic mail and electronic file transfer capabilities, as well as access to remote sites such as supercomputer facilities. The ECF WINDOWS environment is composed of 183 PCs for CAD and general applications that run Windows7. The ECF WINDOWS servers also support labs in Civil, Lassonde Mineral, Mechanical and Industrial, Chemical, Materials Science, and Engineering Science. ECF also maintains LINUX and WINDOWS multiprocessor machines as well as a bank of remote access WINDOWS workstations giving students the ability to work remotely.

COORDINATED BACHELOR/MASTER’S PROGRAM

Students who intend to continue their studies to a Master’s degree after completion of the B.A.Sc. program may pursue the Coordinated Bachelor/Master’s Program in the Fourth Year of the undergraduate curriculum. Departmental approval is required. After completion of the B.A.Sc. degree, and upon acceptance by the School of Graduate Studies, students can extend the topic of his or her coordinated program thesis to a Master’s thesis, which is normally under the supervision of the same thesis advisor. This program permits a significant reduction in the time it would typically take a student to complete his or her Master’s degree requirements.

A student who wishes to enrol in a coordinated program thesis should consult the Departmental Graduate Coordinators about the academic requirements for the M.A.Sc. or M.Eng. Degrees and obtain approval of his or her thesis topic from the B.A.Sc. Thesis Coordinator. The Thesis Coordinator will require assurance that the B.A.Sc. thesis project provides a suitable preparation for the proposed M.A.Sc. thesis or M.Eng. project and that satisfactory arrangements have been made for supervision of both the coordinated program thesis and the proposed Master’s program.

GRADUATE STUDY AND RESEARCH

Beyond the undergraduate level, the Faculty has a strong commitment to graduate studies and research. Our graduate students work in an environment where innovation thrives, and where they play a vital role in ground-breaking research.

The Faculty offers the following four degrees at the graduate level:

- Master of Engineering (M.Eng.) - Professional degree in engineering with certificate options in ELITE (Entrepreneurship, Leadership, Innovation, and Technology in Engineering), EPP (Engineering and Public Policy), Robotics and Mechatronics, and Globalization
- Master of Applied Science (M.A.Sc.) - Traditional, full-time, research-intensive master's degree
- Master of Health Science in Clinical Engineering (M.H.Sc.) - Combines the fields of engineering, life sciences, medicine and clinical application
- Doctor of Philosophy (Ph.D.) - Highest degree in engineering

For further information visit our website at: www.engineering.utoronto.ca

SPECIAL STUDENTS

Persons wishing to enrol as Special Students (not proceeding to the degree) should consult the Engineering Undergraduate Admissions Office at 416-978-0120 regarding admission requirements and the procedure for application.

The deadlines for submitting applications are as follows:
- Summer Session - March 1
- Fall Session - August 1
- Winter Session - November 1

Fees must be paid by the first day of classes. Failure to pay by this date will result in the cancellation of registration.
### UNDERGRADUATE ENROLMENT AS OF NOVEMBER 1, 2011

<table>
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<tr>
<th>Program</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
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<td>1,069</td>
<td>1,028</td>
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ACADEMIC STAFF OF THE FACULTY

Aerospace Science and Engineering

TITLED PROFESSOR AND DIRECTOR

PROFESSOR AND ASSOCIATE DIRECTOR
O.L. Gulder, B.Sc. (METU), Ph.D. (MANCHESTER), A.F.A.I.A.A.

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ADJUNCT ASSISTANT PROFESSOR
P. Trbovich, B.A. (OTTAWA), M.A. (CARLETON), Ph.D. (CARLETON), Psychology

CROSS-APPOINTED ACADEMIC STAFF
C. Allen, B.Sc. (OTTAWA), Ph.D. (McGILL), Pharmacy
C. Amon, Sc.D. (MIT), FAAA, FASEE, FASM, FIEEE, PE(VA), NAE, Dean, Faculty of Applied Science and Engineering, Alumni Chair Professor of Bioengineering
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P. Carlen, M.D. (TORONTO), F.R.C.P.C., University Health Network
A.M. Cheung, M.D. (JOHNS HOPKINS), Ph.D. (HARVARD); Medicine, Engineering, Women’s Health
D. Clevelovitch, B.Sc. (MANITOBA), M.Sc. (MANITOBA), Ph.D. (MANITOBA), Dentistry
J. Drake, B.S. (PRINCETON), M.B.B.CH.(DUBLIN), M.Sc., F.R.C.S.
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A. Guenther, B.Sc. (TECHNION, ISRAEL), M.Sc. (TECHNION, ISRAEL), Ph.D. (MANITOBA), Dentistry
R.S.C. Cobbold, B.Sc. (SASK), Ph.D. (SASK), F.R.S.C., Electrical & Computer Engineering

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A. Keating, B.Sc. (OTTAWA), M.D. (OTTAWA), Hematology; Gloria and Seymour Epstein Chair in Cell Therapy and Transplantation, University Health Network
S. Kelley, B.A. (SEATON HALL), Ph.D. (C.I.T.), Biochemistry
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C. Steele, B.A. (TORONTO), M.H.Sc. (TORONTO), Ph.D. (TORONTO), Speech-Language Pathology; Neuroscience
B. Strauss, Ph.D. (ERASMUS U, NETHERLANDS), M.D. (TORONTO), Medicine
Y. Sun, M.S. (MINNESOTA), Ph.D. (MINNESOTA), Mechanical and Industrial Engineering
M. Thompson, Ph.D. (MoMASTER), Chemistry
P. van Lieshout, M.Sc. (RADBOUD U (NUMEGEN), THE NETHERLANDS), Ph.D. (NICI, RADBOUD U (NUMEGEN), THE NETHERLANDS), Speech-Language Pathology, TRI, Department of Psychology, UTM - Human Communications Lab
A. Wheeler, BS. (FURMAN U), Ph.D. (STANFORD), Chemistry, Banting and Best Department of Medical Research, Canada Research Chair in Bioanalytical Chemistry
C. Whyne, B.Sc. (QUEENS), Ph.D. (UC BERKELEY/SAN FRANCISCO), Surgery, Sunnybrook Health Sciences Centre
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A. Yee, M.D. (TORONTO), M.Sc. (TORONTO), Surgery, Sunnybrook Health Sciences Centre
G. Zheng, B.S. (CHINA), Ph.D. (SUNY at Buffalo), Medical Biophysics, Joey and Toby Tanenbaum/Brazilian Ball Chair in Prostate Cancer Research, Ontario Cancer Institute

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PROFESSOR, ASSOCIATE CHAIR AND GRADUATE COORDINATOR

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R.R. Farnood, B.A.Sc., M.A.Sc. (Sharif), Ph.D. (Toronto), P.Eng.

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W.H. Burgess, B.Ch.E., M.F.S., Ph.D. (Cornell), P.Eng.
M. Mackay, B.Sc., A.R.C.S.T., Ph.D. (Glasgow), F.C.I.C., P.Eng.
S. Sandler, B.A.Sc., M.A.Sc. (Toronto), F.C.I.C., P.Eng.
R.T. Woodhams, B.Sc., M.Sc. (UWO), Ph.D. (Brooklyn), S.P.E.

UNIVERSITY PROFESSOR
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C.M. Yip, B.A.Sc. (Toronto), Ph.D. (Minnesota), P.Eng.

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W.R. Cluett, B.Sc. (Queens), Ph.D. (Alberta), P.Eng.
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G.J. Evans, B.A.Sc., M.A.Sc., Ph.D. (Toronto), P.Eng.
M.T. Kortschot, B.A.Sc., M.A.Sc. (Toronto), Ph.D. (Cambridge), P.Eng.
C.A. Mims, B.S. (Texas), Ph.D. (Berkeley)
R.C. Newman, B.A., Ph.D. (Cambridge), D.Sc. (Manchester)
Overview of the Faculty

B.A. Saville, B.Sc., Ph.D. (Alberta), P.Eng.
H.N. Tran, B.Sc. (Shizuoka), M.Eng. (Tokyo, Shizuoka), Ph.D. (Toronto), Frank Dottori Professor of Pulp and Paper Engineering

ASSISTANT PROFESSORS

E.J. Acosta, B.S. (del Zulia), M.S., Ph.D. (Oklahoma)
T.P. Bender, B.Sc., Ph.D. (Ottawa), M.C.I.C., M.A.C.S.
Y-H. (Cathy) Chin, B.Sc (University of Oklahoma), M.Sc (University of Oklahoma), Ph.D (University of California, Berkeley)
Y. Lawryshyn, B.A.Sc., M.A.Sc., Ph.D. (Toronto), MBA (Western), P.Eng.
R. Mahadevan, B.Tech. (IIT, Madras), Ph.D. (Delaware)
E.R. Master, B.Sc. (McGill), Ph.D. (UBC)
A. P. McGuigan, M.Eng. (Oxford), PhD (Toronto), Post-Doc (Harvard, Stanford)
M. Radisic, B.Eng. (McMaster), Ph.D. (MIT)
A. Ramachandran, B.Chem. Eng (University Institute of Chemical Technology, Mumbai, India), Ph.D. (University of Notre Dame, Indiana USA)

CROSS-APPOINTED ACADEMIC STAFF

C. Allen, B.Sc. (Ottawa), Ph.D. (McGill), Faculty of Pharmacy
J. Audet, B.Sc., B.A.Sc., M.A.Sc. (Laval), Ph.D. (UBC), Institute for Biomaterials and Biomedical Engineering
W.C. Chan, B.Sc. (Illinois), Ph.D. (Indiana), Institute for Biomaterials and Biomedical Engineering
P.A. Cooper, B.Sc. (Toronto), M.Sc. (Oregon), B.Ed. (Toronto), Ph.D. (Toronto), Faculty of Forestry
B. Cox, B.A., Ph.D. (Cambridge), Department of Materials Science and Engineering
J.E. Davies, B.Sc., Ph.D., D.D.S., Institute for Biomaterials and Biomedical Engineering (Professor)
M. Diamond, Ph.D. (Toronto), Department of Geography
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Distinguished Adjunct Professor
S. Das Gupta, B.SC.(CALCUTTA), M.SC., PH.D., D.I.C,(LOND),
Adjunct Associate Professor
V.I. Lakshmanan, PH.D., MIMM., FCIM, Adjunct Professor
S.V. Nair, M.SC.(COCHIN), PH.D.(INDORE), Adjunct Professor
G. Palumbo, B.A.SC., M.A.SC., PH.D., Adjunct Professor
C. Ravindran, B.Sc., B.ENG., M.SC., PH.D., Adjunct Professor
S. Ramsay, B.A.SC., M.A.SC., PH.D.
A.Y. Shik, B.SC., PH.D.(LENGRAD), Head of Nanoelectronics
Lab, IOFFE Institute.
R. Sridhar, PH.D., DIC, Adjunct Professor
F.M. Wheeler, M.SC., PH.D. (VAS Ostrava), P.ENG.
R. Williams, PH.D.(LONDON), Adjunct Professor
B. Yacobi, B.SC., PH.D., Adjunct Professor

Mechanical and Industrial Engineering

PROFESSOR AND CHAIR, DEPARTMENT OF MECHANICAL AND
INDUSTRIAL ENGINEERING
J.W. Zu, B.Sc.(TSINGHUA), M.Sc.(TSINGHUA), Ph.D.(MANITOBA),
P.Eng., F.A.S.M.E.

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P.Eng.

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Ph.D.(MICHIGAN), P.Eng.

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Ph.D.(TORONTO), P.Eng.
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C.Eng., FIEEE, FASME
D.F. James, B.Sc (OU), M.S.(CALTECH), Ph.D.(CALTECH),
M.A.(CANTAB), P.Eng.
A.K.S. Jardine, B.Sc., M.Sc.(STRATH), Ph.D.(BIRM), C.Eng.,
D. McCammond, B.Sc.(QU BELFAST), Ph.D.(OU BELFAST),

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Overview of the Faculty

A.W. Neumann, B.A., Dr. rer. nat. (Mainz) Northrup Frye Scholar
J.S. Rogers, B.Sc (Eng.Phys.) (Dal), M.S. (Stan), Ph.D. (Stan), P.Eng.
J.W. Senders, A.B. (Harv), Ph.D. (Tilburg)
I.B. Turkson, B.S.(Pitts), M.S.(Pitts), Ph.D.(Pitts), P.Eng.
J. Van de Vegte, Dipl.Ing.(Delft), M.A.Sc., Ph.D., P.Eng.
R.D. Venter, B.Sc.(Rand), M.Eng.(McM), Ph.D.(McM), P.Eng.
C.A. Ward, B.Sc.(Tex), Ph.D.(Northwestern), P.Eng.

TITLED PROFESSORS
M.S. Fox, B.Sc., Ph.D.(Carnegie-Mellon), F. A.A.A. NSERC, Industrial Research Chair in Enterprise Integration
J. Mostaghimi, B.Sc.(Sharif, Iran) M.Sc.(Minnesota), Ph.D.(Minnesota), P.Eng., F.A.S.M.E., Canada Research Chair in Advanced Coatings

TITLED ASSOCIATE PROFESSORS
O. Kesler, B.S.E.(Penn), S.M.(MIT), Sc.D.(MIT), Canada Research Chair of Fuel Cell Materials and Manufacturing
H.E. Naguib, B.Sc.(Alexandria), M.Eng.(Acad of SC & Tech, Egypt), Ph.D.(Toronto), P.Eng., Canada Research Chair of Smart and Functional Polymers
C.A. Simmons, B.Sc.Eng.(Guelph), S.M.(MIT), Ph.D.(Toronto), P.Eng., Canada Research Chair of Mechanobiology

PROFESSORS
C. Amon, Licenciatura (Simon Bolivar) M.S. (MIT), Sc.D (MIT), F.A.A.A. NSERC, Industrial Research Chair of Fuel Cell Materials and Manufacturing
K. Behedinan, B.Eng(K.N. Toosi), M.A.Sc. (Sharif), Ph.D. (Uvic), P.Eng.
B. Benhabib, B.Sc.(Bogazici), M.Sc.(Technion), Ph.D.(Toronto), P.Eng.
M.W. Carter, B.Math.(Wat), M.Math.(Wat), Ph.D.(Wat)
M.H. Chignall, B.S.(Cantor), M.S.(Ohio), Ph.D.(Cantor)
V. Makis, M.Sc., Ph.D.(Prague)
A. Mandelis, B.S.(Yale), M.A.(Princ.), M.Sc.(Princ.), Ph.D.(Princ.), F.A.P.S.
S.A. Meguid, B.M.E.(Cairo), M.Sc.(Cairo), Ph.D.(Umist), P.Eng., C.Eng., F.I.MechE, Masme, MAIA
P. Milgram, B.A.Sc., M.S.E.E.(Technion), Ph.D., P.Eng.
J.K. Mills, B.Sc.(Man), M.A.Sc.(Toronto), Ph.D.(Toronto), P.Eng.
J.K. Spelt, B.A.Sc.(Toronto), M.A.Sc.(Toronto), M.E.(Caltech), Ph.D., P.Eng.
D.A. Steinman, B.A.Sc.(Toronto), M.A.Sc.(Toronto), Ph.D.(Toronto), P.Eng.

ASSOCIATE PROFESSORS
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J.C. Beck, M.Sc.(St. Francis Xavier), M.Sc.(Toronto), Ph.D.(Toronto)
M. Consens, B.Eng.(Uruguay), M.Sc.(Toronto), Ph.D.(Toronto)
M. Gruninger, B.Sc.(Alberta), M.Sc.(Toronto), Ph.D(Toronto)
G.A. Jamieson, B.S.(Ill), M.A.Sc.(Toronto), Ph.D(Toronto), P.Eng
S. McCahan, B.S.(Cornell), M.S.(Rpi), Ph.D., P.Eng.
L.H. Shu, B.S. (Nevada), S.M. (Mit), Ph.D. (Mit)
D.A. Sinton, B.A.Sc.(Toronto), M.Eng. (McGill), Ph.D.(Toronto)
P.E. Sullivan, B.S.M.E.(Clarkson), M.S.M.E.(Clarkson), Ph.D.(Queens), P.Eng.
Y. Sun, B.S.(Dalian), M.S.(Chinese Acad of Sci), M.S.(Minnesota), Ph.D.(Minnesota), P.Eng.

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A. Bazylak, B.E.(Sask), M.A.Sc.(Victoria), Ph.D.(Victoria)
T. Chan, B.Sc.(Ubc), Ph.D.(Mit)
B. Donmez, B.S.(Bogazici), M.S.(Iowa), Ph.D.(Iowa)
A. Guenther, M.S.(Hannover), Ph.D.(Eth)
G. Nejat, B.A.Sc.(Toronto), Ph.D.(Toronto)
L. You, B.Sc.(Peking), M.Sc.(Peking), Ph.D.(Cuny)

CROSS-APPOINTED ACADEMIC STAFF
E. Acosta, B.Sc., M.A.Sc., Ph.D., Chemical Engineering and Applied Chemistry
G. Fernie, B.Sc.(Sussex), Ph.D. (Strathclyde), Medicine
D. Martell, B.A.Sc., M.A.Sc., Ph.D.(Toronto), Forestry
J.C. Paradi, B.A.Sc., M.A.Sc., Ph.D., P.Eng.(SSHRC/NSERC Industrial Research Chair in the Management of Technological Change), Chemical Engineering and Applied Chemistry
M. Popovic, M.Sc., M.A.Sc., Ph.D., IBBME

SENIOR LECTURER
D.M. Frances, B.A.Sc.(Toronto), M.A.Sc.(Toronto), Ph.D.(Toronto), P.Eng.

LECTURERS
J. Bazylik, B.Sc.(Sask)
M. Mackay, B.A.Sc. (Queen's), Ph.D.(Toronto)

ADJUNCT AND STATUS-ONLY PROFESSORS
S. Armstrong, B.Sc.(Westminster), M.A.(Toronto)
N. Atalla, B.Eng., M.Eng.(Univ Tech Compiagne), Ph.D.(Florida Atlantic)
J. Bookbinder, B.A.Sc., M.A.Sc., Ph.D.(Toronto), M.Sc.(California)
D. Cameron, B.A.Sc.(Toronto), M.A.Sc.(Toronto), L.L.B.(Toronto), P.Eng.
E. Crotti, B.A.Sc.(Ubc), M.A.Sc.(Waterloo), Ph.D.(Toronto)
I. Dincer, B.Sc.(Seluk), M.Sc.(Yildiz Tech), Ph.D.(Istanbul Tech)
S. Dworkin, B.Eng.(McMaster), M.Sc., M.Phil. Ph.D.(Yale)
K. Farkas, M.Sc.(Miskolc), Ph.D.(Waterloo)
D. Fels, B.Sc.(Guelph), M.H.Sc.(Toronto), Ph.D.(Toronto)
M.L. Hair, B.Sc. (Durham), Ph.D.(Durham)
J. Hollands, B.A.(Waterloo), M.A.(Guelph), Ph.D.(Toronto)
F. Honavar, B.Sc.(Tehran), M.A.Sc.(Waterloo),

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Overview of the Faculty

M. Hoorfar, B.A.Sc. (TEHRAN), M.A.Sc., Ph.D. (TORONTO)
F. Lin, B.A.Sc. (TORONTO), M.A.Sc. (TORONTO), M.D. (OTTAWA), Ph.D. (TORONTO)
G. Liu, B.A.Sc. (UNIV SCI & TECH, CHINA), M.A.Sc. (SHENYANG), Ph.D. (TORONTO)
R. Maev, B.Sc. + M.Sc. (MOSCOW), Ph.D. & Dr. Sc. (RUSSIAN ACADEMY OF SCI)
M. Metcalfe, B.A.Sc. (TORONTO), M.S. (STANFORD), Ph.D. (STANFORD)
K. Michaelian, Ph.D. (SIMON FRASER)
C. Moreau, B.Sc., M.Sc., Ph.D. (LAVAL)
M. Munro, B.A.Sc. (WATERLOO), S.M. (MIT), Ph.D. (WATERLOO), P.Eng.
M. Papini, B.A.Sc. (TORONTO), M.A.Sc. (TORONTO), Ph.D. (TORONTO)
M. Paraschivoiu, B.Eng. (ECOLE POLYTECH), M.A.Sc. (ECOLE POLYTECH), Ph.D. (MIT)
S.E. Prasad, B.Sc., M.Sc., Ph.D. (ANDHRA UNIV, INDIA)
G. Rizvi, B.S. (KARACHI), M.S. (SAN JOSE), M.A.Sc. (TORONTO), Ph.D. (TORONTO)
J.S. Rogers, B.Sc. (ENG. PHYS.), (DAL), M.S. (STAN), Ph.D. (STAN), P.Eng.
A. Salehian, B.S. (SHARIF), M.S. (TEHRAN), Ph.D. (VIRGINIA)
F. Salustri, B.A.Sc., M.A.Sc., Ph.D. (TORONTO)
A. Smiley, B.Sc. (WESTERN ONTARIO), M.A.Sc. (WATERLOO), Ph.D. (WATERLOO)
D. Sun, B.A.Sc. (TSINGHUA), M.A.Sc. (TSINGHUA), Ph.D. (CUHK)
T. Topaloglou, B.Sc. (THESSALONIKI), M.Sc. (CRETE), Ph.D. (TORONTO)
M. Wahab, B.Sc. Eng. (MORATUWA), M.Eng. (ASIAN INST), Ph.D. (TORONTO)
G. Zaric, B.Sc. (UWO), M.A.Sc. (WATERLOO), M.S. (STANFORD), Ph.D. (STANFORD)
### FACULTY TEACHING AWARD & EARLY CAREER TEACHING AWARD

#### RECIPIENT LIST

#### FACULTY TEACHING AWARD

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010/2011</td>
<td>Professor James S. Wallace</td>
<td>Mechanical and Industrial</td>
</tr>
<tr>
<td>2009/2010</td>
<td>Professor Ali Sheikholesmani</td>
<td>Electrical and Computer</td>
</tr>
<tr>
<td>2008/2009</td>
<td>Professor John Carter</td>
<td>Electrical and Computer</td>
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<tr>
<td>2007/2008</td>
<td>Professor Tarek S. Abdelrahman</td>
<td>Electrical and Computer</td>
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<tr>
<td>2006/2007</td>
<td>Professor Raviraj Adve</td>
<td>Electrical and Computer</td>
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<tr>
<td>2005/2006</td>
<td>Professor Frank Kschischang</td>
<td>Electrical and Computer</td>
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<tr>
<td>2004/2005</td>
<td>Professor C.R. Ethier</td>
<td>Mechanical and Industrial</td>
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<tr>
<td>2003/2004</td>
<td>Professor K.D. Pressnail</td>
<td>Civil</td>
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<tr>
<td>2003/2004</td>
<td>Professor Z.G. Vranesic</td>
<td>Electrical and Computer</td>
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<tr>
<td>2002/2003</td>
<td>Professor D.C.S. Kuhn</td>
<td>Chemical</td>
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<tr>
<td>2001/2002</td>
<td>Professor B.W. Karney</td>
<td>Civil</td>
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<tr>
<td>2000/2001</td>
<td>Professor A.N. Sinclair</td>
<td>Mechanical and Industrial</td>
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<td>1999/2000</td>
<td>Professor S. McCahan</td>
<td>Mechanical and Industrial</td>
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<td>1998/1999</td>
<td>Professor P.G. Gulak</td>
<td>Electrical and Computer</td>
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<td>1997/1998</td>
<td>Professor G.T. Will</td>
<td>Civil</td>
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<tr>
<td>1996/1997</td>
<td>Professor S.J. Thorpe</td>
<td>Metallurgy and Materials Science</td>
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<td>1995/1996</td>
<td>Professor T.C. Kenney</td>
<td>Civil</td>
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<td>1994/1995</td>
<td>Professor Y.L. Cheng</td>
<td>Chemical</td>
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<td>1993/1994</td>
<td>Professor A.W. Neumann</td>
<td>Mechanical</td>
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<tr>
<td>1992/1993</td>
<td>Professor J.M. Lee</td>
<td>Metallurgy and Materials Science</td>
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<td>1991/1992</td>
<td>Professor M.V. Sefton</td>
<td>Chemical</td>
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<td>1990/1991</td>
<td>Professor W.L. Cleghorn</td>
<td>Mechanical</td>
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<td>1989/1990</td>
<td>Professor P.J. Foley</td>
<td>Industrial</td>
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<td>1988/1989</td>
<td>Professor A.S. Sedra</td>
<td>Electrical</td>
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<td>1988/1989</td>
<td>Professor M.P. Collins</td>
<td>Civil</td>
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<td>1987/1988</td>
<td>Professor I. McCausland</td>
<td>Electrical</td>
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<td>1986/1987</td>
<td>Professor D. Basmadjian</td>
<td>Chemical</td>
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<td>1985/1986</td>
<td>Professor W.H. Vanderburg</td>
<td>Industrial</td>
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<td>1984/1985</td>
<td>Professor W.H. Burgess</td>
<td>Chemical</td>
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<td>1984/1985</td>
<td>Professor D.G.B. Boocock</td>
<td>Chemical</td>
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<tr>
<td>1983/1984</td>
<td>Professor D.F. James</td>
<td>Mechanical</td>
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</tbody>
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#### EARLY CAREER TEACHING AWARD

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<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010/2011</td>
<td>Professor Sean V. Hum</td>
<td>Electrical and Computer</td>
</tr>
<tr>
<td>2009/2010</td>
<td>Professor Glenn Hibbard</td>
<td>Material Science and Engineering</td>
</tr>
<tr>
<td>2008/2009</td>
<td>Professor Craig A. Simmons</td>
<td>Mechanical and Industrial</td>
</tr>
<tr>
<td>2007/2008</td>
<td>Professor Hani Naguib</td>
<td>Mechanical and Industrial</td>
</tr>
<tr>
<td>2006/2007</td>
<td>Professor Wei Yu</td>
<td>Electrical and Computer</td>
</tr>
<tr>
<td>2005/2006</td>
<td>Professor Ali Sheikholeslami</td>
<td>Electrical and Computer</td>
</tr>
<tr>
<td>2004/2005</td>
<td>Professor Evan Charles Bentz</td>
<td>Civil</td>
</tr>
<tr>
<td>2003/2004</td>
<td>Professor D.P. Gauvreau</td>
<td>Civil</td>
</tr>
<tr>
<td>2002/2003</td>
<td>Professor P. Aarabi</td>
<td>Electrical and Computer</td>
</tr>
<tr>
<td>2001/2002</td>
<td>Professor R. Ben Mrad</td>
<td>Mechanical and Industrial</td>
</tr>
<tr>
<td>2001/2002</td>
<td>Professor B. Abdulahi</td>
<td>Civil</td>
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<tr>
<td>2000/2001</td>
<td>Professor C.M. Yip</td>
<td>IBBME</td>
</tr>
<tr>
<td>1999/2000</td>
<td>Professor J.R. Long</td>
<td>Electrical and Computer</td>
</tr>
<tr>
<td>1998/1999</td>
<td>Professor B. McCabe</td>
<td>Civil</td>
</tr>
</tbody>
</table>

#### CENTRES AND INSTITUTES

**BIOZONE**

Director: Elizabeth Edwards  
Website: [www.biozone.utoronto.ca](http://www.biozone.utoronto.ca)
Overview of the Faculty

BioZone is a centre for collaborative and interdisciplinary bioengineering research that brings together researchers, students and industry partners to develop and deploy technically, socially and economically viable technologies. We work to find solutions to optimize use of natural resources, to reuse waste material, to remediate contaminated water and land, to sustain robust and healthy ecosystems, to curtail disease and to offer renewable fuels and products that foster the long-term sustainability our planet. Our mission is to advance and capitalize on the dramatic progress in recent years in biology, particularly in genome science and genome analysis tools while focusing on urgent societal needs in energy, environment and health. BioZone arose from informal collaboration across campus, and within the Department of Chemical Engineering and Applied Chemistry and has grown to include nine Faculty members and their research groups and collaborators. Extensive renovations on the 3rd and 4th floor of the Wallberg Building will be completed in 2012 to add significant research space and enhanced research strength in enzymology, protein characterization and biocatalysis.

CENTRE FOR ADVANCED COATING TECHNOLOGIES (CACT)

Director: Javad Mostaghimi
Website: http://crhe.mie.utoronto.ca/index.php

The Centre for Advanced Coating Technologies (CACT) was established in 1998 as a collaborative effort by researchers from the departments of mechanical engineering and materials science. The Centre now has over 30 researchers, including professors from both departments, research staff members and graduate students.

CACT conducts fundamental research, both numerical and experimental, in the area of thermal spray coating. CACT works closely with industries, other universities and research institutions; research partners have included Pratt & Whitney Canada, Sulzer Metco, VacAero International, GE Global R&D, INCO, TeckCominco, Hydro Quebec, NRC-Industrial Materials Institute and leading universities in the United States, Japan, France and Germany.

Coatings Technology
Components in aircraft, automobiles, power plants or chemical reactors are frequently exposed to severe heat, abrasion and corrosion. A thin layer of a ceramic or super-alloy is often the best way to protect and extend the life of such components. Thermal spray technology is widely used as an efficient, economical and environmentally-friendly method of applying metal or ceramic coatings.

Think of spray painting using molten metal or ceramic instead of paint! Thermal spray coatings are produced by introducing powders of wires into high temperature, high velocity gas jets, created using an electric arc or by burning a fuel. Spray of molten droplets are propelled towards the work-piece, where they impact on the substrate and solidify to produce dense, fine grained layers.

Thermal spray coatings technologies give much higher deposition rates than other chemical or physical vapour deposition techniques, and create little or no environmental problems. They can be used to coat components varying in size from a few millimeters to several meters.

CENTER FOR ADVANCED DIFFUSION-WAVE TECHNOLOGIES (CADIFT)

Director: Professor Andreas Mandelis, Canada Research Chair (Tier 1) in Diffusion-Wave Sciences and Technologies.
Website: http://cadift.mie.utoronto.ca

Diffusion Waves: They go where no light has gone before!
At the core of the Center for Advanced Diffusion-Wave Technologies (CADIFT) are the unique diagnostic capabilities of diffusion waves which include a wide range of physical fields and phenomena (thermal, electronic, photonic, atmospheric, to name a few) thus offering exceptionally wide disciplinary research opportunities. CADIFT activities offer opportunities in truly interdisciplinary research including the physics, mathematics, engineering, instrumental implementation and applications of novel laser-based analytical inspection and monitoring techniques, high-precision measurement methodologies, environmental sensor development, analytical, non-destructive and spectroscopic methodologies, signal processing and measurement science, and imaging techniques for industrial and health sector applications. For a full description of current CADIFT research visit our website.

CENTRE FOR ADVANCED NANOTECHNOLOGY

Director: Harry E. Ruda
Website: www.utoronto.ca/ecn

Nanotechnology is a multidisciplinary field for designing, fabricating, and applying nanometer-scale materials, structures and devices. In general, nanotechnology may involve such engineering disciplines as materials science, electrical, computer and mechanical engineering, as well as chemistry, physics, mathematics, and biotechnology. Specifically, in semiconductor applications, nanotechnology refers to the technology for fabricating electronic and photonic devices with feature sizes ranging from a few nanometers to the sub-micron range, and these fields are commonly termed nanoelectronics and nanophotonics, respectively. Additionally the term nanotechnology is also currently used to refer to the rapidly developing area of nano-electro-mechanical systems (NEMS), which have only just began to show their promise for fields such as sensing, biotechnology, integrated opto-electronic and fiber assemblies.

The Centre for Advanced Nanotechnology (CAN) is based on a multidisciplinary team of faculty and researchers from various departments including both applied science and engineering, arts and sciences, and mathematics and applied mathematics. CAN is Canada’s first centre for nanotechnology research, and it is closely tied to industry and other key research institutions in nanotechnology throughout the world. The main objectives of the Centre, which was established in 1997, include (i) advances in research on both theoretical and experimental methods for a new generation of nanoelectronic and nanophotonic materials, structures and devices, (ii) education and training of a new generation of highly qualified personnel for both industry and academia, (iii) collaboration with other members of the academic and industrial community, and (iv) establishing specialized resources and expertise for the scientific community and government in this expanding field of the science and technology.
The Centre for Global Engineering was created to identify the role of engineering in addressing some of the world’s most complex problems. In particular, CGEN is working to enhance the Faculty’s global impact by working with undergraduate and graduate students, non-profit and non-governmental organizations, for-profit organizations, academic institutions, and other partners in researching appropriate and sustainable solutions to challenging problems in international development and globalization. The Centre's primary areas of focus are in sustainable development, innovation, diffusion, and knowledge translation, and appropriate technologies. Creating innovations in the engineering curriculum to incorporate issues related to globalization is also a major component of CGEN’s work.

CENTRE FOR MANAGEMENT OF TECHNOLOGY AND ENTREPRENEURSHIP

Director: Joseph C. Paradi
Associate Director: Yuri Lawryshyn
Website: www.cmte.utoronto.ca

Technological change in the environment, jobs, educational needs, global competitiveness and society in general will be best served in the future by a great deal of entrepreneurial and innovative activity. Our research is focused on the Financial Services Industry (FSI). To meet global competition, this industry needs to conduct research into improvements in productivity developing new technology for the future. The Faculty of Applied Science and Engineering has pioneered the institution of a teaching and operate research programs in Management of Technology, Innovation, and Intra/Entrepreneurship. The initiative was started in 1991 and has completed over 200 projects at all levels of complexity and intellectual challenge (BASc, MASc and PhD). Entrepreneurial development of students both at undergraduate and graduate levels are a priority. All the research projects involve our industrial sponsors; the work has a significant practical component and could lead to direct benefits to industry. We are interdisciplinary in nature and collaborate with researchers working in measuring and improving Productivity, efficiency and effective in the services industries. We also carry out mathematical modeling and financial Engineering research.

CENTRE FOR SUSTAINABLE ENERGY (CSE)

Director: Oliviera Kesler
Website: www.cse.utoronto.ca

The Centre for Sustainable Energy is a catalyst, facilitating interactions and collaborations to advance the development of cleaner and more efficient energy in Canada. The motivation behind the Centre was the tremendous amount of research already underway throughout the University in a wide variety of energy-related fields. The CSE is open to students, faculty, industry and government members involved in increasing energy efficiency and reducing the environmental impact of energy use and conversion—whether through policy work, computational sustainability, materials science or another route. The Centre sparks connections through initiatives such as its planned monthly workshops on aspects of sustainable energy that provide CSE members opportunities to discuss their work and the broader societal impacts of their research.

CENTRE FOR TECHNOLOGY AND SOCIAL DEVELOPMENT

Director: William H. Vanderburg
Website: http://ctsd.utoronto.ca

The research and teaching efforts of the Centre have opened up a new frontier created by preventative approaches for the engineering, management and regulation of technology. Conventional approaches are based on an intellectual and professional division of labour embedded in an institutional framework in which specialists of all kinds make decisions whose consequences mostly fall beyond their domains of competence, to be dealt with in an end-of-pipe or after-the-fact manner by others in whose specialties undesired effects fall. Hence, problems are first created and then dealt with by adding to the “system”. For example, devices designed to remove pollutants from waste streams may be installed in factories and power plants, or social and health services may be created to assist employees. First creating problems and then attempting to deal with them has proven to be very costly and not very effective. Preventive approaches go to the root of any problem by anticipating possible harmful effects so as to adjust design and decision-making to avoid or greatly reduce them. They are much more effective and, in almost all cases, less costly than their conventional counterparts. A great deal of evidence collected by the Centre suggests that preventive approaches could permit economies to deliver goods and services in a manner that is more competitive and, at the same time, reduce burdens imposed on society and the biosphere. Such approaches complement technical excellence with the methods of the social sciences to anticipate the consequences of design and decision-making. In this way, increasing profitability can frequently be reconciled with higher social and environmental standards. The Centre has built databases of preventative approaches in several areas of application: materials and production, energy, work, the built habitat and computer-based technologies. Apart from developing this new frontier in engineering education and practice, the Centre encourages the introduction of preventative approaches into the core of the curricula of engineering, management science, business administration, accounting and public policy within the University, as well as into industry and government. We also encourage and continue to benefit from the participation of social scientists in the belief that preventative approaches are founded on a synergy between the “two cultures”. The Centre welcomes to its courses students from many disciplines, including environmental studies, urban studies, sociology, political science and education. Preventive approaches also internalize ethical considerations into design and decision-making, as opposed to traditional engineering ethics.
Overview of the Faculty

CENTRE FOR MAINTENANCE OPTIMIZATION AND RELIABILITY ENGINEERING (C-MORE)

Director: Andrew K S Jardine  
Website: http://cmore.mie.utoronto.ca

C-MORE’s research is driven by close interactions with industry, in particular with MORE consortium members and with researchers at universities world-wide. Our focus is on real-world research in engineering asset management in the areas of condition-based maintenance, spares management, failure-finding intervals for protective devices and whole-life costing. These strong industry connections not only benefit the companies we work with, but also our graduate students. Since 2000 C-MORE has been offering an annual 8-day Certificate program in Physical Asset Management to practicing reliability and maintenance professionals.

THE TORONTO INTELLIGENT TRANSPORTATION SYSTEMS (ITS) CENTRE AND TESTBED

Director: Baher Abdulhai  
Website: www.civil.engineering.utoronto.ca/research/transport.htm

The University of Toronto houses Canada’s flagship state of the art Intelligent Transportation Systems Centre and Testbed. ITS, a growing global phenomenon, combines a broad range of diverse technologies which are applied to transportation to save lives, money and time. The range of technologies involved includes micro-electronics, communications and computer informatics. Additionally, ITS cuts across disciplines such as transportation engineering, telecommunications, computer science, financing, electronic, and automobile manufacturing. The new face of the transportation industry as shaped by ITS is no longer restricted to civil engineers nor is it restricted to a single department or agency. Instead, the ITS field is multi-departmental, multi-agency and even multi-jurisdictional. Furthermore, the market share of ITS is projected to expand to hundreds of billion dollars over the next 25 years. Access to this market is vital to the transportation and related technology sectors. In addition to direct transport benefits, a healthy ITS industry would also have other non-traffic-related fringe societal benefits which includes the stimulation of new information technology based industries, creation of new markets and jobs. Traveller information and in-vehicle route guidance provision, in-vehicle computers, display and global positioning equipment manufacturing are a few examples of emerging ITS industries; therefore, ITS is more than just intelligent solutions on the road, but rather a new strategic direction for national and international economies. Unfortunately, and despite of the high demand, ITS research is fairly limited in Canada. Young Canadian talents usually seek ITS education and training in the United States. The University of Toronto took the lead to alleviate this problem by creating an aggressive and comprehensive ITS Research and Development program which includes the ITS Testbed. The Testbed is composed of a university-based R&D center equipped with state of the art capabilities for designing traffic analysis and decision-support tools, and real-time communication links to sensors and control devices all over the physical Toronto transportation network via the two major traffic operation centres in the G.T.A. The Testbed is designed to be a meeting ground for practitioners and researchers from the public, academic and private sectors to research new approaches to transportation systems management, and to accelerate ITS deployment through advanced technology research. The Testbed is the only such multi-jurisdictional, multi-agency, public-private intelligent transportation research facility in Canada with potential to expand to a National Centre of Excellence.

INSTITUTE OF BIOMATERIALS AND BIOMICROENGINEERING

Director: Paul Santerre  
Website: http://ibbme.utoronto.ca/pro.htm

Biomedical engineering applies is an interdisciplinary field that integrates the principles of biology with those of engineering, physical sciences, and mathematics in order to create solutions to problems in the medical/life sciences. Through its faculty (90+), staff and students, and through close collaboration with the faculty of related departments, hospitals and other institutions, the Institute serves as the centre for both Direct Entry and Collaborative Graduate Programs in Biomedical Engineering at the University of Toronto. An undergraduate degree in engineering is not a prerequisite for admission into the MASc/PhD graduate program. The Institute also educates undergraduate-level engineering science and biominiors students in biomedical engineering. An active undergraduate summer student program offers both employment and a structured educational experience, within the Institute’s research laboratories.

Graduate students registered directly into the Institute, or in collaborating graduate departments, proceed towards M.A.Sc., M.Sc., M.H.Sc., or Ph.D. degrees in engineering, dentistry, medicine, or the physical or life sciences, enabling careers in industry, government and universities. The Institute has a Clinical Engineering concentration within its PhD program, which complements its 2 year M.H.Sc professional degree program in Clinical Engineering. Graduates from the Clinical Engineering specialization programs normally find employment in health-care institutions or in the medical devices industry both in Canada and internationally. The Institute’s core laboratories are principally located in the Rosebrugh Building, the Mining Building, the Banting Building, and the Donnelly Centre for Cellular and Biomolecular Research on the St. George Campus however approximately 50% of our core Faculty have laboratories located in other University Departments and the Hospitals. These laboratories serve as centres for development of experimental and clinical techniques and instrumentation; real-time and interactive computer applications; innovative biomaterials; functional replacements for biological tissues; and simulations for electrochemical and physiological models. Many faculty hold appointments in IBBME and in Toronto’s hospital research institutes.
EMERGING COMMUNICATIONS TECHNOLOGY INSTITUTE (ECTI)

Director: Yu Sun
Website: www.ecti.utoronto.ca

ECTI is the University of Toronto's main centre for micro- and nanofabrication, promoting collaborative research with strategic partners and providing researchers with access to state-of-the-art equipment. Over the years, it has attracted researchers from across the University of Toronto, from other universities in southern Ontario and beyond, as well as industrial partners. In 2011, 150 U of T students and post-doctoral fellows working with 50 different professors made regular use of the facility.

ECTI also facilitates advanced educational opportunities and information exchange events. It hosted the Connaught Summer Institute in Nanofabrication in June 2011 for attendees from across Canada. The intensive nine-day event featured discussions led by international experts, networking opportunities and hands-on nanofabrication labs.

Key research areas include nanotechnology and nanofabrication, photonic materials and devices, micro- and nano-electromechanical systems (M/NEMS), biotechnology, microwave devices, micro- and nano-electronic devices, integrated optics, and photovoltaic devices.

LASSONDE INSTITUTE OF MINING

Director: John Hadjigeorgiou
Website: www.lassondeinstitute.utoronto.ca

The Lassonde Institute of Mining is an interdisciplinary research institute within the University of Toronto created to be at the forefront of leading edge research in the whole spectrum of mining activities, ranging from mineral resource identification, through mine planning and excavation, to extraction and processing. It is an international center of excellence in mining engineering, encompassing mining, civil, materials and chemical engineers, geophysicists, geologists, geochemists, materials scientists and environmental scientists who undertake research that crosses disciplines and traditional boundaries.

The institute was created with the financial assistance of the Canadian mineral industry and in particular Dr. Pierre Lassonde to conduct leading edge research and train graduate students and professionals in mineral, mining and process engineering. The Lassonde Institute of Mining is housed in the newly renovated Goldcorp Mining Innovation Suite in the Lassonde Mining Building, 170 College Street, Toronto.

INSTITUTE FOR LEADERSHIP EDUCATION IN ENGINEERING (ILead)

Director: Doug Reeve
Website: www.lot.engineering.utoronto.ca/lead.htm

The first of its kind for engineering in Canada, ILead offers curricular, co-curricular and extracurricular leadership education and development in a three-fold manifest of teaching, research and outreach. ILead features departmental and Faculty-sponsored elective courses, similar to those currently offered through the Leaders of Tomorrow program (LOT). As well, the Institute is committed to research and scholarly work on leadership pedagogy and will also engage with others around the world. ILead holds cross-appointed faculty, has the authority to administer research and scholarly grants, and serves as the administrative home for such projects.

The ILead program for leadership development involves four levels of learning: self, relational, organizational and societal leadership. The self-knowledge level teaches students to identify their values, strengths and weaknesses, as well as talents and passions. They learn to nurture their emotional intelligence and make decisions that align with their personal values. The relational leadership level is where students grow as collaborators, learn effective communication, conflict resolution and team dynamics. The organizational leadership level prepares students with skills to create organizational vision, set direction, embrace ambiguity, reconcile organizational aspirations and constraints and empower others. The final level, societal leadership, explores political participation, social movements and the ability to engage others and act as a catalyst for change. Understanding that it takes a number of different strategies to fully facilitate these four levels, ILead will provide experiences inside and outside the classroom to engage students on a number of fronts: intellectually, socially, psychologically and emotionally with the use of experiential workshops, design laboratories, team projects, field excursions, mentoring, coaching, guided reflection, service learning, discussion tutorials and visioning exercises.

INSTITUTE FOR ROBOTICS AND MECHATRONICS (IRM)

Director: Gabriele D’Eleuterio

The Institute for Robotics and Mechatronics was created in response to the rapid development of fundamental enabling technologies, such as robots, micro-motors or operating systems. It builds upon these developments and will enhance the visibility for our researchers and our Faculty nationally and internationally. The primary objective of the IRM, is to coordinate the large number of academic and research activities already underway at the Faculty. The assembly of a number of research groups will enhance cross-disciplinary research and initiatives. It will also facilitate the commercialization of technology and, going forward, will consider teaching programs focused on robotics and mechatronics in both undergraduate and graduate levels.

PULP & PAPER CENTRE

Director: Hong Yi N. Tran
Website: www.pulpandpaper.utoronto.ca

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Overview of the Faculty

Paper is critical to our civilization. It is a truly strategic material produced from a renewable resource. Paper has been of paramount importance in the transmission and storage of information necessary to science and literature and, indeed, has enabled the creation of modern business and industry. Even in the telematic world, paper is essential in partnership with electronic information systems. Wood pulp is raw material not only for paper, but for thousands of structural, absorbent and packaging products so completely a part of our lives that we often overlook them. Canada is one of the largest suppliers of pulp and newsprint and has a long tradition of scientific and technological leadership. These make it a major force in the pulp and paper world. The Pulp & Paper Centre is an opportunity for the creation of new science and technology to benefit the Canadian economy and for winning the hearts and minds of students and faculty to do the job in collaboration with industry and government. Since it was founded in 1987, the Pulp & Paper Centre has experienced exceptional expansion in student and faculty involvement and research support. In 2008-2009, there were 60 graduate students, 16 undergraduate students, 27 faculty and 28 associated staff from several departments within and outside U of T, and three operating industrial research consortia. Thirty-two companies from eight countries provided financial support to research projects in pulp and paper processing, energy recovery systems and environmental research. The Centre has extensive student involvement at the graduate and undergraduate levels and continues to actively enrich the student’s educational experience through interesting and relevant research projects, seminar programs, professional development programs and international exchanges and tours.

SOUTHERN ONTARIO CENTRE FOR ATMOSPHERIC AEROSOL RESEARCH (SOCAAR)

Director: Greg Evans
Website: www.socaar.utoronto.ca

The Southern Ontario Centre for Atmospheric Aerosol Research (SOCAAR) is an interdisciplinary research centre—hosted in the Faculty of Applied Science and Engineering—dedicated to the study of air quality, with a particular focus on the effects of aerosol on human health, the environment and climate. SOCAAR promotes collaborative research through access to state-of-the-art facilities and partnerships with government and industry. In addition, the Centre offers opportunity for student involvement at the graduate and undergraduate levels. Recent research projects examined:
- Exposure of urban populations to particulate matter
- The toxicity of vehicle emissions
- The influence of particles on cloud formation and climate
- Development of novel methods to analyze atmospheric pollutants

SOCAAR represents the Canadian Aerosol Research Network (CARN), a new initiative formally uniting the collective expertise of leading Canadian aerosol researchers from the University of Toronto, Dalhousie University and the University of British Columbia.

DIVISION OF ENVIRONMENTAL ENGINEERING AND ENERGY SYSTEMS (DEEES)

Director: Bryan Karney
Website: www.energy.engineering.utoronto.ca

The Division of Environmental Engineering and Energy Systems administers and coordinates the Graduate Collaborative Program in Environmental Engineering in conjunction with the Departments of Civil Engineering, Chemical Engineering, Mechanical and Industrial Engineering, Materials Science and Engineering and the Centre for Environment. The Collaborative Program is an interdisciplinary collaborative program designed for students interested in taking a concentration of courses and conducting research in environmental engineering. It is open to MAsC, MEng, and PhD students in the collaborating graduate programs listed above. About 30 full-time faculty members in these departments carry out advanced research and teach postgraduate courses in a wide range of environmental engineering specialties.

URBAN TRANSPORTATION RESEARCH & ADVANCEMENT CENTRE

Chair: Baher Abdulhai
Website: www.utrac.utoronto.ca

Originally established in 1970 as the Joint Program in Transportation as a cooperative research centre with York University, the Joint Program in Transportation was reorganized in 1990 as an engineering research centre exclusive to the University of Toronto. In the fall of 2007, the centre was again reorganized as the Urban Transportation Research and Advancement Centre (UTRAC).

UNIVERSITY OF TORONTO INSTITUTE FOR MULTI-DISCIPLINARY DESIGN AND INNOVATION (UT-IMDI)

The new EDU:D is called the University of Toronto Institute for Multi-Disciplinary Design and Innovation (UT-IMDI). It is officially established as of January 2012 with Dr. Kamran Behdian as its founding director. The aim of UT-IMDI is to create a unique Project-Based Learning (PBL) environment in partnership with industry. UT-IMDI provides students with real-life training opportunities by involving them in practical, industry-based projects. It is a vehicle to promote awareness of design and development challenges facing the industry, with emphasis on its multi-disciplinary nature and evolving technology. Through networking opportunities provided by the institute, students will develop their links with industry thus better positioning themselves for future careers. The design experience gained from the institute will be complementary to the experience gained through the capstone design courses.
ADMISSION REQUIREMENTS

Admission to the Faculty of Applied Science and Engineering is competitive as each year we receive more applications than the number of places available. The Faculty selects students by taking into consideration a wide range of criteria including marks, subjects taken, and supplementary information obtained through the mandatory Student Profile Form. Possession of the minimum entrance requirements does not guarantee admission. Applicants who have been out of studies for more than five years will generally not be considered for admission. Detailed admission requirements can be found online at the Admissions and Awards website www.adm.utoronto.ca. Information can also be found on the Faculty website at www.discover.engineering.utoronto.ca.

Ontario Secondary School Diploma (OSSD)

Applicants must be eligible to receive the Ontario Secondary School Diploma and must present a minimum of six grade 12 U or M courses including:

- English (ENG4U)
- Calculus & Vectors (MCV4U) or Advanced Functions & Introductory Calculus (MCB4U)
- Chemistry (SCH4U)
- Physics (SPH4U)
- Advanced Functions (MHF4U)
- One additional U or M course

Canadian Students

Applicants from Quebec must present 12 academic C.E.G.E.P. courses. Candidates from other provinces and territories of Canada must present grade 12 matriculation, including English, Mathematics, Physics, and Chemistry. For more detailed information, visit the Prospective Student website at www.discover.engineering.utoronto.ca.

Other Applicants

Information on admission requirements for applicants from overseas is available on the Admissions and Awards website at www.adm.utoronto.ca/adm. All applicants are required to have completed senior level courses in mathematics, physics and chemistry.

Transfer Students

Candidates with acceptable standing at other post-secondary institutions will be considered for admission with transfer credit on a case by case basis. Transfer credits are assessed at the time of admission. Candidates who already hold a recognized degree in engineering will not be permitted to proceed to a second undergraduate degree in engineering.

Non-matriculants (Mature Students)

For information regarding admission as a non-matriculant (mature student), please contact the Engineering Undergraduate Admissions Office, 35 St. George St, Room 153, Toronto, Ontario, M5S 1A4, or call 416-978-0120.

Non-Degree (Special) Students

Non-degree students are those taking courses offered by the Faculty who are not working towards an undergraduate degree within the Faculty of Applied Science and Engineering at the University of Toronto. Often these are visiting students who have received a Letter of Permission from their home University and are working towards a degree at that institution. Applicants must provide a copy of proof of status in Canada (e.g. Citizenship or Permanent Resident documents). International students are not eligible to apply. A non-refundable processing fee of $52 will be charged.

Non-degree students must meet any prerequisites for the courses they wish to take. Candidates whose mother tongue is not English will be required to meet an appropriate standard in a recognized Test of English Facility (e.g. TOEFL, MELAB) in addition to meeting the academic requirements. Individuals interested in taking courses as a non-degree student should contact the Engineering Undergraduate Admissions Office at ask@ecf.utoronto.ca or 416-978-0120.
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Below is a list, sorted alphabetically according to the emphasized words, of all APSC scholarships, awards, prizes, grants, and loans.

National Scholarship Program
University of Toronto Scholars Program
President's Entrance Scholarship Program The University's Commitment
University of Toronto Advance Planning for Students (UTAPS)
Government Financial Aid
University of Toronto Work-Study Program
Bursary for Students with Disabilities
Part-Time Studies
International Students
Dean's Honour List

General Terms and Conditions of Awards
Ontario Student Opportunity Trust Fund (OSOTF) Awards

OSOTF ADMISSION SCHOLARSHIPS/AWARDS
Fernando V. Agostinelli Memorial Scholarship
Hira and Kamal Ahuja Award in Engineering
Kenneth Au-Yeung Memorial Scholarship
Jack and Lily Bell Entrance Scholarship
The Robert L. Bullen Admission Scholarship
Class of 5T1 Bursary
Colantonio Family Leadership Award
Colcleugh Family Scholarship
The Sydney C. Cooper Scholarships
I.E.E. Toronto Centre Scholarship
The Lau Family Scholarships
Motorola Foundation Scholarships
Vera Catherine Noakes Scholarship
ProScience Inc. Engineering Entrance Scholarship
Robert J. Richardson Scholarship
Donald Ross Leadership Award
Leon Rubin Scholarships
Robert Sangster Memorial Admission Award
Fred Schaeffer Scholarship in Civil Engineering
Christopher Skrok Memorial Scholarships
Edward and Helen Swanston Scholarships
The Jean Wallace Memorial Scholarship

NON-OSOTF ADMISSION SCHOLARSHIPS
Betz Entrance Scholarship in Electrical & Computer Engineering
The Bi-cultural Admission Scholarship
Calgary Skule™ Admission Scholarship
Chemical Engineering and Applied Chemistry Alumni Entrance Scholarships
Civil Engineering Admission Scholarships
Sydney and Florence Cooper Admission Scholarship
Edward L. Donegan Scholarship in Engineering
John Pearson Duncan Admission Award (Brant County)
Engineering Alumni Association Admission Scholarships
Engineering Science Alumni Admission Scholarships
Enwave Leadership Awards
The ERCO Worldwide Leadership Scholarships
Faculty of Applied Science and Engineering Admission Scholarships
J. Colin Finlayson Admission Scholarship
U of T FIRST Engineering Scholarship
Robert M. Friedland Scholarships
James A. Gow Admission Scholarship
The Grabbil Admission Scholarship
Greater Toronto Sewer and Watermain Contractors Association Admission Scholarship
George A. Guess Admission Scholarships
Frank Howard Guest Admission Bursary
Walter Scott Guest Memorial Scholarships
Reginald and Galer Hagarty Scholarship
Horace Hally Admission Scholarship
Jane Elizabeth Ham Memorial Scholarship
William Harland Leadership Award
Kenneth F. Heddon Memorial Admission Scholarship
The Murray Calder Hendry Scholarship
Roy Jarvis Henry Admission Scholarships
John Hirschorn Memorial Scholarship
Arthur B. Johns Award
Albert and Rose Jong Entrance Scholarship
Kenneth Raffles Kilburn Scholarship(s)
The Harvey W. Kriss Admission Scholarship in Industrial Engineering
Lassonde Scholarships
John C.H. Lee Memorial Scholarship
Donald C. Leigh Memorial Scholarship
James Turner MacBain Scholarship
Salim Majdalany Scholarship
The Hal Major Memorial Admission Award
J. Edgar McAllister Foundation Admission Awards
The John Wolfe McColl Memorial Awards
Lachlan Dales McKellar Admission Scholarships
Mechanical & Industrial Engineering Admission Scholarship(s)
Metallurgy & Materials Science Alumni Admission Scholarships
George R. Mickle Admission Bursaries
Michael M. Mortson Industrial Engineering Admission Scholarship
Professional Engineers Ontario Foundation for Education: Entrance Scholarships
Norman Ramm Scholarship
Edward S. Rogers Admission Scholarship
Edward A. Rolph Scholarships
Leslie and Lois Shaw Admission Scholarship
The Shaw Admission Scholarship
Joey and Toby Tanenbaum Admission Scholarships
The F.C.C.P. - John Hin Chung Tsang Memorial Admission Scholarship
Toronto and Area Road Builders Association Scholarship
Wallberg Admission Scholarship
W.J.T. Wright Admission Scholarship

OSOTF IN-COURSE SCHOLARSHIPS/AWARDS
APSC Award
T. Christie Arnold Scholarship
Anthony A. Brat Memorial Scholarship
Paul Cadario Scholarship
John Dixon Campbell Memorial Scholarship
Canadian Imperial Bank of Commerce BASc/MBA Scholarships
Chachra Family Scholarship in Engineering Science
Chemical Engineering Alumni In-Course Awards
Class of 3T7 Scholarships
Class of 5T0 Engineering Leadership Award
Class of 8T3 Vince Volpe Memorial Award
Class of 9T7 Award
The Sydney C. Cooper Scholarships
George B. Craig Scholarship
C. William Daniel Leadership Awards
Duncan R. Derry Scholarships
Dharma Master Chuk Mor Memorial Scholarship
R.A. Downing Scholarship in Civil Engineering
ECE Alumni Scholarship
Engineering Society Award
Ford Electronics Scholarship
Andrew Frow Memorial Award
General Motors Environmental Engineering Awards
General Motors Women in Electrical and Mechanical Engineering Awards
Herbert Gladish Memorial Scholarship
Jack Gorrie Memorial Undergraduate Scholarship
J. Frank Guenther Scholarship
Anthony A. Haasz Scholarship
Halsall Scholarships in Building Engineering
Lisa Anne Hamann Memorial Award
Chester B. Hamilton Scholarship
Johannes Michael Holmboe Undergraduate Summer Research Fellowship
Philip H. Jones Scholarship
Scholarships and Financial Aid

Andrew Alexander Kinghorn Scholarships
Dietmar Kosalowski Memorial Bursary in Electrical Engineering
Frankie Kwok Memorial Scholarship
Ronald Paul Manning Scholarships
Eric Miglin Scholarship
Marshall Macklin Monaghan Scholarship
Samer Mutlak Memorial Award
Barry James O’Sullivan Grant
The Dr. John Hamilton Parkin Scholarship
James A. Peers Scholarship in Industrial Engineering
Ryn Pudden Memorial Award
The Peter Sands Award in Engineering Science
Kenneth A. Selby Scholarship in Construction Engineering in the Department of Civil Engineering
Douglas Scott Shaw Memorial Scholarship
Shell Canada Limited Engineering Scholarships Program
William Bernard Silverston Scholarship
Christopher Skrok Memorial Scholarships
Gordon R. Slemon Scholarship
Kenneth Ward Smith Award in Engineering Science
Kenneth Ward Smith Scholarships
Robert M. Smith Scholarships
SNC-Lavalin Scholarship
Peter K. Strangway Scholarship
The Maurice Stren Memorial Scholarship
Sullivan Memorial Scholarship
James M. Toguri Memorial Scholarship
The Trenwith and Galipeau Aerospace Science Award
William Ian MacKenzie Turner Scholarship in Industrial Engineering
Class of 8T3 Vince Volpe Memorial Award
Lloyd George Webber Memorial Scholarship
Julie Wilkinson Memorial Scholarship
Yolles-Bergmann Scholarship

NON-OSOTF IN-COURSE SCHOLARSHIPS AND GRANTS
Henry G. Acres Medal
Harvey Aggett Memorial Scholarship
Aloha Innovation Fund
AMERICAN Electrical and Computer Engineering Scholarship
American Concrete Institute, Ontario Chapter Scholarship
Anchor Shoring & Caissons Ltd. Scholarship
Ardaghi Scholarship
Wellington Thomas Ashbridge Memorial Bursaries
The Babb Bursary Fund

Baptie Scholarship
Jack and Barbara Baron Scholarship
Ben Bernstein Memorial Prize in Operational Research
APWA Ontario Chapter Bruce Brunton Award
The Edith Grace Buchanan Summer Research Fellowship
The Burge-Connell Bursary
Carman Burton Bursary
Norman E. Byrne Award
John Dixon Campbell Memorial Prize
#2 Canadian Army University Course Award
Canadian Society of Industrial Engineering Scholarship
Canadian Society for Chemical Engineering Medal
Centennial Thesis Awards
The Wallace G. Chalmers Engineering Design Scholarship
Chemical Institute of Canada Book Prize (Toronto Section)
CISC-Walters Inc. Scholarship
5T6 Civils Scholarship
Ross L. Clark Memorial Scholarship
Class of 2004 Grant
Class of 4T3 Engineering James Ham Award
Class of 4T7 Bursaries
Class of 5T5 Civil Engineering Scholarship
Class of 5T9 Chemical Engineering Leaders of Tomorrow Award
The Constant Temperature Control Limited Scholarships
Consulting Engineers of Ontario(CEO) Scholarship
Crocker Foundation Bursaries
The Alfredo DaCunha Memorial Foundation
Gavin Dass Memorial Scholarship
Hanna Wejtko De Angelis CIV6T0 Scholarship
Roger E. Deane Memorial Scholarship
Delcan Scholarship in Civil Engineering
Joseph A. Devine Bursary
Satinder Kaur Dhillion Memorial Scholarship
G.W. Ross Dowkes Memorial Prize
Earl H. Dudgeon Bursary
Stuart Ellam Grant
The John M. Empsey Scholarships
Enbridge Scholarship in Engineering
Engineering Alumni Centennial Bursaries
5T3 Engineering Award
Engineering 8T4 Leadership Award
Engineering Class of 5T6 Award of Merit
Engineering Science Chairs’ Scholarship
Engineering Science Foundation Scholarship
Enwave Design Awards
Enwave Graduating Awards of Distinction
ERCO Worldwide Leaders of Tomorrow Award
Etkin Medal for Excellence
Faculty of Applied Science and Engineering Leadership Award(s)
Manual A. Fine Scholarship
J.A. Findlay Scholarships
The Denis Flynn Memorial Scholarship
The James Franceschini Foundation Scholarship
Hugh Gall Award
Vern Gomes Memorial Award
The Blake H. Goodings Memorial Award in Mechanical Engineering
Greater Toronto Sewer and Watermain Contractors Association Award in Civil Engineering
H.J. Greeniaus ESROP Fellowship
The George A. Guess Scholarships
Frank Howard Guest Admission Bursary
Frank Howard Guest In-Course Bursary
B. Conrad Hansen Memorial Award Fund
Sydney George Harris Bursary
Glenn P. Hauck Memorial Scholarship
Dr. Arthur Herrmann Memorial Award
Mackay Hewer Memorial Prize
General D.M. Hogarth Bursary
Otto Holden Scholarship
Dr. Vahe Philip Hovnanian Award for Excellence in Chemical Engineering
William V. Hull Scholarship
Husky Injection Molding Systems Ltd. Award(s)
Neil B. Hutcheon Building Science Scholarship
IEEE Canada-Toronto Section Scholarship
IEEE Canada-Toronto Section
Bruno N. Di Stefano Scholarship
IEEE Canadian Foundation Scholarship
Inspec-Sol Scholarship
Sue Joel CIV6T5 Scholarship
The L.E. (Ted) Jones Award in Distinction
Margaret Kende CIV6T0 Scholarship
Lassonde Scholarships
Lassonde Bursaries
Stavros Leventis Award
Charles A. Lowry Prize
The Earl Charles Lyons Memorial Award
James Turner MacBain Scholarship
The Elsie Gregory MacGill Memorial Scholarship
The Alexander MacLean Scholarship
MacLennan-MacLeod Memorial Prize
Salmi Majdalany Scholarship
Charles Gordon Manning Prize
Oscar J. Marshall Scholarship
J. Edgar McAllister Foundation Bursaries
J. Edgard McAllister Summer Research Fellowships
John B. McGeachie Grant
Scholarships and Financial Aid

The Garnet W. McKee-Lachlan Gilchrist Scholarship in Engineering Science
The Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships
The First Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships
The Second Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships
Marlene Metzger CIV670 Scholarship
Hugh Middleton Bursary
R.W. Missen Memorial Prize in Thermodynamics
Kiyoharu and Kiyoaki Momose Memorial Scholarship
R.F. Moore Thesis Award
James L. Morris Memorial Prize
Joseph G. Monkhouse Memorial Bursary in Engineering
Peter L. Munro Memorial Scholarship
Henry and Mary Nahrgang Bursaries
NACE International, Toronto Section, Prize
Nortel Institute Undergraduate Scholarships
Ontario Power Generation Award
Orbis Prize in Software Design
Orbis Scholarship in Engineering
PACE Project Design Award
Gary L. Palmer Memorial Scholarship
Dr. John Hamilton Parkin Paulin Memorial Scholarship
A.B. Platt Award, Toronto Section of the Society of Tribologists and Lubrication Engineers
Frank H.R. Pounsett Memorial Scholarship
Florence Evelyn and William Leonard Prideaux Award
Professional Engineers Ontario Foundation for Education In-course Scholarships
Professional Engineers Ontario Foundation for Education Gold Medal for Academic Achievement
Quadra FNX Mining Ltd. Scholarship
Ransom Scholarship in Chemical Engineering
Reginald J. Redrup Award
J.E. Reid Memorial Prize
Russell Reynolds Scholarship in Engineering Science
The Bertrand G.W. Robinson Award
The Richard Rowland Memorial Scholarship
Mary and Mario Ruggiero Scholarship
Don Salt Memorial Scholarships
Frederick W. Schumacher Scholarship
Marcia Lamont Scott CIV477 Scholarship
Second Mile Engineer Award
Adel S. Sedra Bursary Fund
Adel S. Sedra Gold Medal
Rudolph Seidi Memorial Award In Mechanical Engineering
The Joseph Seidner Bursary Fund
The Shaw Design Scholarships
Kenneth Carless Smith Engineering Science Research Fellowship
Prof. James W. Smith Chemical Engineering Leaders of Tomorrow Award
Society of Chemical Industry Merit Award
Murray F. Southcote Scholarship
C.H.E. Stewart Bursaries
Kenneth H. Sullivan/Pratt & Whitney Canada Scholarship
James D. Todd Memorial Scholarship
Gordon F. Tracy Scholarship
Charles Edwin Trim Scholarship
Troost Family Leaders of Tomorrow Award
Marjorie Hilda Merrick Turner
James W. and H. Grattan Tyrrell Memorial Scholarship
U.M.A. Scholarship in Civil Engineering
University of Toronto Women’s Association Scholarship
U.S. Steel Canada Undergraduate Scholarships
The Lorne Wagner Memorial Bursary
Wallberg Undergraduate Scholarships
Irene Gordon Warnock Memorial Scholarship
The Stewart Wilson Award
W.S. Wilson Medals
William R. Worthington Memorial Scholarship
Barbara Zdasiuk Memorial Scholarship

GUIDELINES AND DESCRIPTIONS

Undergraduate students of the Faculty of Applied Science and Engineering who achieve scholastic excellence are eligible for Scholarships, prizes, bursaries, medals and honours. They have been established through the University, its alumni associations, governments, commercial organizations and other benefactors to encourage and honour outstanding achievement.

The awards are listed alphabetically in four sections: OSOTF Admission Scholarships/Awards and non-OSOTF Admission Scholarships (starting on page 36), for students entering their First year in the Faculty, and OSOTF In-Course Scholarships/Awards and non-OSOTF In-Course Scholarships and Grants (starting on page 49).

THE NATIONAL SCHOLARSHIP PROGRAM

The University of Toronto National Scholarships will be awarded to students who demonstrate superior academic performance, original and creative thought and exceptional achievement in a broad context. The National Scholars will be those who not only excel in academic pursuits but also have an enthusiasm for intellectual exploration and an involvement in the life of their school and community. Each secondary school is invited to nominate one student, on the basis of these criteria, to receive a University of Toronto National Book Award. These students, and others who identify themselves as meeting the National Scholarship criteria, are invited to enter the National Scholarship Competition. Information is sent to secondary schools in the early fall; the applications are available online and the deadline is in mid-November of the student’s graduating year.

Approximately ten National Scholarships will be awarded in a given year. The National Scholarships will cover tuition and incidental fees for four years of undergraduate study, residence support in First year, and will include an additional, renewable monetary award. The annual value of each student’s Scholarship will be determined on the basis of individual financial circumstances.

UNIVERSITY OF TORONTO SCHOLARS PROGRAM

The University of Toronto Scholars Program provides recognition to the University’s outstanding students, at admission and on an on-going basis. There are 350 admission awards which have a value of $5000 and may be held in conjunction with any admission award that students may receive from their college/faculty. Outstanding students are considered automatically for these awards.

Awards under the University of Toronto Scholars Program are not renewable. Outstanding students, however, may be eligible for consideration for University of Toronto (in-course) Scholarships at the end of the First, Second and Third year of their programs. There are about 100 scholarships at
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each level. These in-course awards are worth $1500 and are tenable with other in-course scholarships.

PRESIDENT'S ENTRANCE SCHOLARSHIP PROGRAM

All applicants who meet the following criteria will receive admission scholarship(s) from the University, its faculties or colleges totaling at least $2000 provided that they enroll in First year at U of T in the fall. No application is required.
Eligibility criteria:
- Canadian citizens or permanent residents;
- Studying at a secondary school or CEGEP in Canada;
- Have completed each of the courses required for admissions, including prerequisites, with ‘A’ standing; and
- Admission average is 92% or better

THE UNIVERSITY’S COMMITMENT

The University’s Policy on Student Financial Support states that students should have access to the resources required to meet their financial needs as calculated by the Ontario Student Assistance Program (OSAP). The commitment is based on the assumption that Canadian citizens/permanent residents/protected persons (recognized convention refugees) will first access the government aid for which they are eligible. University of Toronto Advance Planning for Students (UTAPS) funding is assessed based on the Ontario Student Assistance Program, as OSAP provides a uniform, verified method of assessing student need. For students who are assessed by OSAP as requiring maximum assistance, and whose assessed needs are not fully covered by government aid, the University will ensure that the unmet needs are met. Students receiving funding from other provinces, territories or a First Nations band are also eligible for consideration.

UNIVERSITY OF TORONTO ADVANCE PLANNING FOR STUDENTS (UTAPS)

Students who are concerned about the financial cost of attending university can obtain early information about the amount of funding they can expect to receive from government programs and other forms of financial assistance by completing a UTAPS application. Returning students, with calculated unmet need above the government funding maximum, will be considered for UTAPS grant assistance in the fall. The University's financial aid website has additional information and a UTAPS application at http://www.adm.utoronto.ca/. First year applicants should submit their online UTAPS applications by the end of February so they can be considered for need-based admission awards.

GOVERNMENT FINANCIAL AID

The Ontario Student Assistance Program (OSAP) provides need-based financial assistance to Ontario residents who are Canadian citizens, permanent residents or protected persons (recognized convention refugees). Students in course loads of sixty percent or greater are considered for both federal and provincial interest-free student loans and non-repayable grants to assist with educational and living expenses. The Ontario Student Opportunity Grant provides partial forgiveness of loans on an annual basis for students who have incurred large debt loads. OSAP applications are available in May through the OSAP website http://osap.gov.on.ca/ Students from other Canadian provinces and territories should apply through their home provinces. It is recommended that returning students apply for government financial aid by May 31 and new students by mid-June.

UNIVERSITY OF TORONTO WORK-STUDY PROGRAM

This program is funded by the University and the Ministry of Training, Colleges and Universities, and provides on-campus part-time employment to students with financial need. Information and applications are available from Admissions and Awards.

BURSARY FOR STUDENTS WITH DISABILITIES

Non-repayable assistance is available from the federal and provincial governments for government aid recipients who have special educational expenses as a result of a disability. Information and applications are available from Admissions and Awards or Accessibility Services.

PART-TIME STUDIES

The Federal Government has established a loan and grant program for part-time students enrolled in course loads of less than sixty percent. Unlike OSAP loans, the interest on part-time Canada Student Loans becomes repayable thirty days after the loan is received. Federal grants for educational expenses are also available for high-need part-time students.
The Ontario Special Bursary Plan provides assistance to part-time students in receipt of social assistance. The bursary assists with direct educational expenses such as tuition, books, transportation and babysitting.
Further information and application forms may be obtained from Admissions and Awards.

INTERNATIONAL STUDENTS

International students entering Canada or currently in Canada on student authorization are not eligible for government assistance and must ensure that they have sufficient funds to cover all probable expenses. Such students cannot depend on gaining part-time employment in Canada to help their studies.
ADMISSION SCHOLARSHIPS

Please see the “OSOTF” and “Non-OSOTF” Admission Scholarships sections later in this Chapter for details.

IN-COURSE SCHOLARSHIPS AND BURSARIES

Scholarships, prizes, bursaries and loans available to students in attendance in the Faculty are listed in this chapter, starting on page 43. Where it is necessary to apply for an award, details of how to apply are included. In all other cases, the award is made on the recommendation of the Faculty Council and no application is necessary.

DEAN’S HONOUR LIST

In 1983 the Faculty Council instituted the Dean’s Honours List to give special recognition to every student who demonstrates academic excellence in an individual session. The names of students who achieved Honours standing in a given session will appear on the Dean’s Honours List of that session. The list is posted prominently for a limited time in a place within the Faculty designated for this purpose. The lists for successive sessions are compiled in a permanent record maintained in the Office of the Registrar.

GENERAL TERMS AND CONDITIONS OF AWARDS

Scholarships, prizes and medals granted in recognition of academic proficiency are awarded at the end of the Winter Session, and candidates are ranked on the basis of their achievements in the Winter Session and the Fall Session previously completed.

To be eligible for any scholarship or award granted solely on academic standing, a student must normally have completed not less than the normal full load (approximately 5.0 credits units) within the two sessions upon which the award is based. A student whose program in these two sessions contains repeated courses will only be eligible if the aggregate of new courses is equal to or greater than 5.0 credits.

Scholarships, medals and prizes based solely upon academic standing will be awarded only to students who have achieved honours in the work upon which the award is granted, unless otherwise specified in the terms of award. If the award is based on a single course or on part of the work of the session, the candidate must obtain unconditional pass standing in the work of the session, but not necessarily honours standing, unless the terms of the award so specify.

A candidate will not be permitted to hold more than one award in a session unless the statute of each of the awards concerned or the Calendar specifies otherwise.

Tuition and residence fees are a first charge against awards. After the deduction of the applicable charges, any balance remaining will be paid to the recipient in November. Payment will be made only if the candidate is in regular attendance in the Faculty and, if the Calendar so specifies, in the course in which the award is established or granted.

Medals, after they have been suitably engraved, will be given without delay to the winners or forwarded to them by registered mail.

Awards granted to members of graduating classes, other than awards for graduate study and research, will be paid in one installment as soon as possible after the granting of the awards.

The Governing Council may, on the recommendation of the Faculty, permit a candidate to whom an award has been granted to postpone attendance in the Faculty for one year. Further postponement may be permitted on application.

Note: The value of an endowed scholarship or prize is dependent on the actual income of the fund; it is possible that the value of certain scholarships and prizes at the time of payment may be greater or less than the amount stated in the Calendar.

In those cases where the amount of the award is not payable from income earned on an endowed fund, payment will be dependent on the receipt of the amount of the annual award from the donor.

ONTARIO STUDENT OPPORTUNITY TRUST FUND (OSOTF) AWARDS

In the case of all OSOTF awards, eligible candidates must be Ontario residents and they must demonstrate financial need. For the purpose of OSOTF awards, an Ontario resident is either a Canadian citizen or a permanent resident of Canada who has lived in Ontario for twelve consecutive months prior to starting a post-secondary program. Financial need is most easily demonstrated with receipt of OSAP for the current year; other examples of financial need will be considered. For admission OSOTF Awards, it is crucial that applicants for admission complete a UTAPS application in order to demonstrate financial need.

OSOTF ADMISSION SCHOLARSHIPS

Fernando V. Agostinelli Memorial Scholarship
This Scholarship was established in 2007 through a generous donation from Tow/Carruthers and Wallace Ltd., Antoinette Agostinelli, family and friends
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of Fernando Agostinelli. The Scholarship was created to honour Fernando’s many contributions in the field of structural engineering. The Scholarship is awarded on the basis of financial need and academic merit to a student entering First year (full-time) of the Civil Engineering program. In addition, qualities of character and leadership as demonstrated through extra-curricular activities/community involvement is also considered.

**Hira and Kamal Ahuja Award in Engineering**
Established in 2004, through a generous donation by Professor Hira Ahuja, this award is given to a student entering First year of any program in the Faculty on the basis of financial need. Academic merit is also considered. Additional preference is given to a student who has extra-curricular involvement/service in the East Indian community.

**Kenneth Au-Yeung Memorial Scholarship**
This Scholarship was established in 1999 by Ben and Catherine Au-Yeung in memory of their son. The Scholarship is awarded on the basis of financial need, academic achievement in the prerequisite courses as well as a demonstrated commitment to Community Service to a student entering the Computer Engineering program.

**Jack and Lily Bell Entrance Scholarship**
Created through a generous donation by friends and family of Jack and Lily Bell, this award is given to a student entering First year of the Industrial Engineering program on the basis of financial need and academic merit.

**The Robert L. Bullen Admission Scholarship**
This Scholarship, derived from the income of a capital fund, was established in 1982 in memory of the late Robert L. Bullen, B.A.Sc., Metallurgical Engineering, 1929, by his wife, Mrs. Robert L. Bullen.
The Scholarship is awarded annually on the basis of financial need to one or more students entering the First year in the Faculty of Applied Science and Engineering. Academic standing in prerequisite courses is also considered.

**Class of 5T1 Bursary**
This bursary, established in 2001, is provided by the generosity of the Class of 5T1. The bursary is to be awarded on the basis of financial need and academic merit to a student entering into the Faculty of Applied Science and Engineering.

**Colantonio Family Leadership Award**
This Award was established in 2004 through the generosity of John Colantonio in memory of his father, the late Mr. Frank Colantonio. This Award is granted on the basis of financial need and high academic achievement to a student entering the First year of Electrical Engineering. Preference will be given to students who exhibit leadership potential and have a broad range of interests and involvement as demonstrated through student council activity, participation in athletics, community involvement and volunteerism.

**Colcleugh Family Award**
Established in 2004 through the generosity of the Colcleugh family, this Award is given on the basis of financial need to a student entering First year of Chemical Engineering. Preference will be given to students who have attained high academic performance. In addition, students should exhibit leadership potential and have a broad range of interests and involvement and volunteerism. The Award is renewable in Second, Third, and Fourth years providing recipient continues to demonstrate financial need and achieves a minimum average of 75% in each year. If in any given year, the renewal portion is not granted, it shall be awarded, by reversion, to the next qualifying candidate in that year.

**The Sydney C. Cooper Scholarships**
Through the generosity of the family educational and charitable foundation of Sydney C. Cooper (B.A.Sc., Civil Engineering, 1945) two awards are established in the Department of Civil Engineering. One award will be granted to a student entering First year and one to a student entering Fourth year. The First year Award is made on the basis of financial need. Academic achievement, involvement in athletics and participation in extra-curricular activities will also be considered.

**I.E.E. Toronto Centre Scholarship**
In 1997, the Toronto Centre of the Institution of Electrical Engineers established this Scholarship in memory of the late Al Fabian. The award is granted to a student entering the First year of the Electrical Engineering or Computer Engineering programs (alternated annually between the two programs) who has demonstrated financial need. Academic merit will also be considered.

**The Lau Family Scholarships**
These Scholarships were established in 1997 through the generosity of Mr. Lee-Ka Lau and family. Two Scholarships are granted: one to a student entering the First year in Computer Engineering and one to a student entering the First year in Electrical Engineering. The awards are based on financial need. Academic achievement will also be considered. Scholarships may be renewed for Second year in the designated programs on the basis of continued financial need and the achievement of honours standing.

**Motorola Foundation Scholarships**
Established in 1996 through the generosity of the Motorola Foundation, two awards are available for students entering the First year of either Electrical or Computer Engineering on the basis of financial need. Academic standing will also be considered.

**Vera Catherine Noakes Scholarship**
Established in 2001, this Scholarship is to be awarded to a student entering the First year of any undergraduate engineering program on the basis of financial need. Preference will be given, where possible, to a student from the Windsor, Ontario, area.
ProScience Inc. Engineering Entrance Scholarship
Established in 2004 through the generosity of ProScience Incorporated, this award is to be granted to a student entering any undergraduate program in the Faculty who has demonstrated financial need and has excelled academically. Preference will be given to students with a disability.

Robert John Richardson Memorial Scholarship
Established in 2002 from the estate of the late Robert John Richardson, BASC 5T0, this Scholarship is awarded to a student entering the First year of any undergraduate engineering program on the basis of financial need and academic achievement. Preference is given to students from North Bay. If the candidate is from North Bay, the Scholarship is renewable for three years on the basis of continued financial need and provided satisfactory achievement (min. 60%) is obtained at the end of each year. After the scholar has completed his or her four-year program, a new recipient will receive the Scholarship. If the candidate is not from North Bay, the Scholarship will be for the First year of study only.

Donald Ross Leadership Award
Through a generous gift of Mr. Donald Ross in 1997 this award was established in the Department of Chemical Engineering and Applied Chemistry. The award is granted to a student entering the First year of the program on the basis of financial need Academic achievement and demonstrated leadership skills in high school through participation in team sports and/or student affairs and community involvement will also be considered. The Award may be renewed for Second year providing at least 75% standing is maintained and that the awardee is still deserving.

Leon Rubin Scholarships
Established in 1997 through the generosity of William F. McLean, a number of Scholarships are available for students entering the First year of Chemical Engineering on the basis of financial need. Academic standing will also be considered. Awards may be renewed for Second year on the basis of continued financial need and academic achievement at the end of year one.

Robert Sangster Memorial Admission Award
Gift of the family and friends of the late Robert Sangster, B.A.Sc. Electrical Engineering 1949, this Scholarship, of the approximate value of $800, is awarded annually to a student entering the First year of any program in the Faculty of Applied Science and Engineering, on the basis of financial need and satisfactory academic standing in secondary school.

Fred Schaeffer Scholarship in Civil Engineering
Established in 2004 through a generous donation by Mr. Fred Schaeffer, this award is granted to a student entering First year of Civil Engineering on the basis of financial need and academic merit.

Edward and Helen Swanston Scholarships
The Scholarship was established in 1997, made possible by a generous donation from Edward Y. Swanston. The Scholarship is awarded to one or more students entering the First year in the Department of Chemical Engineering and Applied Chemistry on the basis of financial need and extra-curricular involvement in high school through participation in team sports, with the emphasis on sportsmanship, and/or community service. Academic achievement will also be a consideration.

Christopher Skrok Memorial Scholarships
(See listing later in this Chapter)

The Jean Wallace Memorial Scholarship
This award was established in 1999 by William L. Wallace, B.A.Sc., (5T6 Metallurgical Engineering) in memory of his mother, the late Jean Wallace. The award will be granted to one (or two) students entering First year of Materials Engineering on the basis of financial need. Academic achievement and demonstrated leadership qualities through both school and community involvement will also be considered. If no suitable candidate is found at the admissions level, the award may be granted to a student completing year one of the Materials Engineering program based on the same criteria. Departmental recommendation.

NON-OSOTF ADMISSION SCHOLARSHIPS

Betz Entrance Scholarship in Electrical & Computer Engineering
Established in 2010 through a generous donation by Vaughn Betz, this scholarship will be given to student(s) entering the Edward S. Rogers Sr. Department of Electrical and Computer Engineering on the basis of academic achievement. Extra-curricular activities, including a focus on design may also be considered.

The Bi-cultural Admission Scholarship
The Professional Engineers Wives’ Association has established an admission scholarship of the value of the income from the fund to a student entering the First year of any program in the Faculty of Applied Science and Engineering. In addition to achieving outstanding results on the subjects prescribed for admission to the Faculty, candidates must have excelled in at least one course in either of Canada’s official languages in the final Ontario high school year. The first award was made in June 1983.

Calgary Skule™ Admission Scholarship
To be granted to one or more students entering First Year (full-time) of any program in the Faculty. Recipient(s) will be selected on the basis of promising leadership ability as evidenced by extra-curricular/community involvement. Academic ability will also be considered. Recipients must be Canadian citizens or permanent residents from Calgary.

Chemical Engineering and Applied Chemistry
Alumni Entrance Scholarships; Established in 1995, these Scholarships, provided through the generosity of alumni and friends of the Department of
Scholarships and Financial Aid

Chemical Engineering and Applied Chemistry, are open to students entering the First year of the program on the basis of academic standing in the subjects required for admission.

Civil Engineering Admission Scholarships
Established in 1995, these Scholarships, provided through the generosity of alumni and friends of the Department of Civil Engineering, are awarded to students entering the First year of the Civil Engineering program on the basis of academic excellence. Some awards will be renewable provided the student achieves honours standing at the end of First year and proceeds to Second year of the program.

Sydney and Florence Cooper Admission Scholarship
Established in 2007 through a generous donation by Sydney and Florence Cooper, this award is given to a student (or students) entering First year of Civil Engineering on the basis of academic merit. Preference is given to students who have demonstrated leadership in the community and through extra-curricular activities.

Edward L. Donegan Scholarship in Engineering
Established in 2007 through a generous donation by Mr. Edward L. Donegan, this scholarship is to be awarded to student(s) entering First year of any program in the Faculty. The scholarship is granted on the basis of demonstrated academic excellence (min. 85% average on pre-requisite courses). Recipient(s) shall have demonstrated leadership in extra-curricular and community activities. Preference shall be given to students who demonstrate a credible interest in pursuing a Juris doctor or Bachelor of Law degree or its equivalent following undergraduate engineering studies. Financial need may also be considered. The scholarship is renewable at the end of First, Second and Third year provided recipient(s) maintain an overall minimum average of 80%. This award will be made on admission every four years, or in any year in which recipient(s) do not qualify for renewal.

John Pearson Duncan Admission Award (Brant County)
This admission award valued at $100 is provided in memory of the late John Pearson Duncan, B.A.Sc., University of Toronto, 1926. It is granted to a student from a secondary school in Brant County entering the First year of any program in the Faculty, who has achieved not less than 80% on the subjects required for admission.

The financial need of the applicant is considered and the selection is based on a combination of academic excellence and financial need with the provision that financial need not be an absolute requirement for any award.

The first award was made in 1982.

Engineering Alumni Association Admission Scholarships
Five scholarships, each with a possible value of $1,500, are provided annually by the University of Toronto Engineering Alumni Association for students entering the First year of any course in the Faculty of Applied Science and Engineering. The awards are made on the basis of high standing in Ontario Secondary school.

There are two types of scholarships:
(a) The William Ian MacKenzie Turner 2TS Scholarship, named after a “Schoolman of Distinction”, with a full value of $1,500.
(b) Four Centennial Scholarships with a value of $1,000 each when entering First year with an additional $250 if the student achieves Honours standing in First year, and a further $250 if he or she maintains Honours standing in Second year. These amounts do not affect other awards for First and Second year work.

Engineering Science Alumni Admission Scholarships
This scholarship, established by the generosity of various donors, will be awarded to two students entering the First year of Engineering Science on the basis of academic merit. Extra-curricular activities may also be considered.

Enwave Leadership Awards
These Awards were established in 2004 through the generosity of Enwave District Energy Limited. Three awards are given out to students entering First year of either Civil or Chemical Engineering on the basis of high academic performance in high school. Preference will be given to students who have demonstrated initiative and interest in improving the environment and who have the ability to inspire and motivate others to become involved and to achieve. As such, further preference will be given to students who exhibit leadership potential and have a broad range of interests and involvement including student council activity, participation in athletics, community involvement, and volunteerism.

The ERCO Worldwide Leadership Scholarships
Established in 2005 through a generous donation by ERCO Worldwide, these awards are for students entering First year of Chemical Engineering on the basis of high academic achievement. Preference will be given to female students. The recipients should also have the ability to inspire and motivate others to become involved and to achieve. As such, further preference will be given to students who exhibit leadership potential and have a broad range of interests and involvement including student council activity, participation in athletics, community involvement and volunteerism.

Faculty of Applied Science and Engineering Admission Scholarship(s)
These awards, derived from the annual income of a capital donation, are granted to students entering First year of any Engineering program on the basis of outstanding academic achievement in the prerequisite courses.

J. Colin Finlayson Admission Scholarship
Established in 2007 through a generous donation by J. Colin Finlayson, this award is given to a student (or students) entering First year of Mechanical or Industrial Engineering on the basis of academic merit. Preference is given to students who have demonstrated leadership in the community and through extra-curricular activities.
U of T First Engineering Scholarship
Established in 2007, up to 5 awards, each valued at $2000, will be awarded to students admitted to First year of any program in the Faculty. Recipients must have a minimum 90% in pre-requisite courses and have substantial (well above average) involvement in a school robotics team.

Robert M. Friedland Scholarships
These Scholarships were established in 1996 through a generous donation from Robert M. Friedland, Chairman of Indochina Goldfields Ltd., and Bakyrchik Gold PLC. The awards will be granted on the basis of academic standing and preference is given to international students entering the First year of the Lassonde Mineral Engineering Program in the Division of Mineral Engineering. If there are no suitable candidates in the Lassonde Mineral Engineering Program, the award can be granted to international students entering the First year of any undergraduate program in the Faculty. If there are no suitable candidates in the Faculty then the award can be granted to students entering the First year in any Faculty at the University of Toronto. The admission awards are renewable in the Second year provided honours standing is maintained at the end of First year and that the candidate proceeds to the Second year of the Lassonde Mineral Engineering Program.

James A. Gow Admission Scholarship
This Scholarship was established in 1982 through donations provided by friends and colleagues to honour James A. Gow, University of Toronto, 4T6, on his retirement, and to recognize his many contributions to the Faculty.
Jim Gow served the Faculty for 35 years, the last 20 as Secretary and Assistant Dean. Over those years he was friend and counsellor to staff and to countless students who remember him as one dedicated to their well-being.
The Scholarship is awarded annually to a student who achieves high standing in an Ontario Secondary school. The award is tenable in any program.

The Grabill Admission Scholarship
The Grabill Admission Scholarship is the gift of Mr. Dayton L. Grabill, a graduate of this Faculty in 1924. The Scholarship has a value of approximately $500 and is awarded to the candidate with high standing in an Ontario Secondary school.

Greater Toronto Sewer and Watermain Contractors Association Admission Scholarship
The Metropolitan Toronto Sewer and Watermain Contractors Association, an organization of independent contractors, provides this admission scholarship of $6,200. It is awarded to a student entering the First year of the Civil Engineering program who has achieved outstanding marks (not less than an average of 80%) on the Ontario Secondary school subjects prescribed for admission.

George A. Guess Admission Scholarships
(see listing later in this Chapter)

Frank Howard Guest Admission Bursary
(see listing later in this Chapter)

Walter Scott Guest Memorial Scholarships
Established in 1995 by the estate of Frank Howard Guest as a memorial to his father, the late Walter Scott Guest, these Scholarships are awarded to students entering the First year of any undergraduate program in the Faculty on the basis of academic standing.

Reginald and Galer Hagarty Scholarship
This award was established by Lieutenant-Colonel E.W. Hagarty and Charlotte Ellen Hagarty in memory of their sons, Reginald and Galer, and is to be granted to a student entering First year of any undergraduate program on the basis of academic achievement. Recipient must be a graduate of Harbord Collegiate.

Horace Hally Admission Scholarship
This Scholarship was established in 1997 from the estate of the late Horace Angus Hally, a friend of the University of Toronto. The award will be granted to a student entering the First year of the Mechanical Engineering program on the basis of satisfactory academic standing in the secondary school courses required for admission.

Jane Elizabeth Ham Memorial Scholarship
This award was established in 1993 by Professor and Mrs. James Ham in memory of their daughter. The Scholarship will be awarded to a student on entrance to the Faculty, in any program, on the basis of outstanding academic achievement consistently obtained in each of the subjects required and offered for admission. Range of personal interests and financial need is relevant. Half of the total amount of the award is made on entrance and the other half upon registration in the Second year, on the condition that the student obtains honours in the examinations of First year. In addition, there is an OSOTF portion.

William Harland Leadership Award
This Award, established in 2000 by Dr. Carlton Smith in memory of the donor’s late wife, Marguerite Smith, and in honour of the donor’s father-in-law, William Harland, is to be awarded to a student entering the First year of the Civil Engineering Program. To be awarded on the basis of academic credentials, and leadership potential as demonstrated by involvement in student council activity, participation in athletics and community involvement.

Kenneth F. Heddon Memorial Admission Scholarship
Established in 2007 from the estate of Kenneth F. Heddon, this award is granted to a student entering First year of any undergraduate program on the basis of outstanding academic merit.

The Murray Calder Hendry Scholarship
This award was established by the estate of Mrs. Grace Appel Hendry as a memorial to her husband, a graduate of this Faculty in 1905. It has a value of
the income from a capital sum of $10,000 and the recipient must: (a) have attained an average of at least 75% on the Ontario Secondary School subjects required for admission. (b) be entering the First Year of any course in the Faculty of Applied Science and Engineering. The first award was made in the Session 1962-63.

Roy Jarvis Henry Admission Scholarships
The estate of the late Roy Jarvis Henry awards up to four awards to students who have achieved high standing on the Ontario Secondary school qualifications required for admission, one open to students entering Lassonde Mineral Engineering and the others are open to students entering any program in the Faculty. If there is no suitable candidate in Lassonde Mineral Engineering, all awards are tenable in any program in the Faculty.

John Hirschorn Memorial Scholarship
This award was established in 2002 by Ron and Linda Hirschorn to honour the memory of the late John Hirschorn who graduated in 1941 from the Mechanical Engineering Program at the University of Toronto. This Scholarship is granted to a student entering First year of Mechanical Engineering on the basis of academic merit. The Scholarship is renewable for 3 years provided the recipient maintains minimum of 65% average at the end of each year.

Arthur B. Johns Award
This Award was established in 2007 through generous donations by friends and family of Arthur B. Johns. The Award will be given to a student (or students) entering First year, full-time, in the Department of Civil Engineering. The Award is made on the basis of outstanding academic merit. Preference will be given to students who have demonstrated leadership in the community and through extra-curricular activities.

Albert and Rose Jong Entrance Scholarship
Established in 2006 though a generous donation by Dr. Roberta Jong, Dr. Raynard Jong and Dr. Winston Jong, this award is for a student entering First year of either Electrical Engineering or Engineering Science. The Scholarship is made on the basis of academic merit and financial need. Preference will be given to students who have demonstrated leadership in the Chinese-Canadian community. Recipients must be Canadian citizens or permanent residents.

Kenneth Raffles Kilburn Scholarship(s)
Established in 2006 from the estate of the late Kenneth R. Kilburn, these Scholarships are available for students entering or continuing in any program in the Faculty on the basis of outstanding academic ability.

The Harvey W. Kriss Admission Scholarship in Industrial Engineering
This Scholarship was established in 1989 by family, friends and colleagues in memory of Harvey W. Kriss, B.A.Sc. (Engineering and Business 1959), S.M. (MIT, 1961). The award, derived from the annual income, will be granted to a student entering the First year of the Industrial Engineering program. In addition to academic excellence, qualities of character and leadership as demonstrated in school and community activities will be considered.

Lassonde Scholarships
(see listing later is in this Chapter)

John C.H. Lee Memorial Scholarship
The Industrial Engineering Class of 8T7 initiated the John C.H. Lee Memorial Scholarship in memory of their friend and classmate. The Scholarship was funded by friends, classmates, the Korean community and family members seeking to recognize students entering the First year (full-time) of any undergraduate program in the Faculty. The award is made on the basis of high academic achievement in the prerequisite courses, demonstrated athletic proficiency, and extra-curricular involvement both within the community and the high school. Application is required along with a reference letter from either a high school teacher or a past employer. Applicants must be Canadian Citizens or Permanent Residents. Candidates must live in residence in order to enjoy this award.

Donald C. Leigh Memorial Scholarship
This scholarship was established in 2007 through a generous donation by Mrs. Anne Leigh in memory of her husband. The award is given to a student entering First year, Engineering Science, full-time, on the basis of academic excellence. Recipients must be Canadian citizens or permanent residents.

James Turner MacBain Scholarship
(see listing later in this Chapter)

Salim Majdalany Scholarship
(see listing later in this Chapter)

The Hal Major Memorial Admission Award
This Award is provided by the generosity of Mr. George Bird, P.Eng., (class of 4T9, Civil Engineering) in memory of his uncle, Mr. Hal Major, who died in 1986 at the age of 94. The Award is granted to a student entering the First year in the Department of Civil Engineering on the basis of financial need and demonstrated qualities of character and leadership.

J. Edgar McAllister Foundation Admission Awards
Provided by the bequest of the late J. Edgar McAllister, B.A.Sc., numerous awards, varying in amounts, are available to students entering the First year of programs in Mechanical, Chemical, Electrical, Computer, Lassonde Mineral Engineering and Materials Engineering, who have achieved high standing in the secondary school courses prescribed for admission and who are in need of financial assistance.

The John Wolfe McColl Memorial Awards
The income of this fund is divided equally among the Faculty of Applied Science and Engineering, the Faculty of Arts and Science and the Faculty of
Scholarships and Financial Aid

The funds available to the Faculty of Applied Science and Engineering will provide admission scholarships for outstanding students entering the First year of any program.

Lachlan Dales McKellar Admission Scholarships
Provided by a bequest of the late Leona D. McKellar, one or more scholarships are offered to students who have achieved high standing on the prerequisite courses for admission to the Faculty.

Mechanical & Industrial Engineering Admission Scholarship(s)
These Scholarships are awarded to students entering the First year of either the Mechanical or Industrial Engineering Program on the basis of academic merit in the prerequisite courses as well as involvement in extra-curricular activities. Some awards may be renewable at the end of First year. The Department may also chose to offer an admission scholarship payable at the end of First year provided a minimum average is obtained. The minimum average is at the department's discretion.

Metallurgy & Materials Science Alumni
Admission Scholarships
Established in 1995 by friends and alumni of the Department of Materials Science and Engineering, this Scholarship is awarded to students entering the First year of the Materials Engineering program on the basis of outstanding academic performance in the subjects required for admission and involvement in school and community activities. The award is renewable in the Second year of the program provided a min. of 75% is obtained at the end of year one.

George R. Mickle Admission Bursaries
Provided by a bequest of the late George R. Mickle, several bursaries are available to students entering the First year in the Faculty of Applied Science and Engineering. The awards are made on the basis of the applicants' academic standing in the prerequisite courses and financial need.

Michael M. Mortson Industrial Engineering Admission Scholarship
Established in 2009 through a generous donation by Mr. Michael M. Mortson, this scholarship is given to a student entering First year of the Industrial Engineering program on the basis of academic merit. Preference will be given to students who have demonstrated excellence in extra-curricular activities.

Professional Engineers Ontario Foundation for Education Entrance Scholarships
The Ontario Professional Engineers Foundation for Education provides two admission Scholarships of $1,000 each and are designated, where possible, to a male and female student. They are awarded to the candidates who are well-rounded students and exhibit characteristics of leadership.

Norman Ramm Scholarship
This Scholarship, provided by a bequest of the late Norman Ramm, is awarded upon admission to a student from a Canadian province or territory (excluding Ontario) on the basis of academic standing.

Edward S. Rogers Sr. Admission Scholarships
These awards were made possible through a landmark donation from Ted Rogers Jr. and the Rogers family. Edward S. Rogers Sr. was enrolled in the Department of Electrical Engineering in the University of Toronto from 1919-1921. He left the Program before graduating to pursue his radio experimentation. In 1925, he invented the world’s first alternating current (AC) radio tube, which enabled radios to be powered by ordinary household current. He also started the world’s first all electric radio station (CFRB –Canada’s First Rogers Batteryless), which began broadcasting on February 10, 1927. In 1931, Rogers was granted the first television licence in Canada. Edward S. Rogers Sr. was inducted into the Canadian Broadcast Hall of Fame in 1982. During his short but productive life, Edward S. Rogers Sr. displayed the qualities we wish to instill in all students of the Faculty. The Scholarships are awarded to students entering, full-time, the Edward S. Rogers Sr. Department of Electrical and Computer Engineering on the basis of academic achievement and extra-curricular activities. Some awards may be renewable.

Edward A. Rolph Scholarships
Established in 1994 from the estate of Edward A. Rolph and Kathryn S. Rolph, these Scholarships will be granted to one or more students entering the First year of any program in the Faculty on the basis of academic merit. Application is not required.

Leslie and Lois Shaw Admission Scholarship
This award was created in 2002 by the friends and family of Leslie and Lois Shaw and is to be awarded to a student entering First year of either the Department of Chemical Engineering and Applied Chemistry or the Department of Mechanical and Industrial Engineering. In addition to academic standing, preference is given to candidates who possess leadership capabilities as demonstrated through involvement in Student Council, athletics, or community service.

The Shaw Admission Scholarship
Established in 2002 through a generous donation by William and Barbra Shaw, this Scholarship is awarded to a student entering First year of Engineering Science who demonstrates high academic achievement. Preference will be given to a student who possesses leadership skills and design capability as demonstrated in extra-curricular design projects and activities. Selection will be made on the recommendation of the Chair of the Division of Engineering Science. The Scholarship is renewable for three years provided the recipient maintains a minimum 75% overall average and continues in Engineering Science.

Joey and Toby Tanenbaum Admission Scholarships
Established in 2007 through a generous donation by Joseph Tanenbaum, these awards, of varying amounts, are granted to students entering the First
Scholarships and Financial Aid

year of Civil Engineering on the basis of academic merit.

The F.C.C.P. - John Hin Chung Tsang Memorial Admission Scholarship
This award, valued at $750, was establish by Mrs. Pauline Tsang, in co-operation with the Federation of Chinese Canadian Professionals Education Foundation in memory of John Hin Chung Tsang, B.A.Sc., P.Eng. who graduated in 1971 from Electrical Engineering at the University of Toronto. The award is granted to a student entering the First year of the Electrical Engineering Program who achieved the highest average on the prerequisite subjects required for admission to the Faculty.

Toronto & Area Road Builders Association Scholarship
This award, valued at $2,000, was established in 1987 through the generosity of the Toronto & Area Road Builders Association. The award is granted to a student entering the First year of the Civil Engineering Program on the basis of good academic standing and qualities of character and leadership.

Wallberg Admission Scholarship
A number of admission scholarships, each of a value of $1,000 are awarded annually from the income from the Wallberg bequest on the recommendation of the Council of the Faculty to the six candidates with the highest average percentage in subjects prescribed for admission to the Faculty.
To qualify for the Scholarship a candidate must achieve an average of at least 75% in the subjects prescribed for admission and must register in the Faculty of Applied Science and Engineering.
The Scholarship will not be awarded to a student who has spent more than five years in an Ontario Secondary school or its equivalent unless evidence can be provided satisfactory to Council that this extended attendance was for reasons beyond the student's control.

W. J. T. Wright Admission Scholarship
The W.J.T. Wright Admission Scholarship was established in honour of Professor W.J.T. Wright, a highly regarded emeritus member of the Faculty. The capital donation is provided by the 67th University of Toronto Battery of the Canadian Army. The Scholarship is awarded annually to a student entering the First year of the Civil Engineering Program who achieved outstanding marks in the Ontario high school subjects prescribed for admission. The first award was made in 1982.

OSOTF IN-COURSE SCHOLARSHIPS

APSC Award
Established in 1997, this Scholarship, derived from the annual income of a capital donation, is awarded to a student in the Faculty on the basis of financial need. Academic standing will also be considered.

T. Christie Arnold Scholarship
This award was established in 1997 through the generosity of T. Christie Arnold. The award is granted to a student in the Industrial or Mechanical Engineering Program who is entering the BASc/MBA joint program on the basis of financial need. The recipient should also be recognized for engineering management, good academic achievement in the program and particular ability and creativity in their course work. The person should be a well-rounded student involved in extra-curricular activities, i.e., athletic involvement with varsity sports.

Anthony A. Brait Memorial Scholarship
This Scholarship was established in the Division of Engineering Science in 1997 by Margaret Brait, in memory of her late husband, Anthony A. Brait. The award will be granted to a student entering the Second year of the Engineering Science Program on the basis of financial need. Academic standing will also be considered.

Paul Cadario Scholarship
This Scholarship was established in 1996 in the Department of Civil Engineering through the generosity of Mr. Paul Cadario. The award is granted to a student entering the Fourth year of the Program on the basis of financial need. Additionally, academic achievement in the Program and particular ability and creativity in the field of Transportation Engineering, specifically the Third year Transportation Engineering courses will also be considered. The recipient is expected to continue his or her studies in Transportation Engineering in the Fourth year.

John Dixon Campbell Memorial Scholarship
Established in 2004 by friends, family and colleagues of the late John Dixon Campbell, this award is granted to a student in Fourth year of any program in the Faculty who has demonstrated financial need and has the highest academic merit in the area of Maintenance Optimization and Reliability Engineering. Should the recipient of the John Dixon Memorial Prize demonstrate financial need, he or she will be eligible to receive this Scholarship as well.

Canadian Imperial Bank of Commerce BASc/MBA Scholarships
These Scholarships, established in 2001, are to be awarded to students entering the Jeffrey Skoll BASc/MBA Program. Preference will be given to students who have displayed high academic merit in their first three years of Engineering studies and who have a high level of leadership potential. Additional preference will be given to students who demonstrate financial need.

Chachra Family Scholarship in Engineering Science
This Scholarship was established in 2004 by Mrs. Saroj and Mr. Fakir Chachra in honour of their daughter, Debbie, who received her Ph.D. in Biomedical Engineering from U of T in 2001. The Scholarship is awarded to a student proceeding to Second year of Engineering Science on the basis of financial need and academic achievement. Preference is given to female students who meet the criteria.
Scholarships and Financial Aid

Chemical Engineering Alumni In-Course Awards
These awards were established in 2004 by staff and alumni of the Department of Chemical Engineering and Applied Chemistry. Two awards will be granted to students completing Second or Third year of Chemical Engineering on the basis of financial need. Academic ability and leadership ability as demonstrated by participation in community and/or University involvement will also be considered.

Class of 3T7 Scholarships
These Scholarships, established in 1997 through the generosity of the Class of 3T7, are granted to students in any program in the Faculty on the basis of financial need.

Class of 5T0 Engineering Leadership Award
This Award was established through the generosity of the Class of 5T0 and is granted to a student entering Second year of any program who has demonstrated financial need and attained high academic performance. The recipient should also have the ability to inspire and motivate others to become involved and to achieve: thereafter, preference is given to students who exhibit leadership potential and have a broad range of interests and involvement including student council activity, participation in athletics, community involvement, and volunteerism.

Class of 8T3 Vince Volpe Memorial Award
This award was established through the generosity of friends and classmates of Vince Volpe. Vince Volpe, a graduate of the class of Civil 8T3, was an outstanding leader and friend to all his classmates. He was active in intramural sports, the Civil Engineering Club, and was Vice-President of the Engineering Society. The award is given to a student entering 4th year of Civil Engineering. Selection is made on the basis of financial need, academic achievement, and extra-curricular activities/community involvement.

Class of 9T7 Award
This Award, established through the generosity of the Class of 9T7 in their graduating year, is given to a student who has completed the Second year, full-time, and is proceeding to the Third year, full-time, of any program on the basis of financial need. Academic standing and extra-curricular/community involvement will also be considered.

The Sidney C. Cooper Scholarships
Through the generosity of Sidney C. Cooper (B.A. Sc., Civil Engineering, 1945) two awards have been established in the Department of Civil Engineering. One award will be granted to a student entering the First year and one award will be granted to a student entering the Fourth year. The Fourth year Award will be made on the recommendation of the Chair on the basis of financial need. Academic achievement in the work of the Third year and a demonstrated interest (through summer employment) in construction engineering will also be considered.

George B. Craig Scholarship
This award, provided through the generosity of Professor Steve J. Thorpe, was established in 1997 for George B. Craig, B.A.Sc., M.A.Sc., Ph.D., F.A.S.M., P.Eng., Professor Emeritus and former Speaker of Faculty Council. The award, derived from the annual income, is granted to a student in the Department of Materials Science and Engineering who has demonstrated financial need. Academic achievement will also be considered.

C. William Daniel Leadership Awards
Established in 1998 through the generosity of Mr. C. William Daniel, this award is granted to three students entering either Third or Fourth year of studies in any undergraduate Engineering program. Decisions will be made on the basis of academic standing and leadership qualities as demonstrated by Student Council activity, participation in athletics and community involvement. Additionally, two of the recipients must demonstrate financial need.

Duncan R. Derry Scholarships
The Scholarship fund was established in 1997 through the generosity of Mrs. Duncan Derry, Mr. Donald M. Ross and friends and family of Mr. Duncan R. Derry. As award will be made to a student entering the Second year of the Lassonde Mineral Engineering Program on the basis of financial need. Academic standing, qualities of character and leadership and extra-curricular activities will also be considered. The Scholarship is renewable for both Third and Fourth years provided academic standing is maintained and continued financial need is demonstrated.

Dharma Master Chuk Mor Memorial Scholarship
T.Y. Lung established this endowed scholarship in memory of Buddhist monk Chuk Mor (1913-2002) who was an educator and artist well known in the fields of Chinese poetry, Chinese painting and Chinese calligraphy. This scholarship is awarded to a full-time student entering Third year of any engineering program on the basis of financial need and academic achievement.

R.A. Downing Scholarship in Civil Engineering
This award was established in 2003 through a generous donation by Lois Downing in memory of the late Robert Downing. The award will be made to an undergraduate student in Civil Engineering on the basis of financial need and academic merit.

ECE Alumni Scholarship
This Scholarship was established in 1997 through the generous donations of alumni of the Department of Electrical and Computer Engineering. The award will be made to a student in either Electrical or Computer Engineering on the basis of financial need. Academic achievement will also be considered.

Engineering Society Award
Established in 1997 and provided by the generosity of the undergraduate students in the Faculty of Applied Science and Engineering, these awards, based on the annual income, will be distributed on the basis of financial need. Academic ability and extra-curricular involvement within the undergraduate engineering community will also be considered. Awards will be made in consultation with the Engineering Society Executive.
Scholarships and Financial Aid

Ford Electronics Scholarship
This Scholarship, derived from the annual income of a capital donation, was established through the generosity of Ford Electronics Manufacturing Corporation in 1997. It will be granted to a student in the Electrical Engineering Program on the basis of financial need. Academic standing will also be considered.

Andrew Frow Memorial Award
This Award was established in 2004 through a generous donation made by the Engineering Society and augmented by friends and family in memory of Andrew Frow. Andrew, a Mechanical Engineering student, was killed in a two-vehicle collision while driving the Blue Sky Solar Racing team’s solar car on Highway 7/8 near Kitchener-Waterloo. Andrew was a member of the team which was participating in the Canadian Solar Tour to highlight alternative energy technology. The Award is granted to a student entering Second, Third or Fourth year of any engineering program on the basis of financial need, academic merit and strong extra-curricular involvement within the University of Toronto.

General Motors Environmental Engineering Awards
This Award was established in 1997 through a generous donation from the General Motors of Canada Limited. Annual income derived from the capital provides up to seven awards to students entering Second, Third, and Fourth year in Environmental Engineering on the basis financial need. Academic achievement will also be considered.

General Motors Women in Electrical and Mechanical Engineering Awards
This Award was established in 1997 through a generous donation from the General Motors of Canada Limited. Annual income derived from the capital provides up to fifteen awards to female students in First, Second, and Third year of Electrical and Mechanical Engineering studies on the basis of financial need. Academic achievement will also be considered.

Jack Gorrie Memorial Undergraduate Scholarship
Established by donations from Mary Louise Gorrie and friends of the late Jack D. Gorrie, this scholarship is given to a student completing Second year of Engineering Science and proceeding into Third year of the same program. The award is made on the basis of financial need, academic achievement, and involvement in extra-curricular activities within the University.

Herbert Gladish Memorial Scholarship
This Scholarship was established in 1997 by Sailrail Automated Systems Inc. in memory of the late Herbert Gladish. The award is granted to a student entering Third year of the Engineering Science Program on the basis of financial need. Academic achievement in the Program will also be considered. Preference will be given to a student who has demonstrated innovation and excellence in the Second year design course.

J. Frank Guenther Scholarship
The J. Frank Guenther Scholarship was established in 1997 in the Division of Engineering Science through the generosity of BVA Systems Limited. The award will be made to either a student entering Second year who has shown progress and increased effort from the first to second semester or to a student entering Third year who has demonstrated progress and increased effort from the First to Second year. The candidate must demonstrate financial need to receive the award. Selection will be made on the recommendation of the Chair of Engineering Science.

Anthony A. Haasz Scholarship
This Scholarship was established in 1997 by Anthony A. Haasz, B.A.Sc., M.A.Sc., Ph.D., P.Eng., Professor and Director of the Institute for Aerospace Studies. The Scholarship, derived from the annual income, is granted to a student entering the Third year in the Aerospace Option in the Engineering Science Program on the basis of financial need. Academic achievement will also be considered.

Halsall Scholarships in Building Engineering
Provided in 1997 through the generosity of Halsall Associates Ltd., these awards are tenable in the Department of Civil Engineering or in the Infrastructure Option of Engineering Science. One award is made to a student completing Second year and one award is made to a student completing Third year on the basis of financial need. The recipients should also exhibit a high level of interest and academic achievement in Civil Engineering applied to buildings, as well as significant contribution to community and/or student activities. The relevant course content would include structures, materials and building science.

Lisa Anne Hamann Memorial Award
This Award was established by family and friends in memory of Lisa Ann Hamann (nee Anzil) P.Eng., a graduate of the Class of 8T6 Mechanical Engineering, who passed away in 1995 in her 31st year. Lisa was a successful Nuclear Engineer with Ontario Hydro, whose career path evolved from nuclear design, through project management and lastly as an Account Executive in International Sales. The consummate professional, committed to excellence in all her ventures, she was gifted with intelligence, talent and strength. Her personality and qualities never failed to inspire and encourage individuals with whom she came into contact with. She excelled in a business environment that is often difficult and challenging for female professionals and earned the respect of those she worked with around the world from Korea, China and Japan, to Kenya, Ukraine, Bulgaria and the Czech Republic. She chaired the Toronto Chapter of the Canadian Nuclear Society for two years, committed to the promotion of nuclear energy and its benefits to society and the electrical industry. Lisa promoted an athletic lifestyle while at Ontario Hydro, organising the annual fun runs, multi-team participation at the YMCA Corporate Challenge and outside of work she was an active member of the Ontario Association of Triathletes. She competed for many years and twice successfully completed the Ironman Canada Triathlon, a gruelling endurance race consisting of a 2k swim, 180k bike ride and full marathon run. This endowment fund, created through generous contributions from family, friends and colleagues, has a capital value of approximately $30,000. The annual income will generate an award to be presented to a female student in Third or Fourth year of the Mechanical Engineering Program. The recipient
will be chosen on the basis of good academic standing, demonstrated leadership ability, commitment to a healthy and athletic lifestyle, involvement in community activities and financial need.

It is hoped that through this Award, Lisa’s values, courage and accomplishments can become a beacon and opportunity for other women to pursue a career in the field of engineering.

Chester B. Hamilton Scholarship
Members of the family of the late Chester B. Hamilton, a graduate of the Faculty in 1906, established an annual Scholarship in his memory. The first award was made in 1958-59.

In 1997, Diana L. MacFeeters, Elizabeth D. Hamilton and David C. Hamilton augmented the fund through a generous gift. The award is granted to a Third year student in the Mechanical Engineering Program on the basis of financial need and who has shown academic ability at the annual examinations of the Third year.

Johannes Michael Holmboe Undergraduate Summer Research Fellowship
This Fellowship was established in 2004 through a bequest from the estate of Ruth Anna Holmboe in memory of her late husband, Johannes Michael Holmboe, who was a 1950 graduate of the Faculty in Chemical Engineering. One or more fellowship(s) will be available to student(s) completing Years 1, 2, or 3 on the basis of financial need. Additionally, academic ability and the responsibility of the applicant in the research project will also be considered. The fellowship(s) will be awarded to student(s) to work on research project(s) under the supervision of staff and/or graduate students during the summer.

Philip H. Jones Scholarship
Established in 1997, this Scholarship is granted to a student entering the Fourth year of the Environmental Engineering Option in the Department of Civil Engineering on the basis of financial need. Academic achievement in the Program and particular ability and creativity in the field of Environmental Engineering will also be considered. The recipient is expected to continue his or her studies in Environmental Engineering in the Fourth year of the Program.

Andrew Alexander Kinghorn Scholarships
Four Scholarships are available annually on the basis of financial need. One is awarded to the student on the basis of financial need and academic standing in the First year of Engineering Science; one to the student on the basis of financial need and academic standing in the First year of all programs except Engineering Science and one each to the students on the basis of financial need and academic standing in the Second and Third years respectively among the candidates of all programs. Should a candidate hold an award of equal or greater value, the award may be made to the next ranking candidate.

Dietmar Koslowski Memorial
Bursary in Electrical Engineering
This award was established in 1987 in memory of the late Dietmar Koslowski, P.Eng, (6T7) by his parents and family. The bursary, derived from the annual interest of the capital fund, will be granted, on the recommendation of the Chair, to a student completing the Third year in the Department of Electrical and Computer Engineering. In addition to financial need, good academic standing will also be considered. The first award was made in the 1987-88 session.

Frankie Kwok Memorial Scholarship
This Scholarship, established in 1997, is provided through the generosity of McKinsey & Company, family, friends and colleagues of the late Dr. Frankie Kwok. The award is granted to a student entering the Third year of the Mechanical Engineering Program on the basis of financial need. Academic achievement and demonstrated leadership skills through participation in team sports and/or student affairs and community involvement will also be considered.

Ronald Paul Manning Scholarships
Provided through the generosity of Ronald P. Manning (B.A.Sc.,5T9, M. Eng.) in 1997 one or more awards will be granted to a student entering the Fourth year of the Electrical Engineering Program on the basis of financial need. Academic achievement in the Program and demonstrated particular ability and creativity in the field of communications or computers will be considered. Recipients must be Canadian Citizens working towards a degree in Electrical Engineering and are expected to continue their studies in the Fourth year of the Program. Special consideration will be given to those students who have a history of good grades but have experienced some adversity during the Third year due to illness, bereavement, etc.

Eric Miglin Scholarship
This Scholarship was established in 1997 on the occasion on his 25th reunion, by Eric J. Miglin, a graduate of Industrial Engineering and President of the Engineering Society in 1972. This award is granted to a student who has completed the Third year in any program in the Faculty on the basis of financial need. Academic standing and active involvement in student and/or University government will also be considered.

Marshall Macklin Monaghan Scholarship
This award was established in 1997 through a generous donation from Marshall Macklin Monaghan Limited. The award, derived from the annual income, is granted to a student in the Department of Civil Engineering on the basis of financial need and academic ability.

Samer Mutlak Memorial Award

Samer was a warm, jovial, and caring person, always able to bring a smile to those whose lives he touched. He took part in many social events within the University. He was a leader and an organizer taking part in frosh orientation, Lady Godiva Week, hockey, and the student industrial engineering
conferences.
He took pride in being an industrial engineer. He will be remembered fondly for his sense of humor. He was a good friend.
The Award, derived from the annual income, will be made to a student completing Third year in Industrial Engineering on the recommendation of the Department Chair on the basis of financial need, academic ability and contribution to, and involvement in the activities of the Department and the University.

**Barry James O’Sullivan Grant**
This grant was established in 2003 through a bequest from the estate of Victoria Doris O’Sullivan in memory of her son Barry James O’Sullivan, whose untimely death in 1969 occurred while he was studying Engineering at U of T. This award will be made to a student entering or proceeding in any undergraduate program in the Faculty on the basis of financial need.
Application should be made on the Undergraduate Grant Application Form.

**James A. Peers Scholarship in Industrial Engineering**
The James A. Peers Scholarship was established in 1997 by Jim Peers, who graduated from the Department of Industrial Engineering in 1973. This award, derived from the annual income, is granted on the recommendation of the Chair to a student proceeding to the Second year in Industrial Engineering on the basis of financial need. Academic achievement, qualities of character, leadership and commitment to the profession will also be considered. Not tenable with other awards.

**Ryn Pudden Memorial Award**
This Award was established in 1999 in memory of Ryn Pudden through the generosity of her family. The Award is granted to a female student in Engineering Science who demonstrates financial need. In addition, preference will be given to a student who is entering the Third year of the Aerospace Option and is involved in extra-curricular activities (e.g. Music, student council, athletics).

**The Peter Sands Award in Engineering Science**
This Award was established by family and friends in memory of the late Peter Sands, B.A.Sc. (1962), M.A.Sc. (1966). The Award will be made on the recommendation of the Chair to a student completing the Second year of Engineering Science on the basis of financial need. In addition, good academic standing (not necessarily Honours), qualities of character, leadership and commitment to the profession will also be considered. Preference will be given to students who have pre-registered in the Computer Option.

**Kenneth A. Selby Scholarship in Construction Engineering in the Department of Civil Engineering**
This Scholarship was established in 1997 by Kenneth A. Selby, B.A.Sc., M.B.A., Ph.D.(ILL), P.Eng. The award will be granted to a student entering the Fourth year of the Civil Engineering Department on the basis of financial need. Academic achievement in the Program and particular ability and creativity in the field of construction engineering, specifically Second and Third year construction engineering-related courses will also be considered.

**Douglas Scott Shaw Memorial Scholarship**
This award was established by Andrea Boucher-Shaw in loving memory of her husband, the late Douglas Scott Shaw. The award is granted to a student who has completed first, second or Third year of Industrial Engineering and is made on the basis of financial need and a shown marked improvement in grades from the previous year.

**Shell Canada Limited Engineering Scholarships Program**
Established in 1997 through the generosity of Shell Canada Limited, these Scholarships are granted to two students entering Third year and two students entering Fourth year in each of the following three departments: Mineral Engineering, Chemical Engineering and Applied Chemistry and Mechanical & Industrial Engineering. The awards are granted on the basis on financial need. Academic performance will also be considered. The first awards were granted in the 1998-99 Session.

**William Bernard Silverston Scholarship**
William Bernard Silverston, having received a degree in Mechanical Engineering in Poland, went on to lead a distinguished international career in engineering, management, and business. To recognize his tremendous innovation in design and management, his son, Robert Silverston, established this Scholarship in the Faculty in 1997.
The award, derived from the annual income, will be granted to a student entering the Third year of the Mechanical Engineering Program on the basis of financial need. The recipient should also have demonstrated the ability to produce innovative and original designs which are based on sound engineering and applied science principles. Candidates should convey a spirit and love for the discipline.

**Christopher Skrok Memorial Scholarships**
These Scholarships were established in 2003 through the generosity of Stanislawa Skrok, in honour of her husband Christopher Skrok (Civil 6T0). The awards will be granted to three students entering First year of Civil Engineering and three students entering Fourth year of Civil Engineering on the basis of Financial need and academic standing.

**Gordon R. Slemon Scholarship**
The award is granted to a student entering the Third year of the Electrical Engineering Program on the basis of financial need. Academic achievement in the Second year of the Program and an aptitude in design will also be considered. The award will be made on the recommendation of the Chair.

**Kenneth Carless Smith Award in Engineering Science**
Established in 2004 through a generous donation by Professor Kenneth Carless Smith and Ms. Laura Fujino, this Award is made on the
recommendation of the Chair of the Division of Engineering Science to one or more students completing 2nd or 3rd year of Engineering Science. The Award is made on the basis of financial need and a demonstrated interest and aptitude in the area of electronics. Interest may be shown by strong performance in appropriate courses and/or research and design projects.

Kenneth Ward Smith Scholarships
Provided through the generosity of Carlton G. Smith two awards are granted, on the recommendation of the Chair of the Division, to students completing the Second year of the Engineering Science Program and who are proceeding to the Third year in the Aerospace Option. Recipients will be selected on the basis of financial need, academic standing and qualities of character and leadership.

Robert M. Smith Scholarships
These Scholarships, made possible by a generous donation, were established in 1996. The awards are granted on the basis of financial need to a student entering the Third year of the Lassonde Mineral Engineering Program. Academic standing will also be considered. The Scholarship is renewable in the Fourth year on the basis of continued financial need and academic standing. Should the candidate not qualify for the renewal, the award can be granted by reversion to the next qualifying candidate in the Fourth year of the Program.

SNC-Lavalin Scholarship
This Scholarship was established in 1997 through the generosity of SNC-Lavalin Group Inc. and is awarded to a student entering Second year of either the Lassonde Mineral or Materials Engineering Program on the basis of financial need. Academic standing will also be considered.

Peter K. Strangway Scholarship
This award was established in 1997 through the generosity of Dr. Peter K. Strangway. The Scholarship is granted to a student entering the Third or Fourth year in Materials Engineering on the basis of financial need. Academic credentials will also be considered.

The Maurice Stren Memorial Scholarship
This Scholarship was established in 1995 by Mrs. Sadie Stren in memory of her husband, Maurice, who graduated from the Department of Mechanical Engineering in 1943. Throughout his long career, Mr. Stren possessed an unbounded enthusiasm for all facets of Engineering. The award, which is derived from the annual income of a bequest of a capital sum of $10,000 is granted, on the recommendation of the Chair, to a student completing the Second year of the Mechanical Engineering Program. In addition to academic excellence, qualities of character and financial need will also be considered. The first award was granted in the 1995-96 Session.

Sullivan Memorial Scholarship
The Sullivan Memorial Scholarship commemorates May and Philip Sullivan, of Sydney, Australia. Being denied the benefits of an advanced education, they fostered their three children’s ambitions. All became University faculty, one in Australia, one in New Zealand, and one in Canada. The award is derived from the annual income and is awarded to a student entering the Second year of the Engineering Science Program on the basis of financial need. Academic standing will also be considered. The selection is made by the Chair of the Division. The first award was granted in the 1998-99 Session.

James M. Toguri Memorial Scholarship
This Scholarship was established in 2004 by friends and family in memory of Professor James M. Toguri. The award is to be granted to a full-time student proceeding to Third or Fourth year of Materials Engineering on the basis of financial need and academic achievement. In addition, candidates should have genuine interest in a career in chemical process metallurgy, as demonstrated by either course selection, summer research experience, PEY placement and/or fourth year thesis topic. Preference will be given to students with demonstrated qualities of leadership. Recommendation of the Chair or his/her designate.

The Trenwith and Galipeau Aerospace Science Award
This Award was established in 1997 through a donation from Mr. John Galipeau. The income derived from the capital provides a Scholarship to a student in Third or Fourth year of the Aerospace Option in Engineering Science based on financial need. Academic merit is also considered. If given at the Third year level, the Award may be renewed for the Fourth year provided the criteria is still met.

William Ian MacKenzie Turner Scholarship in Industrial Engineering
This award was established in recognition of the professional achievements of William Ian MacKenzie Turner (B.A.Sc., Electrical Engineering, 1925), and of his dedication to the interests of the undergraduates and graduates of the Faculty of Applied Science and Engineering. The Scholarship, derived from the annual income, is awarded to the student on the basis of financial need who, having obtained Honours standing, ranks in first place on the results of the annual examinations in the Third year of the Industrial Engineering Program. Should the candidate hold an award of greater value, the award may be made to the next ranking candidate. The first award, under these terms, was made in the 1998-99 Session.

Lloyd George Webber Memorial Scholarship
This Scholarship was established in 1997 in memory of Lloyd George Webber (3T6, Chemical Engineering). The award will be granted to a student completing Third year of Chemical Engineering and Applied Chemistry on the basis of financial need. Academic standing will also be considered.

Julie Wilkinson Memorial Scholarship
This Scholarship was established by family and friends of the late Julie Wilkinson. Julie was the Office Manager of the Engineering Society for 11 years. In addition to her job in the Faculty, she worked part-time for the Automobile Journalists Association of Canada (AJAC) where she eventually became Treasurer. On top of all this responsibility, Julie decided to go back to school part-time and was working towards an Industrial Engineering degree. Julie was a warm and caring person who always had a smile for everyone.

In honour of her memory, the Scholarship will be made to a student registered in any year of the Industrial Engineering Program on the basis of financial need, extra-curricular activities, demonstrated involvement in the Engineering Society, and academic standing. Recommendations will be made by the
The Ardagh Scholarship has been provided by Professor E.G.R. Ardagh, B.A.Sc., F.R.S.C., formerly professor of Applied Chemistry, in memory of his

The Ardagh Scholarship is awarded to a student of the Second year in this Faculty who, obtaining honours and being ranked one of the first three in the annual examinations, has been adjudged highest of the three in general student activities and service in the University during First year. The annual value of the Scholarship is the income from the fund.

When regulations do not permit the winner to hold this Scholarship the students to be considered for the award shall be the first three in the year exclusive of any student who holds a Scholarship of higher value.

Aloha Innovation Fund
This fund was established in 2003 through a generous donation by an anonymous donor. The fund is for undergraduate students in the Department of Electrical & Computer Engineering and includes prizes for undergraduate projects that show innovation and excellence in team work and execution, funding for well planned and innovative project proposals or awards to students who are judged to have demonstrated a high degree of innovation in any of their academic activities.

AMC Electrical and Computer Engineering Scholarship
Established in 2010 through a generous donation by AMC Canada, this scholarship is given to 2 students completing Year 3 of Electrical or Computer Engineering. One to a student whose focus is on hardware engineering and one to a student whose focus is on software engineering as demonstrated through relevant course(s). The awards will be made on the basis of outstanding academic achievement and demonstrated leadership. Successful candidates must demonstrate an obvious commitment to, and interest in, CPU, GPU as well as semi-conductors.

American Concrete Institute, Ontario Chapter Scholarship
Established in 1992 through the generosity of The Ontario Chapter of the American Concrete Institute, this Scholarship is awarded, on the recommendation of the Chair, to a student graduating from the Department of Civil Engineering with the most meritorious final year thesis related to the use of concrete.

Anchor Schoring & Caissons Ltd. Scholarship
Created in 2009 through a generous donation by Anchor Schoring & Caissons Ltd., this scholarship is awarded to full-time students completing Second or Third year of Civil Engineering specializing in structures and/or geotechnical. Academic achievement and extra-curricular activities will also be considered.

APWA Ontario Chapter Bruce Brunton Award
Established in 2000 by the Ontario Chapter of the American Public Works. It is to be awarded to a student in any year in Civil Engineering on the basis of financial need, and academic achievement sufficient enough to proceed to the next year of the Program. The value of the Award is $500.

Ardagh Scholarship
The Ardagh Scholarship has been provided by Professor E.G.R. Ardagh, B.A.Sc., F.R.S.C., formerly professor of Applied Chemistry, in memory of his

NON-OSOTF IN-COURSE SCHOLARSHIPS AND GRANTS

Henry G. Acres Medal
The Henry G. Acres Medal is awarded annually to the Fourth year student in Civil, Mechanical, Electrical, or Computer Engineering who obtains the highest aggregate percentage at the annual examinations of the Third and Fourth years, provided always that the student obtains honours standing in the examinations of the Fourth year. In addition to the medal the student will receive an honorarium in the amount of $500. Receipt of the award does not preclude a student from being granted such other awards as may, in the opinion of the Council, be appropriate.

The Henry G. Acres Medal was established in 1950 by Mrs. Henry G. Acres in memory of her late husband, Henry G. Acres, M.E., D.Sc., a graduate of the School of Practical Science in the class of 1903. From 1981 onward, continuation of the award has been possible through the generosity of Acres International Limited, who also provide an honorarium of $500 to the recipient of the medal.

Throughout his professional life Dr. Acres was associated with major power developments in Canada and abroad. As chief hydraulic engineer for the Hydro-Electric Power Commission of Ontario from 1911 to 1923, he was responsible for the design and construction of nearly twenty power plants, including the Queenston-Chippewa development. In 1924 he formed H.G. Acres and Company Ltd., now known as Acres International Limited, and until his death in 1945, he continued to widen and extend his interests. He became chief engineer of the Grand River Conservation Commission and was responsible for the design and construction of the Shand dam and related work. Later, he was consulting engineer for the extensive power developments at Shipshaw on the Saguenay River, which were vital to the production of aluminum for war purposes. Many of the provinces of Canada sought his services and he advised with respect to work in Newfoundland, South America and India.

Harvey Aggett Memorial Scholarship
This Scholarship was donated by the late Mr. J.T. Aggett of Toronto, as a perpetual memorial to his son, the late Lieutenant Harvey Aggett, who enlisted in March, 1915, during his Second year in this Faculty, and was killed in action at Passchendaele on November 6, 1917.

This annual Scholarship is to be awarded to a student of the Second year in this Faculty who, obtaining honours and being ranked one of the first three in the annual examinations, has been adjudged highest of the three in general student activities and service in the University during First year. The annual value of the Scholarship is the income from the fund.

When regulations do not permit the winner to hold this Scholarship the students to be considered for the award shall be the first three in the year exclusive of any student who holds a Scholarship of higher value.

Aloha Innovation Fund
This fund was established in 2003 through a generous donation by an anonymous donor. The fund is for undergraduate students in the Department of Electrical & Computer Engineering and includes prizes for undergraduate projects that show innovation and excellence in team work and execution, funding for well planned and innovative project proposals or awards to students who are judged to have demonstrated a high degree of innovation in any of their academic activities.

AMC Electrical and Computer Engineering Scholarship
Established in 2010 through a generous donation by AMC Canada, this scholarship is given to 2 students completing Year 3 of Electrical or Computer Engineering. One to a student whose focus is on hardware engineering and one to a student whose focus is on software engineering as demonstrated through relevant course(s). The awards will be made on the basis of outstanding academic achievement and demonstrated leadership. Successful candidates must demonstrate an obvious commitment to, and interest in, CPU, GPU as well as semi-conductors.

American Concrete Institute, Ontario Chapter Scholarship
Established in 1992 through the generosity of The Ontario Chapter of the American Concrete Institute, this Scholarship is awarded, on the recommendation of the Chair, to a student graduating from the Department of Civil Engineering with the most meritorious final year thesis related to the use of concrete.

Anchor Schoring & Caissons Ltd. Scholarship
Created in 2009 through a generous donation by Anchor Schoring & Caissons Ltd., this scholarship is awarded to full-time students completing Second or Third year of Civil Engineering specializing in structures and/or geotechnical. Academic achievement and extra-curricular activities will also be considered.

APWA Ontario Chapter Bruce Brunton Award
Established in 2000 by the Ontario Chapter of the American Public Works. It is to be awarded to a student in any year in Civil Engineering on the basis of financial need, and academic achievement sufficient enough to proceed to the next year of the Program. The value of the Award is $500.

Ardagh Scholarship
The Ardagh Scholarship has been provided by Professor E.G.R. Ardagh, B.A.Sc., F.R.S.C., formerly professor of Applied Chemistry, in memory of his
parents.
It is awarded to a student completing Second year of Chemical Engineering who has demonstrated academic achievement and exemplary leadership within the University or broader community. The first award was made on the results of the annual examination in 1946.

**Wellington Thomas Ashbridge Memorial Bursaries**
Established by members of the family of Wellington Thomas Ashbridge, C.E., a graduate of the School of Practical Science in 1888, this fund provides bursary assistance to students in good standing in any year of the Civil Engineering Program who are in need of financial assistance. In any session any residue of income remaining after the awards to Civil Engineering students may be used to provide bursaries for students in other Programs in the Faculty.
Application is made on the Undergraduate Grant Application Form.

**The Babb Bursary Fund**
Bursaries from this fund are available to students in any year of the Aerospace Option in Engineering Science. Application is made on the Undergraduate Grant Application Form.

**Baptie Scholarship**
The Baptie Scholarship is derived from a bequest under the will of the late Mrs. Margaret W. Baptie of Ottawa. The Governing Council has directed that a Scholarship of one half the annual income shall be awarded annually to an engineering student on the record of his or her First year. The Board of Governors also authorizes a remission of fees in the case of the holder of the Scholarship, up to $75. The conditions of the award are that the Scholarship be awarded to the student who, in the annual examinations of First year, enrolled in any of the programs of Civil Engineering, Mechanical Engineering, Chemical Engineering, Electrical Engineering, Computer Engineering, or Materials Engineering, obtains the highest aggregate percentage of marks in those subjects which are common to the First year curricula of those courses. The first award was made in the 1925-26 Session.

**Jack and Barbara Baron Scholarship**
This scholarship is awarded to a student entering Second Year (full-time) of any undergraduate program, having completed First Year of Track One in the Faculty. Recipients will be selected on the basis of financial need and strong academic achievement.

**Ben Bernholtz Memorial Prize in Operational Research**
This prize, of the value of the annual income, is awarded to the student completing the Third year of the Industrial Engineering Program who achieves the highest aggregate mark in the two courses Operational Research I and II. The prize was established in 1980 by colleagues and friends of the late Dr. Ben Bernholtz, twice Chair of the Department of Industrial Engineering and a founder of the Canadian Operational Research Society. Should the candidate be qualified for another award of higher value, the award may be reverted to the student with the next highest aggregate mark in the specified courses.

**The Edith Grace Buchan Summer Research Fellowship**
A summer research fellowship is provided by a bequest of the late Edith Grace Buchan. The fellowship is open to students who have completed the First, Second or Third year in any program in the Faculty. Interested students should apply by application to the chair of their department early in the Winter Session. The selection will be made on the basis of the applicant’s academic background and interests.

**The Burge-Connell Bursary**
Provided through the generosity of the Women’s Association of the Mining Industry of Canada, this bursary is open to students in Second year in Geology or Lassonde Mineral Engineering. Consideration will be given to academic standing and financial need. The recipient must be a Canadian citizen or permanent resident and show an interest in pursuing the study and application of geological science both on earth and on other planets. Application information can be obtained from the Office of the Registrar in the Faculty of Applied Science & Engineering.

**Carman Burton Bursary**
This bursary was established in 1986 in memory of the late Carman Burton (2T0, Electrical Engineering) by his wife, Mrs. C.E. Burton. The annual income from a capital donation will provide bursaries to students registered in the Faculty in any undergraduate program on the basis of good academic standing and financial need. Application should be made on the Undergraduate Grant Application Form.

**Norman E. Byrne Award**
This Award is made annually by the University Masonic Lodge in honour of one of their members, a Past Grand Master of the Grand Lodge of Canada in Ontario, Mr. Norman E. Byrne, a graduate of Mechanical Engineering, Toronto. The Award will be made on the recommendation of the Chair on the basis of financial need, academic excellence, and qualities of character as demonstrated by University and Community activities to a student who has completed the First, Second or Third year of the Mechanical Engineering Program. The value of the Award is $1000.

**John Dixon Campbell Memorial Prize**
Established in 2004 by friends, family, and colleagues of the late John Dixon Campbell, this award, in the form of a certificate, is granted to a student in Fourth year of any program in the Faculty who has the highest academic merit in the area of Maintenance Optimization and Reliability Engineering. Should the recipient of this Prize demonstrate financial need, he or she will be eligible to receive the John Dixon Memorial Scholarship as well.
Scholarships and Financial Aid

#2 Canadian Army University Course Award
Established in 2002, this Award is granted to a student entering Third year of any undergraduate program on the basis of high academic achievement and participation in other activities, i.e. sports, drama, school activities. The student must demonstrate financial need.

Canadian Society of Industrial Engineering Scholarship
The Toronto Chapter, Canadian Society for Industrial Engineering, offers a Scholarship of $300 to a student entering the Fourth year of the Industrial Engineering Program. The student must have consistently maintained high, though not necessarily honours standing, during the previous three years, and must be an active member of the University of Toronto Student Chapter of C.S.I.E. The selection will be made on the recommendation of the Chair of the Department of Mechanical & Industrial Engineering.

Canadian Society for Chemical Engineering Medal
The Canadian Society for Chemical Engineering provides a medal and a cash award of $100 to the student registered in the Chemical Engineering Program who, having achieved Honours, receives the highest standing in the written and laboratory work of the Third year. The first award was made on the results of the final examinations of 1947. From 1985 onwards, the cash portion of the prize is provided through the generosity of the Local Toronto Chapter of the Canadian Society for Chemical Engineering.

Centennial Thesis Awards
The Centennial Thesis Awards were established in 1972-73 in honour of the Centennial of the founding of the Faculty in 1873. To recognize excellence in Fourth year thesis work, one award is made annually in each of the Faculty’s nine degree programs, based on departmental recommendations. The Award is in the form of a $50 prize and an accompanying certificate.

The Wallace G. Chalmers Engineering Design Scholarships
In 1986, Mrs. Clarice Chalmers established the Wallace Chalmers Engineering Design Awards to encourage and provide recognition for students in the Mechanical Engineering creative design courses. In 1997, Mrs. Chalmers converted the Wallace Chalmers Engineering Design Awards to the Wallace G. Chalmers Engineering Design Scholarships in order that the Scholarship may continue in perpetuity. These Scholarships are to encourage and provide recognition for students in the Mechanical Engineering creative design courses. Three design awards are available each year but will only be awarded when the leading candidates have clearly displayed outstanding design ability and originality. Wallace Chalmers graduated in 1950 from the Department of Mechanical Engineering at the University of Toronto. Throughout his career, Mr. Chalmers demonstrated a keen interest in design and perceived the need to place greater emphasis on the design aspect of engineering education. One award is available for each of Second, Third, and Fourth year.

The Second year award is for a student enrolled in MIE221H1S Manufacturing Engineering. This award is targeted at the design achievement attained in the project component of this course. The third year award is for a student enrolled in MIE301H1F Kinematics and Dynamics of Machines. The award is directed to the individual who has clearly demonstrated design originality and creativity in the course work of this course identified above. The Fourth year award is available for a student who has demonstrated exceptional design capability in the course MIE496Y/F/S Thesis. The five leading candidates for each award will be invited to present their designs to a panel of designers who in turn will nominate the winner. The design panel will be appointed by the Chair of the Department of Mechanical & Industrial Engineering.

Chemical Institute of Canada Book Prize (Toronto Section)
This award consists of a $100 book prize plus a certificate and a one year membership in the relevant constituent society of the CIC. The award is presented to the student in Third year of the Chemical Engineering Program who has shown the most improvement in a chemistry and/or chemistry related program. The award does not necessarily go to the student who achieves the second highest standing in a particular program.

CISC/Walters Inc. Scholarship
This award, valued at $2000, was established in 2003 by the Canadian Institute of Steel Construction and is given to a student who has completed Third year of Civil Engineering on the basis of overall academic performance in Steel & Timber Design.

5T6 Civils Scholarship
The 5T6 Civils, consisting of the graduating members of the 1956 Civil Engineering Class of the University of Toronto, have established an annual Scholarship of $3000 open to students who have completed the Second year of the Civil Engineering Program and are registered in the Third year of the Program. Application is not required. The award will be based on a recommendation by a selection committee composed of the Department of Civil Engineering Undergraduate Student Counsellor, and two other members of the teaching staff, who are acquainted with the students in Third year of the Civil Engineering Program. The selection of the recipient is based on qualities of scholarship, leadership and character. In addition to high academic marks, the recipient will also be involved in extra curricular activities to demonstrate the qualities of leadership and character. The award is presented at the annual reunion of the Class of 5T6 Civils and is not tenable with any other scholarship of greater value. The first award was made in 1964.

Ross L. Clark Memorial Scholarship
The friends of Ross L. Clark, 3T7 Civil graduate, have set up a scholarship to honour his substantial contributions to municipal and environmental engineering, practiced so well by him as Commissioner of Works for Metropolitan Toronto for many years. The value of the Scholarship is the annual income. It will be awarded to a student entering the Fourth year of the Civil Engineering Program, who has demonstrated a significant interest in Environmental Engineering and has a high academic standing. Recommendation for the Scholarship is made by the Chair of the Department of Civil Engineering. The Scholarship is not tenable with other awards of $1,000 or higher value. Application is not required.
Established in 2011 from the Estate of the late Satinder Kaur Dhillon, this award is given to a student completing First or Second year of Engineering.

Satinder Kaur Dhillon Memorial Scholarship

Established in 2010 from the estate of the late Joseph A. Devine, one or more bursaries awarded to students on the basis of financial need.

Joseph A. Devine Bursary

Delcan Scholarship in Civil Engineering

Valued at $750, this Scholarship is provided by De Leuw Cather Canada Ltd. in memory of the late Jack Spiegelman (B.A.Sc., Civil Engineering, 1951).

Gavin Dass Memorial Scholarship

This Award was established in 2004 through the generosity of James Ham. Professor Ham, a 4T3 Electrical Engineering graduate, served as the Head of the Department of Electrical Engineering in 1964 and then as Dean of the Faculty for seven years starting in 1966. From 1974-76 he chaired the Royal Commission on Health and Safety of Workers in Mines. His Commission's Report was the impetus for the government's 1978 Occupational Health and Safety Act governing worker safety in the Province of Ontario. The Report's challenge to the mining industry to develop and maintain an Internal Responsibility System (IRS) for the protection of workers has been heeded by many other industries as well. The IRS model is now the recognized standard for safe and healthy workplaces around the world. James Ham became Dean of the School of Graduate Studies in 1976 and, two years later, University President for a period of 5 years. While still President, in 1980, Professor Ham was bestowed with our country's highest honour, the Order of Canada. After his term as President, Professor Ham returned to teaching for the Department of Industrial Engineering.

This Award is granted to a student entering either Third or Fourth year of any undergraduate program. The recipient must have achieved an average of 70% or higher. In addition, the Award will be made on the basis of demonstrated leadership qualities as exhibited through participation in athletics, community involvement, and/or student council activity. The recipient must be a Canadian citizen or Permanent Resident.

Class of 4T7 Bursaries

These Scholarships, established in 1997, are provided by the generosity of the Class of 4T7. The awards, derived from the annual income, are awarded to a student in the Faculty on the basis of financial need. Applications should be made on the Undergraduate Grant Application Form.

Class of 5T5 Civil Engineering Scholarship

Established in 2004 through the generosity of the Class of 5T5 Civil Engineering, this award is granted to a student entering Fourth year of Civil Engineering on the basis of financial need. Preference is given to students who have excelled academically. Additional preference is given to students who have demonstrated leadership qualities as exhibited through student counsel activity, participation on Faculty/University teams and clubs, community involvement, and participation in athletics.

Class of 5T9 Chemical Engineering Leaders of Tomorrow Award

This Award was established in 2006 through a generous donation by the Chemical Engineering Class of 5T9. The objective of this Award is to recognize students in their Third year of Chemical Engineering who have shown the potential to become outstanding leaders, and to inspire others to action and to excellence. This may be demonstrated in a number of ways, including participation in student council or clubs, community organizations, cultural groups or athletics. Candidates should enumerate their service to others through volunteering or community work.

Gavin Dass Memorial Scholarship

Established in the Faculty of Arts and Science, on the recommendation of the Department of Physiology, this award is granted to a student completing Fourth year of the Specialist or Major Program in Biology and Physics, the Specialist Program in Theoretical Physiology, or the Biomedical Engineering option in Engineering Science. The student should have shown a strong interest in theoretical physiology, either through classroom projects or summer research, and should additionally have shown an interest in the world around him/her. The student should have some significant involvement in student or community organizations.

A letter outlining the applicant’s extra-curricular activities and motivation for studying theoretical biology and should be submitted to the Department of Physiology by April 1.

Hanna Wejtko De Angelis CIV6T0 Scholarship

This Scholarship was established in 2011 by the Department of Civil Engineering in honour of the first 5 women to graduate from Civil Engineering, of which Hanna Wejtko De Angelis is one. The award, valued at $500, is given to a student entering Second year of Civil Engineering, having completed First year of any program in the Faculty, who achieves the 3rd highest mark in the first year Statics course (CIV100/102). The award is not tenable with other merit-based scholarships of greater value. Should this be the case, the award would revert to the next qualifying student.

Roger E. Deane Memorial Scholarship

This Scholarship, which has a value of up to $250, was established in memory of Professor Roger E. Deane by his colleagues within the University and the geology profession, in commemoration of his distinguished contributions to geology.

It is to be awarded annually to the students, full or part-time, showing the best performance at the Department geological field camp.

Delcan Scholarship in Civil Engineering

Valued at $750, this Scholarship is provided by De Leuw Cather Canada Ltd. in memory of the late Jack Spiegelman (B.A.Sc., Civil Engineering, 1951). Mr. Spiegelman was former Director and Chief Transit Engineer of the Company.

The award is made on recommendation of the Chair of the Department to a student entering the Fourth year of the Civil Engineering Program who has achieved high standing, with Honours, on the examinations of the Third year, and who has demonstrated qualities of character and leadership indicative of becoming a worthy member of the profession. The Scholarship is not tenable with other awards of greater value. Application is not required.

Joseph A. Devine Bursary

Established in 2010 from the estate of the late Joseph A. Devine, one or more bursaries awarded to students on the basis of financial need.

Satinder Kaur Dhillon Memorial Scholarship

Established in 2011 from the Estate of the late Satinder Kaur Dhillon, this award is given to a student completing First or Second year of Engineering.
Scholarships and Financial Aid

Science on the basis of outstanding academic achievement.

G.W. Ross Dowkes Memorial Prize
Donated by W.J. Dowkes, a graduate of the class of 1962, in memory of his father, the late G.W. Ross Dowkes, this prize is awarded to the student in the Chemical Engineering Program who, in the opinion of the Chair, has demonstrated the most marked improvement in academic standing. Preference is given to a final-year student.

Canadian Society for Mechanical Engineering Earl H. Dudgeon Bursary
This bursary was established in 1997 through the generosity of T. Christie Arnold. The bursary is awarded to a student in any year of the Mechanical Engineering Program on the basis of financial need. Application should be made on the Undergraduate Grant Application Form.

Stuart Ellam Grant
The income from a capital fund established from the estate of the late Ida Maud Lillian Ellam in memory of her late son Stuart Ellam. The grant is given to an undergraduate student in the Faculty on the basis of financial need. Application should be made on the Undergraduate Grant Application Form.

The John M. Empey Scholarships
This Fund was established under a bequest of $10,000 in the will of the late John Morgan Empey, B.A.Sc., 1903. Three scholarships of equal value are provided from the income from the fund. One of these is awarded in each of the First, Second, and Third years on the annual examinations, to a student who, obtaining Honours, achieves the highest average percentage of marks in the written and laboratory subjects of the Year. The Scholarships are open to any students registered in the Faculty. In case the winner does not attend the Faculty during the session following the award, the right to the Scholarship will be forfeited and the award will be made to another eligible student. The Scholarships were awarded for the first time in 1944.

Enbridge Scholarship in Engineering
Established in 2006 through a generous donation by Enbridge Gas Distribution Inc., this award is awarded to a student entering the Third year of any undergraduate program in the Faculty. The recipient must have achieved a minimum B average in Second year. Preference will be given to a student who demonstrates significant community involvement and volunteerism. Additional preference will be given to a student who exhibits leadership qualities as demonstrated through involvement in extra-curricular activities, athletics, and student council.

Engineering Alumni Centennial Bursaries
Through the generosity of the Engineering Alumni Association, several bursaries have been established in the Faculty of Applied Science and Engineering. These are awarded on the basis of academic achievement and financial need, with preference being given to students in the Third and Fourth years. Application should be made on the Undergraduate Grant Application Form.

5T3 Engineering Award
The Class of 5T3 established the 5T3 Engineering Award in 2003. This award is given to a Third year, full-time or part-time, student in any undergraduate program on the basis of high academic achievement, financial need, and qualities of character and leadership as demonstrated through involvement in extra-curricular activities both within the University and the community at large. Recipients must be Canadian Citizens or permanent residents.

Engineering 8T4 Leadership Award
Established in 2009 by the Engineering Class of 8T4, this award is given to a student entering Second, Third or Fourth year (full-time) of any program in the Faculty on the basis of high academic achievement. Recipients must have demonstrated leadership skills through involvement in extra-curricular and/or community involvement. Financial need may also be considered.

Engineering Class of 5T6 Award of Merit
The Award of the value of the annual income will be granted to a student who completes First year, of any undergraduate engineering program. In addition to having excelled in their academic studies, the recipient must demonstrate qualifications of character and leadership through involvement in extracurricular activities either within the University of Toronto or the community at large. Nominations will be made by the Engineering Society, in consultation with members of the Class of 5T6 wherever possible. The recipient will also receive a certificate.

Engineering Science Chairs' Scholarship
This Award was established in 2011 through generous donations by former Chairs of the Division of Engineering Science. The award is given to a student completing the Foundation years and proceeding to Third year of Engineering Science, on the basis of outstanding academic achievement and extra-curricular involvement. Chair's Recommendation.

Engineering Science Foundation Scholarship
This Award was established in 2011 through a generous donation by Dr. Rong Kai Hong. The award is given to three students entering, full-time, the Third year of Engineering Science, on the basis of strong academic achievement and upon recommendation of the Chair (or alternate) of the Division of Engineering Science.

Enwave Design Awards
These awards were established through the generosity of Enwave District Energy Limited. Two awards are given to students (or team of students) who are enrolled in the designated “Capstone” Design Courses and whose project has an environmental and/or sustainability related focus.
Scholarships and Financial Aid

Enwave Graduating Awards of Distinction
These Awards were established in 2004 through the generosity of Enwave District Energy Limited. Each year there will be four awards given. These are to be known as the Enwave Scholarship in Chemical Engineering, the Enwave Scholarship in Electrical Engineering, the Enwave Scholarship in Environmental Engineering and the Enwave Scholarship in Sustainable Energy. Candidates will be nominated by the Chair of the respective department or designate. Selection will be made on the basis of academic performance* in the Fourth year and the following:
For Chemical Engineering: Preference will be given to students who demonstrate a particular aptitude for studies related to alternative energy technologies.
For Electrical Engineering: Preference will be given to students who demonstrate a particular aptitude for studies related to power generation and distribution.
For Environmental Engineering (Minor): Preference will be given to students who demonstrate an aptitude for studies related to environmental sustainability and sustainable development.
For Sustainable Energy (Minor): Preference will be given to students who demonstrate an aptitude for studies related to sustainable energy.
* Academic performance in the designated areas may be determined through specific course work and/or intellectual quality of the Fourth year thesis.

ERCO Worldwide Leaders of Tomorrow Award
This award was established in 2011 through a generous donation by ERCO Worldwide Division of Superior Plus LP. The award is given to a student in Third or Fourth year of Chemical Engineering who has shown the potential to become an outstanding leader and to inspire others to action and to excellence. This may be demonstrated in a number of ways, including participation in student councils or clubs, community organizations, cultural groups, or athletics. Applicants should enumerate their service to others through volunteering or community work.

Etkin Medal for Excellence
This Etkin medal was established by University Professor Bernard Etkin, formerly Chair of Engineering Science (1967-1972) and Dean of the Faculty (1973-1979). It will be first awarded in 2003. It is an award for academic excellence that commemorates a career-long interest in the theory and application of solid and fluid mechanics, subjects he taught for many years to students in Engineering Science, and which were the basis of most of his research and professional work. The award is presented to a Third year student in Engineering Science. In each year, the Chair of Engineering Science chooses one or more courses from among the relevant offerings in solid and fluid mechanics in the second and Third year curriculum and nominates the recipient of the medal for outstanding performance in those courses.

Faculty of Applied Science and Engineering Leadership Award(s)
Established in 2006, these Awards are available for students entering Second, Third, or Fourth year of any program in the Faculty. Though academic ability is considered, candidates must have shown the potential to become outstanding leaders, and to inspire others to action and excellence. This may be done through participation in student council or clubs, community organizations, cultural groups or athletics. Candidates should enumerate their service to others through volunteering or community work.

Manual A. Fine Scholarship
Established in 2009 through a generous donation by Heavy Construction Association of Toronto, this award is given to a student entering Third or Fourth year (full-time) of Civil Engineering on the basis of strong academic achievement and a demonstrated interest in construction as evidenced by their focus of study, extra-curricular activities and/or summer employment.

J.A. Findlay Scholarships
These Scholarships were established through a legacy bequeathed by the late Janet Findlay to the Department of Mechanical & Industrial Engineering. Two scholarships are available, each the value of half the fund’s income. One is for a Third year student in the Mechanical Engineering Program, the other for a Fourth year student, but only if the student continues in the Mechanical Engineering Program.

The Denis Flynn Memorial Scholarship
Established through the generosity of the Metropolitan Toronto Road Builders Association, this award has a value of $1,000 and is granted to a student completing the First year of the Civil Engineering Program on the basis of good academic standing and qualities of character and leadership. In order to enjoy the award the recipient must register in the Second year of the Program.

The James Franceschini Foundation Scholarship
Scholarships of the annual value of the income of this foundation are awarded to students in First, Second and Third year of the Civil Engineering Program who achieve high standing, with Honours, at the annual examinations.

Hugh Gall Award
The Hugh Gall Award was established in 1946 by the graduate class of 1910 “to commemorate a deceased classmate who was a splendid type of student, a loyal friend, and nationally outstanding in athletic achievement during his undergraduate career.”

Upon expiration of the original gift in 1951 the Award was supported by Mrs. Hugh Gall until her death in 1970; under the terms of her will a sum of $5,000 was provided to support the Award in perpetuity, the annual value of the Award being the income from the bequest.

The Award is made to a student who, having completed First year with a general average of at least 66% without conditions, has entered the Second year, and needs financial assistance to continue. It is desirable, but not necessary, that the recipient not already have been given any other scholarships or study for any other scholarship applicable to the Second year, and shows indications of a firm intention and ability to follow successfully the profession of...
Scholarships and Financial Aid

Applications should be made on the In-course Bursary Form.

Vern Gomes Memorial Award
Established by classmates and friends of the late J. Vernon Gomes, this Award, of the approximate value of $65, is made to the student entering the Fourth year of Electrical or Computer Engineering who, having obtained an average not lower than 60% in Third year, is considered by the Electrical and Computer Engineering Student Staff Committee to have made the most valuable contribution to the class.

The Blake H. Goodings Memorial Award in Mechanical Engineering
The Blake H. Goodings Memorial Award was established in 1987 by his wife, Mrs. Gloria Goodings, in memory of her husband, a graduate of this Faculty in 1949.

Goodings Memorial Award is tenable with other awards.

Greater Toronto Sewer and Watermain Contractors Association Award in Civil Engineering
The Greater Toronto Sewer and Watermain Contractors Association provides this award of the value of $1,000. It is granted to a student entering the Fourth year of the Civil Engineering Program who has demonstrated excellent academic excellence and who has shown significant interest in municipal engineering through summer employment and choice of elective courses. Recommendation for the Award is made by the Chair of the Department, in consultation with the donor. In addition to academic standing, qualities of character and leadership as evidenced by involvement in University and extracurricular activities will be considered.

H.J. Greeniaus ESROP Fellowship
This award was established in 2002 by the H.J. Greeniaus family and is awarded to a student who has been accepted to the ESROP Program, which has been created to provide undergraduate students in Engineering Science with the opportunity to undertake research over the summer with a faculty member.

The George A. Guess Scholarships
The estate of Edna F. Guess, wife of George A. Guess, formerly Head of the Department of Metallurgical Engineering & Materials Science, has bequeathed funds to the University to establish the George A. Guess Memorial Fund for the assistance of needy students in the Materials Engineering Program.

The annual income of the Fund is used to provide graduate fellowships, summer studentships and an undergraduate fund in the Department; and two kinds of undergraduate scholarships: the Guess Admission Scholarship and the Guess In-Course Scholarships in recognition of academic achievement in the Faculty.

The Guess Admission Scholarship is awarded to student(s) with high standing in the subjects needed for admission to the First year of the Materials Engineering Program. The Guess In-Course Scholarships are to be awarded to students completing First, Second or Third year of materials Engineering as the basis of achieving a minimum average of 75%. In addition, extra-curricular/leadership qualities may also be considered.

Frank Howard Guest Admission Bursary
Established in 1995, this bursary is awarded to students entering the First year of any undergraduate program in the Faculty of Applied Science & Engineering on the basis of academic achievement and financial need. Applicants must submit a Statement of Financial Need to the Central Admissions & Awards Office, 315 Bloor Street West, Toronto.

Frank Howard Guest In-Course Bursary
Established in 1995, this bursary is awarded to students enrolled in any year of any undergraduate program in the Faculty of Applied Science & Engineering on the basis of academic standing and financial need. Applicants must complete the regular Undergraduate Grant Application form. Special attention will be given to applicants who are participating in exchange programs in other universities and countries.

B. Conrad Hansen Memorial Award Fund
The fund was established in 1979 in memory of the late B. Conrad Hansen, B.A.Sc., Electrical Engineering, 1962. The income from the fund is used to provide one or more bursaries for students in need of financial assistance, preference being given to students in the Second or Third year of Electrical or Computer Engineering.

Sydney George Harris Bursary
Established in 1994, the bursary is granted, on recommendation of the Chair, to a student entering either Third or Fourth year in any program. In addition to mental capacity, the student must show leadership ability and give promise, through activities, of becoming a worthwhile influence in the affairs of the profession and community. While attention is given to scholastic ability, as evidenced by academic standing, it is not the governing factor. The recipient must, however, stand in the top quarter of the class. Special consideration is given to financial need. The annual value is approximately $1,000.

Glenn P. Hauck Memorial Scholarship
Established in 2010, through a generous donation by Stephen and Linda Hauck, this scholarship will be given to a student entering Third Year of Engineering Science who is facing challenges with dignity and perseverance and who participates in extra-curricular activities. Recommendation by the Chair of the Division.

Dr. Arthur Herrmann Memorial Award
The family of Dr. Arthur Alexander Herrmann has established a memorial fund in memory of the 100th anniversary of his birth (July 4, 1891). The Award
is derived from the income of the fund and will be granted to a Fourth year student in the Mechanical Engineering Program whose major interest and thesis topic reflect concern for the protection of the environment.

Dr. Herrmann won international recognition as an expert on plywood and its applications; he invented a machine for the manufacture of plywood pipes or tubes, and was a well-known researcher, lecturer, and author.

**Mackay Hewer Memorial Prize**
This prize, of the value of the annual income, was established in memory of the late Professor Mackay Hewer, a member of the teaching staff in the former Department of Mining Engineering, and later in the Department of Chemical Engineering and Applied Chemistry. It is awarded to the student completing the Fourth year of the Chemical Engineering Program who achieves the highest standing in Fourth year courses related to environmental studies. The first award was made in 1980-81.

**General D.M. Hogarth Bursary**
Established in 1992, this bursary is awarded to students registered in any year in either Lassonde Mineral Engineering or Materials Engineering on the basis of financial need. Applicants must complete the regular Undergraduate Grant Application form.

**Otto Holden Scholarship**
Otto Holden, B.A.Sc., C.E., D.Eng., was a distinguished hydraulic engineer of international reputation. He served Ontario Hydro for 47 years and retired as Chief Engineer in 1960, having been involved in almost all of the major hydro-electric developments in Ontario. On his death, Mr. Holden left a sum of money that was later augmented by his widow, the late Florence Holden, to establish a scholarship in the Faculty of Applied Science and Engineering. This Scholarship, which has a value of approximately $900, is awarded to the student who, completing the Fourth year of either Civil Engineering or Mechanical Engineering with Honours, achieves the highest aggregate marks in hydraulic engineering subjects in the Program. The first award was made in the 1967-68 session.

**Dr. Vahe Philip Hovnanian Award for Excellence in Chemical Engineering**
This Award was established in 2003 through the generous donation of Dr. Vahe Philip Hovnanian. The Award, valued at the equivalent of $1,000 US, is made to an undergraduate student in Chemical Engineering in the basis of outstanding academic ability (top half of the class) and financial need.

**William V. Hull Scholarship**
Established in 1981 from a bequest of the late William V. Hull, this award of the annual value drawn from the income of the fund is made to a student ranking in first place in any program on the examinations of the Third year.

**Husky Injection Molding Systems Ltd. Award(s)**
Established in 2010 through a generous donation by Husky Injection Molding Systems Ltd. Four awards are provided annually to students entering 2nd year of Mechanical Engineering after successful completion of 1st year in any program in the Faculty. The awards are made on the basis of strong academic achievement and financial need.

**Neil B. Hutcheon Building Science Scholarship**
Two awards available for students with the highest and second highest marks in CIV575H1.

**IEEE Canada-Toronto Section Scholarship**
This Scholarship, of the value of $2000, is provided by the generosity of the Toronto Section of the Institute of Electrical and Electronics Engineers, Inc. (IEEE). It is awarded to a student completing the Third year in the Department of Electrical and Computer Engineering who has the highest academic standing in the examinations of the year. In order to enjoy the Scholarship, the student must register in the Fourth year of the Program. The first award was made in 1982.

**IEEE Canada-Toronto Section Bruno N. Di Stefano Scholarship**
This Scholarship, of the value of $2000, is provided by the generosity of the Toronto Section of the Institute of Electrical and Electronics Engineers, Inc. (IEEE) in honour of Bruno N. Di Stefano. It is awarded to a student completing the Third year in the Department of Electrical and Computer Engineering who has the highest academic standing in the examinations of the year. In order to enjoy the Scholarship, the student must register in the Fourth year of the Program. The first award was made in 1982.

**IEEE Canadian Foundation Scholarship**
Established through the generosity of the Institute of Electrical and Electronics Engineers, Inc. (IEEE), this Scholarship is granted to a student completing Third year of Electrical Engineering on the recommendation of the Chair of the Department, the Chair of the IEEE Student Branch and the IEEE Student Branch Counsellor. In addition to good academic standing, the recipient must demonstrate a sincere interest in, and commitment to the activities of the IEEE McNaughton Learning Resource Centre.

The candidate application must be accompanied by a written report on the activities of the Centre and submitted to the IEEE Student Branch Counsellor by February 15. Nominations must be submitted by the IEEE Student Branch Counsellor in writing or online to the IEEE Canadian Foundation by March 15.

**Inspec-Sol Scholarship Fund**
Established in 2010 through a generous donation by Inspec-Sol Inc. This award is granted to a student entering 3rd or 4th year, full-time, Civil Engineering. Recipients must have achieved a minimum of 80% in courses related to Geotechnical Engineering; demonstrated leadership, community involvement and financial need will also be considered. Recipients must be Canadian citizens or permanent residents.

**Sue Joel CIV675 Scholarship**
This Scholarship was established in 2011 by the department of Civil Engineering in honour of the first 5 women to graduate from Civil Engineering, of
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which Sue Joel is one. The award, valued at $500, is given to a student entering Second year of Civil Engineering, having completed First year of any program in the Faculty, who achieves the 4th highest mark in the first year Statics course (CIV100/102). The award is not tenable with other merit-based scholarships of greater value. Should this be the case, the award would revert to the next qualifying student.

The L.E. (Ted) Jones Award of Distinction
The Award was established to acknowledge the contributions of L.E. (Ted) Jones, Professor Emeritus of Mechanical Engineering (on staff: Applied Physics, 1936-44; Mechanical Engineering, 1944-75) and Engineering Archivist (from 1970), over his long and distinguished career, to students, alumni and the Faculty, as well as his continuing support and dedication to the Engineering Society and the Engineering Alumni Association of the University of Toronto. The Award endorses Ted’s great appreciation of the arts and his love of music in particular.

The Award is presented annually to a graduating student in the Faculty of Applied Science and Engineering who has achieved distinction in his or her academic program while making a significant contribution in the musical field during the year at University. Sponsored by the Engineering Alumni Association, the Award consists of a certificate of recognition presented annually at the Grad Ball and subsequently at Spring Reunion.

Nominations for the Award may be submitted to the Engineering Alumni Office by undergraduate students, members of the Faculty, or alumni by January 31 of the year in which the Award is to be given. Nominations should include sufficient information for the Committee to determine the merits of the nominee. The Committee reserves the right to suspend presentation of the Award if suitable candidates are not identified in any year. The selection Committee will comprise the Director-Alumni Relations, a member of the Faculty, the President and first Vice-President of the Engineering Alumni Association, the President and the Fourth year Chair of the Engineering Society.

The first Award was presented in the spring of 1997 and will be awarded annually thereafter.

Margaret Kende CIV6T0 Scholarship
This Scholarship was established in 2011 by the Department of Civil Engineering in honour of the first 5 women to graduate from Civil Engineering, of which Margaret Kende is one. The award, valued at $500, is given to a student entering Second year of Civil Engineering, having completed First year of any program in the Faculty, with the most improvement between first and second term of First year as measured by the full-time term averages. The award is not tenable with other merit-based scholarships of greater value.

Lassonde Scholarships
The Lassonde Scholarships were established through the generosity of Mr. Pierre Lassonde. These Scholarships, derived from the annual interest of the capital fund, will be granted as follows: Several awards granted on admission to the Lassonde Mineral Engineering Program or Lassonde Institute of Mining based on academic standing and qualities of character and leadership. These awards are renewable once provided honours standing is maintained and provided the recipient proceeds to the Second year of the Lassonde Mining Program. If the Scholarship(s) is not renewed, it will be awarded by reversion to the best qualified candidate. The remaining scholarships are to be divided among students in the Second, Third and Fourth years of the Lassonde Mineral Engineering Program on the basis of academic standing and qualities of character and leadership. The recipients of these awards will be known as the Lassonde Scholars.

Lassonde Bursaries
In addition to the above scholarships the Lassonde Bursaries have also been established. The bursaries will be granted on the basis of financial need to students in any year of the Lassonde Mineral Engineering Program.

Applicants must complete the regular Undergraduate Grant Application form.

Stavros Leventis Award
Provided by Mrs. Elisha Leventis, classmates 6T8 and friends of the late Stavros Leventis, this Award is given to a student in Second or Third year of Electrical Engineering who, while maintaining a B average or better, contributes to the University and community at large through volunteer participation. The student must possess qualities of leadership and integrity and demonstrate a keen interest in computers.

Charles A. Lowry Prize
Gift of the late Mrs. B. Lowry, this prize is awarded to a student in Mechanical, Electrical, or Computer Engineering who, having successfully completed the First year in the Faculty of Applied Science and Engineering, achieved the highest mark in the course CIV101F, Structures, Materials and Design.

The Earl Charles Lyons Memorial Award
The Earl Charles Lyons Memorial Award was established in 1983 by his wife, Mrs. Earl C. Lyons, in memory of her husband, a graduate of this Faculty in 1933.

The Award, which is set up in perpetuity, is of the value of the annual income of a capital donation. It is made on the recommendation of the Chair of the Department of Mechanical & Industrial Engineering to a student completing the Third year of the Mechanical Engineering Program with Honours. In addition to academic standing, consideration will be given to character and leadership capabilities through involvement in student and professional activities. This Award is not tenable with other awards. The first award was made in the 1983-84 Session.

James Turner MacBain Scholarship and Bursaries
Established in 1990, this bequest from the estate of James Turner MacBain provides awards annually from the income of the fund. The James Turner MacBain Scholarship, derived from half of the income, is awarded to a student entering the First year in any program in the Faculty on the basis of academic excellence.

One half of the annual income will provide one or more bursaries to students registered in any year in the Faculty on the basis of financial need. Application for the James Turner MacBain bursaries should be made on the Undergraduate Grant Application form. The first awards were made in the 1991-92 session.

The Elsie Gregory MacGill Memorial Scholarship
Established in 1995, this award is granted to an outstanding female student in the Fourth year of any program in the Faculty on the basis of academic standing and demonstrated commitment to women's issues within the Faculty and the community at large. In addition to academic standing, qualities of
character and leadership abilities are also considered. The award will alternate with the Faculty of Arts & Science.

The Alexander MacLean Scholarship
The Scholarship was established by graduates of the University of Toronto and other friends in honour of Professor Alexander MacLean, B.A.(1908) who retired in 1954. The Scholarship is awarded to an outstanding student in GLG 318H and/or GLG 319H in the Department of Geology, Faculty of Arts and Science, or completing Third year of Lassonde Mineral Engineering, Faculty of Applied Science and Engineering. The first award was made in 1955.

MacLennan-MacLeod Memorial Prize
The Graduating Class of 1910 has donated an annual prize in memory of their first Class President, George MacLennan, who was killed in action in France in 1917, and of Doug MacLeod, their first Secretary, who died in France in 1916 from wounds received in action. The prize, of the value of approximately $25, is awarded to the First year student in the Faculty of Applied Science and Engineering who ranks highest in Calculus among those who obtain standing without condition at the annual examinations; or, in the event of more than one student obtaining equally high rank in Calculus, to the one of these who also has the highest standing in some other subject common to the competitors, such as Algebra, such subject to be determined by the Council of the Faculty. An award will not be made in any year in which, in the opinion of the Council, no student obtains a sufficiently high standing in Calculus to merit the award. If in any year no award is made, a second award will be available in the subsequent year.

Salim Majdalany Scholarship
The Scholarship was established by family and friends in memory of the late Salim Majdalany (B.A.Sc., 1980, Civil Engineering). The award is granted on academic standing to a student from Lebanon, Syria, Jordan, Iraq, or any other member state of the Arab League, who is entering or is enrolled in the Faculty of Applied Science and Engineering or the Faculty of Law. The award is open to students in both Faculties but priority is to be given to candidates from the Faculty of Applied Science and Engineering.

Charles Gordon Manning Prize
The Charles Gordon Manning Prize was established by a bequest under the will of the late Jennie Manning in the amount of $500, the annual income from which is to be used to buy books for the winner of the prize. The recipient must be enrolled in the Second year of a course offered by the Faculty of Applied Science and Engineering and, in the opinion of the Council, rank second to the student awarded the Harvey Aggett Memorial Scholarship in the considerations for the award of that Scholarship. Specifically, these are: achieving Honours in the final examinations and being ranked one of the first three at those examinations relative to the pass requirements in the department; and being adjudged highest of the three in general student activities and service in the University during First year. The first award was made on the results of the annual examinations in 1954.

Oscar J. Marshall Scholarship
This award was established through a donation from the estate of Oscar J. Marshall. The Scholarship is to be awarded to a student in Third year, full-time, in the Department of Civil Engineering who has obtained the highest academic standing in the Survey Camp course.

J. Edgar McAllister Foundation Bursaries
Through the generosity of the late J. Edgar McAllister, a graduate of the Faculty in 1895, a fund has been established in the University to be known as the J. Edgar McAllister Foundation, to provide financial aid for students who require it, in Mechanical, Chemical, Electrical, Computer, Lassonde Mineral, or Materials Engineering. Application should be made on the Undergraduate Grant Application Form.

J. Edgar McAllister Summer Research Fellowships
Summer research fellowships are available to undergraduate students who have completed the First, Second or Third year of Chemical, Electrical, Computer, Mechanical, Lassonde Mineral, or Materials Engineering. Interested students should apply by application to the Chair of their department early in the Winter Session. Selection criteria will include the applicant’s academic background and interests, and financial need.

John B. McGeachie Grant
Established in 2002 through a generous donation by John B. McGeachie, this grant is given to a Third year student of any program on the basis of financial need. Application should be made on the Undergraduate Grant Application Form.

The Garnet W. McKee-Lachlan Gilchrist Scholarship in Engineering Science
Mrs. Garnet W. McKee and Professor Lachlan Gilchrist each contributed $1,000 to provide for a scholarship in the First year of the course in Engineering Science. The value of the Scholarship is the annual income from the capital fund and is awarded to the student who ranks first in Honours at the annual examinations of the First year in Engineering Science. If for any reason that student is ineligible to hold the Scholarship, it will be awarded by reversion to the student ranking second in Honours in the course. To receive payment the winner must register in the Second year of the course in Engineering Science. The Scholarship was awarded for the first time on the results of the annual examinations in 1947.

The Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships
Professor Lachlan Gilchrist of the Department of Physics, University of Toronto, received financial assistance from certain organizations and individuals to help him in prosecution of his research work in Geophysics. With the consent of the contributors, the unexpended balance of these gifts was transferred by Professor Gilchrist to the Board of Governors of the University to be used as an endowment for scholarships, two of which were established in the Faculty of Applied Science and Engineering. Additional amounts received from the estate of Garnet W. McKee and from the Hollinger Consolidated Gold Mines Ltd. have been added to this fund.
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The Scholarships are awarded by the Governing Council on the recommendation of the Council of the Faculty of Applied Science and Engineering. The first awards were made on the results of the annual examinations in 1941.

The First Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship
This Scholarship is awarded to the student in the Second year of Engineering Science who has the highest aggregate standing at the examinations of the First and Second years in the course, provided always that the student obtains Honours standing at the examinations of the Second year.

The Second Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship
This Scholarship is awarded to the student who ranks second in Second year of Engineering Science and who achieves the highest aggregate standing at the First and Seconds years of that course, provided always that such student obtains Honours standing in the examinations of the Second year.

If in any year there is no student who has fulfilled the condition as laid down for the Second Lachlan Gilchrist Geophysics Scholarship, it shall be awarded to the student in the Second year of Engineering Science who achieves the second highest aggregate standing at the examinations of the First and Second years of that course, provided always that such student obtains Honours standing in the examinations of the Second year.

Marlene Metzger CIV6T0 Scholarship
This Scholarship was established in 2011 by the Department of Civil Engineering in honour of the first 5 women to graduate from Civil Engineering, of which Marlene Metzger is one. The award, valued at $500, is given to a student entering Second year of Civil Engineering, having completed First year of any program in the Faculty, who achieves the 2nd highest mark in the first year Statics course (CIV100/102). The award is not tenable with other merit-based scholarships of greater value. Should this be the case, the award would revert to the next qualifying student.

Hugh Middleton Bursary
This award, established in 2001, is to be awarded to a student in the Faculty of Applied Science and Engineering on the basis of financial need. Application should be made on the Undergraduate Grant Application form.

R.W. Missen Memorial Prize in Thermodynamics
This award was created in 2008 through a generous donation by family and friends of the late Professor Ronald W. Missen, a faculty member of the Department of Chemical Engineering and Applied Chemistry for 35 years, in memory of his professional and scholarly achievements. The award is given to the student who receives the highest mark in CHE323H1: Engineering Thermodynamics, which was taught by Professor Missen for many years.

Kiyoharu and Kiyomega Momose Memorial Scholarship
This Scholarship in the amount of approximately $300 was bequeathed by Yoshiko Momose. The award will be made to a student entering the fourth year in Medical, Engineering or Sociology. It was the hope of the donor that the recipient would exhibit qualities of leadership and all-around participation in extracurricular activities. The award will alternate among the Faculties of Medicine, Engineering and Arts and Science.

R.F. Moore Thesis Award
Established in 2003, this Award is made on the recommendation of the Chair of the Department of Mechanical & Industrial Engineering to a Fourth year Industrial Engineering student (or students) for the best thesis or capstone design project in the Industry category. The Award consists of a certificate and travel expenses for the recipient to attend the IIE Conference. In the event of a joint project winning - funding will be provided for only one presenter. The individual(s) must be a member of the IIE. The thesis or capstone design project must be based on a practical industrial problem researched during the Fourth year or during the previous summer employment. The term “industry” is defined to include manufacturing, resource production, the service industry, including the health care field, and other situations. The submission for this prize must be accompanied by a letter from a senior executive of the company involved attesting to the satisfactory completion of the research and analysis. Each application must include a note committing the student on winning the prize to present the work at the following annual IIE student conference.

James L. Morris Memorial Prize
The James L. Morris Memorial Prize is the gift of Mrs. J.H. Craig and Mr. J.R. Morris, K.C., in memory of their father, James L. Morris, C.E., O.L.S., D.Eng., the first graduate of the School of Practical Science, who died in 1946 after a distinguished career.
Graduating in Civil Engineering in 1881 as the sole member of his class, Dr. Morris engaged in railway work for some time, first as an engineer and then as a contractor. For forty-three years he conducted a successful civil engineering practice in Pembroke, Ontario, involving important undertakings in the field of municipal power and bridge work.
The prize, of the value of the annual income from $3,000, is awarded annually to the student in the Second year of the Civil Engineering Program who achieves the highest aggregate percentage at the annual examinations of the First and Second years of the course, provided always that the student achieve Honours standing at the examinations of the Second year.

Joseph G. Monkhouse Memorial Bursary in Engineering
This award, established in 2000 by the Estate of Margaret E. Monkhouse, is to be awarded to a student who has high academic qualifications and shows financial need. Application should be made on the Undergraduate Grant Application form.

Peter L. Munro Memorial Scholarship
This fund was established in 1987 by family, friends and business associates in memory of Peter L. Munro, 5T9, Mining Engineering. One award granted on the recommendation of the Chair of the Division of Mineral Engineering to students completing the Second or Third year who demonstrate commitment to the Canadian Mining Industry. In addition to good academic standing, financial need and qualities of character and leadership will also be considered. The first award was made on the results of the 1987-88 Session.

Henry and Mary Nahrgang Bursaries
The income of the capital sum donated by the late Armond R. Nahrgang, class of 1923, is used to provide bursaries for qualified students in need of financial aid.
financial assistance. Application should be made on the Undergraduate Grant Application Form.

**NACE International, Toronto Section, Prize**
The Toronto Section of the National Association of Corrosion Engineers (NACE) provides one prize annually of a value of $200 to be awarded to the student in the Fourth year of a program in any field whose thesis on the subject of Corrosion Science and Engineering is considered to be of suitable quality and the most satisfactory. The first award was made in 1989-90 academic year.

**Nortel Institute Undergraduate Scholarship(s)**
This Scholarship is made possible through a donation from Nortel Networks Limited. It is awarded to students in Second or Third year of Applied Science and Engineering Arts and Science on the basis of financial need and academic merit and an essay. Candidates must submit an essay on “The Future of Communications” (maximum 500 words) along with two references. Application forms are available from the Faculty Registrar’s Office. The application deadline is November 1.

**Ontario Power Generation Award**
Provided through the generosity of Ontario Power Generation, this Scholarship is awarded to students entering the Second year of either Electrical, Computer, Mechanical, Chemical, or Environmental Engineering. Students must be a member of employment equity target group (women, aboriginal, disabled, visible minority). In addition to academic standing (minimum B average) the following will also be considered: demonstrated leadership skills, possess strong oral and written communication skills, and are involved in extra-curricular activities. Candidates must be legally eligible to work in Canada upon graduation. Will not be receiving more than one award of equal or greater value in Second year.

**Orbis Prize in Software Design**
This prize is given to graduating students as follows: $4000 to the top software design team; $1000 to the runners up in the Edward S. Rogers Department of Electrical & Computer Engineering. Students must be enrolled in the designated “Capstone” Design Course(s).

**Orbis Scholarship in Engineering**
This Scholarship was established in 2011 by Orbis Investment Management Ltd. and is awarded to two students, one entering Third year and one entering Fourth year in the Electrical and Computer Option of Engineering Science. The award is made on the basis of strong academic achievement. Extra-curricular involvement, demonstrated leadership may also be considered. Recommendation of Chair (or alternate) of the Division of Engineering Science.

**PACE Project Design Award**
This Scholarship was established in 2012 through a generous donation by Mr. Mehran Omidvar. The award is given to an individual or group who exhibit creativity in design through use of PACE sponsored software. Recipients may be in 3rd or 4th year; selection will be made on the recommendation of the PACE Integrator.

**Gary L. Palmer Memorial Scholarship**
This award was established in 2009 through the generosity of Anne Palmer in memory of her late husband, Gary Palmer, and by her two daughters, Jennifer and Kristianne, in honour of their father who died in an airplane accident in 2006.

Gary, a former student of the Engineering Physics program at the University of Toronto, went on to enjoy a successful career in computer engineering and telecommunications. A lifelong passion for cycling led Gary to race competitively in Canada, the United States and France. He also shared his enthusiasm for aviation through his involvement with the EAA, ultimately holding the position of president of his local chapter for 13 years. Gary was a man blessed with great intellect, a rich sense of humor, compassion and a desire to contribute. A natural leader, he was always eager to share his knowledge and help others.

The award is presented to a student who is entering the Third year of Engineering Science and who has demonstrated financial need and promise in their field as evidenced by academic improvement from year to year.

**The Dr. John Hamilton Parkin Scholarship**
Established by family friends and colleagues in 1983, this award honours the late Dr. John Hamilton Parkin, IT1, IT2 Mechanical and Electrical Engineering.

His class of 1908-11 was the last in the S.P.S. Diploma course with degree option. From the mechanical field he moved to a pioneering role in aeronautics on staff in the University of Toronto's new Mechanical Department from 1912 until 1929 (Associate Professor), with a three-year wartime leave to the chemical industry. He set up Canada's first university windtunnel (1919), initiated Canada's first undergraduate Aeronautical Program (1928) and began a lifelong career in applied research.

Moving to Ottawa, he gave strong leadership at the National Research Council, becoming Director, Division of Mechanical Engineering (1937), and founding Director, National Aeronautical Establishment (1951). His authorship was prolific and his career accomplishments have been widely acknowledged through distinguished honours and awards, including C.B.E. and F.R.S.C.

The award, the value of which is the annual income of a donation, is given to a student completing the Third year of the Aerospace Option in the Engineering Science Program on the basis of financial need, academic standing and a demonstrated sincere interest in the aerospace field. This award is tenable with other awards.

**Paulin Memorial Scholarship**
The Paulin Memorial Scholarship, provided through the generosity of the late Mr. Fred W. Paulin, a graduate of this Faculty in 1907, was established in memory of his brother, John Cameron Paulin, a student of this Faculty who was fatally injured in 1906 during a football practice. The Scholarship, which has the value of the income from a capital fund of $10,000, is awarded to a student who obtains high standing in the work of the First year in the Faculty of Applied Science and Engineering.

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A. B. Platt Award, Toronto Section of the Society of Tribologists and Lubrication Engineers
Funded in perpetuity by a capital donation from the Toronto Section of the Society of Tribologists and Lubrication Engineers (STLE), this prize is awarded annually to the student in the Fourth year of either Mechanical, Chemical or Materials Engineering Program whose work in tribology (friction, wear, lubrication, wear resistant coatings) is considered to be of suitable quality and the most satisfactory. The Award has a value of $100, of which $75 is presented to the student, and $25 to the Department for the purchase of publications on tribology.

Frank H.R. Pounsett Memorial Scholarship
This award, established in 2010 by the estate of Margaret Catharine Pounsett in memory of her late husband, is given to the top student completing Second year of Electrical Engineering.

Florence Evelyn and William Leonard Prideaux Award
This Award, established by the estates of Florence Evelyn and William Leonard Prideaux is to be awarded to a Canadian Inuit or Aboriginal Boy Scout from the North West Territories or Moosonee area who is entering or registered in the Faculty of Applied Science and Engineering, Architecture Programs in the Faculty of Arts and Science or Wycliffe College. It is to be awarded on the basis of scouting service and experience.

Professional Engineers Ontario Foundation for Education In-Course Scholarships
The Professional Engineers Foundation for Education offers a total of eight scholarships to students in First, Second and Third years in the Faculty of Applied Science and Engineering in any Program; The awards are granted on the basis of strong academic performance and leadership or role model qualities as demonstrated through involvement in professional affairs and extra-curricular activities.

Professional Engineers Ontario Foundation for Education Gold Medal for Academic Achievement
The Professional Engineers Ontario Foundation for Education has established in the Faculty of Applied Science and Engineering an award in the form of a medal. The award will be made to the student in the final undergraduate year in any program who, obtaining Honours, achieves the highest weighted average percentage in the practical work and written examination of the year.

Quadra FNX Mining Ltd. Scholarship
This award was established in 2011 through a generous donation by Quadra FNX Mining Ltd. The award is given to a full-time student entering Second, Third, or Fourth year of the Faculty, in the Environmental Engineering Minor, on the basis of strong academic achievement. Preference is given to students who demonstrate an interest in the mining industry based on course selection, extra-curricular activities and/or work term(s).

Ransom Scholarship in Chemical Engineering
The Ransom Scholarship in the Chemical Engineering & Applied Chemistry Department was established by A.C. Ransom, Esq. of Toronto to encourage and give financial assistance to students in the Department. This donation, consisting of $5,000, provides for a perpetual scholarship of an annual amount derived from the income of the donation. The first award was made on results of the annual examinations in 1938. The Scholarship is awarded annually to the student registered in the Chemical Engineering Program who achieves the highest aggregate percentage of marks in the examinations of the First year. The Scholarship will be paid to the winner only if the recipient proceeds to the Second year of the Program at the University of Toronto.

Reginald J. Redrupp Award
This Award was established in 1987 by friends and colleagues in memory of Reginald J. Redrupp, a distinguished mining banker with the Canadian Imperial Bank of Commerce who was active in the Prospectors and Developers Association and the Canadian Institute of Mining and Metallurgy. Two awards derived from the income will be given annually to students proceeding to the Second year of Lassonde Mineral Engineering. Academic standing, financial need and commitment to the Canadian mining industry may be considered in granting the Award.

J.E. Reid Memorial Prize
This prize, established in 1967 in memory of the late Professor J.E. Reid, is awarded to the student in the Fourth year of the Electrical or Computer Engineering Program who, graduating with Honours, achieves the highest aggregate marks in electronic communication.

The Russell Reynolds Scholarship in Engineering Science
This award, established in 2001, is to be awarded to a student entering the Third year in the Division of Engineering Science. This student must have displayed high academic achievement. Preference will be given to a student demonstrating financial need. This Scholarship is not tenable with other awards.

The Bertrand G. W. Robinson Award
The annual income from a bequest made in 1991 from the Estate of the late Bertrand G.W. Robinson provides one or more bursaries to students in the Third year in any program, on the basis of financial need. Mr. Robinson graduated in Mining Engineering in 1930 and was employed in managerial positions in the gold mining industry of Northern Ontario. He was the Canadian representative of Hardinge Mining Equipment of York, Pennsylvania, and acted as a consultant to mining projects in Canada, England, and East Indies. After retirement, he returned to the University of Toronto and in November, 1979 graduated with his Master of Engineering. Application should be made on the Undergraduate Grant Application Form.

The Richard Rowland Memorial Scholarship
This Scholarship was established by family, friends and colleagues in memory of Richard Rowland, an active member of Phi Delta Theta and a 1989 graduate of Mechanical Engineering. Richard passed away in 1996 as a result of an automobile accident. While Richard was successful in his work as an engineer, he found time to explore the outdoors when canoeing and skiing. He was also active in amateur theatricals. His circle of friends reflected these varied activities.
It is to be awarded on the recommendation of the Chair to a student completing Third year of the Mechanical Engineering Program who has a good overall academic record, intends to continue in the Fourth year and has demonstrated an interest in Heating, Ventilating, and Air Conditioning. This award is restricted, (by request of the donor) to students who are Canadian Citizens or permanent Canadian residents and is not tenable with other awards of equal or greater value.

**Mary and Mario Ruggiero Scholarship**
Established in 2009 through a generous donation by Mary and Mario Ruggiero. This award is granted on the basis of strong academic achievement to a student entering 2nd, 3rd or 4th year of Engineering Science, full-time.

**Don Salt Memorial Scholarships**
In memory of Donald John Salt, a graduate of the Faculty of Applied Science and Engineering and a practising geophysicist, the Canadian Exploration Geophysical Society has provided two Scholarships of $500. They are open to students in the Third and Fourth years of certain courses in the Faculty of Arts and Science, and in Lassonde Mineral Engineering in the Faculty of Applied Science and Engineering. The award is made on evidence of the interest and ability of the applicant in relation to the field of mining geophysics. Application should be made either to the Chair of the Department of Physics or the Chair of the Department of Geology and Applied Earth Science by March 1 in the calendar year in which the award is to be made.

**Frederick W. Schumacher Scholarship**
The Frederick W. Schumacher Scholarship has been established in the Faculty of Applied Science and Engineering and in the Faculty of Arts under a bequest of the late Frederick W. Schumacher. It has a value of the income from the fund. The scholar must be enrolled in the Second, Third or Fourth year in Lassonde Mineral Engineering in the Faculty of Applied Science and Engineering, or in Physics and Geology of Geological Sciences in the Faculty of Arts and Science and must have high academic standing.

**Marcia Lamont Scott CIV4T7 Scholarship**
This Scholarship was established in 2011 by the Department of Civil Engineering in honour of the first 5 women to graduate from Civil Engineering, of which Marcia Lamont Scott is one. The award, valued at $500, is given to a student entering Second year of Civil Engineering, having completed First year of any program in the Faculty, who achieves the highest mark in the first year Statics course (CIV100/102). The award is not tenable with other merit-based scholarships of greater value. Should this be the case, the award would revert to the next qualifying student.

**Class of 3T5 Second Mile Award**
This award was established by the Engineering Class of 3T5, and has been awarded each year since 1945. The name is based on the biblical text “Whosoever shall compel thee to go one mile, go with him twain”. The second mile is the voluntary mile. Convinced that a successful engineer must be not only professionally competent but also constantly aware of his or her broader responsibilities, the donors encourage undergraduates to participate fully in extra-curricular activities of all kinds. The Award comprises of a monetary prize and an illuminated scroll, and is presented to a student in the final year. In making the award, consideration is given to academic standing, voluntary service, and breadth of extra-curricular activities. The ultimate objective is to encourage each engineer to engage in second mile activities throughout his or her career, resulting in benefits for the individual, the profession, and for society.

**Adel S. Sedra Bursary Fund**
This bursary fund was established in 1997 by Adel S. Sedra, B.Sc., M.A.Sc., Ph.D., a graduate of the Faculty, former Chair of the Department of Electrical and Computer Engineering and Vice-President and Provost of the University of Toronto. The awards, derived from the annual income from a capital donation, will be granted to students in any year in the Department of Electrical and Computer Engineering on the basis of financial need. Application should be made on the Undergraduate Grant Application Form.

**Adel S. Sedra Gold Medal**
This award was established in 2002 through the donation of J. Robert S. Prichard, former President of the University of Toronto, to recognize Professor Sedra’s exceptional contributions to both the discipline of engineering and the leadership of the University of Toronto through his service as Professor, Chair, and Vice President and Provost. The medal is awarded annually to two students in the graduating class who have earned the highest cumulative grade point average in each of Electrical and Computer Engineering.

**Rudolph Seidl Memorial Award in Mechanical Engineering**
This Award was established by Mrs. Rudolph Seidl in memory of her husband, Mr. Rudolph Seidl, an employee in the Department of Mechanical Engineering until his retirement in 1975. This Award is to be given to a student who has achieved honours standing in Second year, Mechanical Engineering, has demonstrated a strong character and has financial need. Department Recommendation.

**The Joseph Seidner Bursary Fund**
The Joseph Seidner Bursary Fund was established in 1987 by Mr. Joseph Seidner, a principal in the firm of Brady & Seidner Associates Ltd., a large Mechanical Contractor in Ontario and who for many years contributed to the well-being of the construction industry. The annual income of the capital in the Bursary Fund, established in the Faculty of Applied Science and Engineering, at the University of Toronto, is to be awarded to one or more deserving Second or Third year Ontario students in the Mechanical Engineering Program on the basis of financial need arising during the course of an academic year. This award is open to Canadian citizens or permanent Canadian residents. Application should be made on the Undergraduate Grant Application Form.

**The Shaw Design Scholarship(s)**
Established in 2002 through a generous donation by William and Barbra Shaw, these Scholarships are awarded to students beginning Third year of the
Scholarships and Financial Aid

Engineering Science Program. Preference will be given to students who have high academic standing in the first two years. Additional preference will be given to students who demonstrate strong achievement in the 2nd Year Engineering Design course and who are involved in extracurricular design projects. Selection will be made by Departmental nomination and announced at a suitable occasion, such as the annual Engineering Science dinner.

Kenneth Carless Smith Engineering Science Research Fellowship
Established in 2011, this fellowship will be awarded to students in the Division of Engineering Science on the basis of academic merit and on the basis of suitability for the fellowship.

Professor James W. Smith Chemical Engineering Leaders of Tomorrow Award
This Award was established in 2006 through a generous donation by Dr. Stephen G. Dunn, Dr. Joseph C. Paradi, Dr. Larry E. Seeley, and Dr. Bert O. Wasmund, who are former students of Professor J.W. Smith, and an additional donation by Hatch Limited. The objective of this Award is to recognize students in their Second year of Chemical Engineering who have shown the potential to become outstanding leaders, and to inspire others to action and to excellence. This may be demonstrated in a number of ways, including participation in student council or clubs, community organizations, cultural groups or athletics. Candidates should enumerate their service to others through volunteering or community work.

Society of Chemical Industry Merit Award
The Society of Chemical Industry Merit Award presents a commemorative plaque each year to the student in Fourth year in the Department of Chemical Engineering and Applied Chemistry who achieves the highest weighted average over the four years.

Murray F. Southcote Scholarship
This Scholarship was established in 1965 through the generosity of friends and associates of the late Murray F. Southcote (through W.R. Laidlaw). This Scholarship is granted to a student who obtains high academic standing at the end of Third year in any program in the Faculty.

C.H.E. Stewart Bursaries
Under the provisions of the will of the late Mary Jones Stewart, a sum of $10,000 was bequeathed to the University, the income of which is to be used to provide a number of bursaries to students in Third and Fourth years of courses in the Faculty of Applied Science and Engineering. The awards are made on the basis of financial need, scholastic ability and general character, with preference given to students who are descendants of veterans of the First and Second World Wars. Application should be made on the Undergraduate Grant Application Form.

The Kenneth H. Sullivan / Pratt & Whitney Canada Scholarship
This Scholarship was established in 2003, through a generous donation by both Pratt & Whitney Canada Corp. and the family of Kenneth H. Sullivan. This award, valued at $5,000, is made to a Third year student in the Aerospace Option of the Division of Engineering Science on the basis of high academic standing. Preference will be given to students who have demonstrated an interest in the study of the powerplant aspects of aerospace engineering. Recipient must be Canadian Citizen or Permanent Resident.

James D. Todd Memorial Scholarship
The James D. Todd Memorial Scholarship is valued at $500 and is awarded to the student with the highest standing in a course relating to cost engineering. This award was established in 1984 by the American Association of Cost Engineers (AACE, Inc.) Toronto Section, in memory of James D. Todd, who held several offices in the AACE, Toronto Section. His career included cost analysis, planning and construction over a broad range of heavy engineering projects. He set high professional standards for himself and worked indefatigably in the enhancement of the careers of others. The first award was made in the 1983-84 Session.

Gordon F. Tracy Scholarship
Donated by the family of the late Gordon F. Tracy, Professor of Electrical Engineering in this Faculty, this Scholarship has the value of the annual income on the capital fund of $10,000. It is awarded to the student who, achieving Honours standing in the Third year of Electrical or Computer Engineering, obtains the highest aggregate marks in the Third year examinations in the subjects pertaining to electromechanical energy conversion.

Charles Edwin Trim Scholarship
This Scholarship fund was established in 1991 by Mrs. Hazel Trim in memory of her husband Charles Edwin Trim. The income derived from the capital will provide one or more Scholarships on the basis of academic excellence. Preference will be given to students entering the Third or Fourth year.

Troost Family Leaders of Tomorrow Award
This Award was established in 2010 through a generous donation by Mr. William (Bill) and Mrs. Kathleen Troost. The objective of this Award is to recognize students in their Fourth year of Chemical Engineering who have shown the potential to become outstanding leaders, and to inspire others to action and to excellence. This may be demonstrated in a number of ways, including participation in student council or clubs, community organizations, cultural groups or athletics. Candidates should enumerate their service to others through volunteering or community work.

Marjorie Hilda Merrick Turner Award
The President of the Engineering Society receives the Marjorie Hilda Merrick Turner Award, which is derived from the income of a capital fund, established in 1985 by the sons of Mrs. Marjorie H.M. Turner. As a granddaughter, daughter, wife, mother, and grandmother of members of Engineering Societies, Mrs. Turner has observed first hand the evolution and growth of the engineering profession in Canada, from the construction of the country’s infrastructure, through the expansion of its resource and secondary manufacturing industries, to the development of its high technology capabilities. This Award reflects her recognition and support of the well-rounded individual, as typified by the President of the Engineering Society. It was her wish to provide some modest financial assistance to the incumbent with the hope that it will further encourage the recipient to strive for excellence in all areas of life.
Scholarships and Financial Aid

James W. and H. Grattan Tyrrell Memorial Scholarship in Civil Engineering
Established in 1976 by H. Grattan Knox Tyrrell of the United States in memory of James W. Tyrrell and H. Grattan Tyrrell, graduates of the School of Practical Science in 1883 and 1886 respectively, this Scholarship recognizes academic excellence in the work of the Third year of the Civil Engineering Program. The award is restricted (by request of the donor) to students holding Canadian citizenship.

U.M.A. Scholarship in Civil Engineering
Established in 1984 through the generosity of the U.M.A. Group, this Scholarship is awarded on the recommendation of the Chair to a student completing the Second year of the Civil Engineering Program. In addition to high academic achievement, diversity of interests and suitability for leadership in the engineering profession will be considered. The first award was made on the results of the 1984-85 session.

University of Toronto Women’s Association Scholarship
In 1995 the University of Toronto Women’s Association donated a capital sum to the University, a portion of which provides an award in the Faculty of Applied Science & Engineering. This Scholarship is awarded to a male or female student in any year of any program in the Faculty on the basis of academic standing. The value of the award is derived from the annual income.

U.S. Steel Canada Undergraduate Scholarships
These Scholarships, derived from the annual income of a capital donation were established in 1997 through the generosity of U.S. Steel Canada (formerly Stelco Inc.) Several Scholarships are available to students in the Department of Materials Science and Engineering on the basis of academic standing. In addition, leadership qualities as demonstrated through extra-curricular activities may also be considered.

The Lorne Wagner Memorial Bursary
Annually, two or more awards derived from the annual income will be made to students registered in any year in the Engineering Science Program. The selection will be made by the Chair on the basis of financial need to students who show promise and have a commitment to the Engineering Science Division.

The award was established in memory of the late Lorne Steven Wagner, who was killed in an automobile accident in 1980 after completing his First year in Engineering Science. Application should be made on the Undergraduate Grant Application Form.

Wallberg Undergraduate Scholarships
These Scholarships, eight in number, of the value of $1,500 each, derived from the Wallberg bequest, are awarded annually on the basis of academic standing. There are four Scholarships awarded in First year and two awarded in each of the Third and Fourth years.

The first awards were made on the results of the annual examinations in 1947.

Irene Gordon Warnock Memorial Scholarship
Established in 2009 by the Estate of the late Irene Gordon Warnock, this scholarship is awarded to a student entering Second year of Materials Engineering on the basis of academic achievement. Recipients must be Canadian citizens or permanent residents and must have achieved honours.

The Stewart Wilson Award
This Award, first made in 1965-66, is available through the generosity of the Engineering Alumni Association. Its value fluctuates to cover the residence fee of New College ($6208-6362 for 1999-00).

It is open to students who, proceeding to the Second or Third year of any course in the Faculty of Applied Science and Engineering, were resident or non-resident members of New College during their First or Second year. The Award is based upon academic ability, leadership qualities, contribution to New College activities and financial need. The Award winner shall reside in the New College residence during the academic year of the award.

Application should be made to the Registrar of New College by April 1st, and announcements regarding a successful candidate will be made by June 30th.

W.S. Wilson Medals
These medals have been provided by the Engineering Alumni Association in recognition of the service to the Faculty of Applied Science and Engineering of its former Assistant Dean and Secretary, William Stewart Wilson.

A medal is awarded to the student in each graduating course, who, attaining Honours, achieves the highest standing in the final year of the course. The first awards were made in the Session 1962-63.

William R. Worthington Memorial Scholarship
The William R. Worthington Memorial Scholarship, the gift of Ida R. Worthington in memory of her brother, William R. Worthington, DIPL. (1904), B.A.Sc. (1905), of the value of the income from the fund, is awarded annually to a student in Second year of the Civil Engineering Program who ranks highest at the annual examinations of that year. The first award was made in the 1954-55 Session.

Barbara Zdasiuk Memorial Scholarship
An award fund has been established by the family and friends of Barbara Zdasiuk, a graduate of Engineering Science, who died in a traffic accident in 1980. The award, consisting of a medal, appropriately inscribed, and a cash prize drawn from the income of the fund, is made to the graduating student completing any option in Engineering Science who has obtained the highest cumulative total of weighted session averages for the eight sessions of the Program.

LOAN FUNDS
Small loans can be made to students who are in urgent need of assistance. The funds are not large and the loans must be restricted both in amount and number. Inquiries for loans should be made in the Office of the Registrar, Galbraith Building, Room 153.
TUITION FEES

Method of Payment
Students will individually receive detailed instructions regarding the payment of fees in the Summer. Students may also check the fees information available on the Student Accounts website at www.fees.utoronto.ca.

Invoice Payment
An invoice detailing the fees payable will be posted to the student’s account on the Student Web Service (SWS) (http://www.rosi.utoronto.ca). Students may pay this invoice in person at their banking institution through a teller or a banking machine.

Electronic Payment:
Students may also pay through telephone or online banking if your bank offers this service. Contact your financial institution via the appropriate method and provide them with your account number and payee information. Your account number is printed in a box located on the top right-hand corner of your paper invoice and is also displayed on the invoice format of your account on ROSI. It consists of the first five characters of your surname (in capital letters) and 10 numbers which is your student number with leading zeroes. Make sure you distinguish between the letter ‘O’ and the number ‘zero’. The payee for the transaction is “University of Toronto”.

Methods of Payment Outside Canada:
Please see the Student Accounts website for details at: www.fees.utoronto.ca

Official Registration
A minimum first installment of tuition fees (65% of the total fee) must be paid or fees must be deferred (through Scholarship or OSAP) by August 31st, 2012 in order for a student to be considered “Registered” on ROSI, thereby ensuring courses are secure and “locked” into the student’s account. Students who have not paid their fees by this date will have their courses removed. Requests for reinstatement into courses are subject to the “Late Registration Fee” and course availability (see “Penalties” and “Late Registration” below.)

Verify Your Registration Status
Check to see if you are “Registered” on ROSI by logging into the website and selecting “Timetables” from the main menu. Display your timetable for the current session and view the upper right portion of the timetable to check your “Status”. If your status is “REG” your registration is complete. If your status is “INVIT” you risk being removed from your courses.

OSAP Deferrals
Students in financial need may apply for OSAP online at www.osap.gov.on.ca. If you are an approved OSAP recipient, you may request a fees deferral provided that you have no outstanding fees from previous sessions. Once your fees are deferred you are considered “Registered” and your courses will not be removed on ROSI.

Outstanding Balances
All fees are posted to your student account. Monthly payments towards any outstanding account balance are required and the balance of the account must be cleared by the end of the session (April 30th of each year). The outstanding balance of the account is subject to a monthly service charge of 1.5% (19.56% per annum). For more information, please refer to www.fees.utoronto.ca. Please note that when you make your tuition/fees payment at a bank, it takes at least 5 to 7 business days for it to be processed and received by the University. You are responsible for additional interest charges incurred for payments processed after deadlines have passed.

All payments are applied to outstanding charges from previous sessions first, then to the current session. Fees and other charges set forth in this Calendar are subject to change by the Governing Council.

FEES SCHEDULE

The new fees for the 2012-2013 session will be available on the Student Accounts website at www.fees.utoronto.ca beginning in July 2012. Check this website for the finalized session fees once these are available. For reference, below are the amounts from the 2011-2012 academic year.

FULL-TIME STUDENTS, 2011-2012

DOMESTIC STUDENTS

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Fee</td>
<td>$10,903.00</td>
<td>$10,499.00</td>
<td>$10,110.00</td>
<td>$9,735.00</td>
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<tr>
<td>Incidental Fees*</td>
<td>$1,349.38</td>
<td>$1,349.38</td>
<td>$1,349.38</td>
<td>$1,349.38</td>
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<tr>
<td>Total Fee (If paid in one installment)</td>
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<td>$11,848.38</td>
<td>$11,459.38</td>
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<tr>
<td>Minimum First Installment</td>
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<td>$7,701.45</td>
<td>$7,448.60</td>
<td>$7,204.85</td>
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### INTERNATIONAL STUDENTS

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Fee</td>
<td>$29,055.00</td>
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<td>Incidental Fees*</td>
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<td>$1,349.38</td>
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<tr>
<td>Total Fee</td>
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<td>Minimum First Installment</td>
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### PART-TIME AND SPECIAL STUDENTS, 2011-2012

#### DOMESTIC STUDENTS

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<th>Academic Year</th>
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<th>III</th>
<th>IV</th>
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<tbody>
<tr>
<td>Academic Fee</td>
<td>$10,903.00</td>
<td>$10,499.00</td>
<td>$10,110.00</td>
<td>$9,735.00</td>
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<tr>
<td>For each Engineering course</td>
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<td>$1,049.90</td>
<td>$1,011.00</td>
<td>$973.50</td>
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<td>Incidental Fee (once annually)</td>
<td>$394.14</td>
<td>$394.14</td>
<td>$394.14</td>
<td>$394.14</td>
</tr>
</tbody>
</table>

#### INTERNATIONAL STUDENTS

<table>
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<tr>
<th>Academic Year</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>For each Engineering course</td>
<td>$2,905.50</td>
<td>$2,773.50</td>
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<td>$394.14</td>
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*Non academic incidental fees include: campus fees; student society fees; Engineering Career Office; OSOTIF Student Aid, Endowment Fund Fee; Temporary study levy; ROSI access fee.

### OTHER FEES

- **Copy of documents in student information file, per page (other than transcript)** $0.25
- **Copy of examination paper, per paper (non-refundable);**
  - Deadlines: Last day to request exam copies is October 15th for April-May and June Engineering Exams and February 15th for December Engineering Exams. $13.00
- **Letter of Permission** $30.00
- **Re-checking marks, per course**
  - Deadlines: last day to request mark recheck is October 15th for April-May and June Courses and February 15th for December Courses (Note: Fee is refunded if an error is found) $13.00
- **Re-enrolment Application** $24.00
- **Registration Letter** $7.00
  - Each additional copy $0.50
- **Special Student Application, per submission** $52.00
- **Student Card replacement**
  - Obtain TCard replacement form from Registrar’s office with photo ID $12.00
- **Transcript request (each copy)**
  - Processed by UTTC- (U of T Transcript Centre.) $10.00
  - Request transcripts online at: www.rosi.utoronto.ca
* Please note that under University of Toronto policy transcripts, letters of permission, and registration letters cannot be issued by fax.

SUMMARY OF STUDENT EXPENSES

The following statement of approximate expenses will give the student a general idea of the cost of obtaining an education in the Faculty of Applied Science and Engineering at the University of Toronto, exclusive of personal expenses:

1. Books and instruments, per year $1000.
2. Fees- see fees schedule above.
3. Room and board (meal plan included) approximately $7,840-$12,200 per year, or $980-$1,525 per month.

Check with individual residence offices for details. Information on Student Housing is available on the Student Housing website at: www.housing.utoronto.ca

REFUND SCHEDULE

Students who withdraw from the University (see section below regarding withdrawal penalty) may be eligible for a fees refund depending on the date of withdrawal from the institution. Further information about refund schedules are listed on the Student Accounts website at: www.fees.utoronto.ca

PENALTIES

Late Registration

Any student who registers after the first day of class is required to pay a late registration fee as follows: $43.00, plus $5.00 per day up to a maximum of $60.00.

Withdrawal from the University

Students who withdraw entirely from the University, thereby canceling their registration in a program (Degree POSI) on or after the published date for the first day of classes in the session will be assessed a minimum charge of $216.00 in respect of academic fees.

Further information about the minimum charge is listed on the Student Accounts website at: www.fees.utoronto.ca

Re-instatement Fee

$60

Academic Sanctions

The following academic sanctions will be imposed on students who have outstanding University obligations:

1. Transcripts of academic record will not be issued.
2. Registration will be refused to a continuing or returning student.

An outstanding University obligation includes:

- Tuition fees
- Academic and other incidental fees
- Residence fees and other residence charges
- Library fines
- Bookstore accounts
- Loans made by colleges, faculties or the University
- Health Service accounts
- Unreturned or damaged instruments, materials and equipment
- Orders for the restitution of property or for the payment of damages and fines imposed under the Code of Student Conduct (see Chapter 6)
STUDENT SUPPORT, SERVICES AND RESOURCES

A variety of counselling and registrarial services are offered to undergraduate students in the Faculty of Applied Science and Engineering. These services can be found through the student’s home department, the Office of the Registrar, as well as from the University of Toronto at large. Below you will find a list of the most commonly requested services and offices.

OFFICE OF THE REGISTRAR

The Office of the Registrar works closely with departments concerning all matters related to Engineering students. Within the Office of the Registrar are the First Year Office (located in GB157), which offers academic counselling to First Year students, and the Engineering Undergraduate Admissions Office (located in GB153) which manages the admissions process, transfer credits, financial aid and OSAP distribution. Some of the services offered include:

- Academic and personal counselling
- Academic scheduling
- Course listings building and classroom locations
- Final Exam Copy and Final Course Mark Re-Check
- Final examinations scheduling
- Graduation
- Letter of Registration/Confirmation of Registration
- Petitions and appeals
- Program transfers
- Registration and enrolment
- Student records
- Scholarships and Financial Aid
- Transfer credits
- Transcripts

For a listing of all services provided by the Registrar’s Office, please visit our website at: www.undergrad.engineering.utoronto.ca. In addition, if you have questions regarding any aspect of your undergraduate experience, you can email the Faculty Registrar at registrar@ecf.utoronto.ca.

OFFICE OF THE FACULTY REGISTRAR

Faculty Registrar, Barbara McCann
35 St George Street, Room 157
Phone: (416) 978-5896
Fax: (416) 978-1866
Email: registrar@ecf.utoronto.ca
Office hours: Monday 9-4; Tuesday 10-5; Wednesday-Friday 9-4

FIRST YEAR OFFICE

Assistant Registrar, First Year, Leslie Grife
Student Success Specialist, Lesley Mak
First Year Assistant, Vanessa Andres
Phone: 416-978-4625
Room 170, Galbraith Building
Email: firstyr@ecf.utoronto.ca

UNDERGRADUATE PROGRAM COUNSELLOR OFFICES

Upper Year students should contact their departmental undergraduate program counsellor for assistance related to their programs. Program counsellors can provide detailed academic guidance regarding course selections and options for your specific program, as well as assistance in interpreting Faculty policies and procedures.

CHEMICAL ENGINEERING
Ms Jane Park
Room 216A, Wallberg Building, 416-978-5336
Email: ugrad.chemeng@utoronto.ca

CIVIL & MINERAL ENGINEERING
Ms Shayni Clarke
Room 105, Galbraith Building, 416-978-5905
Email: shayni@civ.utoronto.ca

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Student Services and Resources

COMPUTER AND ELECTRICAL ENGINEERING
Professor W.T. Ng
Room B600, Sandford Fleming Building
or
Ms Linda Espeut
(416) 978-8570
Room B600, Sandford Fleming Building
Email: askece@ecf.utoronto.ca

CROSS-DISCIPLINARY PROGRAM OFFICE (ENGINEERING MINORS)
Ms Sharon Brown
44 St. George Street, 416-978-3532| Fax 416-946-0371
Email: cdp@ecf.utoronto.ca

ENGINEERING SCIENCE
Ms Hana Lee (1st & 2nd year students)
Room 2110, Bahen Centre, (416) 946-7351
Email: nsci1_2@ecf.utoronto.ca

Ms Anne Marie Kwan (3rd & 4th year students)
Room 2110, Bahen Centre, (416) 946-7352
Email: nsci3_4@ecf.utoronto.ca

MECHANICAL AND INDUSTRIAL ENGINEERING
Ms. Carla Baptista
Room 109, Mechanical Building, (416) 978-6420
Email: carla@mie.utoronto.ca

MATERIALS ENGINEERING
Ms Maria Fryman
Room 140, Wallberg Building (416) 978-3012
Email: mse@ecf.utoronto.ca

REPOSITORY OF STUDENT INFORMATION (ROSI) AND STUDENT WEB SERVICE(SWS)

www.rosi.utoronto.ca
ROSI, the Repository of Student Information contains data relating to a student’s admission to and academic performance at the University of Toronto.

Student Web Service (SWS)
The Student Web Service (SWS) provides students and alumni of the University of Toronto with direct access to certain portions of their University records on ROSI, the Repository of Student Information. To gain access you have to provide a valid student number and a valid Personal Identification Number. Students can add and drop courses, vote in student elections, order transcripts, update addresses, etc. Alumni can order transcripts. Some services, such as course enrolment and elections, are available only during periods specified by relevant faculties or organizations.

Responsible Use of SWS
You are expected to be responsible when using the Student Web Service. You should not attempt to flood the system with requests, or to automate the process of course enrolment. Such activity may clog the system so that other students may be denied access or experience degraded performance. Any student(s) attempting such activity may be denied access to the SWS until after the relevant registration period.
For a list of available services on the SWS, please check www.rosi.utoronto.ca/about.html

First Time Log in Instructions/PIN Reset Instructions
To log in to ROSI, you need your U of T student number and your 6-digit personal identification number (PIN). The first time you log in to ROSI, your PIN represents your birth date in the form YYMMDD. (e.g. If you were born July 31, 1982, then your initial PIN would be 820731). Once you successfully log in to ROSI for the first time, for security purposes, you will be prompted to change your PIN to a new six digit PIN. This new PIN will be what you use to access ROSI in the future. Please note, your PIN must be six digits and must be comprised of numbers only.

You should set up the PIN reactivation feature. If you forget your PIN in the future and you have set up the PIN reactivation feature, you can then retrieve your PIN through the question prompts ROSI gives you through this feature. If you try to log into ROSI unsuccessfully three times in a row, your account will be suspended until your PIN is reset. If you are not set up for PIN reactivation and your account is suspended, you must come to the Engineering Registrar’s Office in GB157 with your T-card. If you cannot come to the Registrar’s Office in person, then you must fax a request to the Office and provide your:

Name
Student Number

© 2012 University of Toronto - Faculty of Applied Science and Engineering
Date of Birth
Social Insurance Number
Mailing address, as last modified on ROSI
Signature

This allows the Registrar’s Office to verify that you are the one requesting a PIN reset. The PIN reset form can be found at: www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/Confirming_Your_Registration/ROSI_PIN_Reactivation.htm. The fax number for the Registrar’s Office is 416-978-1866. PIN reset requests cannot be made by telephone.

UNIVERSITY OF TORONTO PORTAL
www.portalinfo.utoronto.ca

The Portal connects you to the services and information you want, and making it easier to interact with your friends and the University. The Portal is about making connections between students, faculty and staff.

T-CARD/LIBRARY CARD
www.utoronto.ca/tcard

The student photo identification card is a wallet-sized card bearing the student’s photograph and signature, and serves as evidence of registration in the Faculty. It is used for identification purposes within the University, such as Faculty examinations, University libraries, student activities, and Athletic Association privileges. There is a fee of $12.00 for the replacement of a lost card.

LETTERS OF REGISTRATION
www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/Confirming_Your_Registration/Letters_of_Registration_Confirmation.htm

If a current or former student of the Faculty requires a letter that confirms their registration, they can make such a request from the Registrar’s Office. Letters of Registration are $7.00 with tax included. Payment must accompany such requests, and processing takes up to five (5) business days. The Office of the Registrar cannot be responsible for letters lost or delayed in the mail.

TRANSCRIPTS

The transcript of a student’s record reports the standing in all courses attempted, information about the student’s academic status including record of suspension and refusal of further registration, and completion of degree requirements. Course results are added to each student’s record at the end of the session. Individual courses from which a student withdraws within the normal time limit are not shown. Transcript requests should be submitted on the Web at: www.rosi.utoronto.ca. Requests may also be made in person or by writing the University of Toronto Transcript Centre at Room 1006, 100 St. George Street, Toronto, ON M5S 3G3. A fee of $10.00 which includes PST and GST is charged for each transcript. Cheques and money orders should be made payable to the University of Toronto. Transcripts are not issued for students who have outstanding financial obligations with the University. The University is not responsible for transcripts lost in the mail.

OTHER RESOURCES FOR STUDENTS IN THE FACULTY

ENGINEERING COMPUTING FACILITY
www.undergrad.engineering.utoronto.ca/Student_Life/Engineering_Computing_Facility.htm

ENGINEERING COMMUNICATION PROGRAM AND ENGINEERING COMMUNICATION CENTRE
www.engineering.utoronto.ca/Directory/Student_Resources/Engineering_Communication_Program.htm

ENGINEERING CAREER CENTRE
www.ecc.utoronto.ca

PROFESSIONAL EXPERIENCE YEAR (PEY) PROGRAM
www.pey.utoronto.ca
45 Willcocks Street, 2nd Floor (New College)
Telephone: 416-978-6649
Email: pey@ecf.utoronto.ca

The Professional Experience Year (PEY) Internship Program allows students to apply their engineering knowledge in a 12-16 month project-based professional internship. The length of the internship offers students sufficient time to become involved in large-scale projects, build relationships with employers, and reach professional milestones. Students who elect to participate in this optional program make industry contacts, gain valuable career skills and significant professional experience before graduation. The PEY internship program is over 30 years old and during this time it has earned an outstanding reputation in both academic and industry circles. It offers students an exceptional education, a range of engineering related career paths to
Student Services and Resources

choose from, and strong, established industry partnerships. It also provides a strong practical foundation for individuals who are interested in completing
graduate studies. Students who participate in the program are enrolled in the nine Engineering programs, as well as Computer Science, Geology,
Toxicology, Pharmaceutical Chemistry, Commerce, and other Arts & Science programs. Students register for PEY in their 2nd or 3rd year of study and
complete their internship during the following academic year. For the current PEY 2011 - 2012 internship year, 675 students are in placements at over
200 companies. Some of our past out of province and international placement locations include: Alberta, British Columbia, Newfoundland, Belgium,
Chile, India, Japan, Taiwan, Switzerland, Czech Republic, United States, Romania and Indonesia. The average internship salary for 20011/2012 was
$42,638.

ENGINEERING SUMMER INTERNSHIP PROGRAM (eSIP)

www.engineeringcareers.utoronto.ca
45 Willcocks Street, 2nd Floor (New College)
Telephone: 416-946-3730
Email: career@ecf.utoronto.ca

The Engineering Summer Internship Program (eSIP) is a paid 4 month summer co-op program available to eligible engineering students in year 2 or 3 of
study, including engineering international students. While a relatively young program in its sixth year, eSIP serves as an introductory career development
program for students. Through formalized and interactive workshops and individual counseling appointments, students are introduced to concepts and
tools to prepare them for the workplace. The majority of applicants are in their year 2 of study, for which eSIP holds particular value in preparing
students to be competitive for future opportunities, such as the intensive model of the PEY internship.

UNIVERSITY OF TORONTO STUDENT LIFE PROGRAMS AND SERVICES

Student Life Programs and Services
Dedicated to student success and development, the division of Student Life Programs & Services on the St. George Campus provides the supports,
opportunities and resources students need to reach their full potential. The division consists of 11 distinct units dedicated to supporting a variety of
personal and learning needs as well as a central team of program, communications, and information technology professionals who pull it all together.

The Division of Student Life Programs and Services includes:

Academic Success Centre
Accessibility Services
Career Centre
Centre for Community Partnerships
Counselling & Psychological Services (CAPS)
First Nations House
Hart House
Health Services
International Student Centre
Multi-faith Centre
Student Housing Service
(Source page: www.studentlife.utoronto.ca)

Student Life Programs and Services are dedicated to enhancing the student experience by providing academic, health and personal support services
and opportunities to participate in the campus and wider community. The following is a list of the services and programs that fall under Student Life.

Academic Success Centre
The Academic Success Centre is dedicated to making sure you achieve your highest possible learning potential. Through lectures, workshops, groups,
counselling and online, the ASC helps students become better learners. The Centre is open to students at all levels, and has specialized programming
for both undergraduate and graduate students. Staff members at the ASC also collaborate with student groups, staff members and faculties to develop
tailored programs on a wide range of learning topics.

Academic Success Centre
214 College Street
416-978-7970
www.asc.utoronto.ca

Accessiblility Services
Accessibility Services provides services and programs for students with a documented disability, be it physical, sensory, a learning disability or a mental
health disorder. Students with a temporary disability (i.e. broken arm or leg) also qualify. Services include alternative test and exam arrangements, note-
taking services, on-campus transportation, adaptive equipment and assistive devices and skills development.

Accessiblility Services
Robarts Library
130 St. George Street, First Floor

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Career Centre
The Career Centre offers a variety of services to help students with the career development process. Services include 24 hour online access to thousands of part-time, full-time, summer and volunteer job postings, resource library, resume clinic, personal counselling, career exploration programs and workshops on topics such as conducting an affective employment search, writing proper resumes and preparing for employment interviews.

Career Centre
Koffler Student Services Centre
214 College Street
416-978-8000
career.centre@utoronto.ca
www.careers.utoronto.ca

Counselling and Psychological Services
Students dealing with personal matters such as, difficulties adjusting to university life, anxiety, depression, shyness, relationship problems, sex and gender concerns, disturbances resulting from abuse and assault, prolonged stress, and other personal difficulties can speak with a professional counsellor at CAPS.

Counselling and Psychological Services also assists students with psychological and emotional concerns including depression anxiety, depression, obsessions and compulsions, phobias, relationship difficulties, eating and body image issues, attention and/or concentration problems, problems with sleep, and substance abuse. All services are confidential.

Counselling and Psychological Services
Koffler Student Services Centre
214 College Street
416-978-8070
www.caps.utoronto.ca

Centre for Community Partnerships
A resource for all three U of T campuses, the CCP connects students interested in learning through experience with meaningful learning opportunities in the U of T community. Services include helping campus organizations find suitable community projects, providing pre-placement orientation and training workshops, assisting faculty with the design of service learning courses and offering structured service opportunities for students.

Centre for Community Partnerships
569 Spadina Avenue, Suite 315
416-978-6558
serve.learn@utoronto.ca
www.ccp.utoronto.ca

First Nations House
First Nations House provides culturally supportive student services and programs for Aboriginal students and the general university community, including academic and personal counselling, financial aid information, housing, daycare, employment referrals, tutoring, a resource centre, and numerous cultural events throughout the year.

First Nations House
563 Spadina Avenue, Third Floor
416-978-8227
fnh.info@utoronto.ca
www.fnh.utoronto.ca

Hart House
Hart House has great spaces to relax, to read, to listen to music, to study …to just be. Boasting a full service Athletics Centre, the Arbor Room (great food at fair prices), a renowned art collection, Hart House Theatre, a hair salon, catering and event planning, and a beautiful farm, Hart House offers a broad range of services, activities, events, programming and involvement opportunities.

Hart House
7 Hart House Circle
416-978-2452
Health Service
The multidisciplinary team at the Health Service offers U of T students and their partners the same services as a family doctor's office, and more. We provide confidential, student-centred health care, including comprehensive medical care, travel education, immunization, counselling, and referrals.

Health Service
Koffler Student Services Centre
214 College Street, 2nd Floor
416-978-8030
health.services@utoronto.ca
www.healthservice.utoronto.ca

Center for International Experience
The CIE provides services and programs for international students and any students with cross-cultural interests. Services and programs include information on visas and work permits, University Health Insurance plan (UHIP), income tax filing, English conversation program, cross-cultural counselling, Work and Study Abroad resource Centre and social, cultural and recreational programs designed to promote Canadian and World cultures. Student families are welcome to participate in most programs and activities.

Centre for International Experience
33 St. George Street
416-978-2564
cie.reception@utoronto.ca
www.cie.utoronto.ca

Multi-Faith Centre
The Multi-Faith Centre exists to support the spiritual well-being of students, staff and faculty and to increase our understanding and respect of religious beliefs and practices. It does so by providing opportunities for members of the community to reflect, worship, contemplate, teach and learn, read and study, celebrate, mourn, engage in dialogue and interact on a daily basis.

Multi-Faith Centre
569 Spadina Avenue
416-946-3120
multi.faith@utoronto.ca
www.multifaith.utoronto.ca

Student Housing Service
The Student Housing Service provides an online registry for family, shared and private accommodation in all three U of T communities, temporary accommodation, buy and sell boards, street maps, legal information and residence information. An Emergency Housing Coordinator is also available to help students facing a temporary housing crisis.

Student Housing Service
Koffler Student Services Centre
214 College Street, 2nd Floor
416-978-8045
housing.services@utoronto.ca
www.housing.utoronto.ca

UNIVERSITY OF TORONTO STUDENT SERVICES AND RESOURCES

A-Z Of Student Services
www.life.utoronto.ca/get-info/a-z-list.htm

ULIFE-What are you doing after classes?
www.ulife.utoronto.ca

Other Resources:
Academic Integrity, Resources for Students
Antiracism and Cultural Diversity Office
Campus Community Police
Centre for International Experience
Equity Offices
Family Care Office
ACADEMIC INTEGRITY, RESOURCES FOR STUDENTS

Centre for Teaching Support & Innovation

Web: www.teaching.utoronto.ca  
Email: ctsi.teaching@utoronto.ca

All institutions of higher learning place a strong emphasis on integrity—in both their teaching and their research. This certainly holds true for the University of Toronto which is governed by both a Code of Student Conduct and a Code of Behaviour on Academic Matters. The University of Toronto is committed to ensuring academic integrity at all levels and relies on both faculty and students to fulfill this goal.

ANTIRACISM AND CULTURAL DIVERSITY OFFICE

Web: www.antiracism.utoronto.ca  
Simcoe Hall, 27 King’s College Circle  
First Floor, Room 128 (Room 128 is within Research Area Suite 133S)  
Telephone: (416) 978-1259  
Fax: (416) 971-2289

The Antiracism and Cultural Diversity Office is committed to:

- Ensuring that every member of the University community is accorded the requisite environment to learn and work free of bias or discrimination
- Ensuring every individual on campus has the right to be treated with dignity and respect
- Providing a mechanism for dialogue, investigation and mediation of current conflicts and/or disputes associated with race, ethnicity, culture and religion so they can be dealt with respectfully
- Facilitating the institutional commitment of the University of Toronto as an organization exemplifying commitment to anti-racism and the elimination of systemic discrimination

The office also provides training and education, complaint management and resolution in issues relating to race, ancestry, and place of origin, culture, and ethnicity, and advises individuals and groups in taking responsibility for creating safe spaces in classrooms, residences, workspaces where ethnic, racial, cultural and religious differences are respected.

CAMPUS COMMUNITY POLICE

Web: www.campuspolice.utoronto.ca  
Email: communitypolice@utoronto.ca  
St. George Campus  
21 Sussex Ave, Main Floor  
Telephone: (416) 978-2323, Urgent: (416) 978-2222  
Fax: (416) 978-1099

The University of Toronto Police Service is dedicated to creating and maintaining a safe and secure environment for students, staff, faculty and visitors. In fulfilling this purpose, the Campus Police work in partnership with the community in developing programs and conducting activities to promote safety and security on campus.

COMMUNITY SAFETY OFFICE

Web: www.communitysafety.utoronto.ca  
21 Sussex Ave. 2nd Floor  
Telephone: (416) 978-1485  
Fax: (416) 946-8296

The Community Safety Office addresses personal and community safety issues for students, staff and faculty across all three campuses. They can assist you with issues such as personal safety, harassment, stalking, abusive relationships, assaults, bullying, self defense courses, and much more. They also offer workshops, and other resources. All consultations are confidential.
Student Services and Resources

CO-OP JAPAN PROGRAM
Web: www.thecoopjapanprogram.com

The Co-op Japan Program is a Canadian-based, international co-op/internship program linking undergraduate students in engineering, science, business and the arts with Japanese businesses. The Co-op Japan Program formally integrates an undergraduate student’s Canadian academic studies with valuable work experience in a Japanese company. The program is open to universities and colleges nationally and is currently administered from the University of British Columbia. The program is only open to undergraduate students who have completed at least the Fall session of their Third year and meet certain eligibility requirements.

EQITY @ U OF T - WE NEED YOU IN IT!
Web: www.equity.utoronto.ca

Our Equity Offices provide the U of T Community with the resources, education and awareness initiatives that support the University’s goal to eliminate, reduce or mitigate the effects of any barriers to full participation in University Life. Our Equity Officers also provide advice, guidance and support on specific issues as they arise.

FAMILY CARE OFFICE
Web: www.familycare.utoronto.ca
Email: family.care@utoronto.ca
Koffler Student Services Centre, 214 College Street, Main Floor
Telephone: (416) 978-0951

Many students balance family obligations with their studies. The University is committed to fostering a family-friendly learning and working environment. The Family Care Office provides information, guidance, and referral services to students requiring child care (facilities, programs, or subsidies), elder care and assistance with other family matters. Additional services include support groups and workshops such as “Choosing Child Care that Works for your Family”, “Helping Your Child through a Separation or Divorce”, and “Elder Care: Navigating the System.” All services are free and confidential. The Family Care Office has a resource centre containing practical materials on family issues ranging from pregnancy and infant care to lesbian and gay parenting and caring for elderly family members. It also houses information on activities and facilities for student families on campus and in the community.

FREEDOM OF INFORMATION & PROTECTION OF PRIVACY OFFICE
www.artsci.utoronto.ca/faculty-staff/human-resources/fippa

The University of Toronto respects your privacy.

The University is committed to the requirements of FIPPA. Established University of Toronto values and long-standing practices for privacy and access are consistent with FIPPA principles. These principles were reflected in University practice and policy long before FIPPA applied to the University. The University continues to support access and privacy through its commitment to the requirements of FIPPA.

INFORMATION COMMONS
www.utoronto.ca/ic

The Information Commons (IC) provides front-line support/help through our Help Desk to students, faculty, and staff for several institutional services such as institutional email (UTORmail) and general Internet access (browsers, wireless, UTORid password changes, etc.).

Free AntiVirus Software Available!
Symantec (Norton) antivirus software is available for free for all students, faculty and staff at UofT. Download the software from: www.antivirus.utoronto.ca.

CENTRE FOR INTERNATIONAL EXPERIENCE
Web: www.cie.utoronto.ca
Email: student.exchange@utoronto.ca
Cumberlanda House
33 St. George Street, Room 204
Telephone: (416) 946-3138

If you wish to study abroad during the academic year, you should visit the Centre for International Experience's Student Exchange Program Office, which organizes international and Canadian exchanges for U of T students. Exchange programs operate under formal agreements between the University of Toronto and partner universities around the world and in Canada. The student exchange programs offer students a variety of opportunities to study at partner institutions while gaining an understanding of different cultures, heritage, values and lifestyles found across borders. While studying on exchange at a host university abroad, University of Toronto students pay the full-time tuition and compulsory incidental fees of the University of Toronto,
and not the tuition fees of the host university. Applications for most programs are due each year by mid-January. For more information please see the International Student Exchanges section in Chapter 7.

**ONLINE HARASSMENT**

Web: [www.enough.utoronto.ca](http://www.enough.utoronto.ca)

The University of Toronto has set up a website, named Enough, to deal with online harassment and to provide help on how to safeguard your online identity.

**REPORT HOMOPHOBIA**

Web: [www.sgdo.utoronto.ca/Report_Bullying.htm](http://www.sgdo.utoronto.ca/Report_Bullying.htm)

The Report Homophobia program provides a way for you to report incidents and behaviour on campus motivated by intolerance and hatred toward lesbians, gay men, bisexuals, transgender and queer people. The program is run by the Office of LGBTQ Resources Programs and is specifically designed for reporting hate incidents relating to sexual minority, sexual orientation, gender and sex.

**SEXUAL & GENDER DIVERSITY OFFICE**

Web: [www.sgdo.utoronto.ca](http://www.sgdo.utoronto.ca)

Email: [lgbtq.resources@utoronto.ca](mailto:lgbtq.resources@utoronto.ca)

21 Sussex Avenue, Suites 416 & 417

Telephone: 416-946-5624

The Sexual & Gender Diversity Office works with students, staff and faculty to provide programs, services, training resources, and outreach on issues related to the LGBTQ population at the University of Toronto. The Office develops initiatives and programming which support the lives of individuals at the University of Toronto who are lesbian, gay, bisexual, transgender, queer, or questioning their sexual orientation or gender identity. Our initiatives also focus on providing a positive learning and work environment for all that is free of discrimination and harassment. Any member of the University community is welcome to contact the Office with concerns, complaints, issues or ideas. Services are provided confidentially to anyone experiencing a problem related to heterosexism or homophobia, or who has questions, educational needs or other related concerns.

**SEXUAL HARASSMENT OFFICE**

Web: [www.utoronto.ca/sho](http://www.utoronto.ca/sho)

40 Sussex Avenue, 3rd floor

Telephone: (416) 978-3908

Fax: (416) 971-2289

Hours: Monday – Friday, 9:00 am to 4:00 pm

The Sexual Harassment Office handles complaints of harassment based on sex or sexual orientation at the University of Toronto. Sexual harassment is unwanted sexual attention or unwanted emphasis on your sex or sexual orientation. It includes any unwelcome pressure for sexual favours, any comments, gestures or other conduct which places an offensive focus on the sex or sexual orientation of another person, and any gender-based conduct that is directed at you and that creates an intimidating, hostile or offensive working or learning environment for you.

**STATUS OF WOMEN OFFICE**

Web: [www.status-women.utoronto.ca](http://www.status-women.utoronto.ca)

The Status of Women Office works toward full gender equity for women students, staff, and faculty on all three campuses by developing relevant policy, providing advice, identifying key issues to those in senior administration, organizing events, and generally being “an effective catalyst for change”.

**SUMMER ABROAD PROGRAMS**

Web: [www.summerabroad.utoronto.ca](http://www.summerabroad.utoronto.ca)

Email: summer.abroad@utoronto.ca

Professional and International Programs

Woodsworth College, 119 St. George Street, 3rd Floor

Telephone: (416) 978-8713

Fax: (416) 946-3516

Administered by Woodsworth College and the Faculty of Arts & Science, the University of Toronto’s Summer Abroad program is designed to enrich students’ academic lives by providing an exciting and educational international experience. Students complete a University of Toronto undergraduate credit course that is relevant to the location in which the course is taught. The program takes place over 4-6 weeks in the summer. The courses offered through the Summer Abroad program are typically all Arts & Science courses, but Engineering students are still welcome to apply and use the credit as...
**Office of the University Ombudsperson**

As part of the University's commitment to ensuring that the rights of its individual members are protected, the University Ombudsperson investigates complaints from any member of the University not handled through regular University channels. The Ombudsperson is independent of all administrative structures of the University and is accountable only to Governing Council. In handling a complaint, the Ombudsperson has access to all relevant files and information and to all appropriate University officials. All matters are in strict confidence, unless the individual involved approves otherwise. The Ombudsperson offers advice and assistance and can recommend changes in academic or administrative procedures where this seems justified. For additional information, please visit our website at: www.utoronto.ca/ombudsperson. The services of the Office are available by appointment at all three UofT campuses. Please phone 416-946-3485 or e-mail us at ombuds.person@utoronto.ca.

**Walk-Smart**

Walk Smart is a police or student escort service where you can request that someone walk with you at night to locations on the U of T Campus such as between campus buildings, to parking lots, and TTC transit stops near the campus. To request an escort, please call 416-978-7233 (SAFE). When dialing this number your call will be received promptly by the Walk Safer dispatcher. They are available Monday - Friday, 7:00pm - 12:00am from September to April.

**Student Organizations**

**Engineering Society**

Every undergraduate in the Faculty is a member of the Engineering Society. Founded in 1885, it is the oldest formal Engineering organization in Canada. Together with its constituent “course clubs” (one for each program), the Society plans and operates many student activities and services. It is the focal point for that traditional unity of spirit among Engineering students, which is the envy of other groups in the University and which continues throughout its members’ professional careers. The Society operates the Engineering Stores in the basement of the Sandford Fleming building, which supplies students with most of their school supplies and instruments. In addition, the Society deals with matters of policy relating to student academic affairs, and has representation on the Faculty’s governing body, the Council, and its working committees.

**Engsoc Club Directory**

**Association of Part-Time Undergraduate Students (APUS)**

All part-time undergraduate students on all three campuses of the University of Toronto are members of the Association of Part-time Undergraduate Students. The mission of the Association of Part-time Undergraduate Students (APUS) is to ensure that part-time undergraduate students have access to the full range of programs, services and resources at the University of Toronto in order to improve the quality of the part-time undergraduate educational experience. APUS works to ensure that a variety of post-secondary educational opportunities are available for students who, for any reason, choose to study part-time. APUS believes that education can be combined with work, family and other activities and that part-time study represents a viable option for students who can not study full-time. To this end, APUS promotes the concepts of life-long learning, evening, weekend and summer study and flexible academic programming across the University. The objectives of APUS services are to improve the quality of the total educational experience, in its broadest sense.
I. RESPONSIBILITIES OF STUDENTS

Students are responsible for making themselves familiar with the information in the Calendar. Remember: A minimum first installment or deferral of fees must be paid before a student is considered registered. Please refer to the Fees and Expenses section of this calendar.

- Students are responsible for ensuring that their course enrolment is accurate and complete and that the courses in which they enrol meet the requirements for graduation. Course prerequisites and any restrictions on enrolment should be noted carefully prior to registration. Whenever the requirements are not understood, a student should consult their department's undergraduate counselor/advisor or the Associate Chair of the Undergraduate Studies.

- Students are required to attend the courses of instruction and the examinations in all subjects prescribed.

- Students must conform to all lecture, tutorial and laboratory regulations.

- Students shall comply with all due dates and manner of submission for all work submitted for credit in a course. Consequences for failure to comply shall be specified and announced by the instructor. All session work must be submitted no later than the last day of lectures in the session as published in this Calendar.

- If a student is unable to complete any portion of their course work due to medical, psychological or compassionate circumstances, they should inform the instructor by submitting a “Petition for Consideration in Course Work”, with supporting documents (e.g., U of T Medical Certificate). Please refer to Section I - Petitions in this chapter.

- A student has the right to withdraw from a course or program without academic penalty before the ninth week of the session (see Sessional Dates listing at the beginning of the Calendar) with approval from their department's undergraduate counselor/advisor. A student who does not complete the course or write the final examination will receive final marks in the course consisting of the sum of their earned session marks with zero for the uncompleted work and examination. These marks will be included in the calculation of Session Averages. A student who in any session withdraws from the Faculty after the deadline to withdraw without academic penalty (as specified in the Calendar) is deemed to have failed the session.

- It is generally desirable for students to engage in extracurricular activities to a reasonable extent so that they do not become too narrowly academic in interest and outlook but no academic credit can be given for such activities. Extracurricular activities require considerable time for the proper performance of the duties connected with them. A student on probation, or with marginal academic records, should not undertake such activities. Students will not be given any special consideration for conflicts resulting from such activities and are responsible for meeting the requirements of all aspects of his or her academic work.

Responsibilities of Students with Regard to the Use of Computer Facilities

- All computer equipment in the Faculty is to be used for academic purposes only.

- The use of any computer equipment to display or distribute material that could reasonably be expected to degrade, offend, or promote hatred or violence against any person or group is inconsistent with the purpose of the equipment, and is not permitted. Examples of unacceptable material include pornography, racial slurs, and pictures of men or women who are not fully dressed.

These regulations are designed to promote an atmosphere in which all students can pursue their academic programs, as well as discourage wastage of computer resources. Violators are subject to having all their U of T computer accounts closed down, and/or other disciplinary action under the provisions of the University of Toronto Code of Student Conduct. Maintaining the integrity of the Faculty's computer facilities is everyone's responsibility. If you see an individual using computer equipment anywhere in this Faculty in a manner that you believe to be inconsistent with the regulations, please record the time, date, room number, workstation number (if in a facility with more than one terminal or computer) and the exact nature of the offence (description of what is being displayed). Send the information to the Director, Engineering Computing Facility, Engineering Annex Room 206 or send email to: office@ecf.utoronto.ca. The Director will then determine the identity of the user and the type of activity in which the user was engaged at the time it was recorded.

II. DEFINITIONS OF TERMS

1. Sessions

The academic program consists of a consecutive sequence of sessions. There are three sessions per academic year:

- Fall Session (September-December)
- Winter Session (January-April)
- Summer Session (May-August)

With permission of the responsible division or department, courses may be taken in summer sessions. The evaluation period for the purpose of promotion is the Fall Session or the Winter Session.

The notations 1F, 1W, 2F, 2W, etc., are used to represent the Fall Session and the Winter Session for the respective year of study.

2. Sessional Averages

a) Fall Session Average
The Fall Session Average is calculated on the basis of all Fall Session courses in which the student is enrolled. The weighting factor for each course is the number of weight units assigned to it. Full-year courses are not included in the calculation of the Fall Session Average. These courses are identified as “IPR” on the student’s record in the Fall Session.

b) Winter Session Average
The Winter Session Average is calculated on the basis of all Winter and full year courses in which the student is enrolled. The weighting factor for each course is the number of weight units assigned to it. The results of full-year courses are included in the Winter Session Average with a weight equal to the sum of the Fall and Winter Session weights.
3. Course Marks and Grades

The following course marks and grades relate to the performance of a student in the work of a particular course. A course grade or mark should not be interpreted as an assessment of status within a program of studies since this is determined by the Promotional Regulations set out in Section III, IV, and V. In particular, please refer to Section III, Part 8 regarding credit for courses.

The equivalents of the Numerical Scale of Marks in the refined Letter Grade Scale and the Grade Point Value are as follows:

* The grade point values above apply to marks earned in individual courses; grade point averages are weighted sums of the grade points earned (see below), and thus do not necessarily correspond exactly to the scale below. For example, a B+ average would include grade point averages from 3.20 to 3.40, while the lowest B- average would be 2.50.

<table>
<thead>
<tr>
<th>Numerical Scale of Mark</th>
<th>Letter Grade</th>
<th>Refined Grade Point Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-100</td>
<td>A+</td>
<td>4.0</td>
</tr>
<tr>
<td>85-89</td>
<td>A</td>
<td>4.0</td>
</tr>
<tr>
<td>80-84</td>
<td>A-</td>
<td>3.7</td>
</tr>
<tr>
<td>77-79</td>
<td>B+</td>
<td>3.3</td>
</tr>
<tr>
<td>73-76</td>
<td>B</td>
<td>3.0</td>
</tr>
<tr>
<td>70-72</td>
<td>B-</td>
<td>2.7</td>
</tr>
<tr>
<td>67-69</td>
<td>C+</td>
<td>2.3</td>
</tr>
<tr>
<td>63-66</td>
<td>C</td>
<td>2.0</td>
</tr>
<tr>
<td>60-62</td>
<td>C-</td>
<td>1.7</td>
</tr>
<tr>
<td>57-59</td>
<td>D+</td>
<td>1.3</td>
</tr>
<tr>
<td>53-56</td>
<td>D</td>
<td>1.0</td>
</tr>
<tr>
<td>50-52</td>
<td>D-</td>
<td>0.7</td>
</tr>
<tr>
<td>0-49</td>
<td>F</td>
<td>0.0</td>
</tr>
</tbody>
</table>

4. Grade Point Average

Note: The Faculty of Applied Science and Engineering does not promote students on the basis of the GPA but on the basis of the weighted sessional average.

The Grade Point Average is the weighted sum of the grade points earned, divided by the number of courses in which grade points were earned.

Courses noted “AEG” are not included in the average, nor are transfer credits, courses taken elsewhere on a Letter of Permission, nor courses designated as “extra”.

Three types of grade point averages are shown on the Official Student transcript:

- The Sessional GPA (SGPA) is based on courses taken in a single session (Fall, Winter or Summer);
- The Annual GPA (AGPA) is based on courses taken in the Fall-Winter Sessions;
- The Cumulative GPA (CGPA) takes into account all courses taken for degree credit in the Faculty.

5. Non-Grade Symbols

The following non-grade symbols may appear on grade reports and transcripts instead of course marks and/or equivalent letter grades. They have no grade point or term sessional average values.

- AEG - Aegrotat standing granted on the basis of session work and medical or similar evidence where the student was not able to write the final examination in the course. AEG is assigned by a division upon approval of a student's petition. It carries credit for the course but is not considered for averaging purposes.
- CR/NCR –Credit/No Credit. Used to report results for academic requirements such as practical experience, English proficiency, field camps, etc. The grades CR and NCR have no numerical equivalence and are not included in the calculation of Sessional Averages.
- DNW - Did not write/did not attend/did little work (when used as final course result, DNW is assigned by the instructor and must be changed to another grade/symbol during the divisional grade review.
- GWR - Grade withheld pending Review under the Code of Behaviour on Academic Matters.
- IPR - (Course) In Progress.
- LWD - Permitted to withdraw from a course without academic penalty. Applies only to courses taken as humanities and social science electives,
complementary studies or Free electives from the Faculty of Arts and Science (See VII, 8).

• NGA - No grade available.
• SDF - Standing deferred on the basis of incomplete course work because of medical or similar reasons (to be replaced by a regular mark before the expiry of a specified extension period).
• WDR - Granted privilege of late withdrawal from a course, caused by circumstances beyond the student’s control, without academic penalty.

The following non-grade statements may appear on grade reports and transcripts in conjunction with the course mark and letter grade:

• Assessed - Indicates that an assessed mark has been granted, through petition to the Committee on Examinations, on the basis of session work and medical or similar evidence.
• EXT - Extra course - Not for degree credit; course has no effect on status or grade point average.
• INC (incomplete) - Notwithstanding the mark obtained by a student in a course, the instructor may report the designation ‘Incomplete’ in addition to the student’s final course mark, if:
  a) a student has not made a reasonable attempt to complete major session assignments, projects laboratories, tutorials or the thesis, and
  b) the instructor has made a reasonable effort to inform the student as early as possible in the session that an important part of the session work is incomplete. If the instructor’s report is confirmed by the Committee on Examinations, the student will be required to clear the incomplete status to receive credit for the course, although the original course mark will not be altered.

An incomplete status may be cleared by obtaining an evaluation of 50% or greater on the required course work which must be completed within a time period specific by the professor but not later than the end of the next corresponding session. A student who does not clear an incomplete course designation in the manner prescribed above will not receive credit for the course and the result will be treated as an F grade, i.e. Regulation IV-8 pertaining to the repeating or replacing of courses with F grades will apply.

III. UNIVERSITY OF TORONTO POLICIES AND GUIDELINES

RESOURCES

All University policies can be found at: www.governingcouncil.utoronto.ca/policies.htm

Those which are of particular importance to students are:
Policy on Access to Student Academic Records
Code of Behaviour on Academic Matters
Code of Student Conduct
Grading Practices Policy
Policy on Official Correspondence with Students

More information about students’ rights and responsibilities can be found at: http://life.utoronto.ca/get-help/rights-responsibilities.htm

DISCIPLINE

A) Academic
Code of Behaviour on Academic Matters

The Governing Council of the University of Toronto has approved a Code of Behaviour on Academic Matters, which applies to students and members of the teaching staff of the University. The full text of the Code is available from the Office of the Registrar, however, excerpts are shown below for convenience. Wherever in this Code an offence is described as depending on ‘knowing’, the offence shall likewise be deemed to have been committed if the person ought reasonably to have known.

Academic Offences

The University and its members have a responsibility to ensure that a climate that might encourage, or conditions that might enable cheating, misrepresentation or unfairness not be tolerated. To this end, all must acknowledge that seeking credit or other advantages by fraud or misrepresentation, or seeking to disadvantage others by disruptive behaviour is unacceptable, as is any dishonesty or unfairness in dealing with the work or record of a student.

It shall be an offence for a student knowingly:

a) to forge or in any other way alter or falsify any document or evidence required by University, or to utter, circulate or make use of any such forged, altered or falsified document, whether the record be in print or electronic form;

b) to use or possess an unauthorized aid or aids or obtain unauthorized assistance in any academic examination or session test or in connection with any other form of academic work;

c) to personate another person, or to have another person personate, at any academic examination or session test or in connection with any other form of academic work;

d) to represent as one’s own any idea or expression of an idea or work of another in any academic examination or session test or in connection with any other form of academic work, i.e. to commit plagiarism;

e) to submit, without the knowledge and approval of the instructor to whom it is submitted, any academic work for which credit has previously been obtained or is being sought in another course or program of study in the University or elsewhere;

f) to submit any academic work containing a purported statement of fact or reference to a source which has been concocted.
Academic Regulations

It shall be an offence for a faculty member knowingly:

a) to approve any of the previously described offences;

b) to evaluate an application for admission or transfer to a course or program of study by reference to any criterion that is not academically

justified.

c) to evaluate academic work by a student by reference to any criterion that does not relate to its merit, to the time within which it is to be resubmitted or to

the manner in which it is to be performed.

It shall be an offence for a faculty member and student alike knowingly:

a) to forge or in any other way alter or falsify any academic record, or to utter, circulate or make use of any such forged, altered or falsified record, whether the record be in print or electronic form;

b) to engage in any form of cheating, academic dishonesty or misconduct, fraud or misrepresentation not herein otherwise described, in order to obtain

academic credit or other academic advantage of any kind. A graduate of the University may be charged with any of the above offences committed

knowledgeably while he or she was an active student, when, in the opinion of the Provost, the offence, if detected, would have resulted in a sanction

sufficiently severe that the degree would not have been granted at the time that it was.

Parties to Offences

Every member is a party to an offence under this Code who knowingly:

i) actually commits it;

ii) does or omits to do anything for the purpose of aiding or assisting another member to commit the offence;

iii) does or omits to do anything for the purpose of aiding or assisting any other abets, counsels, procures or conspires with another member to commit

or be a party to an offence; or

iv) abets, counsels, procures or conspires with any other person who, if that person were a member, would have committed or have been a party to the

offence.

Every party to an offence under this Code is liable upon admission of the commission thereof, or upon conviction, as the case may be, to the sanctions

applicable to that offence. Every member who, having an intent to commit an offence under this Code, does or omits to do anything for the

purpose of carrying out that intention (other than mere preparation to commit the offence) is guilty of an attempt to commit the offence and liable

upon conviction to the same sanctions as if he or she had committed the offence. When a group is found guilty of an offence under this Code, every

officer, director or agent of the group, being a member of the University, who directed, authorized or participated in the commission of the offence is a

party to and guilty of the offence and is liable upon conviction to the sanctions provided for the offence.

 Procedures

Note: Where a student commits an offence, the Faculty in which the student is registered has responsibility over the student in the matter.

a) Where an instructor has reasonable grounds to believe that an academic offence has been committed by a student, the instructor shall so inform the

student immediately after learning of the act or conduct complained of, giving reasons, and invite the student to discuss the matter.

Nothing the student says in such a discussion may be used nor may be receivable in evidence against the student.

b) If after such discussion, the instructor is satisfied that no academic offence has been committed, he or she shall so inform the student and no further

action shall be taken in the matter by the instructor, unless fresh evidence comes to the attention of the instructor, in which case he or she

may again proceed in accordance with (a) above.

c) If after such discussion, the instructor believes that an academic offence has been committed by the student, or if the student fails or neglects to

respond to the invitation for discussion, the instructor shall make a report of the matter to the department chair or through the department chair to

the Dean.

d) When the Dean or the department chair, as the case may be, has been so informed, he or she shall notify the student in writing accordingly, provide

him or her with a copy of the Code and subsequently afford the student an opportunity for discussion of the matter. In the case of the

Dean being informed, the chair of the department and the instructor shall be invited by the Dean to be present at the meeting with the student. The Dean

shall conduct the interview.

e) Before proceeding with the meeting, the Dean shall inform the student that he or she is entitled to seek advice, or to be accompanied by counsel at

the meeting, before making, and is not obliged to make, any statement or admission, but shall warn that if he or she makes any

statement of admission in the meeting, it may be used or be receivable in evidence against the student in the hearing of any charge with respect to the

offence or alleged offence in question. The Dean shall also advise the student, without further comment or discussion, of the sanctions that

may be imposed (see Sanctions below) that the Dean is not obliged to impose a sanction but may instead request that the Provost lay a charge against

the student. Where such advice and warning have been given, the statements and admissions, if any, made in such a meeting may be

used or received in evidence against the student in any such hearing.

f) If the Dean, on the advice of the department chair and the instructor, or if the department chair on the advice of the instructor, subsequently decides

that no academic offence has been committed and that no further action in the matter is required, the student shall be so informed in writing and the

student’s work shall be accepted for normal evaluation or, if the student was prevented from withdrawing from the course by the withdrawal date, he or

she shall be allowed to do so. Thereafter, the matter shall not be introduced into evidence at a Tribunal hearing for another offence.

g) If the student admits the alleged offence, the Dean or the department chair may either impose the sanction(s) that he or she considers appropriate

(see Sanction below) or refer the matter to the Dean or Provost, as the case may be, and in either event shall inform the student in writing accordingly.

No further action in the matter shall be taken by the instructor, the department chair or the Dean if the Dean imposes a sanction.

h) If the student is dissatisfied with a sanction imposed by the department chair or the Dean, as the case may be, the student may refer the matter to the

Dean or Provost, as the case may be, for consideration.

i) If the student does not admit the alleged offence, the Dean may, after consultation with the instructor and the department chair, request that the

Provost lay a charge against the student. If the Provost agrees to lay a charge, the case shall then proceed to the Trial Division of the Tribunal.

j) Normally, decanal procedures will not be examined in a hearing before the Tribunal. A failure to carry out the procedures referred to in this Section, or
Tribunal Sanctions

Academic Board and attached to the Code as Appendix ‘C’.

Divisional Sanctions

1. In an assignment worth 10% or less of the final grade, the department chair may handle the matter if:
   i) the student admits guilt; and
   ii) the assignment of a penalty is limited to at most a mark of zero for the piece of work.

2. One or more of the following sanctions may be imposed by the Dean where a student admits to the commission of an offence:
   a) an oral and/or written reprimand;
   b) an oral and/or written reprimand and, with the permission of the instructor, the resubmission of the piece of academic work, in respect of which the offence was committed, for evaluation. Such a sanction shall be imposed only for minor offences and where the student has committed no previous offence;
   c) assignment of a grade of zero or a failure for the piece of academic work in respect of which the offence was committed;
   d) assignment of a penalty in the form of a reduction of the final grade in the course in respect of which the offence was committed;
   e) denial of privileges to use any facility of the University, including library and computer facilities;
   f) a monetary fine to cover the costs of replacing damaged property or misused supplies in respect of which the offence was committed;
   g) assignment of a grade of zero or a failure for the course in respect of which the offence was committed;
   h) suspension from attendance in a course or courses, a program, an academic division or unit, or the University for a period of not more than twelve months. Where a student has not completed a course or courses in respect of which an offence has not been committed, withdrawal from the course or courses without academic penalty shall be allowed.

3. The Dean shall have the power to record any sanction imposed on the student’s academic record and transcript for such length of time as he or she considers appropriate. However, the sanctions of suspension or a notation specifying academic misconduct as the reason for a grade of zero for a course shall normally be recorded for a period of five years.

4. The Provost shall, from time to time, indicate appropriate sanctions for certain offences. These guidelines shall be sent for information to the Academic Board and attached to the Code as Appendix ‘C’.

Tribunal Sanctions

1. One or more of the following sanctions may be imposed by the Tribunal upon the conviction of any student:
   a) an oral and/or written reprimand;
   b) an oral and/or written reprimand and, with the permission of the instructor, the resubmission of the piece of academic work, in respect of which the offence was committed, for evaluation. Such a sanction shall be imposed only for minor offences and where the student has committed no previous offence;
   c) assignment of a grade of zero or a failure for the piece of academic work in respect of which the offence was committed;
   d) assignment of a penalty in the form of a reduction of the final grade in the course in respect of which the offence was committed;
   e) denial of privileges to use any facility of the University, including library and computer facilities;
   f) a monetary fine to cover the costs of replacing damaged property or misused supplies in respect of which the offence was committed;
   g) assignment of a grade of zero or a failure for any completed or uncompleted course or courses in respect of which any offence was committed;
   h) suspension from attendance in a course or courses, a program, an academic division or unit, or the University for a period of time up to five years as may be determined by the Tribunal. Where a student has not completed a course or courses in respect of which an offence has not been committed, withdrawal from the course or courses without academic penalty shall be allowed;
   i) recommendation of expulsion from the University. The Tribunal has power only to recommend that such a penalty be imposed. In any such case, the recommendation shall be made by the Tribunal to the President for a recommendation by him or her to the Governing Council. Expulsion shall mean that the student shall be denied any further registration at the University in any program and his or her academic record and transcript shall record permanently this sanction. Where a student has not completed a course or courses in respect of which an offence has not been committed, withdrawal
from the course or courses without academic penalty shall be allowed. If a recommendation for expulsion is not adopted, the Governing Council shall have the power to impose such lesser penalty as it sees fit.

j) (i) recommendation to the Governing Council for cancellation, recall or suspension of one or more degrees, diplomas or certificates obtained by any graduate; or

ii) cancellation of academic standing or academic credits obtained by any former student who, while enrolled, committed any offence which if, detected before the granting of the degree, diploma, certificate, standing or credits would, in the judgement of the Tribunal, have resulted in a conviction and the application of a sanction sufficiently severe that the degree, diploma, certificate, standing, credits or marks would not have been granted.

2. The hearing panel shall have the power to order that any sanction imposed by the Tribunal be recorded on the student’s academic record and transcript for such length of time as the jury considers appropriate.

3. The Tribunal may, if it considers appropriate, report any case to the Provost who may publish a notice of the decision of the Tribunal and the sanction or sanctions imposed in the University newspapers, with the name of the student withheld.

www.governingcouncil.utoronto.ca/policies/behaveac.htm

IV. OFFICERS OF THE UNIVERSITY

A list of officials of the University of Toronto can be found on the Governing Council website at www.governingcouncil.utoronto.ca

V. ACADEMIC PROGRAM LOAD

Please note: Program load may vary by year of study and Program.

The normal full academic load is 2.50 credits per session. Students in second or higher years may, in exceptional cases, increase their academic load to a maximum of 3.00 credits. Students taking a full year core course will not be allowed to drop this course in the Winter Session. A full-time student may reduce their academic load below the full academic load by 0.50 credits by dropping a CS, HSS or technical/free elective course if it is possible to take the same or a replacement course in a summer or subsequent session. It is recommended that a student consult their undergraduate counsellor/advisor for advice on how this may impact their ability to complete their degree requirements within the expected period of time. Reducing the academic load to less than a full load as defined by a student’s year and program of study will make the student ineligible for certain scholarships and Dean’s Honours list. Full-time students with reduced course loads are still required to pay the full-time program fee, and will not be entitled to any tuition fee refunds.

VI. DEGREE REQUIREMENTS

To qualify for a degree, a student must complete a full undergraduate program as outlined in the Faculty Calendar within nine calendar years of first registration, exclusive of mandatory absences from his or her program. Further, no student will be allowed to graduate if they do not meet the criteria that may lead to registration as a Professional Engineer as set by the Canadian Engineering Accreditation Board (CEAB).

A full undergraduate program consists of eight Fall and Winter Sessions taken in order. To gain credit for a session a student must:

a) satisfy the academic regulations to proceed to the succeeding session as described herein, and

b) not be subsequently required to repeat the session for which credit is to be gained, and

c) not have any outstanding designations of ‘standing deferred,’ ‘incomplete,’ ‘No Grade Available,’ or GWR (Grade Withheld pending Review under Code of Conduct on Academic Matters) for any course in any session (see Regulations I-5 and I-7).

2. Final Session

To be eligible to graduate, a student must attain a weighted Session Average of 60% or greater in their final session. Any student who does not achieve a weighted Session Average of 60% in their final session (4W), but has attained a weighted Session Average that allows them to proceed to the next session on probation, shall repeat the final session and achieve a weighted Session Average of 60% or greater to graduate.

An academic standing of Proceeding on Probation, or On Repeat Probation will be removed and changed to Pass (or Honours if applicable) at the conclusion of the final session during which all requirements for graduation are satisfied (effective Spring 2012).

3. English Proficiency Requirement

The Faculty requires each student to show an ability to write English coherently and correctly in all written work submitted for evaluation. Consequently, the Faculty reserves the right to ask each student to write a post-admission English Proficiency Assessment at the beginning of his or her first year of studies. Every student will also take at least one course that includes a written communication component within their curriculum. Satisfactory completion of the course or courses is required for graduation.

4. Practical Experience Requirement

It is a regulation of the Faculty of Applied Science and Engineering that all students complete a minimum of 600 hours of practical work before graduation. Full details of the practical experience requirement are outlined in “Curriculum and Programs”.

VII. ACADEMIC STANDING

1. There are three categories of Academic Standing used for promotion:

Clear: A student with a Clear standing may proceed to subsequent sessions.

Proceeding On Probation: A student is placed on Probation the first time the Session Average is between 55% to 60%. Probation is a warning that
academic performance is not satisfactory.

On Repeat Probation: A student placed on Repeat Probation must withdraw from the Faculty for a prescribed period of time in accordance to the promotion regulations. A second instance of Repeat Probation will result in refusal of further registration in the Faculty.

2. Honours Standing:
   a) i) In sessions 1F, 1W, 2F, 2W and 3F or 3W, Honours standing in the work of session is granted to students carrying a full academic load (2.50 credits per session), if the session is not being repeated and if the weighted Session Average is 80% or greater. Note that extra (EXT) courses are not included in the academic load.
   ii) During fourth year, a student may reduce their course load in either 4F or 4W (but not both) and be eligible for Honours Standing if the session is not being repeated and if the weighted Session Average is 80% or greater.
   b) To obtain Honours upon graduation a full-time student must achieve a cumulative average across years 2, 3 and 4 of 79.5% or higher and a weighted sessional fourth year average of 74.5% or higher, excluding any required first year courses, repeated courses and courses marked as “Extra”.

VIII. PROMOTION REGULATIONS

The Promotion Regulations are the academic standards that dictate whether a student will proceed to the next session or not. These regulations apply to all students who are registered in the Faculty. The first session (Fall Session) commences in September and ends in December. The second session (Winter Session) begins in January and ends in April/May.

1. Removing Probation:
   A full-time student who has two successive sessions (excluding summer sessions) with a weighted Session Average of 70% or greater, none of which is a repeated session, will have their status improved by one step. For example: a student who has an academic status of “Repeat Probation” after two successive full-time sessions with a weighted Session Average of 70% or better will have a new academic status of “Proceeding On Probation.” Therefore, a student who is on Repeat Probation and who is entering third year can improve their status to “Clear” by graduation (four successive full-time sessions with a weighted Session Average of 70% or greater). Note full time session means four or more courses.

An academic standing of Proceeding on Probation, or On Repeat Probation will be removed and changed to Pass (or Honours if applicable) at the conclusion of the final session during which all requirements for graduation are satisfied (effective Spring 2012).

2. Required Withdrawal:
   A student who has failed a session is required to withdraw and must discontinue their studies as soon as grades are made official. This applies whether or not the student is enrolled in courses that continue in the following session. In all cases where a full year course is dropped, the student will not receive credit for any work already done in the course. A student who is required to withdraw after a Fall Session will be withdrawn by the Registrar’s Office and will receive a refund for the Winter Session. A student who wishes to withdraw voluntarily must complete a withdrawal form at the Registrar’s Office. A student who is required to withdraw after a Winter Session need not complete a withdrawal form.

3. Repetition of a Session:
   A student is not permitted to repeat the same session more than once. Thus, any student who would otherwise be required to repeat a session more than once is given the status ‘Failed - will not be considered for re-admission.’ In permitting a student to proceed to the next session, it is assumed by the Faculty that the student has both the ability and necessary background to obtain a weighted Session Average of 60% or greater.
   a) In a repeated session, no credit is retained for courses previously taken in which a mark of less than 70% was achieved. Courses in which a mark of 70% or greater has been achieved need not be repeated. A student who is repeating a session may choose elective courses different from those he or she chose on the previous attempt.
   b) A first year student may not improve his or her academic standing by voluntarily repeating a session, for example; if a student is on academic probation and the promotional standing of the student will not be improved by the results of the voluntarily repeated session if his or her weighted Session Average for the session is 60% or greater.

4. Re-enrolment after Withdrawal:
   A student who has withdrawn from the Faculty must apply for re-enrolment by the stated deadline dates for the Fall Session and Winter Session as stated in the Calendar for a decision on their eligibility to resume studies in the Faculty. Specific deadline dates are listed in the “Sessional Dates” section of the Calendar. Please contact the Office of the Registrar for application information. Re-enrolment is not automatic. First year students making such applications should consult the First Year Counsellor.

5. Credit for Courses in the Fall and Winter Session:
   a) A student whose mark is less than 50% in any course taken as part of the academic load in a session will not be given credit for the course. If credit is not obtained for a course, the students must register for and repeat the course at the first opportunity. If a mark of 50% or greater is obtained in the repeated course, credit will be given for the course.
   b) If credit is not obtained for the original course on the second attempt, be it through repeating or substituting of a course, the student will be permitted one additional opportunity to clear the requirement. In such case, the student must register for and repeat the course or a substituted course at the first opportunity. If credit is not obtained for the original course or for the substituted course on the third attempt, the student will be given the status 'Failed -Refused Further Registration.’
   c) A student who is not in a regular full-time or part-time program and is taking courses either to obtain credit for a missing requirement or to repeat a previous failed course must achieve a mark of 50% or greater in order to retain credit in such courses.
d) PEY students who are given permission to take courses during their internship program will be given credit for those courses in which they obtain a mark of 50% or greater.

e) In the event that the requirement to repeat or substitute a course causes timetable conflicts that cannot be sanctioned by the department or division, study of higher level conflict courses must be deferred.

f) Promotion rules shall apply in the usual manner to students who are repeating or substituting courses or repeating examinations. Grades for repeated or substituted courses or repeated examinations shall be included in the weighted Session Average.

7. Credit for Courses in the Summer Session:
A student taking any University of Toronto summer course(s) including repeated courses, must obtain a grade of at least 50% in order to retain credit. Therefore, there will be no audit/promotional assessment for the Summer Session and credit for courses will be assessed on a per course basis. Exclusion:  T-Program students.

8. Late Withdrawal from Select Arts and Science courses

a) Students pursuing a degree in the Faculty of Applied Science and Engineering may request to withdraw without petition from a total of no more than 3.0 FCEs (throughout their total academic career) of HSS/CS and Free Elective courses offered by the Faculty of Arts and Science, provided the request is made by the last day of term in the relevant course. This provision does not apply to courses offered by the Faculty of Applied Science and Engineering, including HSS/CS or free elective courses offered by the Faculty of Applied Science and Engineering.

b) Students will make such requests to their undergraduate counsellor/advisor, who has the authorization to approve such requests if the circumstances warrant approval of an exception to the normal drop deadlines.

c) Approved withdrawals under this procedure will be noted on the academic record by the course designation LWD (Late Withdrawal). This course status will have no effect on the GPA, Sessional Averages, or other elements of the academic record

PROMOTION REGULATIONS: TEXT

There are two important parameters to the Promotion Regulations: a student’s previous record and the weighted Session Average (SA) achieved by the student in the current session. The regulations are presented below in text format. They are presented in nine sections, according to the student’s previous record.

1. First year Students Enrolling with a Clear Record –Session 1F

a) Session Average 60% or greater: Passed. Proceed to the next session 1W with a clear record.

b) Session Average between 55% and 60%: Placed on Probation with three options:
   i) Proceed to 1W on probation if all course marks are 50% or greater.
   ii) Enrol in the T-Program on probation. Repeat all courses with marks less than 50%. Students may elect to repeat other courses which have marks between 50% and 59%. Must repeat specific courses as decided by the Chair, First Year and the T-Program Coordinator. Up to three courses may be repeated. Students who are part-time or who are required to repeat/take four or more 1F courses are not eligible to enrol in the T-Program.
   iii) Withdraw from the Faculty with the right to return to a subsequent Session 1F on probation. If more than three course marks are less than 50% or is required to take four or more 1F courses, a student must withdraw.

c) Session Average between 50% and 55%: Placed on Probation with two options:
   i) Enroll in the T-Program on Probation. Will repeat all courses with marks less than 60%. If more than three courses have marks less than 60%, normally the three courses with the lowest grades will be repeated. Students who are part-time or who are required to repeat four or more courses are not eligible to enrol in the T-Program and must withdraw.
   ii) Withdraw from the Faculty with the right to return to a subsequent Session 1F on probation. If more than three course marks are less than 50%, a student must withdraw.

d) Session Average between 45% and 50%: Placed on probation. Must withdraw from the Faculty and is eligible to repeat sessions when next offered.

e) Session Average less than 45%: Failed. May apply for re-admission.

Re-admission, if granted, will be on repeat probation.

2. First year Students proceeding with a Clear Record –Session 1W*

a) Session Average 60% or greater: Passed. Proceed to the next session with a clear record.

b) Session Average between 55% and 60%: Placed on Probation. Proceed to the next session on probation.

c) Session Average less than 55%: Placed on repeat probation. Repeat session immediately when next offered.

*Students cannot proceed to second year if more than two first year courses are outstanding.

3. First year Students in the T-Program –Session 1W

a) Session Average 60% or greater: Passed. Proceed to the Summer Session on probation in the T-Program.

b) Session Average less than 60% or a mark in a repeated course below 50% Failed. May apply for re-admission. Re-admission, if granted, will be on repeat probation.

4. First year Students in the T-Program –Summer Session*

a) Session Average 60% or greater: Passed. Proceed to 2F on probation

b) Session average less than 60%: Placed on repeat probation. Repeat session 1W when next offered on repeat probation.

*Students cannot proceed to second year if more than two first year courses are outstanding.
5. First year Engineering Science Students –Session 1F
a) Session Average 60% or greater: Passed. Proceed to the next session (1W) with a clear record.
b) Session Average between 55% and 60%: Passed. Proceed to the next session (1W) with a clear record in Engineering Science or:
   i) Conditionally transfer to another Engineering program of choice. Final acceptance into a program of choice is conditional upon a student achieving a Winter Session Average of 60% or greater,
   ii) Transfer to another Engineering program with space with no conditions.
c) Session Average between 45% and 55%: Placed on Probation. Required to transfer to a program with space with two options:
   i) Enrol in the T-Program on Probation. Required to take as repeated those courses equivalent to courses with marks less than 60% (APS111H1 in lieu of ESC101H1 if the mark in ESC101H1 is less than 50%). If more than three courses have marks less than 60%, the three courses with the lowest grades will be repeated.
   ii) Withdraw from the Faculty with the right to return to a subsequent Session 1F on probation in a program with space. If more than 3 course marks are less than 50%, a student must withdraw. Not eligible to apply for re-admission to the Engineering Science Program.
d) Session Average less than 45%: Failed. May apply for re-admission.
   Re-admission, if granted, will be on repeat probation. Not eligible to apply for re-admission to the Engineering Science program.

6. First year Engineering Science Students –Session 1W*
*No first-year Engineering Science student transferring to a Core 8 program, shall proceed to second year (2F) with more than two outstanding Core 8 course equivalents.
a) Session Average equal to or greater than 65%: Passed. Proceed to next session with a clear record.
b) Session Average between 55% and 65%: Passed. Proceed to next session with a clear record in any other 2nd year Engineering program.
c) Session Average between 50% and 55%: Placed on Probation. Proceed to next session on probation in an Engineering program with space.
d) Session Average less than 50%: Placed on repeat probation. Repeat session immediately when next offered on repeat probation in a program with space (not Engineering Science or Track One).

7. Students proceeding with a Clear Record–Sessions 2F,2W,3F,3W,4F,or 4W
a) Session Average 60% or greater: Passed. Proceed to the next session with a clear record.
b) Session Average between 55% and 60%: Placed on Probation. Proceed to the next session on probation.
c) Session Average less than 55%: Placed on repeat probation. Repeat session immediately when next offered.

8. Students proceeding on Probation-Sessions 1W,2F,2W,3F,3W,4F,or 4W
a) Session Average 60% or greater: Passed. Proceed to the next session on probation
b) Session average less than 60%: Placed on repeat probation. Repeat session immediately when next offered.

9. Students proceeding on Repeat Probation-Sessions 1W,2F,2W,3F,3W,4F,or 4W
a) Session Average 60% or greater: Passed. Proceed to the next session on repeat probation
b) Session average less than 60%: Failed. Refused further registration. Will not be considered for re-admission.

10. Students repeating any session
a) Session Average 60% or greater: Passed. Proceed to the next session on probation
b) Session average less than 60%: Failed. Refused further registration. Will not be considered for re-admission.

PROMOTION REGULATIONS: CHART

The following chart summarizes the text version of the promotion regulations. In the event of conflict between the text version and the chart version, the text version shall govern.

<table>
<thead>
<tr>
<th>Status at Start of Session</th>
<th>Session Average</th>
<th>Status at Start of Session</th>
<th>Session Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>0</td>
<td>45%</td>
<td>50%</td>
</tr>
<tr>
<td>Repeat Probation</td>
<td>Probation</td>
<td>Probation Proceed to 1W in T-Program or withdraw for 8 months and repeat 1F*</td>
<td>Probation Proceed to 1W on Probation, or T-Program or withdraw for 8 months and repeat 1F</td>
</tr>
<tr>
<td>Failed-May apply for re-admission</td>
<td>Withdraw for 8 months and repeat 1F Session</td>
<td>Proceed to 1W in T-Program or withdraw for 8 months and repeat 1F*</td>
<td></td>
</tr>
</tbody>
</table>

*A student who is part-time or has more than three course marks below 50% will be required to withdraw and is eligible to return to repeat 1F in a subsequent session on probation*
### First Year Winter Session - 1W

<table>
<thead>
<tr>
<th>Status at Start of Session</th>
<th>Session Average</th>
<th>55%</th>
<th>60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>Repeat Probation</td>
<td>Failed - Must withdraw for 8 months. Upon return, must repeat session</td>
<td>Probation</td>
</tr>
<tr>
<td>Prohibition</td>
<td>Repeat Probation</td>
<td>Failed - Must withdraw for 8 months. Upon return, must repeat session</td>
<td>Probation</td>
</tr>
<tr>
<td>Repeat Probation</td>
<td>Refused Further Registration</td>
<td>Failed - Not eligible to continue in the Faculty of Applied Science and Engineering</td>
<td>Repeat Probation</td>
</tr>
</tbody>
</table>

*Students cannot proceed to second year if more than two first year courses are outstanding.

### T-Program Winter Session - 1W

<table>
<thead>
<tr>
<th>Status at Start of Session</th>
<th>Session Average</th>
<th>60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Probation in the T-Program</td>
<td>Repeat Probation</td>
<td>Failed - May apply for re-admission</td>
</tr>
</tbody>
</table>

*Condition: No repeated course may have a final mark less than 50%*

### T-Program Summer Session

<table>
<thead>
<tr>
<th>Status at Start of Session</th>
<th>Session Average</th>
<th>60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Probation in the T-Program</td>
<td>Repeat Probation</td>
<td>Failed - Must withdraw for 6 months. Upon return must repeat regular 1W.</td>
</tr>
</tbody>
</table>

*Students cannot proceed to second year if more than two first year courses are outstanding.

### First Year Engineering Science Fall Session - 1F Newly admitted First Year Students

<table>
<thead>
<tr>
<th>Status at Start of Session</th>
<th>Session Average</th>
<th>45%</th>
<th>55%</th>
<th>60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>Repeat Probation</td>
<td>Failed - May apply for re-admission in a program with space</td>
<td>Probation</td>
<td>Enrol in the T-Program or withdraw and repeat 1F - in a program with space</td>
</tr>
<tr>
<td></td>
<td>Clear</td>
<td>May Proceed - Pass, Honours or Transfer to any Program</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*55-60% Options:

a) Remain in Engineering Science and proceed to 1W subject to Engineering Science promotion rules
b) Voluntarily transfer to another Engineering program with space and be unconditionally accepted
c) Voluntarily transfer to another Engineering program. Acceptance in a program of choice in 1W is conditional upon receiving a Winter Session average of 60% or greater
d) Students who transfer into Track One are subject to Track One 1W transfer regulations
No first-year Engineering Science student transferring to a Core 8 program, shall proceed to second year (2F) with more than two outstanding Core 8 course equivalents.

Fall and Winter Sessions 2nd, 3rd and 4th year

<table>
<thead>
<tr>
<th>Status at Start of Session</th>
<th>Session Average</th>
<th>55%</th>
<th>60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>Repeat Probation</td>
<td>Probation</td>
<td>Clear</td>
</tr>
<tr>
<td></td>
<td>Failed - Repeat session 1W immediately in a program with space (not Engineering Science or Track One)</td>
<td>Transfer to a program with space on probation</td>
<td>Transfer to another Engineering Program</td>
</tr>
<tr>
<td>Probation</td>
<td>Repeat Probation</td>
<td>Probation</td>
<td>Clear</td>
</tr>
<tr>
<td></td>
<td>Failed - Repeat session immediately when next offered</td>
<td>Proceed on probation</td>
<td>May proceed-Pass or Honours</td>
</tr>
<tr>
<td>Repeat Probation</td>
<td>Refused Further Registration</td>
<td>Probation</td>
<td>Repeat Probation</td>
</tr>
<tr>
<td></td>
<td>Failed - Not eligible to continue in the Faculty of Applied Science and Engineering</td>
<td>Proceed on Probation</td>
<td></td>
</tr>
</tbody>
</table>

IX. TRANSFERS

1. Transfer within the Faculty
   A student may apply to transfer from one program to another within the Faculty of Applied Science and Engineering. Students must submit an online Request to Transfer application available via the Registrar’s Office website. Program Transfers at the completion of first year will not normally involve any additional courses to remedy deficiencies.

   a) Transfers between regular Engineering programs:
      i) Applications to transfer between Engineering programs may be submitted at any time during the Winter Session of First year but not later than the deadline as listed in the Sessional Dates section. All such applications are considered together on their merits after that date.
      ii) The approval of transfers is subject to the availability of places reserved for internal transfers. For the past few years, two or three programs each
year have been unable to accept all students seeking transfer.

iii) Students who have submitted an online request to transfer application before the deadline and who have completed first year with a clear record and with a Winter Session Average of 65% or greater will receive preference for these internal places. Students who obtain Honours in both sessions of First year will be allowed to transfer to the Second year Engineering program of their choice.

b) Transfers from Track One:
   i) A Track One student who has achieved a Session Average of 60% or greater in both terms of First year (1F and 1W) may transfer to their program of choice.
   ii) A Track One student who achieved less than a 60% session average in either term (1F or 1W) but who are eligible to proceed to 2nd year may apply to enroll in a program of their choice. However, their choices may be limited to a program with space.

c) Transfers between Electrical and Computer Engineering Programs:
   Students will select their courses in third and Fourth year to fulfill program requirements in computer engineering or in electrical engineering.

d) Transfers between Mechanical and Industrial Engineering Programs:
   i) Applications to transfer between Mechanical and Industrial Engineering programs must be submitted no later than the deadline after the current academic year.
   ii) Students who wish to transfer between the Mechanical and Industrial Engineering programs will be allowed to do so if admitted directly to the First year Fall Session of the Mechanical or Industrial Engineering program.
   iii) Students not in category (ii) above will be allowed to transfer if places are available.

e) Transfers to the Engineering Science Program:
   Transfers from Engineering programs to Engineering Science are permitted after sessions 1F and/or 1W only in cases where the student has a superior academic record.

f) Transfers from the Engineering Science Program:
   i) Newly admitted First year Engineering Science students will be accepted to transfer to any Engineering program on or before the last day to add or substitute Fall Session courses.
   ii) First year Engineering Science students who obtain a Fall Session Average of 60% or greater will be accepted to transfer to any Engineering program on or before the last day to add Winter Session Courses. Students with Fall Sessional Averages between 55% and 60% will be conditionally accepted into a program of choice. Students with Fall Sessional Averages between 45% and 55% will be accepted to transfer to any program in which space is available, in the T-Program.
   iii) First year Engineering Science students who obtain Winter Sessional Averages of 55% or greater will be accepted to transfer to any Engineering program provided their Request to Transfer online application is submitted prior to the deadline. Students who obtain Winter Sessional Averages between 50% and 55% must have submitted an application to transfer not later than the deadline and these applications will be considered on their merits along with the applications for transfer from students in Engineering programs.

2. Transfers to Other Faculties:
   A student interested in admission to another Faculty in the University of Toronto should consult with the Registrar or Admissions Officer of the Faculty concerned about the feasibility of obtaining transfer credit upon admission. Information regarding the application process can be found at www.adm.utoronto.ca. More information may also be obtained from the Undergraduate Engineering website: www.undergrad.engineering.utoronto.ca or the Office of the Registrar.

X. FACULTY FINAL EXAMINATIONS

Final examinations are held at the end of the Fall and Winter Sessions. Students who make personal commitments during the examination period do so at their own risk. No special consideration will be given and no special arrangements made in the event of conflicts. Information regarding dates and times of examinations will not be given by telephone.

Rules for the Conduct of Examinations

1. Timetable and Seating Lists
   The timetable of examinations and a list showing the rooms in which the candidates in each course have been assigned to write will be posted in prominent locations prior to the examinations.

2. Aids Permissible and Not Permissible
   a) A candidate will be permitted to bring to the examination and use only pen and pencil, drafting instruments, and if permitted, electronic calculators. All equipment brought to the examination must be placed on the candidate’s desk and kept in view during the examination.
   b) With the exceptions noted under f), g) and h) below, a candidate must not bring to the examination desk any books, notes in any form, loose paper, calculator cases, instrument cases, or other containers.
   c) Permissible calculators must be non-printing, non-communicating, silent and self-powered. The type of calculator permitted will be one of the following, as specified by the professor at the commencement of the course and on the final examination paper.
     i) All programmable and non-programmable electronic calculators and pocket computers.
     ii) All non-programmable electronic calculators.
     iii) Calculators from a list of approved calculators as issued by the Faculty Registrar.
4. Ending the Examination  
   a) At ten minutes and five minutes before closing time the presiding examiner will announce the number of minutes remaining for writing.  
   b) Candidates who have finished writing and wish to leave the examination room before the five minute announcement must first personally hand in all their answer books, whether used or not, at the presiding examiner’s desk, together with special data if provided.  
   c) After the five minute announcement all candidates still in their seats must remain quietly seated, even if finished writing, until all the answer books and special data have been collected, and the presiding examiner announces that they may leave the room.  
   d) When closing time is announced, all candidates are to stop writing immediately, assemble their answer books, whether used or not, and special data which may have been provided, and hand them to the Assistants who will collect all materials from the seated candidates.  
   e) The examination paper belongs to the candidate unless otherwise stated.  
   f) When all materials have been collected, the presiding examiner will announce that candidates may leave the room. All rules for the conduct of candidates during examinations remain in full force until this announcement is made.

5. Conduct during the examination  
   a) A candidate giving assistance to or receiving assistance from, or communicating in any manner with any person other than the examiner, the presiding examiner or assistants, or copying, or having at the examination unauthorized aids of any kind, is liable to the sanctions listed in the Code of Behaviour on Academic Matters.  
   b) Eating, drinking and smoking are not permitted in examination rooms.  
   c) If it is necessary for a candidate to leave the room he or she may do so and return if accompanied by the presiding examiner or an assistant.  
   d) A candidate must not write on any paper, other than that in the answer book, and must keep all papers on the desk.

6. Reproduction of Final Examination Papers  
A student may obtain a photocopy of any final examination paper that they have written under the jurisdiction of the the Faculty of Applied Science and Engineering by submitting an online request within the period ending February 15 or October 15 (whichever comes first), following the session in which the course was taken. A fee of $13, payable by credit card or cash, for each examination paper to be reproduced must accompany the request. The Office of the Registrar may offer a period of Final Exam Viewing appointments after the term. Contact the Office of the Registrar for details.

7. Re-Checking of Marks  
Within the period ending February 15 or October 15 (whichever comes first), following the session in which the course was taken, a student may have the final mark in any course listed in the Faculty Calendar re-checked by submitting an online request and making payment of $13 (by credit card or cash) for each course to be re-checked.
The instructor will review the student’s examination paper (if a final examination was held in the course) to ensure that all questions were properly marked in accordance with the marking procedure used for the entire class, that the addition of marks was correct, that the session marks were correctly compiled, and that the clerical operations involved in the computation and reporting of the final mark were correct. Mark adjustments based upon lenient reconsideration of the students work will not be made. If an adjustment is required it may be positive or negative.

If the instructor finds an error which results in any change in the student’s final mark, the fee for re-checking the mark will be refunded.

XI. GRADING POLICIES

1. The instructor in each course shall announce, at a regularly scheduled class meeting held as early as possible in the session but before the final date to add or substitute courses, the details of the composition of the final mark which applies to the course, the exam type, the timing of each major session evaluation and the type of electronic calculators which will be permitted on session tests and final examinations. This information shall also be submitted to the Committee on Examinations via the Registrar of the Faculty, specifying the weighting of each component of the final course mark.

2. After the final date to add or substitute courses, the composition of the final mark in a course cannot be changed without the consent of a simple majority of students attending the class, provided the vote is announced no later than in the previous class. Any changes must be reported to the Committee on Examinations. The only exception to this is in the case of the declaration of a disruption.

3. Instructors shall submit course results as percentages.

4. a) All written session work must normally be returned to students after evaluation with what the instructor considers to be appropriate commentary. At least one piece of session work worth at least 10% of a student’s performance, whether lab report, assignment, essay, etc., shall be returned to the student prior to the last day for withdrawal from the course without academic penalty.
   b) After evaluating and returning items of session work, the instructor or the teaching assistant(s) shall be available as appropriate to meet with each student who wishes to discuss the work and/or the commentary offered.
   c) Final examination papers are not returned to students. The instructor shall deliver the marked examination papers in alphabetical order to the Office of the Registrar for storage. The papers will be stored until February 15 or October 15 (whichever comes first) following the session in which the course was offered, after which they will be destroyed.

5. The following rules and guidelines apply to the evaluation of student performance in all courses offered within the Faculty. Where appropriate, however, an instructor may apply to the committee on Examination for permission to deviate from the rules.
   a) The composition of final marks may be based upon
      i) a final examination
      ii) independent term work performed under supervision, i.e. session tests or any other work which, in the judgment of the instructor, is a reliable measure of the performance of the student evaluated, and
      iii) session work not closely supervised
   b) The dates of session tests should be announced in advance. Unannounced session tests, if used, should not count for more than a minor fraction of the total mark for independent session work, and the value of this fraction should be specified early in the session when the details of the composition of the final course mark are announced in class.
   c) A final examination, conducted under the jurisdiction of the Faculty Council and counting for at least 35% of the final mark shall be held in each lecture course.

   d) No one essay, test, examination, etc. should have a value of more than 80% of the final grade.
   d) A component of the final course marks must be derived from session work, and the final examination must not count for all of the final mark, unless the Committee on Examinations approves other arrangements on an annual basis.
   e) The portion of marks for lecture courses which is derived from not closely supervised work shall not exceed a total of 25% of the final mark in a course unless the Committee on Examinations approves other arrangements. Work included in this category shall normally be accompanied by a sign-off statement attesting to the fact that the work being submitted either by an individual student or a group of students is their own work. The proportion of marks which can be derived without a sign-off statement, where students are free and encouraged to work together, is to be limited to 5% of the final course mark.
   f) Each instructor must specify on session test and final examination papers the type of calculator permitted (see X (2) (c) above).
   g) The only aids which a candidate may bring to the final examination and use, other than those which may be provided by the examiner or specified on the examination paper, are pen and pencil, a bilingual dictionary (for students having difficulty with the English language) if presented to the presiding examiner for inspection and approval prior to each examination at which its use is proposed, and drafting instruments without their carrying cases.
   h) The following five types of final examination papers are approved for use in examinations conducted under Council’s jurisdiction. The relative value of each part of the examination must be indicated on all final examination papers. Further, unless otherwise specified, the only aids permitted are those outlined in Regulation X-2.

Type A Papers for which no data are permitted other than the information printed on the examination paper.

Type B Papers for which separate special aids or data, as specified at the top of the examination paper, are provided by the examiner for distribution to the candidates by the Registrar of the Faculty.

Type C Papers for which the candidate may prepare, bring to the examination and use, a single aid sheet, such aid sheet being on a standard form supplied to the examiner by the Registrar of the Faculty. Students may enter on both sides of the aid sheet any information they desire, without restriction, except that nothing may be affixed or appended to it.
II. Appeals

Such petitions through the Engineering Portal website. Petitions requesting the alteration of marks or promotional regulations will not be considered.

Students may petition with respect to the applicability to them of any academic regulation of the Faculty. These petitions must show the grounds on which they believe that the regulation should be waived or altered. Students should consult their undergraduate counsellor/advisor before submitting such petitions through the Engineering Portal website. Petitions requesting the alteration of marks or promotional regulations will not be considered.

A student may petition for exemption from a specific academic regulation of the Faculty; however, he or she must provide sufficient reason why the regulation should be waived or altered. It is highly recommended that students first consult with their undergraduate counsellor/advisor before they submit a petition for special consideration.

Students who believe that their academic performance has been adversely affected by illness, mishap or other circumstance during the examination period should submit a Petition for Consideration in Final Examinations. Such petitions must be submitted online through the Engineering Portal within one week of the student's last examination.

A student who is unavoidably absent at any time during the session, and consequently misses any graded work, should discuss the matter with the appropriate instructor and, if necessary, submit a Petition for Consideration in Course Work. Such a petition must be accompanied by appropriate documentation (e.g., medical certificate) and must be submitted to the instructor within one week of the student's return to classes.

There are three types of petitions:

i) Petition for Consideration in Course Work

A student who is unavoidably absent at any time during the session, and consequently misses any graded work, should discuss the matter with the appropriate instructor and, if necessary, submit a Petition for Consideration in Course Work. Such a petition must be accompanied by appropriate documentation (e.g., medical certificate) and must be submitted to the instructor within one week of the student's return to classes.

ii) Petition for Consideration in Final Examinations

A student who believes that their academic performance has been adversely affected by illness, mishap or other circumstance during the examination period should submit a Petition for Consideration in Final Examinations. Such petitions must be submitted online through the Engineering Portal within one week of the date of the student's last examination.

A student may petition for exemption from a specific academic regulation of the Faculty; however, he or she must provide sufficient reason why the regulation should be waived or altered. It is highly recommended that students first consult with their undergraduate counsellor/advisor before they submit a petition for special consideration.

The full text of the University’s Grading Practices Policy is available at the following link: www.governingcouncil.utoronto.ca/policies/grading.htm

XII. PETITIONS AND APPEALS

I. Petitions

1. Petition forms are available on the Undergraduate Engineering website: www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/Petitions.htm

There are three types of petitions:

i) Petition for Consideration in Course Work

A student who is unavoidably absent at any time during the session, and consequently misses any graded work, should discuss the matter with the appropriate instructor and, if necessary, submit a Petition for Consideration in Course Work. Such a petition must be accompanied by appropriate documentation (e.g., medical certificate) and must be submitted to the instructor within one week of the student's return to classes.

ii) Petition for Consideration in Final Examinations

A student who believes that their academic performance has been adversely affected by illness, mishap or other circumstance during the examination period should submit a Petition for Consideration in Final Examinations. Such petitions must be submitted online through the Engineering Portal within one week of the date of the student's last examination.

A student may petition for exemption from a specific academic regulation of the Faculty; however, he or she must provide sufficient reason why the regulation should be waived or altered. It is highly recommended that students first consult with their undergraduate counsellor/advisor before they submit a petition for special consideration.

Students may petition with respect to the applicability to them of any academic regulation of the Faculty. These petitions must show the grounds on which they believe that the regulation should be waived or altered. Students should consult their undergraduate counsellor/advisor before submitting such petitions through the Engineering Portal website. Petitions requesting the alteration of marks or promotional regulations will not be considered.
1. A student wishing to appeal a decision with respect to any petition should submit an appeal in written form to the Faculty Academic Appeal Board via the Registrar’s Office. Appeals to the Faculty Academic Appeals Board must be made within thirty days of the date of notification of a petition decision from a standing Committee of Council. The Faculty Academic Appeal Board Chair will appoint a hearing panel which will consist of at least three members of the Board of whom at least one shall be a student member. Normally, the Chair of the Academic Appeals Board acts as the Chair of the hearing panel. Hearings will be called by the Chair as required, but not later than ninety business days after the submission of the appeal. Both parties to the appeal are entitled to present throughout the hearing, to make opening statements, call evidence and make closing submissions. After hearing the appeal, the hearing panel may dismiss the appeal, allow the appeal and render the decision that it believes should have been made, or remit the matter back to the decision-maker for consideration. The decision of the Faculty Academic Appeals Board is considered the final decision of the Faculty.

2. A student wishing to appeal against a final decision of the Faculty may appeal to the Governing Council of the University. In that event, the student should consult the Director, Appeals, Discipline and Faculty Grievances, Office of the Governing Council, about the preparation and submission of the appeal. Appeals to the Governing Council must be made within ninety days of the date of notification of the final decision of the Faculty.

III. Office of the University Ombudsperson
As part of the University’s commitment to ensuring that the rights of its individual members are protected, the University Ombudsperson investigates complaints from any member of the University not handled through regular University channels. The Ombudsperson offers advice and assistance and can recommend changes in academic or administrative procedures where this seems justified. In handling a complaint, the Ombudsperson has access to all relevant files and information and to all appropriate University Officials. The Ombudsperson handles all matters in strict confidence, unless the individual involved approves otherwise. The Ombudsperson is independent of all administrative structures of the University and is accountable only to Governing Council.

Office of the Ombudsperson
McMurrich Building First Floor, Room 102 12 Queen’s Park Cres. West Toronto, Ontario M5S 1S8 Phone: (416) 946-3485 Fax: (416) 978-3439 Email: ombuds.person@utoronto.ca
ACCREDITATION AND THE ASSOCIATIONS OF PROFESSIONAL ENGINEERS

The practice of engineering is regulated, by statute, in all Canadian provinces and territories. To become a Professional Engineer you must satisfy the requirements of the licensing bodies. These requirements include a degree from an accredited program, successful completion of a professional practice examination in engineering law and ethics, and suitable experience.

All programs listed in this Calendar are accredited and evaluated regularly by the Canadian Engineering Accreditation Board (CEAB) of the Canadian Council of Professional Engineers. Therefore graduation from the Faculty of Applied Science and Engineering may lead to registration as a Professional Engineer in the provincial Associations of Professional Engineers, in accordance with their individual policies.

No student will be permitted to graduate who does not meet these requirements as this would jeopardize accreditation for the program.

Detailed information about the Canadian Council of Professional Engineers can be found at: www.ccpe.ca

GENERAL PROGRAM GUIDELINES

Each program in Engineering and in Engineering Science consists of a technical component and a complementary studies component. The curriculum provides considerable latitude to students in choosing their programs of study. On the following pages the curriculum of each program is set forth in detail. The curriculum for students in First Year (in First and Second Years in Engineering Science) forms a basis in the fundamental subjects prior to subsequent specialization in various Engineering disciplines. Students are able to choose from a range of technical electives in their senior years. In the Fourth Year, all programs contain a thesis or a design project, which provides students with the opportunity to carry out original work in their chosen fields of study.

The curricula, regulations and course information contained in this Calendar are valid for the current academic year only and so, over the course of a student’s attendance in the Faculty, curricula, regulations and course information may change. All such changes will be posted on the Undergraduate Engineering website.

The Faculty reserves the right to withdraw any course for which there is insufficient enrolment or resources, and to limit the enrolment in any course.

Weight Factor

Weight Factors are associated with every course, and are intended to help students determine the relative weight of every course, in terms of time spent in class. Most courses in the Faculty of Applied Science and Engineering are weighted 0.5, but some (full year courses) are weighted at 1.0 and others (quarter courses) are weighted at 0.25. Weight factors for courses outside of the Faculty may vary.

Weight factors are used to calculate what is referred to as the ‘weighted session average’ used in promotions (see Chapter 6). A regular program normally consists of five courses per session with a total weight of 2.5 credits; with prior approval of the Chair of their Department, full-time students may elect to increase their loads to a maximum of 3.0 credits per session.

To be eligible for any scholarship or award granted solely on academic standing, a student must have completed not less than the normal full load (2.5 credits per term) within the two sessions upon which the award is based. A student whose program in these two sessions contains repeated courses will only be eligible if the aggregate of new courses is equal to or greater than 2.5 credits per term.

COURSE DEFINITIONS

Core Course

A core course is defined as any course in a Program of Study that is expressly required by a department or division in order to fulfill degree requirements.

Electives

Elective courses fall into three categories: Technical Electives; Free Electives; and Complementary Studies Electives. In general, students must not select elective courses that would involve excessive duplication of material covered elsewhere in their programs. As the promotion of engineering students is based on weighted session averages, honours/pass/fail or credit/no-credit courses may not be taken as electives.

Technical Electives

Each program has a selection of Technical Electives, carefully designed to enhance students’ technical knowledge in specific areas. Details regarding technical electives can be found under each program listing.

Free Electives

Some programs require students to take a Free Elective. A Free Elective has few restrictions: any degree credit course listed in the current calendars of the Faculty of Applied Science and Engineering, the Faculty of Arts and Science, and the School of Graduate Studies is acceptable as a Free Elective provided it does not duplicate material covered in courses taken or to be taken.
Complementary Studies

All students are required to take Complementary Studies electives at some point during their program.

Complementary studies is broadly defined as studies in humanities, social sciences, arts, management, engineering economics and communication that complement the technical content in the curriculum. Language courses may be included within complementary studies provided they are not taken to fulfill an admission requirement.

Within this context of complementary studies, the Faculty is aware of the heavy responsibility that lies on the shoulders of engineers in our modern technological society, and it strives to educate engineers with a strong sense of responsibility to others. The Faculty therefore requires from students a firm foundation of engineering ethics, familiarity with their heritage and history, and sensitivity to the social context in which they function. To this end, in addition to developing competence in appropriate aspects of mathematics, the physical sciences and design, aspiring engineers must acquire an understanding of the humane aspects of engineering. Therefore, some areas of study under the heading of complementary studies are considered to be essential in the education of an engineer, namely these four elements (described in more detail below):

1. An introduction to the methodologies and thought process of the humanities and social sciences,
2. A basic knowledge of engineering economics,
3. Competence in oral and written communications,
4. An awareness of the impact of technology on society.

Some of these elements have been incorporated into the set curriculum for each program; others are introduced through the selection of Humanities and Social Science (HSS) and Complementary Studies (CS) electives. We urge students to plan their complementary studies electives in accordance with their career aspirations; however, to ensure eligibility for registration as a professional engineer, HSS/CS electives must fit set definitions as outlined below. Please note that HSS electives are a sub-set of CS electives, so while all HSS electives can count towards CS requirements, not all CS electives can be considered HSS electives. A listing of appropriate HSS and CS electives can be found on the Engineering website, at:

www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/Electives.htm

1. Humanities and Social Sciences (HSS)

Engineers’ colleagues frequently have a background in the humanities and social sciences rather than in the physical or mathematical sciences, so students need to have some understanding of the modes of thought used in these disciplines. The Faculty of Arts and Science offers a very comprehensive selection of such courses. Individual programs have various requirements and opportunities to take Humanities and Social Sciences electives. Subject to conditions imposed by the Faculty of Arts and Science, students may choose any course that does not include: languages, grammar, mathematics (including symbolic logic and probability & inductive logic), economics, technique (e.g. art, music, video production), physical and life sciences (e.g. physics, chemistry, biology, zoology, computer science and psychology).

The HSS courses that are available to students are listed here:

www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/Electives/HSS_Electives.htm

Students seeking a broader choice in their Humanities and Social Sciences electives can obtain more information about appropriate courses and enrolment procedures from the Faculty Registrar’s Office (www.undergrad.engineering.utoronto.ca) or their departmental office. Enrolment may involve submission of a ballot or consultation with the offering department.

2. Engineering Economics

Each program includes at least one required course on engineering economics. These courses provide an opportunity for students to become familiar with the basic tools used to assess the economic viability of proposed engineering projects. The program-required courses are: CHE249H1 F, CME368H1 S, MIE258H1 F, ECE472H F/S, CHE374H1 F

3. Oral and Written Communications

Engineers must be able to communicate their ideas effectively to peers, other professionals, and the public at large. Technically sound solutions will often be accepted only after the engineer has convinced the public and governmental agencies that they are also socially acceptable. Consequently, technical communication is essential to Engineering. Each program includes the equivalent of one course on technical communication and takes part in a Language Across the Curriculum program that develops communication skills in core engineering courses. The communication courses and the Language program aim to develop skills in report writing, public speaking and graphical presentation with the goal that students will gain solid experience as technical communicators before graduation.

4. Impact of Technology on Society

The courses APS111F and APS112S Engineering Strategies & Practice I and II are required for all programs except Engineering Science, for which ESC101F and ESC102S, Engineering Science Praxis I and II are required.

Letters of Permission

A Letter of Permission is required for engineering students seeking to take a course from another university. The Letter of Permission will outline the course(s) the student has permission to take, the transfer credit(s) that can be granted, and how they will be applied to the degree (as extra credit, technical elective, HSS/CS, etc).

Students may request any course from a recognized Canadian University, or from an international university that the University of Toronto has an exchange agreement with. Students wishing to take a course from an institution not noted in one of these two categories should note that the course will be closely examined to ensure it is comparable to the academic standards of the University of Toronto. Courses should be academically rigorous and include a written examination, or a significant component of closely supervised work. Online courses will be subject to a special review, to ensure they

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meet the expectations of the University of Toronto.

Core courses are not usually approved on a Letter of Permission.

To receive credit for completing a course on Letter of Permission, the student must achieve at least one full letter grade above a pass at the host institution, or 60% using the University of Toronto grading scale.

The Letter of Permission request form can be found at the Engineering Undergraduate Admissions Office, located within the Galbraith building at 35 St. George Street, Room 153. This form must be submitted with a copy of the official course description from the host institution's academic calendar. A non refundable processing fee of $30 per letter of permission will be charged.

Please note that a Letter of Permission does not apply to courses taken while participating in an official International Exchange.

**COMPLEMENTARY STUDIES CERTIFICATE PROGRAMS**

Students may wish to consider other areas of complementary studies. Courses in these areas contain some of the four essential elements described above.

**Engineering Business**

The Undergraduate Engineering Business Certificate is a collaborative effort across the Faculty of Applied Science and Engineering and the Rotman School of Management and is open to Engineering students interested in learning more about the business dimension of engineering, from finance and economics to management and leadership. Courses focus on economics and accounting fundamentals, with a choice between marketing and strategy, management and organizational behaviour, or entrepreneurship.

The requirements of an Engineering Business Certificate in the Faculty of Applied Science and Engineering are the successful completion of the following courses:

1) Required Departmental Engineering Economics Course (CHE249H1, CHE374H1, CME368H1, ECE472H1, MIE258H1)
2) JRE300H1 - Foundations of Accounting and Finance (CS elective)
3) JRE410H1 - Markets and Competitive Strategy (CS elective) OR JRE420H1 - People Management and Organizational Behaviour (CS elective) OR CHE488H1/CIV488H1/ECE488H1/MIE488H1/MSE488H1 - Entrepreneurship and Business for Engineers

Note:

Students may complete either the Engineering Business Certificate or the Entrepreneurship Certificate, but not both.

**Entrepreneurship, Innovation and Small Business**

Since the dawn of the industrial revolution, engineers have been amongst the most successful entrepreneurs, and this is especially true in today's global economy. The enormous growth of the e-Economy has enabled many young people to be successful even earlier than the previous generation did. Wealth creation is a legitimate aspiration today and many of you will be successful in this endeavor. Furthermore, strategic uses of technology in all sorts of businesses make the difference between success and failure for these firms. The “entrepreneurial” spirit together with drive and persistency are requirements for success. Also, to participate effectively in this global economy, large and medium sized corporations are desperately seeking intrapreneurs, entrepreneurial individuals who prefer to work inside a larger firm rather than to start or run their own business. Owning a business has many advantages. Entrepreneurs can control their own lives, structure their own progress, be accountable for their own success and can see the fruit of their labours in the wealth they create. After all, engineers are the most capable people to be in the forefront of this drive which will depend on the on-line e-Business environment fostered by the Internet and the Web in the new millennium. The development of these talents is addressed in a set of two courses but be forewarned that these courses require a substantial effort on the part of the student and the instructors. They are unusual in that, to be accepted into them, a student has to possess some of the prerequisite personality traits and some unique abilities required to become a successful entrepreneur.

Prior to being accepted into APS234H1, a short test is offered to those who believe that they have the drive and talents to start their own business. APS234H1 is available in the Fall semester in any but the first year of study. APS432H1 is offered in the Winter and can be taken in the same or a later year. The courses are sequential and the first is the pre-requisite of the second.

The following are the required certificate courses:

- APS234H1 Entrepreneurship and Small Business
- APS432H1 Entrepreneurship and Business Management
- Required Departmental Engineering Economics Course (CHE249H1, CHE374H1, CME368H1, ECE472H1, MIE258H1)

Note: Students may complete either the Engineering Business Certificate or the Entrepreneurship Certificate, but not both.

**Global Engineering**

The Undergraduate Certificate in Global Engineering is open to Engineering students interested in developing their knowledge of global issues and how engineers can influence and improve conditions around the world. The courses focus on a variety of concepts such as effects of emerging and appropriate technologies in both developed and developing economies, global energy systems, innovative finance techniques, current theories in international development and foreign aid. All undergraduate Engineering students are eligible to participate in this minor course of study.

The requirements for a Global Engineering Certificate in the Faculty of Applied Science and Engineering are the successful completion of the following courses:

1) Two of:
Curriculum and Programs

- APS510H1 - Technologies and Organizations in Global Energy Systems (CS elective)
- APS520H1 - Technology, Engineering and Global Development (HSS elective, as of 2011-2012)
- APS530H1 - Appropriate Technology and Design for Global Development

2) One elective from the following courses:
- ANT204H1 - Anthropology of the Contemporary World (HSS elective)
- ENV333H1 - Ecological Worldviews (HSS elective)
- GGR216H1 - Global Cities (HSS elective)
- JGI216H1 - Urbanization & Global Change (HSS elective)
- POL108Y1 - Global Networks (HSS elective)

Preventive Engineering and Social Development
The Centre for Technology and Social Development offers an elective sequence of three courses leading to a Certificate in Preventive Engineering and Social Development. It is designed to help future engineers become as socially and environmentally literate as they are technically competent by enabling them to anticipate the consequences of their design and decision-making and to apply this knowledge in a negative-feedback mode to prevent or greatly reduce undesired and harmful effects on human life, society and the biosphere. The results of such a preventive orientation are, almost always, much more cost-effective than their conventional counterparts. Studies of the career paths of engineers show that they quickly move into administrative and managerial functions for which a broader perspective is required. An understanding of how technology interacts with human life, society and the biosphere (the ecology of technology) is essential to complement their understanding of how the inputs of materials, labour, knowledge and capital are converted to desired outputs (the economy of technology).

The requirements for the elective sequence are: APS301H1, APS302H1 and APS304H1.
Students who successfully complete these three courses are eligible for the Certificate. For further information, please refer to the description of the Centre for Technology and Social Development in this Calendar. Students should register for this elective sequence when they begin the third course.

Program and Course Approvals
Students must obtain the approval of their department for their course selection and, in selecting elective courses, and must also conform to any enrolment requirements set by the department offering the course. A student wishing to take as an elective a course not included in the sources specified above may seek permission to do so by petition to the Faculty Registrar.

PRACTICAL EXPERIENCE REQUIREMENT

Every student must complete a minimum of 600 hours of practical work before graduation. The nature of the work should form an integral part of a student’s education and career development. It therefore must contain a good measure of responsibility (e.g., management of programs, systems, equipment, personnel, or finances), sound judgment and effective communication, and be supportive of the professional career of the student after graduation. Work in many facets of industry, government or public service would be acceptable for this requirement.

This experience may be obtained at any time during the program or through the Engineering Summer Internship Program (eSIP) or Professional Experience Year (PEY) Program, but work done before entering the Faculty may also meet the requirement. Participation in the Professional Experience Year or the Engineering Summer Internship Program automatically satisfies the practical experience requirement, provided that students complete and submit the requisite reports.

Practical experience certificate forms may be obtained from the Registrar’s website and shall be signed by the employer or supervisor. Students should return completed forms to their departmental counsellor’s office. The satisfaction or non-satisfaction of this requirement for graduation will be indicated on the student’s grade report in the fourth year winter session as a grade of CR (Credit) or NCR (No Credit).

The Professional Engineers of Ontario (PEO) may allow pre-graduation experience to count towards 12 months of the four year “engineering experience” required for eligibility for the P.Eng. designation. For further information visit the PEO web site www.peo.on.ca. Please note that the records required by the PEO are separate and distinct from the 600 hours practical experience required for completion of a degree program in the Faculty of Applied Science and Engineering.

Students are required to have completed a total of 600 hours of acceptable practical experience before graduation (normally during their summer vacation periods). Students registered within this program, may elect to enrol and participate in the Engineering Summer Internship Program (eSIP) and the Professional Experience Year (PEY) program. The eSIP program is a paid 4month summer program open to qualified students and serves as an introductory career development program to the PEY. The PEY program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a participating company.

ENGINEERING SUMMER INTERNSHIP PROGRAM (eSIP) PROGRAM

The Engineering Summer Internship Program (eSIP) is a paid 4 month summer co-op program available to eligible engineering students in year 2 or 3 of study, including engineering international students. While a relatively young program in its sixth year, eSIP serves as an introductory career development program for students. Students participate in formalized and interactive workshops and individual counseling appointments. These workshops range from large group, small group and one on one consultation, which focus on helping the students to maximize the value of the internship, from both a personal and professional perspective. While participation in the development program is voluntary, the objective is that the overall preparation, acquired knowledge and gained insight will remain invaluable to the ongoing career development beyond the academic years. The eSIP office monitors the internship and provides support where and when needed and the student’s progress on the job is supervised and evaluated by the student’s employer.
These program elements allow students to:

- Have far greater flexibility to select electives in each program by avoiding scheduling conflicts.
- Better use the services offered by each faculty, without the requirement of a dedicated “bridging” administrative service.
- Maintain a connection, both physically and philosophically with each faculty independent of the other.

THE JEFFREY SKOLL BASc/MBA PROGRAM (SKOLL PROGRAM)

The Jeffrey Skoll Combined BASc/MBA Program allows qualified and selected students of the Faculty of Applied Science and Engineering (APSC) to complete both a BASc and an MBA degree nearly simultaneously - and in a reduced time.

The program genesis dates back to the mid-1990’s and clearly followed from the wide recognition that “engineering” and “management” provide an important combination of skills and understanding. The method to address this recognized need - having a combined program between the two cognizant faculties (the Faculty of Applied Science and Engineering and the Rotman School of Management) - is a well understood strategic goal, in particular given the highly competitive employment environment that pervades the market.

Following an extensive review of the Skoll Program, a number of enhancements have been implemented to improve the overall student experience, provide stronger student services, and allow students to maintain a connection to each faculty as they complete their studies. The Skoll Program application process remains unchanged:

- Students will apply to and be accepted into the program while in engineering, with the admission process as outlined on the Skoll website. Students will have to complete an application form, write the GMAT exam (acceptable performance on the exam to be gauged by Rotman), provide 3 satisfactory reference letters and complete a final brief interview with both Rotman and Engineering representatives. Students will be admitted into the program during their fourth year of studies in the BASc program.

The following are the current elements of the program:

- Once accepted into the program, students continue in their engineering studies, and complete the 4 year BASc program. Students in the Skoll program will graduate from Engineering and receive their Iron Rings with their classmates.
- Students in the Skoll program will be required to complete a 12 to 16 month “PEY” (Professional Experience Year) component using the existing APSC machinery (PEY office) to secure the placement. To ensure uniformity, and further, to allow Skoll engineering students to graduate as a cohort, all Skoll students will complete the “PEY” between their 3rd and 4th years of engineering studies.
- Beginning the September following graduation from engineering, Skoll students will enter the Rotman School of Management, and complete their MBA with regular Rotman MBAs students. After completing their MBA studies, Skoll students will graduate with their MBA class.

These program elements allow students to:

- Maintain a connection, both physically and philosophically with each faculty independent of the other.
- Better use the services offered by each faculty, without the requirement of a dedicated “bridging” administrative service.
- Have far greater flexibility to select electives in each program by avoiding scheduling conflicts.
PART-TIME STUDIES

All years of the BASc degree in Chemical, Civil, Computer, Electrical, Industrial, Materials, Mechanical and Mineral Engineering may be taken on a part-time basis (maximum of three courses per session).

First Year Students
First year students who are registered on a full-time basis may request to transfer to part-time studies by the deadline indicated under the “Fall Sessional Dates”. Permission to make this transfer must be obtained from either the Chair, First Year or the Faculty Registrar. Transfers from part-time to full-time studies will normally be permitted only after completion of an entire program year (usually 10 courses).

Upper Year Students
Students who have completed first, second or third year as full-time students may apply to transfer to part-time studies by submitting a Transfer form by the deadline indicated under the “Winter Sessional Dates”.

Academic Program Load
A part-time student may enroll in a maximum of three one-session courses in each of the Fall Session, the Winter Session and the Summer Session with permission of the responsible Division or Department. Once enrolled in the part-time program, a student must complete all the courses for a program year over a minimum of two calendar years before requesting to continue studies on a full-time basis. For example, a part-time student who requires ten courses to complete First Year may not proceed to Second Year after one year, i.e. the ten courses must be spread over a minimum of two years.

The selection of courses must satisfy the prerequisite and co-requisite structure specified in the course descriptions. Students admitted with advanced standing who require the equivalent of at least 18 one-session courses to complete the requirements for a degree may register in a part-time program subject to the same conditions as other students. Students who require the equivalent of fewer than 18 one-session courses must attend on a full-time basis.

Promotion Regulations
Part-time students are governed by the promotion regulations described in Chapter 6.

Degree Requirements
To qualify for a degree, a student must complete a full undergraduate program within nine calendar years of first registration, exclusive of mandatory absences from their program.

INTERNATIONAL STUDENT EXCHANGES

The Center for International Experience (CIE) administers university-wide international and Canadian exchanges for University of Toronto students. The exchange programs offer students a variety of opportunities to study at partner institutions while gaining an understanding of different cultures, heritage, values and lifestyles found across borders.

Exchange programs operate under formal agreements between the University of Toronto and partner universities abroad and in Canada. University of Toronto students who participate in exchange programs will pay full-time tuition and compulsory incidental fees to the University of Toronto. Students can then study at one of the University of Toronto’s partner universities without paying tuition fees at the host university.

Please note that many of the universities in countries where English is not the host country’s official language still offer many, if not all, courses in English. Notable examples include universities in Hong Kong, Singapore, and Sweden.

Applications for most programs are due each year by the end of February.

EXCHANGE PATHWAYS

When considering going on exchange, one of the first decisions you will have to make is about the type of exchange pathway you will follow. As an Applied Science and Engineering student, you have two pathways to choose between - the structured exchange pathway or the traditional non-structured exchange pathway.

The structured exchange pathway is pre-arranged between your department and the host institution. You will still have some choice in selecting your courses, but you will be doing so from a pre-approved course list. This option requires less academic planning on your part and simplifies the transfer credit process.

The traditional non-structured exchange pathway is one that you arrange yourself at any of CIE’s partner institutions. In choosing this option, you are able to design the exchange that is right for you. This option requires additional planning and discussion with your department to reduce the academic risk in terms of transfer credits.
THE FOLLOWING EXCHANGE PROGRAMS ARE AVAILABLE THROUGH CIE:

Argentina
Torcuato Di Tella University

Australia
Australian National University
University of Adelaide
University of Melbourne
University of New South Wales
University of Queensland
University of Sydney

Barbados
University of the West Indies (Cave Hill)

Canada
McGill University
University of British Columbia

China
Chinese University of Hong Kong
Fudan University
Hong Kong University of Science & Technology
Tsinghua University
University of Hong Kong

The Czech Republic
Masaryk University

Denmark
University of Aarhus

England
Herstmonceux Castle (CUSAP)
King’s College, London
Lancaster University
Loughborough University
University College, London
University of Birmingham
University of Leeds
University of Liverpool
University of Manchester
University of Nottingham
University of Sheffield

Estonia
University of Tartu

France
Ecole Centrale
Lyon 1 (Claude Bernard University)
Lyon 2 (Lumière University)
Lyon 3 (Jean Moulin University)
Ontario/Rhône-Alpes Program (ORA)
Paris 1 (Pantheon-Sorbonne University)
Paris 3 (Sorbonne-Nouvelle University)
Paris 9 (Paris-Dauphine University)
Paris Tech Institutes
Sciences Po, Paris

Germany
DAAD Scholarship Program
Humboldt University at Berlin
Ontario/Baden-Württemberg Program (OBW)
University of Bonn

India
India Institute of Technology, Kanpur
(Engineering)
Ontario/Maharashtra-Goa Program

Israel
Hebrew University of Jerusalem
Technion-Israel Institute of Technology
Tel Aviv University

Italy
University of Siena

Jamaica
University of the West Indies (Mona)

Japan
Keio University
Kyoto University
Nagoya University
Nihon University
Waseda University

Korea (South)
Korea University
Korean Advanced Institute of Science and Technology
Seoul National University
Yonsei University

Netherlands
University of Amsterdam

New Zealand
University of Auckland
University of Otago

Norway
University of Oslo

Poland
Jagiellonian University

Scotland
University of Edinburgh
University of Glasgow
University of St Andrews
University of Strathclyde

Singapore
Nanyang Technological University
National University of Singapore

Sweden
Lund University
Uppsala University

Switzerland
Swiss Federal Institute of Technology Zurich

Taiwan
National Taiwan University

Trinidad and Tobago
University of the West Indies (St. Augustine)

United States of America
Killam Fellowships Program
DEGREE POST (PROGRAM OF STUDY) CODES

The Faculty uses the following Degree POST Codes to note which program a student is currently enrolled in. Options within a program are categorized by a unique degree POST code. Full-time and part-time students will fall under one of these codes. It is possible for students to change their degree POST code during their time in the faculty.

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<td>Non-Degree Special Student</td>
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<td>BASc</td>
<td>Mechanical Engineering</td>
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Minors in the Faculty of Applied Science and Engineering

Manager and Student Counsellor
Sharon Brown
Cross-Disciplinary Programs Office
44 St. George St.
416-978-3532
E-mail: cdp@ecf.utoronto.ca
www.minors.engineering.utoronto.ca

Engineering Minors

Students wishing to pursue an Engineering minor must take a minimum of six courses.

Completion of an Engineering Minor is subject to the following constraints:
1. Students must ensure they meet the requirements of their chosen engineering-degree program or Option therein;
2. Of the 6 (half year) courses required for the minor, one (half year) course can also be a core course in a student’s Program or Option, if applicable;
3. Either a Thesis or Design course can count for up to two (half year) electives towards the 6 required courses IF the Thesis or Design course is strongly related to the subject area of the minor. This requires approval of the Director of the Minor;
4. Availability of the courses to complete an engineering minor (including the foundational courses) for timetabling purposes is not guaranteed; the onus is on the student to ensure compatibility with their timetable;
5. Students must secure approval from their home department before selecting any elective outside their home department.

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MINOR IN BIOENGINEERING (AEMINBIO)

The Undergraduate Bioengineering Minor is a collaborative effort across the Faculty of Applied Science and Engineering and is open to Engineering students interested in learning more about biology and its application to engineering. Our definition of bioengineering is broad, reaching to all areas at the interface of engineering and biology. This includes bioprocess engineering, environmental microbiology, biomaterials, tissue engineering, bioelectricity, biomedical imaging, biomechanical engineering, nanotechnology related to medicine and the environment, and engineering design for human interfaces. All undergraduate Engineering students except students in the Engineering Science Biomedical Option are eligible to participate in this minor course of study.

Requirements for the Minor in Bioengineering

The requirements for a Bioengineering Minor in the Faculty of Applied Science and Engineering are the successful completion of the following courses:

**Denotes courses available to Engineering Science students only

1. CHE353H1 - Engineering Biology OR BME105H1/BME205H1** - Systems Biology
2. One of:
   i) CHE354H1 —Cellular and Molecular Biology OR BME395H1** Cellular and Molecular Bioengineering 1, or
   ii) MIE331H1 —Physiological Control Systems OR BME350H1** - Physiological Control Systems
3. Four (4) other electives from the list of Bioengineering designated courses or departmental thesis and design courses subject to the following constraints:

a. Of the 6 (half year) bioengineering courses required, one (half year) course can also be a core course in a student’s Program, if applicable.

b. Of the 4 elective courses, at least 2 must be from the Advanced category.

c. Either a Thesis or Design course can count for up to two (half year) courses towards the 6 required courses IF the Thesis or Design course is strongly related to bioengineering. This requires approval by the Bioengineering Minor Director.

d. Some Departments may require students to select their electives from a pre-approved subset. Please contact your Departmental Advisor for details.

e. Arts and Science Courses listed below may be considered eligible electives for students taking the Bioengineering Minor (to be counted at a weight of 0.50 only), subject to the student meeting any prerequisite requirements. Students must also seek the approval of their home program to ensure that they meet their degree requirements. In situations where these courses don’t meet those of their home program, students can elect to take these as extra courses.

Minor in Bioengineering

Courses Offered in the Fall

<table>
<thead>
<tr>
<th>Courses Offered in the Fall</th>
<th>Lect.</th>
<th>Lab.</th>
<th>Tut.</th>
<th>Wgt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Requirement Courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomedical Systems Engineering I: Organ Systems</td>
<td>BME350H1 F</td>
<td>3</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Engineering Biology</td>
<td>CHE353H1 F</td>
<td>3</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Introductory Courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomedical Systems Engineering I: Organ Systems</td>
<td>BME350H1 F</td>
<td>3</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Organic Chemistry and Biochemistry</td>
<td>CHE391H1 F</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Biotransport Phenomena</td>
<td>CHE393H1 F</td>
<td>3</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Water and Wastewater Treatment Processes</td>
<td>CIV342H1 F</td>
<td>3</td>
<td>1</td>
<td>-</td>
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<tr>
<td>General &amp;Human Genetics Psychology For Engineers</td>
<td>HMB265H1 F</td>
<td>2</td>
<td>-</td>
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<tr>
<td>Psychology For Engineers</td>
<td>MIE242H1 F</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Industrial Ergonomics and the Workplace</td>
<td>MIE343H1 F</td>
<td>3</td>
<td>3</td>
<td>-</td>
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<tr>
<td>Biomaterial Processing and Properties</td>
<td>MSE440H1 F</td>
<td>3</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Discovering Wood and its Role in Societal Development</td>
<td>FOR308H1 F</td>
<td>3</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Human Physiology I</td>
<td>PSL300H1 F</td>
<td>3</td>
<td>-</td>
<td>1</td>
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</table>

Courses Offered in the Winter

<table>
<thead>
<tr>
<th>Courses Offered in the Winter</th>
<th>Lect.</th>
<th>Lab.</th>
<th>Tut.</th>
<th>Wgt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Requirement Courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomedical Engineering Technology and Investigation</td>
<td>BME205H1 S</td>
<td>2</td>
<td>1.25</td>
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<tr>
<td>Physiological Control Systems</td>
<td>MIE331H1 S</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Introductory Courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomedical Engineering Technology and Investigation</td>
<td>BME340H1 S</td>
<td>2</td>
<td>4</td>
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<tr>
<td>Biomechanics I</td>
<td>MIE440H1 S</td>
<td>2</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Food Engineering</td>
<td>CHE462H1 S</td>
<td>3</td>
<td>-</td>
<td>1</td>
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<tr>
<td>Introduction to Genes, Genetics &amp;Biotechnology</td>
<td>HMB201H1 S</td>
<td>2</td>
<td>-</td>
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<tr>
<td>Physiological Control Systems</td>
<td>MIE331H1 S</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Biomechanics I</td>
<td>MIE439H1 S</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Pharmacology and Pharmacokinetic Principles</td>
<td>PCL201H1 S</td>
<td>3</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

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Course Requirements for the Minor in Environmental Engineering

The requirements for an Environmental Engineering Minor in the Faculty of Applied Science and Engineering are the successful completion of the following courses.

1. Two (2) courses from the following:
   (If you take more than 2, the extra course may be able to count as an elective below)
   i) APS301H1 - Technology in Society and the Biosphere I
   ii) CIV220H1 - Urban Environmental Ecology OR MIE380H1 - Ecological Systems
   iii) CIV440H1 - Environmental Impact and Risk Assessment
   iv) CHE467H1 - Environmental Engineering

2. Four (4) other electives from the list of Environmental Engineering designated courses or departmental thesis and design courses subject to the following constraints:
   a. Of the 6 (half year) environmental engineering courses required, one (half year) course can also be a core course in a student’s Program, if applicable.
   b. Of the 4 elective courses, at least 2 must be from the Advanced category.
   c. Either a Thesis or Design course can count for up to two (half year) courses towards the 6 required courses IF the Thesis or Design course is strongly related to environmental engineering. This requires approval by the Environmental Engineering Minor Director.

Notes

1. For those Engineering Science students who transferred into another program, BME105H1/BME205H1 can replace CHE353H1 and is an eligible prerequisite for CHE354H1 and MIE331H1.
2. If a student takes both CHE354H1 and MIE331H1, one of these courses can be counted as one of the four electives.
3. BME440H1 and BME455H1 are open to all students in the Faculty of Applied Science and Engineering, except those in Engineering Science, so long as the pre-requisites for each have been met.
4. BME205H1, BME340H1, BME350H1, BME395H1, BME396H1, BME510H1, CHE391H1 and CHE393H1 are only open to Engineering Science Students.

MINOR IN ENVIRONMENTAL ENGINEERING (AEMINENV)

Students interested in learning more about ecology, sustainable design, risk assessment and environmental impact may be interested in this minor. Our definition of environmental engineering is broad, reaching to all areas at the interface of engineering and the environment. This includes ecology and ecological impacts, waste management, water and wastewater treatment, environmental microbiology, water resources engineering, hydrology, preventive engineering, life cycle analysis, design for the environment, and extends to the social and environmental impacts of technology. All undergraduate Engineering students are eligible to participate in this minor course of study.
Minor in Environmental Engineering

Courses Offered in the Fall

Core Requirement Courses
- Technology in Society and the Biosphere I
  - APS301H F 3 - 1 0.50
- Environmental Engineering
  - CHE467H F 3 - 1 0.50
- Urban Engineering Ecology
  - CIV220H F 3 - 1 0.50

Introductory Courses
- Environmental Engineering
  - CHE467H F 3 - 1 0.50
- Urban Engineering Ecology
  - CIV220H F 3 - 1 0.50
- Terrestrial Energy Systems
  - CIV300H F 3 - 2 0.50
- Water and Wastewater
  - CIV342H F 3 1 - 0.50
  - Building Science
  - CIV375H F 3 1 2 0.50
- Energy Policy and Environment
  - ENV350H F - - - 0.50
- Discovering Wood and its Role in Societal Development
  - FOR308H F 3 - 1 0.50

Advanced Courses
- Bioprocess Engineering
  - CHE466H F 3 0.66 1 0.50
- Aqueous Process Engineering
  - CHE565H F 3 - 1 0.50
- Analytical Environmental Chemistry
  - CMH410H F 2 4 - 0.50
- Transport Planning
  - CIV311H F 3 - 1 0.50
- Groundwater Flow and Contamination
  - CIV459H F 3 - 1 0.50
- Water Resources Engineering
  - CIV550H F 3 - 2 0.50
- Alternative Energy Systems Management
  - MIE515H F 3 - 1 0.50
- Extractive Metallurgy
  - MSE504H F 3 - 2 0.50

Courses Offered in the Winter

Core Requirement Courses
- Environmental Impact and Risk Assessment
  - CIV440H F 3 - 1 0.50

Introductory Courses
- Environmental Chemistry
  - CHE460H F 3 - 2 0.50
- Environmental Pathways and Impact Assessment
  - CHE460H F 3 - 2 0.50
- Hydraulics and Hydrology
  - CIV250H S 3 1.50 1 0.50
- Terrestrial Energy Systems
  - CIV300H S 3 - 2 0.50
- Environmental Impact and Risk Assessment
  - CIV440H S 3 - 1 0.50
- Design for the Environment
  - MIE315H S 3 - 1 0.50
- Environmental Degradation of Materials
  - MSE315H S 3 - 2 0.50

Advanced Courses
- Technology in Society and the Biosphere II
  - APS302H F 3 - 1 0.50
- Preventive Engineering and Social Development
  - APS304H F 3 - 1 0.50
- Appropriate Technology & Design for Global Development
  - APS305H F 3 - - 0.50
- Pulp and Paper Processes
  - CHE564H F 3 - 1 0.50
- Topics in Atmospheric Chemistry
  - CMH415H S 2 - - 0.50
- Environmental Engineering
  - CIV541H F 3 - - 0.50
- Sustainable Buildings
  - CIV576H F 3 - 1 0.50
- Infrastructure for Sustainable Cities
  - CIV577H S 3 - 1 0.50
- Urban Forest Conservation
  - FOR421H F 2 - - 0.50
- Design and Manufacturing of Sustainable Materials
  - FOR424H F 3 - 1 0.50

MINOR IN SUSTAINABLE ENERGY (AEMINENR)

This minor is for students interested in learning more about energy, its sustainable use, energy demand management, and the public policy context in which energy use and production is regulated. Our courses reach all areas of energy use, production, distribution, transmission, storage, and control, and aspects of public policy. Students in the Engineering Science Energy System Option are not allowed to take this minor.

Course Requirements for the Minor in Sustainable Energy

The requirements for a Sustainable Energy Minor in the Faculty of Applied Science and Engineering are the successful completion of the following courses:

1. CIV300H1 - Terrestrial Energy Systems

2. One of:
   i) APS305H1 - Energy Policy (CS)
   ii) ENV350H1 Energy Policy & Environment (A&S HSS)

3. Four (4) other electives from the list of Sustainable Energy designated courses or departmental thesis and design courses subject to the following constraints:

   a. Of the 6 (half year) sustainable energy courses required, one (half year) course can also be a core course in a student’s Program, if applicable.
   b. Of the 4 elective courses, at least 2 must be from the Advanced category.
   c. Either a Thesis or Design course can count for up to two (half year) courses towards the 6 required courses IF the Thesis or Design course is strongly related to sustainable energy. This requires approval by the Sustainable Energy Minor Director.
d. Some Departments may require students to select their electives from a pre-approved subset. Please contact your Departmental Advisor for details.
e. Arts and Science Courses listed below may be considered eligible electives for students taking the Sustainable Energy Minor, subject to the student meeting any prerequisite requirements. Students must also seek the approval of their home program to ensure that they meet their degree requirements. In situations where these courses don’t meet those of their home program, students can elect to take these as extra courses.

**MINOR IN ENGINEERING BUSINESS (AEMINBUS)**

This minor is for students interested in learning more about the business dimension of engineering, from finance and economics to management and leadership. Courses reach to areas of wealth production and creation, accounting, research and development, management, economics and entrepreneurship, all within a global context. Students in the Engineering Science Mathematics, Statistics and Finance Option are not eligible to take this minor.

**Course Requirements for the Minor in Engineering Business**

The requirements for an Engineering Business Minor in the Faculty of Applied Science and Engineering are the successful completion of the following courses:

1. Required Departmental Engineering Economics Course (CHE249H1, CHE374H1, CME368H1, ECE472H1, MIE258H1)
2. JRE300H1 - Foundations of Accounting and Finance (CS Elective)
3. JRE410H1 - Markets and Competitive Strategy (CS Elective)
4. JRE420H1 - People Management and Organizational Behaviour (CS Elective)

5. Two (2) Course Electives from the list of Engineering Business designated courses. A Departmental Thesis course may be counted as 1 elective (if an H course) or 2 electives (if a Y course) IF strongly related to Engineering Business. This requires approval of the Director of the Minor.

**Minor in Engineering Business**

Courses offered in the Fall

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Engineering Economics Course</td>
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<tr>
<td>Engineering Economic Analysis</td>
<td>CHE249H1 F 3</td>
<td>-</td>
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<td>0.50</td>
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<tr>
<td>Economic Analysis and Decision Making</td>
<td>CHE374H1 F 3</td>
<td>-</td>
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<tr>
<td>Engineering Economics and Decision Making</td>
<td>CME368H1 F 3</td>
<td>-</td>
<td>1</td>
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<tr>
<td>Engineering Economic Analysis &amp; Entrepreneurship</td>
<td>MIE258H1 F 3</td>
<td>-</td>
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</table>

**Required Courses**

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Fundamentals of Accounting and Finance</td>
<td>JRE300H1 F 3</td>
<td>-</td>
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<tr>
<td>Markets and Competitive Strategy</td>
<td>JRE410H1 F 2</td>
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**Elective Courses**

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<tbody>
<tr>
<td>Entrepreneurship and Small Business</td>
<td>APS234H1 F 4</td>
<td>-</td>
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<tr>
<td>Innovative Technologies and Organizations in Global Energy Systems</td>
<td>APS510H1 F 3</td>
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<tr>
<td>Entrepreneurship and Business for Engineers</td>
<td>ECE488H1 F 3</td>
<td>-</td>
<td>2</td>
<td>0.50</td>
</tr>
<tr>
<td>Discovering Wood and its Role in Societal Development</td>
<td>FOR308H1 F 3</td>
<td>-</td>
<td>1</td>
<td>0.50</td>
</tr>
<tr>
<td>Technology and Prosperity</td>
<td>HPS308H1 F 2</td>
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<tr>
<td>Entrepreneurship and Business for Engineers</td>
<td>MIE488H1 F 3</td>
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<tr>
<td>Entrepreneurship and Business for Engineers</td>
<td>MSE488H1 F 3</td>
<td>-</td>
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<tr>
<td>Business Process Engineering</td>
<td>MIE354H1 F 3</td>
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**Courses offered in the Winter**

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Engineering Economics Course</td>
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<tr>
<td>Engineering Economic Analysis</td>
<td>ECE472H1 S 3</td>
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**Required Courses**

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<tr>
<th></th>
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<tbody>
<tr>
<td>Fundamentals of Accounting and Finance</td>
<td>JRE300H1 S 3</td>
<td>-</td>
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<tr>
<td>People Management and Organizational Behaviour</td>
<td>JRE420H1 S 3</td>
<td>-</td>
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</table>

**Elective Courses**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Entrepreneurship and Business Management</td>
<td>APS432H1 S 4</td>
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<tr>
<td>Cognitive and Psychological Foundations</td>
<td>APS442H1 S 3</td>
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<tr>
<td>Leadership and Leading for Groups and</td>
<td>APS443H1 S 2</td>
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<tr>
<td>Technology, Engineering and Global Development</td>
<td>APS520H1 S 3</td>
<td>-</td>
<td>1</td>
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<tr>
<td>Entrepreneurship and Business for Engineers</td>
<td>CHE488H1 S 3</td>
<td>-</td>
<td>2</td>
<td>0.50</td>
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<tr>
<td>Entrepreneurship and Business for Engineers</td>
<td>CIV488H1 S 3</td>
<td>-</td>
<td>2</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**MINOR IN ROBOTICS AND MECHATRONICS (AEMINRAM)**

The Minor in Robotics and Mechatronics is a collaborative effort among The Edward S. Rogers Sr. Department of Electrical and Computer Engineering, Department of Mechanical and Industrial Engineering, the Institute for Aerospace Studies, and the Institute of Biomaterials and Biomedical Engineering. It is open to all students in the Faculty of Applied Science and Engineering who are interested in learning more about robotics and mechatronics. The minor in robotics and mechatronics exposes students to the fundamental paradigms, the enabling technologies, the design, and the applications of robotics and mechatronics. The program is intended to give a comprehensive view to these fields by drawing together relevant courses from all of the engineering departments. The emphasis is on giving the student a systems view rather than a narrowly focused study of one area. Courses examine the areas of sensing and actuation, control and signal processing, computer vision, intelligent algorithms, computation, and system integration. The minor prepares students for careers in industries that have a growing investment in automation, autonomy, and intelligent systems. It is open to all students in the Faculty of Applied Science and Engineering.

**Requirements for the Minor in Robotics and Mechatronics**

The requirements for a Robotics and Mechatronics Minor in the Faculty of Applied Science and Engineering are the successful completion of the following courses:

1. One of:
   (i) CHE322H1 – Process Dynamics and Control
   (ii) ECE311H1 – Dynamic Systems and Control
   (iii) ECE356H1 – Linear Systems and Control
   (iv) MIE404H1 – Control Systems I
   (v) AER372H1 – Control Systems
2. One of:
   (i) ECE532H1 –Digital Systems Design
   (ii) MIE438H1 –Microprocessors and Embedded Microcontrollers

3. Four (4) other electives from the list of robotics and mechatronics-designated courses or a departmental thesis or design course subject to the following constraints:
   a. Of the 6 (half year) courses required, one (half year) course can also be a core course in a student's Program, if applicable.
   b. Of the four elective courses, at least two must be from the Advanced category.
   c. A thesis course can count for up to two electives (2 HCEs) toward the six required Minor courses if the thesis is strongly related to robotics or mechatronics. This requires approval by the Director of the Minor.
   d. Of the six Minor courses required, not all can have the same course prefix.

### Introductory Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Exclusions</th>
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<tbody>
<tr>
<td>AER301H1</td>
<td>Dynamics</td>
<td>MIE301H1</td>
</tr>
<tr>
<td>ECE314H1</td>
<td>Fundamentals of Electrical Energy Systems</td>
<td>ECE349H1</td>
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<tr>
<td>ECE349H1</td>
<td>Introduction to Energy Systems</td>
<td>ECE314H1</td>
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<tr>
<td>ECE316H1</td>
<td>Communication Systems</td>
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<tr>
<td>ECE331H1</td>
<td>Analog Electronics</td>
<td>MIE346H1, ECE354H1</td>
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<tr>
<td>ECE354H1</td>
<td>Electronic Circuits</td>
<td>ECE331H1</td>
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<tr>
<td>ECE334H1</td>
<td>Digital Electronics</td>
<td>MIE346H1</td>
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<tr>
<td>ECE342H1</td>
<td>Computer Hardware</td>
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<tr>
<td>ECE344H1</td>
<td>Operating Systems</td>
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<tr>
<td>ECE353H1</td>
<td>Systems Software</td>
<td>ECE353H1</td>
</tr>
<tr>
<td>ECE345H1</td>
<td>Algorithms and Data Structures</td>
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<tr>
<td>ECE358H1</td>
<td>Foundations of Computing</td>
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<td>Analog and Digital Electronics for Mechatronics</td>
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## Advanced Courses

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<tr>
<th>Course Code</th>
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<td>AER506H1</td>
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<td>Robotics</td>
<td>ECE470H1, MIE422H1</td>
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<td>CHE507H1</td>
<td>Data-Based Modeling for Prediction and Control</td>
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<td>Minds and Machines</td>
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## Notes

- Courses in italics are Engineering Science courses.
- Computer Science courses may have limited enrollment.
- Courses requiring special approval must be approved by the undergraduate Associate Chair of the student’s home department.
Curriculum and Programs

Introductory Courses

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<thead>
<tr>
<th>Fall Courses</th>
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Advanced Courses

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SELF-INITIATED MINORS

Students may be eligible to receive acknowledgement of an Arts and Science minor upon completion of its associated course requirements within specific disciplines (political science, cinema studies etc.). Information regarding minor requirements for each discipline may be found in the Arts and Science Calendar. A student must complete all requirements within nine calendar years of first registration, exclusive of mandatory absences from their program.

Students are advised that pursuing a self-initiated minor may extend their studies by a term or year in order to complete all program requirements.

Students must obtain documentation from the relevant department within the Faculty of Arts and Science so as to provide the Faculty with evidence that all requirements will have been completed. Successful completion will result in the annotation of the students’ transcripts as to the completion of the minor.

Students may use any of their HSS elective credits, any of their CS elective credits, any Free Electives credits and/or any 2 other courses (2 Half Course Equivalents) towards their Arts and Science Minor. All other courses taken for the Minor designation must be taken as Extra courses.

Students who have IB, AP, GCE, FB or CAPE credits may apply to the Engineering Registrar’s Office to have the Faculty of Arts and Science equivalent courses listed on their transcript as Extra courses; the course equivalencies are those in place at the time of first registration. These credits may be counted towards any Arts and Science degree designation and may be used as pre-requisites for any higher level course in the Faculty of Arts and Sciences.
Science.

Students wishing to pursue a Major or Specialist designation must apply to the Faculty of Arts and Science for admission for a 2nd degree.

Note: In some disciplines, the Faculty of Arts and Science has found it necessary to restrict enrolment in upper-level courses to their own students. Students planning to pursue minors should consult the department concerned regarding the availability of courses.
First Year

CHAIR, FIRST YEAR
Associate Professor K.D. Pressnail, B.A.Sc., LLB., M.A.Sc., Ph.D.

ASSISTANT REGISTRAR, FIRST YEAR
Ms Leslie Grife, B.A.(Hons)

STUDENT SUCCESS SPECIALIST
Ms Lesley Mak, B.Sc.(Hons), M.Ed.

FIRST YEAR ASSISTANT
Ms Vanessa Andres, B.A.(Hons), MI

Room 170, Galbraith Building
416-978-4625, firstyear@ecf.utoronto.ca
www.undergrad.engineering.utoronto.ca/Advising_Support/First_Year_Office.htm

The First Year Engineering curriculum is designed for students continuing in one of the following programs in Second Year: Chemical, Civil, Computer, Electrical, Industrial, Materials, Mechanical, or Mineral Engineering. Students are admitted to one of these programs or TrackOne on entering First Year. This guarantees a place in a program in subsequent years, subject to maintenance of satisfactory standing. Students who complete First Year with a clear record in one of the above programs may request to transfer to another program (see Academic Regulations, Chapter 6 for details). Students in TrackOne or who wish to transfer at the end of First Year must submit their requests to the First Year Office no later than the deadline as listed in the Sessional Dates.

The academic year consists of two sessions, Fall (September through December) and Winter (January through April). Students typically take five courses per session. Timetables, detailing which courses students will take in each session, will be provided to students in August. The First Year curriculum is shown in each program section, with the TrackOne General First Year curriculum shown below:

TrackOne- GENERAL FIRST YEAR ENGINEERING COURSE (AEENGBASC)

TrackOne is the general First Year curriculum of the Faculty. Students admitted to this program transfer to one of eight Engineering Programs, including Chemical, Civil, Computer, Electrical, Industrial, Mechanical, Mineral, or Materials Science Engineering, after the successful completion of the First Year curriculum, as listed below.

FIRST YEAR - TrackOne

<table>
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<th>Winter Session - Year 1</th>
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<td>Engineering Strategies</td>
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<td>Ethics in Engineering</td>
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<td>CIV100H1 F</td>
<td>Introduction to Materials and Chemistry</td>
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<td>Linear Algebra</td>
<td>MAT188H1 F</td>
<td>ECE110H1 S</td>
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<tr>
<td>Calculus A</td>
<td>MAT196H1 F</td>
<td>MAT197H1 S</td>
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T-PROGRAM IN FIRST YEAR

The T-Program enables students in First Year who have been placed on probation after the Fall Session to immediately repeat a maximum of three courses and defer up to three Winter Session courses to the Summer Session (May and June). Full-time students must carry five courses during the Winter Session.

These five Fall Session courses are offered again in the Winter Session. Normally they are only open to T-Program students and to other students required to immediately repeat the course.

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Students who must repeat MSE101 or CHE112 will enrol in one of the sections offered in the Winter Session, if scheduling permits.

The courses offered in the Summer Session are:

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</table>

Courses to be dropped from the Winter Session and courses to be taken in the Summer Session will depend on the student’s program of study and will be decided by the First Year Office.

For details regarding the T-Program Promotional Regulations, please see the Academic Regulations portion of the calendar.
Aerospace Science and Engineering

UNDERGRADUATE PROGRAM IN AEROSPACE SCIENCE AND ENGINEERING

The University of Toronto offers a comprehensive program of study in Aerospace Science and Engineering at both the undergraduate and graduate levels. The undergraduate program is offered through the Division of Engineering Science, while the graduate program is offered at the University of Toronto Institute for Aerospace Studies (UTIAS). All Engineering Science students follow a common curriculum during the first two years, with emphasis on mathematics, science, and engineering fundamentals. The final two years in the Aerospace Option focus on aeronautics and space engineering, with courses delivered primarily by faculty from UTIAS. The undergraduate aerospace curriculum reflects the diverse and dynamic activities associated with the aerospace industry in Canada and abroad. Students are exposed to courses associated with aeronautical and space sciences and engineering, and also gain practical experience in laboratory and design courses. Capstone design courses in fourth year include Space Systems Design, where student teams design hardware associated with a space mission, such as a Hubble telescope repair mission, or a Europa landing probe. Engineers from MDA Space Missions play a major role in the delivery of this course. In the Aircraft Design course, student teams design and build model aircraft with various configurations, which are then flown in a fly-off competition at the end of the term. The aerospace field has progressed extensively since the record-setting flights by F.W. Baldwin and J.A.D. McCurdy - both University of Toronto engineering graduates - during the early 1900s. It has evolved into a multi-disciplinary activity that finds itself at the cutting edge of high technology research and development. Consequently, the field is rich with technological and engineering challenges in diverse areas such as hypersonic aerodynamics, multi-disciplinary optimization, and space exploration. Students at the fourth year level will have opportunities to select courses and work on thesis projects related to the many specialized areas of active research at UTIAS. While the undergraduate program prepares students for immediate entry into a professional engineering career, many students continue to the graduate level in order to enhance their qualifications and employment opportunities. For further information regarding undergraduate aerospace studies please refer to the Engineering Science program in this Calendar, the website www.engsci.utoronto.ca or contact the Engineering Science Administrative Office at 416-978-2903.

GRADUATE PROGRAM IN AEROSPACE SCIENCE AND ENGINEERING

UTIAS offers graduate programs leading to research intensive M.A.Sc., and Ph.D. degrees and a professionally oriented M.Eng. degree. Graduate research areas include aircraft flight systems and control, flight simulation, computational fluid dynamics, combustion and propulsion, aerodynamic shape optimization, experimental fluid dynamics, flow control, structural mechanics, advanced composite materials, multidisciplinary optimization of aircraft, multifunctional systems, spacecraft dynamics and control, autonomous space robotics, microsatellites, space mechatronics, plasma-materials interactions and materials for fusion reactors. Details of entrance regulations and courses of study are given in the calendar of the School of Graduate Studies and on the website www.utias.utoronto.ca.

It should be noted that a student who has graduated in another branch of engineering, mathematics, physics or chemistry, and wishes to pursue graduate work at the Institute for Aerospace Studies, may be admitted to the graduate program. In that case the courses leading to the M.A.Sc. or M.Eng. degree will be arranged on an individual basis to make up for deficiencies in undergraduate training.
Chemical Engineering and Applied Chemistry

UNDERGRADUATE PROGRAM IN CHEMICAL ENGINEERING (AECHEBASC)

Undergraduate Student Counsellor
Ms Jane Park
Room 216A, Wallberg Building, 416-978-5336
Email: ugrad.chemeng@utoronto.ca

Chemical Engineering is a primary engineering discipline based on the fundamental sciences of chemistry, physics, biochemistry and mathematics, in which processes are conceived, designed and operated to effect compositional changes in materials of all kinds. Chemical engineers play an important role in the development of a healthier environment and safer and healthier industrial workplaces. They develop new industrial processes that are more energy-efficient and environmentally friendly and create products that improve the quality of life. They are responsible for improvements in technologies and in evaluating and controlling hazards. In addition to the basic sciences, chemical engineers use a well-defined body of knowledge in the application of the conservation laws which determine mass flow and energy relations; thermodynamics and kinetics which determine whether reactions are feasible and the rate at which they occur; and the chemical engineering rate laws which determine limits to the transfer of heat, mass and momentum.

Graduating chemical engineers are skilled problem solvers. A strong background in applied chemistry furnishes the chemical engineer with the knowledge to participate in the broadest range of engineering activities, and indeed to pursue other professional careers in management, medicine, law, teaching and government. Instruction in important aspects of economic analysis is also included. In the Fall Session of Fourth Year, students participate in small teams in either the design of a chemical plant. 4th year students may undertake an individual full year research project. This project, the culmination of which is a thesis, serves in many cases as an introduction to research, and provides an opportunity to apply the principles developed during the first three years of the program to problems of engineering interest. A thesis project may, for example, concern an experimental laboratory investigation, the design of a process, or a computer study of a complex chemical system.

The Technical Elective subjects available in the Third and Fourth Years cover a wide range of fundamental and application areas of Chemical Engineering and Applied Chemistry. By choosing electives from a restricted list, it is possible for students to complete the requirements for an Engineering Minor. A minor signifies that a student has gained an enhanced understanding of a specific field of study. For more information on the various Minors, please see the sections of the Calendar relating to these programs.

First Year Chemical Engineering

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<td>MSE101H1</td>
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<tr>
<td>Linear Algebra</td>
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Second Year Chemical Engineering

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<td>Heat and Mass Transfer</td>
<td>CHE210H1</td>
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<td>Applied Chemistry II - Organic Chemistry</td>
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<td>Applied Differential Equations Statistics</td>
<td>CHE222H1</td>
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<td>Calculus and Numerical Methods</td>
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<td>Environmental Chemistry</td>
<td>CHE223H1</td>
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<tr>
<td>Engineering Economic Analysis</td>
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<td>CHE230H1</td>
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<tr>
<td>Seminar Course: Communications Portfolio I</td>
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Practical Experience Requirement

- For information on CHE297Y, see course description in Chapter 8.
- As described in the beginning of this chapter, students are required to have completed a total of 600 hours of acceptable practical experience before graduation (normally during their summer vacation periods).
PROFESSIONAL EXPERIENCE YEAR

Students registered within this program, and all other undergraduate programs within the Faculty of Applied Science and Engineering, may elect to enroll and participate in the Professional Experience Year (PEY) program. The PEY program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a cooperating industry. Details are described in the beginning of this chapter. For more information, consult the Professional Experience Year Office, 45 Willcocks Street 2nd Floor early in session 2F or 3F.

Third Year Chemical Engineering

<table>
<thead>
<tr>
<th>Fall Session - Year 3</th>
<th>Lect.</th>
<th>Lab.</th>
<th>Tut.</th>
<th>Wgt.</th>
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<td>CHE323H1 F</td>
<td>3</td>
<td>4</td>
<td>2</td>
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<tr>
<td>Process Design</td>
<td>CHE324H1 F</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Thermodynamics and Kinetics Laboratory</td>
<td>CHE326H1 F</td>
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<td>-</td>
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<tr>
<td>Reaction Kinetics</td>
<td>CHE332H1 F</td>
<td>3</td>
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<td>2</td>
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<tr>
<td>Technical Elective</td>
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<td>0.50</td>
</tr>
<tr>
<td>Seminar Course: Communications Portfolio II</td>
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<tr>
<td>Complementary Studies/Humanities and Social Sciences Elective</td>
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<tbody>
<tr>
<td>Separation Processes</td>
<td>CHE311H1 S</td>
<td>3</td>
<td>4</td>
<td>2</td>
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<tr>
<td>Process Dynamics and Control</td>
<td>CHE322H1 S</td>
<td>3</td>
<td>-</td>
<td>2</td>
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<tr>
<td>Chemical Reaction</td>
<td>CHE333H1 S</td>
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<tr>
<td>Team Strategies for Engineering Design</td>
<td>CHE334H1 S</td>
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</tr>
<tr>
<td>Seminar Course: Communications Portfolio II</td>
<td>CHE397Y1 Y</td>
<td>-</td>
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</table>

1 For information on CHE397Y, see course description in Chapter 8.
2 In years 3 and 4, two of the four Complementary Studies/Humanities and Social Sciences elective courses must be from the Humanities and Social Sciences category. Students may take their Complementary Studies/Humanities and Social Sciences electives in any order in years 3 and 4.

Fourth Year Chemical Engineering

<table>
<thead>
<tr>
<th>Fall Session - Year 4</th>
<th>Lect.</th>
<th>Lab.</th>
<th>Tut.</th>
<th>Wgt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Materials</td>
<td>CHE341H1 F</td>
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<td>Chemical Plant Design</td>
<td>CHE430Y1 F</td>
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<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Complementary Studies/Humanities and Social Sciences Elective</td>
<td>-</td>
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<td>and one of:</td>
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<tr>
<td>Thesis</td>
<td>CHE499Y1 Y</td>
<td>-</td>
<td>7</td>
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<tr>
<td>Technical Elective</td>
<td>-</td>
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<td>0.50</td>
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</thead>
<tbody>
<tr>
<td>Professional Practice</td>
<td>CHE403H1 S</td>
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<tr>
<td>Technical Elective 1</td>
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<tr>
<td>Technical Elective 2</td>
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<td>Complementary Studies/Humanities and Social Sciences Elective</td>
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<td>and one of:</td>
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<tr>
<td>Thesis</td>
<td>CHE499Y1 Y</td>
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<td>7</td>
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<tr>
<td>Technical Elective 1</td>
<td>-</td>
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<td>0.50</td>
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</tbody>
</table>

1 See below for the list of eligible technical electives.
2 In years 3 and 4, two of the four Complementary Studies/Humanities and Social Sciences elective courses must be from the Humanities and Social Sciences category. Students may take their Complementary Studies/Humanities and Social Sciences electives in any order in years 3 and 4.
3 In years 3 and 4, students must complete a total of 5 Technical Electives, one free elective and 4 HSS/CS electives
4 Some programs require students to take a Free Elective. A Free Elective has few restrictions: any degree credit course listed in the current calendars of the Faculty of Applied Science and Engineering, the Faculty of Arts and Science, and the School of Graduate Studies is acceptable as a Free Elective provided it does not duplicate material covered in courses taken or to be taken.

THESIS

CHE499Y1Y Thesis
Full-year (Fall and Winter Sessions) thesis requires approval of the department and research project supervisor.

TECHNICAL ELECTIVES

Students are required to select their technical electives from the list of approved courses below. Technical Electives outside the group of courses below must first be approved by the Chemical Engineering UG Coordinator.

Students wishing to pursue an Engineering Minor should take their core courses as technical electives in terms 3F and 3S. The organization of the minors and the sets of eligible electives are presented below.
### Technical Electives

#### Fall Session - Year 4

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<tr>
<th></th>
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<tbody>
<tr>
<td>Cellular and Molecular Engineering Biology</td>
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<tr>
<td>Petroleum Processing</td>
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<tr>
<td>Bioprocess Engineering</td>
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<tr>
<td>Environmental Engineering</td>
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<tr>
<td>Special Topics in Chemical Engineering</td>
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<tr>
<td>Modelling in Chemical Engineering</td>
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<tr>
<td>Chemical Properties of Polymers</td>
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<tr>
<td>Aqueous Process Engineering and Biosolvents</td>
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<tr>
<td>Terrestrial Energy Systems</td>
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<tr>
<td>Water and Wastewater Treatment Processes</td>
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<tr>
<td>Building Science</td>
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<tr>
<td>Groundwater Flow and Contamination</td>
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<tr>
<td>Water Resources Engineering</td>
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<tr>
<td>Alternative Energy Systems</td>
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<tr>
<td>Combustion and Fuels</td>
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<tr>
<td>Introduction to Polymer Engineering</td>
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<tr>
<td>Biomaterial Processing and Properties</td>
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#### Winter Session - Year 4

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<tbody>
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<td>Petroleum Processing</td>
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<td>Bioprocess Engineering</td>
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<td>Special Topics in Chemical Engineering</td>
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<td>Water and Wastewater Treatment Processes</td>
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<td>Groundwater Flow and Contamination</td>
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<td>Combustion and Fuels</td>
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<td>Biomaterial Processing and Properties</td>
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### ENGINEERING MINOR ELIGIBLE COURSES

Students interested in pursuing an Engineering Minor (six courses) will find detailed information at the beginning of this chapter. By selecting courses that meet the requirements of both the Chemical Engineering Program and the respective minor, it is possible for a student to complete the minor during the normal course of study. If a student chooses to undertake a thesis within the area of an engineering minor, it may count for 2 of the six required credits. Students wishing to select engineering minor eligible courses that are not in the table of approved courses below, must take those courses as Extra courses for degree purposes.

<table>
<thead>
<tr>
<th>Bioengineering Minor</th>
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<th>Sustainable Energy Minor</th>
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<tr>
<td>CHE353H1</td>
<td>APS301H1</td>
<td>CIV300H1</td>
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<td>2nd Core Elective</td>
<td>CIV440H1 or CHE467H1</td>
<td>APS305H1 or ENV350H1</td>
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<td>Eligible Technical Elective</td>
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<td>CHE462H1</td>
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<td>CIV440H1</td>
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<td>CHE466H1</td>
<td>CHE466H1</td>
<td>CIV375H1</td>
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<td>CHE564H1</td>
<td>CHE564H1</td>
<td>CHE451H1</td>
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<td>CHE565H1</td>
<td>CHE467H1</td>
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<td>BME440H1 or BME340H1</td>
<td>CHE300H1</td>
<td>CHE469H1 or MIE517H1</td>
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<td>BME455H1</td>
<td>CIV342H1</td>
<td>CHE568H1</td>
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<td>CHM415H1</td>
<td>MIE516H1</td>
</tr>
<tr>
<td></td>
<td>MIE517H1</td>
<td>MIE515H1</td>
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</tbody>
</table>
GRADUATE PROGRAMS IN CHEMICAL ENGINEERING

The Department of Chemical Engineering and Applied Chemistry, provides exciting opportunities for students who would like to pursue advanced studies beyond the undergraduate level toward the M.Eng., M.A.Sc. or Ph.D. degrees. More than 20 graduate level courses toward the study requirement of the degree programs are offered by the Department. Financial support is provided to graduate students through research grants and/or fellowships, together with some undergraduate teaching in the laboratories. Undergraduate students interested in postgraduate programs are invited to discuss research activities and graduate studies in the Department with any member of staff at any stage of their undergraduate program. Further information may also be obtained from the Coordinator of Graduate Studies, Department of Chemical Engineering and Applied Chemistry, Room 212, Wallberg Building and from the Calendar of the School of Graduate Studies.
Civil Engineering

UNDERGRADUATE PROGRAM IN CIVIL ENGINEERING (AECIVBASC)

UNDERGRADUATE STUDENT COUNSELLORS:
Ms. Shayni Clarke
Room GB105, Galbraith Building, (416) 978-5905
E-mail: shayni@civ.utoronto.ca

Mr. Colin Anderson
Room GB105, Galbraith Building, (416) 978-0945
E-mail: colin@civ.utoronto.ca

Civil Engineering exists at the intersection of the human, built, and natural environments. Civil Engineers have historically been the professionals leading the design, construction, maintenance and eventual decommissioning of society's physical infrastructure, including: transportation networks, water supply and wastewater treatment systems, the structures for energy generation and distribution systems, buildings and other constructed works, land and water remediation, and more.

Although civil engineering is a highly technical profession, responsible engineering today also requires that engineers understand the impact of their decisions and their constructed works on society at large, including issues of environmental stewardship and life-cycle economic responsibility. For example, significant proportions of the world’s energy and raw materials production goes into the construction and operations of our buildings and transportation systems. Civil Engineers have a significant role to play in making these systems more sustainable for future generations. The undergraduate program is therefore designed to complement technical training with learning opportunities that address these challenges.

Students enhance their undergraduate experience through a number of enriched programs. The undergraduate courses have been deliberately sequenced so that students can take advantage of the Minors in Bioengineering, Environmental Engineering or Sustainable Energy; the Certificate Programs in Preventative Engineering and Social Development or in Entrepreneurship, Innovation and Small Business; co-op work opportunities through the Professional Experience Year Internship Program; and post-graduate academic opportunities through the Jeffrey Skoll BASc/MBA Program or through fast-tracked Master's degree programs.

FIRST YEAR CIVIL ENGINEERING

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<tr>
<td>Fall Session - Year 1</td>
<td>Engineering Strategies &amp; Practice I</td>
<td>APS111H1 F</td>
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<td>Mechanics</td>
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<tr>
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<td>Earth Systems Science</td>
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<tr>
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PERSONAL PROTECTIVE EQUIPMENT

Starting with CIV201H1 - Introduction to Civil Engineering, there will be many occasions where students are required to use personal protective equipment (PPE) including safety footwear bearing the CSA Green Patch, hard hats, protective eyewear with side shields, tear-away safety vests, and ear protection. Students are required to purchase their own PPE. All field trips, laboratories, and other events require advance briefing on the nature of the potential hazards and students are required to attend these briefings and to follow the provided instructions.

PRACTICAL EXPERIENCE REQUIREMENT

Students are required to have completed a total of 600 hours of acceptable practical experience before graduation (normally during their summer vacation periods). Satisfactory completion of CME358H1 - Survey CAMP (Civil and Mineral Practicals), will contribute 100 hours towards this requirement. Satisfactory completion of the Professional Experience Year (PEY) will also completely fulfill the Practical Experience Requirement.
SECOND YEAR CIVIL ENGINEERING

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Lect.</th>
<th>Lab.</th>
<th>Tut.</th>
<th>Wgt.</th>
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<tr>
<td>Technology in Society and the Biosphere I</td>
<td>3</td>
<td>-</td>
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<tr>
<td>Introduction to Civil Engineering</td>
<td>CIV201H1</td>
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<td>-</td>
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<tr>
<td>Urban Engineering Ecology</td>
<td>CIV220H1</td>
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<td>-</td>
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<tr>
<td>Management of Construction</td>
<td>CIV280H1</td>
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<tr>
<td>Engineering Communications I</td>
<td>CIV282H1</td>
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<td>-</td>
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<tr>
<td>Solid Mechanics I</td>
<td>CME210H1</td>
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<tr>
<td>Engineering Mathematics I</td>
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<td>3</td>
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<tr>
<td>Fluid Mechanics I</td>
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**Winter Session - Year 2**

<table>
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<tr>
<th>Course Description</th>
<th>Lect.</th>
<th>Lab.</th>
<th>Tut.</th>
<th>Wgt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Engineering Materials</td>
<td>CIV209H1</td>
<td>3</td>
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<tr>
<td>Structural Analysis I</td>
<td>CIV214H1</td>
<td>3</td>
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<tr>
<td>Civil Engineering Graphics</td>
<td>CIV235H1</td>
<td>2</td>
<td>2</td>
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<td>Hydraulics and Hydrology</td>
<td>CIV250H1</td>
<td>3</td>
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<tr>
<td>Probability Theory for Civil and Mining Engineers</td>
<td>CME263H1</td>
<td>3</td>
<td>-</td>
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</tbody>
</table>

CIV201H1 - Introduction to Civil Engineering, is a three-day field-based course. The course will be held immediately after Labour Day. Students are required to bring and wear their Personal Protective Equipment. The results of this course are used in computing the student's Second Year Fall Session average. An extra fee is charged to cover a transportation fee and accommodation.

Students are required to complete 4 half-courses of CS/HSS, at least two of which must be HSS, before graduation. The core course APS301H1 - Technology in Society and the Biosphere I, counts as one half-course towards this requirement. Note that valid HSS courses are more restrictive in scope than are CS courses. A list of pre-approved CS and HSS courses can be found on the Registrar's website.

Successful completion of APS302H1 - Technology and Society in the Biosphere II and APS304H1 - Preventive Engineering and Social Development, both HSS electives, will satisfy the requirements for the Certificate Program in Preventative Engineering and Social Development.

THIRD YEAR CIVIL ENGINEERING

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Lect.</th>
<th>Lab.</th>
<th>Tut.</th>
<th>Wgt.</th>
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</thead>
<tbody>
<tr>
<td>Steel and Timber Design</td>
<td>CIV312H1</td>
<td>3</td>
<td>-</td>
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<tr>
<td>Transport I - Introduction to Urban Transportation Systems</td>
<td>CIV331H1</td>
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<tr>
<td>Water and Wastewater Treatment Processes</td>
<td>CIV342H1</td>
<td>3</td>
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<tr>
<td>Building Science</td>
<td>CIV375H1</td>
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<tr>
<td>Civil Engineering</td>
<td>CIV382Y1</td>
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<tr>
<td>Geotechnical Engineering I</td>
<td>CME321H1</td>
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<tr>
<td>Survey CAMP (Civil and Mineral Practicals)</td>
<td>CME358H1</td>
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<tr>
<td>Engineering Economics and Decision Making</td>
<td>CME368H1</td>
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**Winter Session - Year 3**

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<tr>
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<th>Lab.</th>
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<tr>
<td>Reinforced Concrete I</td>
<td>CIV313H1</td>
<td>3</td>
<td>-</td>
<td>2 0.50</td>
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<tr>
<td>Geotechnical Engineering II</td>
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<tr>
<td>Transport II - Performance</td>
<td>CIV332H1</td>
<td>3</td>
<td>-</td>
<td>1 0.50</td>
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<tr>
<td>Municipal Engineering</td>
<td>CIV340H1</td>
<td>3</td>
<td>-</td>
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<tr>
<td>Sustainable Energy Systems</td>
<td>CIV380H1</td>
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<td>Civil Engineering</td>
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<tr>
<td>Engineering Mathematics II</td>
<td>CME362H1</td>
<td>3</td>
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CME358H1 - Survey CAMP (Civil and Mineral Practicals), is a two-week field-based course taken in the month prior to starting Third Year. The results of this course are used in computing the student's Third Year Fall Session Average. An extra fee is charged to cover part of the costs of food and accommodation.

PROFESSIONAL EXPERIENCE YEAR

Students registered in undergraduate programs within the Faculty of Applied Science and Engineering may elect to enrol and participate in the Professional Experience Year (PEY) Program. The PEY Program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a cooperating industry. Details are described at the beginning of this chapter. For more information, consult the PEY Office, 45 Willcocks Street 2nd Floor, early in session 2F or 3F.

JEFFREY SKOLL BASC/MBA PROGRAM

The Jeffrey Skoll Combined BASc/MBA Program allows qualified and selected students in the Faculty of Applied Science and Engineering to complete both a BASc and an MBA in a reduced time. Students will be admitted to the program prior to entering their fourth year of studies in the BASc program. Interested students should contact the Registrar's Office early in the Third Year to obtain important information including application deadlines.

MINORS AND CERTIFICATE PROGRAMS

Several Engineering Minors and Certificate Programs are available and generally require the student to successfully complete a carefully selected slate of electives in their Fourth Year. Late in the Third Year Winter Session, students use an on-line pre-registration tool to indicate their preferred fourth-year electives. Students should review the various minor and certificate program requirements and attend the department's information sessions in Third Year to ensure that the appropriate electives are taken in Fourth Year. Students should note that they can also complete the requirements of a minor or certificate program even after they have graduated, as long as the additional requirements are met within nine years of their initial registration in
the BASc program. If completed after graduation, additional fees will be assessed. A transcript will be issued with the amended courses and indication of completed minor or certificate program requirements.

FOURTH YEAR CIVIL ENGINEERING

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<td>Engineering Biology</td>
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<td>3</td>
<td>-</td>
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<tr>
<td>Terrestrial Energy Systems</td>
<td>CIV300H1</td>
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<td>-</td>
<td>2</td>
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<tr>
<td>Reinforced Concrete II</td>
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<td>Construction Engineering</td>
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<td>Concrete Technology</td>
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<td>Introduction to Structural Dynamics</td>
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<td>Rock Mechanics</td>
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<td>Transport Planning</td>
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<td>Groundwater Flow and Contamination</td>
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<td>Water Resources Engineering</td>
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<td>Engineering Biology</td>
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<td>CIV300H1</td>
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<td>-</td>
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<tr>
<td>Environmental Impact and Risk Assessment</td>
<td>CIV440H1</td>
<td>3</td>
<td>-</td>
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</tbody>
</table>

Students may take CIV499H1 - Individual Project in either the F term or the S term, but not in both terms.

OTHER ELECTIVE COURSES

Elective courses in addition to those listed above may be considered based on the following general guidelines. Students wishing to take elective courses from other departments need to ensure that they have the appropriate background and prerequisites. Students with an overall average of 75% or greater in their Third Year may take up to two graduate level (1000-series) courses, depending upon availability. Courses listed as being open only to students in Engineering Science may also be taken if the student has a sufficiently strong background. In all cases the interested student should consult with the Civil Engineering Office of Student Services (GB105) to obtain further information and the appropriate permission.

GRADUATE PROGRAM IN CIVIL ENGINEERING

Qualified candidates may apply for graduate studies in the MEng, MASc and PhD Programs. The MEng program is course-based (although a 1 or 2 course-equivalent project may be taken), whereas the MASc and PhD Programs are research-intensive and require a thesis. More information about the Department's Graduate Programs will be provided in information sessions, and can also be obtained at www.civ.utoronto.ca
Electrical and Computer Engineering

UNDERGRADUATE PROGRAM IN COMPUTER ENGINEERING (AECPEBASC)

UNDERGRADUATE STUDENT COUNSELLORS:
Professor S. Valaee, Associate Chair, Undergraduate Studies
Ms. Linda Espeut
Ms. Jayne Leake

STUDENT ADVISORS
Ms. Karen Irving
Ms. April Cheng

Email: askece@ecf.utoronto.ca
Office: Room B600, Sandford Fleming Building

The computer engineering undergraduate program is distinctive as it is based on the broad areas of Electrical Engineering and Computer Science. These foundations are used in the design and organization of computer systems, the design of programs that turn these systems into useful applications, and the use of computers in communication and control systems. The design includes hardware, as well as, operating systems and software. Computer engineering students will learn how computer systems work and how they can be integrated into larger systems that serve a wide range of users and businesses. As a result, the program also ensures that our students will gain experience in communication, problem-solving and team management skills.

A computer engineer may be involved in the design of computers and computer systems. They may also be engaged in the design of computer-based communications and control systems or in the design of microelectronic circuits, including computer-aided design and manufacturing. Computer system analysis and the design of both hardware and software for applications, such as artificial intelligence and expert systems, database systems, wireless networks, computer security and robotics, are included in the scope of the computer engineer’s work.

The first two years of study provide the essential background in basic science and mathematics, and also introduces the student to the important concepts in Electrical and Computer Engineering such as circuits, digital systems, electronics, and communication systems. These two years of study are identical to Electrical Engineering.

In third and fourth year, the curriculum allows flexibility in a student’s course selection, subject to program and accreditation requirements described below. A student has greater choice from a broad array of courses in six areas of study that would appeal to their individual strengths and interests. A number of streams or course packages called “Public/Built-In Profiles” have been developed by the department’s Curriculum Matters Committee (CMC) members to serve as course selection examples. These can be used as inspiration for a student to help develop more concrete decisions on their own. A student is also free to use one of the public profiles as their template. The example course packages can be found at: www.ece.utoronto.ca/Current_Undergraduate_Studies/program/Curriculum_Streams.htm. An on-line program called Magellan is available to facilitate the course selection process. All second year students will have access to Magellan by the end of their fall term. If at any time a student has questions about their curriculum decisions, contact information can be found at: www.ece.utoronto.ca/Current_Undergraduate_Studies/program/magellan.htm

Graduates of the program may decide to go directly into careers in a wide range of fields, and continue to learn by direct experience and through the opportunities of company-sponsored education. Students may also decide to pursue studies at the graduate level with studies in most areas of Electrical and Computer Engineering, or Computer Science. More detailed information can be found at: www.ece.utoronto.ca/Graduate_Studies.htm
## Curriculum and Programs

### FIRST YEAR COMPUTER ENGINEERING

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### THIRD AND FOURTH YEAR COMPUTER ENGINEERING

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## AREA 4 - CONTROL, COMMUNICATIONS & SIGNAL PROCESSING

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ECE Program Requirements

There are nine requirements:

1. **BREADTH REQUIREMENT**: A minimum of four kernel courses, each in a different area, must be chosen.

2. **DEPTH REQUIREMENT**: Select at least two areas from which one kernel course has been chosen. In each of these two areas, two additional technical courses must be chosen. Kernel courses may also be chosen to meet this requirement.

3. **ENGINEERING ECONOMICS REQUIREMENTS**: ECE472H1 must be chosen. Course can be taken in either third or fourth year.

4. **CAPSTONE REQUIREMENT**: The Design Project, ECE496Y1, must be taken in fourth year. To be eligible to register for the capstone course, you must have at least 7 technical electives or 6 technical electives plus ECE472H1.

5. **MATH/SCIENCE REQUIREMENT**: At least one course from the Math/Science area must be chosen.

6. **TECHNICAL ELECTIVE REQUIREMENT**: A minimum of three additional ECE technical courses must be chosen from any of the six areas of study. With approval from ECE, one of the technical electives can be taken from another department. Only 300, 400 and 500 level courses can be used as a technical elective.

7. **FREE ELECTIVE REQUIREMENT**: One is required, and may be technical or a non-technical course.

8. **COMPLEMENTARY STUDIES REQUIREMENT**: In each of terms 3F, 3S, 4F, and 4S, a complementary studies course must be taken. Of the four complementary studies courses, a minimum of two must be humanities and social science (HSS) courses chosen from an approved list on the Registrar’s website: [www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/Electives/HSS_Electives.htm](www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/Electives/HSS_Electives.htm)

9. **PRACTICAL EXPERIENCE REQUIREMENT**: Students are required to have completed a total of 600 hours of acceptable practical experience before graduation (normally during their summer vacation periods). Students registered within this program, may elect to enrol and participate in the Professional Experience Year (PEY) program. The PEY program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a participating company. Details are described at the beginning of this chapter. For more information, consult the PEY Office early in session 2F or 3F.

A sample course selection arrangement for third and fourth year is shown in the table below.

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<th>Area Kernel</th>
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**Degree Designation**

If, among the eight courses required to satisfy the Breadth requirement (1) and the Depth requirement (2), at least four are selected from Areas 5 and 6, then the student is eligible for the B.A.Sc. degree in Computer Engineering. If, among these eight courses, at least five are selected from Areas 1 to 4, then the student is eligible for the B.A.Sc. degree in Electrical Engineering. By appropriate choice of kernel courses as technical or free electives, it may be possible to satisfy these requirements simultaneously; in this case, the student must choose one of the two designations.

In addition to the above program requirements, all CEAB requirements, including the minimum number of accreditation units (AU's) in the various CEAB categories, must be met in order to graduate.
CEAB Requirements

To satisfy CEAB requirements, students must accumulate, during four years of study, a minimum number of academic units in six categories: complementary studies, mathematics, basic science, engineering science, engineering design, combined engineering science and design. For details on how to verify satisfaction of CEAB requirements, students are referred to the ECE Undergraduate website:
www.ece.utoronto.ca/Current_Undergraduate_Studies/program/magellan.htm.

It is recognized that the course selection process can be complex in the flexible curriculum for third and fourth year. Students are advised to consult the ECE Undergraduate Office on questions related to course selection. In addition, tools will be provided to assist students to ensure satisfaction of all requirements in their course selection. For complete details, students are referred to the ECE Department Undergraduate Studies office at askece@ecf.utoronto.ca.

A student who selects a course of study that does not meet ECE and CEAB requirements will not be eligible to graduate.

Graduate Programs in Computer Engineering

Graduate study and research in Computer Engineering may be pursued in either the Department of Electrical and Computer Engineering or the Department of Computer Science. Both theoretical and applied topics are encouraged. Programs lead to the M.Eng. or M.A.Sc. degree in Engineering or the M.Sc. in Computer Science, and to the Ph.D. in either Department. Prospective graduate studies should consult the Departments early to determine the most appropriate Department in which to register.

UNDERGRADUATE PROGRAM IN ELECTRICAL ENGINEERING (AEELEBASC)

UNDERGRADUATE STUDENT COUNSELLORS:
Professor S. Valaee, Associate Chair, Undergraduate Studies
Ms. Linda Espeut
Ms. Jayne Leake

STUDENT ADVISORS:
Ms. Karen Irving
Ms. April Cheng

Email: askece@ecf.utoronto.ca
Office: Room B600, Sandford Fleming Building

Electrical engineering is an exciting and extensive field that applies the principles of science and mathematics with engineering fundamentals which are then used to develop a student's skills needed to analyze, design and build electrical, electronic and photonics systems. The program includes diverse areas of study such as microelectronics, digital communications, wireless systems, photonics systems, signal processing, control, microprocessors, computer technology, energy systems and electronic device fabrication. This breadth is unique to Electrical Engineering and opens a wide range of career possibilities. As a result, the program also ensures that through their course work, a student gains experience in communication, problem-solving and team management skills.

An electrical engineer may be involved in the design, development and testing of electrical and electronic equipment such as telecommunication systems, industrial process controls, signal processing, navigation systems, power generation, transmission systems, wireless and optical communications and integrated circuit engineering.

The first two years of study provide the essential background in basic science and mathematics and also introduces the student to the important concepts in Electrical and Computer Engineering such as circuits, digital systems, electronics, and communication systems. These two years of study are identical to Computer Engineering.

In third and fourth year, the curriculum allows flexibility in a student’s course selection, subject to program and accreditation requirements described below. A student has greater choice from a broad array of courses in six areas of study that would appeal to their individual strengths and interests. A number of streams or course packages called “Public/Built-In Profiles” have been developed by the department's Curriculum Matters Committee (CMC) members to serve as course selection examples. These can be used as inspiration for a student to help develop more concrete decisions on their own. A student is also free to use one of the public profiles as their template, the example course packages can be found at:
www.ece.utoronto.ca/Current_Undergraduate_Studies/program/Curriculum_Streams.htm. An on-line program called Magellan is available to facilitate the course selection process. All second year students will have access to Magellan by the end of their fall term. If at any time a student has questions about their curriculum decisions, contact information can be found at:
www.ece.utoronto.ca/Current_Undergraduate_Studies/program/magellan.htm

Graduates of the program may decide to go directly into careers in a wide range of fields and continue to learn by direct experience and through the opportunities of company-sponsored education. Students may also decide to pursue studies at the graduate level and can find more detailed information at: www.ece.utoronto.ca/Graduate_Studies.htm
### FIRST YEAR ELECTRICAL ENGINEERING

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### SECOND YEAR ELECTRICAL ENGINEERING

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### THIRD AND FOURTH YEAR ELECTRICAL ENGINEERING

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<th>Lect.</th>
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<td>Operating Systems</td>
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<td>Structures</td>
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<td>Introduction to Databases</td>
<td>CSC343H1</td>
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<td>CSC418H1</td>
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<td>Distributed Systems</td>
<td>ECE419H1</td>
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<td>Computer Security</td>
<td>ECE568H1</td>
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ECE Program Requirements

There are nine requirements:

1. **BREADTH REQUIREMENT**: A minimum of four kernel courses, each in a different area, must be chosen.

2. **DEPTH REQUIREMENT**: Select at least two areas from which one kernel course has been chosen. In each of these two areas, two additional technical courses must be chosen. Kernel courses may also be chosen to meet this requirement.

3. **ENGINEERING ECONOMICS REQUIREMENTS**: ECE472H1 must be chosen. Course can be taken in either third or fourth year.

4. **CAPSTONE REQUIREMENT**: The Design Project, ECE496Y1, must be taken in fourth year. To be eligible to register for the capstone course, you must have at least 7 technical electives or 6 technical electives plus ECE472H1.

5. **MATH/SCIENCE REQUIREMENT**: At least one course from the Math/Science area must be chosen.

6. **TECHNICAL ELECTIVE REQUIREMENT**: A minimum of three additional ECE technical courses must be chosen from any of the six areas of study. With approval from ECE, one of the technical electives can be taken from another department. Only 300, 400 and 500 level courses can be used as a technical elective.

7. **FREE ELECTIVE REQUIREMENT**: One is required, and may be a technical or a non-technical course.

8. **COMPLEMENTARY STUDIES REQUIREMENT**: In each of terms 3F, 3S, 4F, and 4S, a complementary studies course must be taken. Of the four complementary studies courses, a minimum of two must be humanities and social science (HSS) courses chosen from an approved list on the Registrar’s website: www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/Electives/HSS_Electives.htm

9. **PRACTICAL EXPERIENCE REQUIREMENT**: Students are required to have completed a total of 600 hours of acceptable practical experience before graduation (normally during their summer vacation periods). Students registered within this program, may elect to enrol and participate in the Professional Experience Year (PEY) program. The PEY program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a participating company. Details are described at the beginning of this chapter. For more information, consult the PEY Office early in session 2F or 3F.

A sample course selection arrangement for third and fourth year is shown in the table below.

<table>
<thead>
<tr>
<th>3F</th>
<th>Technical Elective</th>
<th>Other Science/Math</th>
<th>Area Kernel</th>
<th>Area Kernel</th>
<th>Complementary Studies</th>
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<tbody>
<tr>
<td>3S</td>
<td>Engineering Economics</td>
<td>Depth</td>
<td>Area Kernel</td>
<td>Area Kernel</td>
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<td>4F</td>
<td>Technical Elective</td>
<td>Depth</td>
<td>Depth</td>
<td>4th Year Design Project</td>
<td>Humanities &amp; Social Science</td>
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<tr>
<td>4S</td>
<td>Free Elective</td>
<td>Technical Elective</td>
<td>Depth</td>
<td>4th Year Design Project</td>
<td>Humanities &amp; Social Science</td>
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</tbody>
</table>

Degree Designation

If, among the eight courses required to satisfy the Breadth requirement (1) and the Depth requirement (2), at least four are selected from Areas 5 and 6, then the student is eligible for the B.A.Sc. degree in Computer Engineering. If, among these eight courses, at least five are selected from Areas 1 to 4, then the student is eligible for the B.A.Sc. degree in Electrical Engineering. By appropriate choice of kernel courses as technical or free electives, it may be possible to satisfy these requirements simultaneously; in this case, the student must choose one of the two designations.
CEAB Requirements

To satisfy CEAB requirements, students must accumulate, during four years of study, a minimum number of academic units in six categories: complementary studies, mathematics, basic science, engineering science, engineering design, combined engineering science and design. For details on how to verify satisfaction of CEAB requirements, students are referred to the ECE Undergraduate website: www.ece.utoronto.ca/Current_Undergraduate_Studies/program/magellan.htm.

It is recognized that the course selection process can be complex in the flexible curriculum for third and fourth year. Students are advised to consult the ECE Undergraduate Office on questions related to course selection. In addition, tools will be provided to assist students to ensure satisfaction of all requirements in their course selection. For complete details, students are referred to the ECE Department Undergraduate Studies office at askece@ecf.utoronto.ca.

A student who selects a course of study that does not meet ECE and CEAB requirements will not be eligible to graduate.

Graduate Programs in Electrical Engineering

Graduate study and research in Electrical Engineering may be pursued in either the Department of Electrical and Computer Engineering or the Department of Computer Science. Both theoretical and applied topics are encouraged. Programs lead to the M.Eng. or M.A.Sc. degree in Engineering or the M.Sc. in Computer Science, and to the Ph.D. in either Department. Prospective graduate studies should consult the Departments early to determine the most appropriate Department in which to register.
Engineering Science

UNDERGRADUATE PROGRAM IN ENGINEERING SCIENCE (AEESCBASE)

CHAIR:
Professor Mark Kortschot, Ph.D., P.Eng.
Room 2110, Bahen Centre, 416-978-2903
Email: chair.engsci@ecf.utoronto.ca

UNDERGRADUATE STUDENT COUNSELLORS:
Hana Lee (Years 1 and 2)
Room 2110, Bahen Centre, 416-946-7351
Email: nsci1_2@ecf.utoronto.ca

Anne Marie Kwan (Years 3 and 4)
Room 2110, Bahen Centre, 416-946-7352
Email: nsci3_4@ecf.utoronto.ca

Engineering Science is an enriched program that provides excellent preparation for postgraduate studies in engineering and science as well as for other professional degree programs such as business, law and medicine. Graduates of the program are also well qualified to immediately embark on professional engineering-related careers.

The Engineering Science program shares elements of the Faculty’s Engineering programs, but is distinct in many respects, with the key differences being:
- The Engineering Science program is designed and delivered at a level that is more academically demanding;
- The Engineering Science program contains more mathematics, science and engineering science, with greater focus on deriving results using a first principles approach;
- The Engineering Science program has a distinct “2+2” curriculum structure, namely a 2-year foundation curriculum followed by a 2-year specialization curriculum in a diverse range of fields, many of which are unique to the Engineering Science program; and
- The Engineering Science program requires that all students complete an independent research-based thesis project.

Engineering Science students in years 1, 2 and 3 are required to maintain a full course load, unless they gain permission from their academic counsellor in the Division of Engineering Science to pursue part time studies or less than a normal/full course load due to medical or personal reasons. Students entering year 4 are expected to maintain a full course load, but students with medical or personal reasons or who have completed program requirements through summer school or while on PEY may go part time or less than a full course load in 4F and/or 4W. This is subject to the approval of their academic counsellor. Please note that a reduced course load in 4F or 4W may impact award assessments. Please refer to the academic calendar under “Academic Regulations VII: Academic Standing” for Honours Standing criteria related to course load, and consult with your academic counsellor for more information.

Transfers in Year 1 from Engineering Science to one of the Faculty’s Engineering programs are permitted early in the Fall Session (towards the end of September), at the end of the Fall Session, and at the end of the Winter Session. Continuation into the Winter Session of Year 1 requires a minimum average of 55% in the Fall Session and continuation into Year 2 requires a minimum average of 65% in the Winter Session of Year 1. Students who do not meet these requirements are permitted to transfer into one of the Faculty’s Engineering programs, subject to the requirements and provisions outlined in the section on Academic Regulations in this Calendar.

THE ENGINEERING SCIENCE CURRICULUM
The first two years of the curriculum focus on the foundations of both engineering and science. The courses in the first two years of the program are common for all students and are only offered to students in the program. At the end of Second Year, each student selects one of the following Options to pursue in their final two years. This represents their major field of specialization:
- Aerospace Engineering
- Biomedical Systems Engineering (formerly Biomedical Engineering)
- Electrical and Computer Engineering
- Energy Systems Engineering
- Engineering Mathematics, Statistics & Finance
- Infrastructure Engineering
- Nanoengineering
- Engineering Physics

The curriculum for the first two years and the curricula for the eight Options are presented on the pages that follow.

Degree Designation
Engineering Science students graduate with the degree “Bachelor of Applied Science in Engineering Science”. On their official transcript, their chosen Option is indicated as their Major, e.g. Major in Aerospace Engineering.
Degree Requirements
In order to graduate, students must meet all of the degree requirements outlined in the section on Academic Regulations in this Calendar. In addition to these requirements, students must also successfully complete their chosen Program of Study in Engineering Science as described on the following pages of this Calendar, as well as the curriculum requirements of the Canadian Engineering Accreditation Board (CEAB).
To complete their chosen Program of Study, students are responsible for ensuring that they have taken all of the required courses and the correct number of technical electives for their Option. Requests for elective course substitutions will be considered but must be approved in advance by the Division of Engineering Science through their counsellor. This also applies to any course listed as ‘Other Technical Elective’. Students must also meet the Complementary Studies (CS) requirements of the program. This includes 2.0 credits, of which 1.0 credit must be in Humanities and Social Sciences (HSS). More information on CS and HSS electives may be found in the Curriculum & Programs section of this Calendar.
To satisfy the CEAB requirements, students must accumulate during their program of study a minimum total number of accreditation units (AU) as well as a minimum number of AU in six categories: complementary studies, mathematics, natural science, engineering science, engineering design, and combined engineering science and design. The Division of Engineering Science provides students with a planning tool called the AU Tracker to help students ensure that they satisfy these requirements. The AU Tracker, which lists all successfully completed courses as well as all of the courses they are enrolled in for the current academic year, confirms whether students are on track to meet or exceed the CEAB requirements.
If a student is deficient in terms of the Program of Study or falls short in any of the CEAB categories, the student must adjust their course selection accordingly in order to graduate.

YEAR 1 CURRICULUM- ENGINEERING SCIENCE

--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
Structures and Materials - An Introduction to Engineering Design | CIV102H1 F | 3 | 1 | 1 | 0.50 | Fundamentals of Electric Circuits | ECE159H1 S | 3 | 1.50 | 1 | 0.50
Praxis I | ESC101H1 F | 3 | - | 2 | 0.50 | Praxis II | ESC102H1 S | 3 | - | 2 | 0.50
Engineering Mathematics and Computation | ESC103H1 F | 2 | - | 2 | 0.50 | Linear Algebra | MAT185H1 S | 3 | - | 1 | 0.50
Calculus I | MAT194H1 F | 3 | - | 1 | 0.50 | Calculus II | MAT195H1 S | 3 | - | 1 | 0.50
and one of: | | | | | | Molecules and Materials | MSE160H1 S | 3 | - | 1 | 0.50
Classical Mechanics | PHY180H1 F | 3 | 1.50 | 1 | 0.50 | and one of: | Computer Algorithms and Data Structures | CSC190H1 S | 3 | - | 0.50
and one of: | Computer Programming | CSC180H1 F | 3 | 3 | - | 0.50 | | Free Elective | 0.50
Computer Programming, Algorithms, Data Structures and Languages | CSC192H1 F | 3 | 3 | - | 0.50 | |

1. Students choosing to take CSC180H1 are required to take CSC190H1 in the Winter Session.
2. Free elective is only available to students who have taken CSC192H1.

YEAR 2 CURRICULUM - ENGINEERING SCIENCE

--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
Vector Calculus & Fluid Mechanics | AER210H1 F | 3 | 0.50 | 2 | 0.50 | Engineering Design | AER201H1 S | 1 | 5 | - | 0.50
Thermodynamics and Heat Transfer | CHE260H1 F | 3 | 0.50 | 1 | 0.50 | Electromagnetism | ECE259H1 S | 3 | - | 1 | 0.50
Digital and Computer Systems | ECE253H1 F | 3 | 3 | - | 0.50 | Quantum and Thermal Physics | PHY294H1 S | 3 | 1.25 | 1 | 0.50
Engineering, Society & Critical Thinking | ESC203H1 F | 3 | - | 1 | 0.50 | Probability and Statistics | STA286H1 S | 3 | - | 1 | 0.50
Calculus III | MAT292H1 F | 3 | - | 2 | 0.50 | Complementary Studies | 0.50
Waves and Modern Physics | PHY293H1 F | 3 | 1 | 1 | 0.50 | Elective | |

1. All students must graduate with 1.0 credit in Humanities & Social Sciences (HSS). Students will gain 0.5 HSS credit from ESC203H1.
2. Please note that additional lectures may be scheduled for AER201H1 in place of laboratory time in the first few weeks of the Winter Session.

PROFESSIONAL EXPERIENCE YEAR

Students registered within this program, and all other undergraduate programs within the Faculty of Applied Science and Engineering, may elect to enrol and participate in the Professional Experience Year (PEY) program. The PEY program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a cooperating industry. Details are described in the beginning of this calendar. For more information, consult the Professional Experience Year Office, 45 Willcocks Street 2nd Floor, early in session 2F or 3F.
## Curriculum and Programs

### OPTION AEROSPACE ENGINEERING (AEESCBASEA)

### YEAR 3 AEROSPACE ENGINEERING

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<tr>
<td>Dynamics</td>
<td>AER301H1 F</td>
<td>3</td>
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<td>AER302H1 S</td>
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<td>3</td>
<td>-</td>
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<td>AER336H1 S</td>
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<td>-</td>
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<td>3</td>
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<td>AER373H1 S</td>
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### FALL SESSION - YEAR 3

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<td>Partial Differential Equations</td>
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<td>Spacecraft Dynamics and Control</td>
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<td>Introduction to Fusion Energy</td>
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<td>Robotics</td>
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<td>ECE557H1 F</td>
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### Winter Session - Year 3

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### Winter Session - Year 4

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<td>Aerospace Propulsion</td>
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1. Students must take a half-year thesis in 4F or 4S, or take a full-year thesis.
2. Students must take at least two of AER503H1, AER506H1, AER510H1 or AER525H1.
OPTION BIOMEDICAL ENGINEERING (AEESCBASEB)

YEAR 4 BIOMEDICAL ENGINEERING

Fall Session - Year 4

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<tr>
<td>Biochemistry I: Proteins, Lipids and Metabolism</td>
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Winter Session - Year 4

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1. Students who have completed Year 3 of the Biomedical Engineering Option should follow the Year 4 of the Biomedical Engineering Option.
2. Students must take at least two of the courses: BME396H1, MSE352H1, MIE439H1, BME595H1 and at least one, but no more than two of BCH210H1, PSL300H1, HMB265H1, PCL201H1 and HMB200H1.
3. HMB200H1 has limited enrolment and is first offered to human biology students. Enrolment information will be communicated to students by early August.
4. Students must take at least one of MIE439H1 or ESC471H1.

OPTION BIOMEDICAL SYSTEMS ENGINEERING (AEESCBASET)

YEAR 3 BIOMEDICAL SYSTEMS ENGINEERING

Fall Session - Year 3

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2. CHE374H1: Students may also take this course in 4F but are recommended to take in 3F.
YEAR 4 ELECTRICAL AND COMPUTER ENGINEERING

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and one of:
- Digital Systems Design: ECE532H1 S 2 3 - 0.50
- Energy Systems Capstone Design: ESC470H1 S - - 5 0.50
- Electrical and Computer Capstone Design: ESC472H1 S - - 5 0.50

1. While a full-year thesis is recommended, students may substitute with a half-year thesis and an ECE or Technical elective.
2. ECE electives or Technical electives can be taken in Year 3 or Year 4 provided that course pre-requisites have been met. Contact the Division of Engineering Science for clarification of course pre-requisites.

**ECE Electives**

**Photonic Electives**

- Fundamentals of Optics: ECE318H1 S 3 3 1 0.50
- Semiconductor Electronic Devices: ECE350H1 S 3 1.50 1 0.50
- Introduction to Micro- and Nano-Fabrication Technologies: ECE442H1 F 3 4 1 0.50
- Optical Communications and Networks: ECE469H1 S 3 3 1 0.50
- Lasers and Detectors: ECE525H1 S 3 - 1 0.50
- Photonic Devices: ECE527H1 F 2 - 1 0.50
- Quantum Mechanics I: PHY356H1 F 2 - 1 0.50
- Quantum Mechanics II: PHY456H1 F 2 - 1 0.50
- Condensed Matter Physics: PHY487H1 F 2 - - 0.50

**ECE Electives**

- Electromagnetic Fields: ECE357H1 S 3 1.50 1 0.50
- Energy Systems and Distributed Generation Radio and Microwave: ECE422H1 S 3 3 1 0.50
- Electric Drives: ECE463H1 F 2 - 1 0.50
- Introduction to Lighting Systems: ECE510H1 F 2 - 1 0.50
- Microwave Circuits: ECE524H1 F 2 - 1 0.50
- Advanced Power Electronics: ECE533H1 F 3 - 1 0.50

**Computer Hardware and Computer Networks**

- Computer Networks I: ECE361H1 F/S 3 3 1 0.50
- Internetworking: ECE461H1 F 3 3 1 0.50
- Computer Networks II: ECE466H1 S 3 3 1 0.50
- Computer Architecture: ECE552H1 F 3 - 1 0.50

**ECE Electives**

- Systems Control: ECE557H1 F 3 1.50 1 0.50
- Digital Communication: ECE417H1 S 3 3 1 0.50
- Neural Bioelectricity: ECE445H1 F 3 3 1 0.50
- Sensory Communication: ECE446H1 F 3 - 1 0.50
- Multimedia Systems: ECE462H1 S 3 2 - 0.50
- Wireless Communication: ECE464H1 S 3 3 1 0.50
- Robot Modeling and Control: ECE470H1 S 3 3 1 0.50
- Intelligent Image Processing: ECE516H1 S 2 3 - 0.50
- Inference Algorithms: ECE521H1 S 3 - 2 0.50
- Random Processes: ECE537H1 F 3 - 2 0.50
- Communication Systems: ECE316H1 F/S 3 3 1 0.50
- Medical Imaging: BME595H1 S 2 3 1 0.50
- Signal Processing: ECE442H1 F 3 4 1 0.50
- Real-Time Computer Control: ECE411H1 S 3 - 1 0.50
- Digital Communication: ECE417H1 S 3 3 1 0.50
- Neural Bioelectricity: ECE445H1 F 3 3 1 0.50
- Sensory Communication: ECE446H1 F 3 - 1 0.50
- Multimedia Systems: ECE462H1 S 3 2 - 0.50
- Wireless Communication: ECE464H1 S 3 3 1 0.50
- Robot Modeling and Control: ECE470H1 S 3 3 1 0.50
- Intelligent Image Processing: ECE516H1 S 2 3 - 0.50
- Inference Algorithms: ECE521H1 S 3 - 2 0.50
- Random Processes: ECE537H1 F 3 - 2 0.50

**ECE Electives**

- Digital Electronics: ECE334H1 F/S 3 3 1 0.50
- Semiconductor Electronic Devices: ECE350H1 S 3 1.50 1 0.50
- Electronic Circuits: ECE354H1 S 3 1.50 0.50
- VLSI Systems and Design: ECE451H1 S 3 3 - 0.50
- Analog Signal Processing Circuits: ECE512H1 F 3 2 0.50
- Analog Integrated Circuits: ECE530H1 S 2 3 1 0.50
- Integrated Circuit Engineering: ECE534H1 F 2 3 - 0.50
- Advanced Electronic Devices: ECE535H1 F 2 - - 0.50

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## ECE Electives

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## OPTION ENERGY SYSTEMS ENGINEERING (AEESCBASEJ)

### YEAR 3 ENERGY SYSTEMS ENGINEERING

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### YEAR 4 ENERGY SYSTEMS ENGINEERING

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1. APS305H1, a core course within the Energy curriculum, counts towards the Complementary Studies requirement.

### OPTION ENGINEERING MATHEMATICS, STATISTICS & FINANCE (AEESCBASEF)

**Year 3 ENGINEERING MATHEMATICS, STATISTICS & FINANCE**

**Fall Session - Year 3**

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**Year 4 ENGINEERING MATHEMATICS, STATISTICS & FINANCE**

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### Domain Courses

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1. Students may take a half-year thesis and an additional 0.5 credit from the electives list instead of a full-year thesis.

OPTION INFRASTRUCTURE ENGINEERING (AEESCBASEI)

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YEAR 4 INFRASTRUCTURE ENGINEERING

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Take any three from the following:

- Transportation and Infrastructure Systems
- Sustainable Energy Systems
- Infrastructure for Sustainable Cities
- Infrastructure Economics
- Simulation
- Freight Transportation and ITS Applications
- Airport Planning
- Transportation and Development
- Transportation Demand Analysis

Take any one from the following:

- Transportation Technology in Society and the Biosphere I
- Management of Construction
- Travel Survey Methods
- Alternative Energy Systems

Structures Speciality

- Reinforced Concrete II
- Concrete Technology
- Introduction to Structural Dynamics
- Prestressed Concretes
- Studies in Building Science
- Mechanics of Reinforced Concrete

Winter Session - Year 4

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Structures Speciality

- Solid Mechanics II
- Behaviour and Design of Steel Structures
- Geotechnical Design
- Sustainable Buildings
- Bridge Engineering
- Principles of Earthquake Engineering and Seismic Design
- Finite Element Methods in Structural Mechanics

1. Students who do not wish to specialize may take courses from either the Transportation or Structures List.
2. Students wanting to take a full-year thesis are only required to take three specialty electives.
3. CIV1508H1, CIV1337H1, CIV1535H1 and CIV1538H1 are offered every other year. Please contact the Division of Engineering Science for more information on the scheduling of these courses.
4. The technical elective may be freely chosen from any 400 or 500 level course offered in Engineering provided students have taken the pre-requisite course. Other non-Engineering courses may be taken with the approval of the Division of Engineering Science. There are also 1000 level courses offered by the Department of Civil Engineering and available to Engineering Science students. Consult the Department of Civil Engineering website for a description of 1000 level CIV courses.
## YEAR 3 NANOENGINEERING

### Fall Session - Year 3

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**Curriculum and Programs**

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OPTION ENGINEERING PHYSICS (AEESCBASEP)

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At least one of:
- Partial Differential Equations | APM384H1 F | 3 | - | 1 | 0.50 |
- Complex Analysis | MAT389H1 F | 3 | - | 1 | 0.50 |

1. It is highly recommended that students take one of ECE342H1, ECE350H1, ECE362H1, MSE358H1 or CHE568H1 to reduce accreditation constraints in Year 4.
2. Students who take 3 Group A electives in the Winter Session must complete 1 Group A elective in the Fall Session. Students must obtain a total of 5.6 credits in Year 3.
3. Students must take PHY427H1 in 3S, 4F, or 4S.
4. Students may take APM346H1 in place of APM384H1.
5. Students may take MAT334H1 in place of MAT389H1.
6. Students may take CHE374H1 in 4F.

YEAR 4 ENGINEERING PHYSICS

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| Two (2) Complementary Studies electives | | | | | | | | | 1.00

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Materials Science and Engineering

UNDERGRADUATE PROGRAM IN MATERIALS ENGINEERING (AEMMSBASC)

UNDERGRADUATE STUDENT COUNSELLOR:
Ms Maria Fryman
Room 140, Wallberg Building 416-978-1374
Email: maria.fryman@utoronto.ca

The goal of the materials engineering undergraduate curriculum is to provide an understanding of the underlying principles of synthesis, characterization and processing of materials and of the interrelationships among structure, properties, and processing. The program prepares students for professional careers in a wide variety of industries, as well as for advanced study in this field. It also provides students with the opportunity to broaden their education in engineering and science or to expand their knowledge in a particular technical area by offering course foundations in four core areas: nanomaterials, materials in manufacturing, biomaterials, materials processing and sustainable development.

The first year of the program establishes basic fundamentals in math, chemistry, and physics with an introduction to design, communications, and societal issues in Engineering. In the second year, the students are introduced to the structural and analytical characterization of materials, electrical and quantum mechanical properties of matter, thermodynamics, fundamentals and processing of organic and inorganic materials, engineering statistics and materials selection in design. The third year is devoted to a series of introductory courses in the four theme areas. Other courses include heat and mass transfer, phase transformations, process design, mechanical behaviour and environmental degradation of materials. The fourth year focuses on in-depth study of the selected theme areas plus an additional materials selection in design course. The fourth year also culminates in a senior design course in which the students integrate the knowledge obtained during their prior studies. The technical aspects of the curriculum are complemented by communication, humanities and social sciences courses and by material on leadership, ethics, team building and environmental responsibility that are distributed throughout the curriculum.

For those students interested in pursuing an Engineering Minor, please read the detailed information provided at the beginning of this chapter. By selecting courses which meet both MSE requirements and the requirements of the respective Minor, it is possible for a student to complete a Minor during the normal course of study.

For those students interested in pursuing the Jeffrey Skoll BASc/MBA (SKOLL) Program, please read the detailed information provided at the beginning of this chapter.

FIRST YEAR MATERIALS ENGINEERING

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SECOND YEAR MATERIALS ENGINEERING

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Practical Experience Requirement - As described in the beginning pages of this chapter, students are required to have completed a total of 600 hours of acceptable practical experience, before graduation, (normally acquired during their summer vacation periods).
ENGINEERING SUMMER INTERNSHIP PROGRAM (eSIP) PROGRAM

The Engineering Summer Internship Program (eSIP) is a paid 4-month summer co-op program available to 2nd & 3rd year engineering students. The value of the eSIP program is that it acts as an introductory career development program, particularly for the 2nd year students that make up the majority of applicants. Students are introduced to concepts and tools to prepare them for the workplace and understand the dynamics therein. This is critical as the knowledge gained from the eSIP 4-month placement makes them competitive and further applied in their participation in the PEY 12-16month Program after their 3rd year of study.

For more information, consult the Engineering Career Centre, 45 Willcocks Street 2nd Floor, early in session 2F or 3F.

PROFESSIONAL EXPERIENCE YEAR

Students registered within this program, and all other undergraduate programs within the Faculty of Applied Science and Engineering, may elect to enrol and participate in the Professional Experience Year (PEY) program. The PEY program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a cooperating industry. Details are described in the beginning of this chapter. For more information, consult the Professional Experience Year Office, 45 Willcocks Street 2nd Floor, early in session 2F or 3F.

THIRD YEAR MATERIALS ENGINEERING

HSS/CS Requirement - In order to fulfill degree and Canadian Engineering Accreditation Board (CEAB) requirements, each student must take a total of 4 half year (or 2 full year) Complementary Studies (CS) Electives. Two of those CS electives must be Humanities/Social Sciences (HSS) courses. In MSE, these courses are taken in 2nd and 3rd years. (Note: Students may choose to take technical electives in 3rd year instead; and, then take their HSS/CS courses in 4th year.) Since students are responsible for ensuring that each HSS/CS elective taken is an approved course, be sure to consult the electives list on the APSC Registrar’s website.

Canadian Engineering Accreditation Board (CEAB) Requirements

In order to complete the MSE Program of Study, students are responsible for ensuring that they have taken all the required core courses, the correct number of Technical Electives (in accordance with Theme requirements), HSS/CS electives (total 1.0 credit of each) and a Free Elective.

To satisfy the CEAB requirements, students must accumulate, during their studies, a minimum total number of “accreditation units” (AUs) as well as a minimum number of AUs in six specific categories: complementary studies, mathematics, natural science, engineering science, engineering design, and combined engineering science & design. MSE can now provide students with a planning tool, the “AU Tracker”, to help ensure that all requirements are met. Using the AU Tracker, a student can list all successfully completed courses, as well as all the courses enrolled in for the current academic year. The Tracker confirms whether or not students are on track to meet or exceed the CEAB requirements.

FOURTH YEAR MATERIALS ENGINEERING

4th Year Themes and Technical Electives

The 5 required Technical Electives selected must include courses from at least 2 of the themes listed below. Note that, of the 5 courses, at least 2 of those courses must be selected from a single theme. A minimum of 3 must be chosen from the MSE themes.

A maximum of 2 Technical Electives may be chosen from other Engineering departments, with the prior approval of the MSE Associate Chair, Undergraduate Studies. Note that all courses may not be offered every year.
Biomaterials Theme:

<table>
<thead>
<tr>
<th>Course Title</th>
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<td>CHE562H1 F</td>
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Materials for Manufacturing Theme:

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<td>CHE543H1 S</td>
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Materials Processing for Sustainable Development Theme:

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Nanomaterials Theme:

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GRADUATE PROGRAMS IN MATERIALS SCIENCE AND ENGINEERING

The Graduate Department of Materials Science and Engineering offers M.Eng., M.A.Sc., or Ph.D. degrees in extractive and physical metallurgy, materials science, nanomaterials, electronic and photonic materials and biomaterials. Detailed information on admission is available from the Undergraduate/Graduate Counsellor.

The research equipment includes modern facilities for optical, electron and X-ray microscopy, mechanical testing, particle characterization, the production of high temperatures and controlled atmospheres, calorimetric and other thermodynamic measurements at high temperatures, crystal growth, etc.

Research interests in the Department include process development, computer-aided materials engineering, physical chemistry of metal extraction, mineral processing, hydrometallurgy, electrometallurgy, powder metallurgy, solidification and crystal growth, welding, structure and mechanical properties of metallic, ceramic and composite materials, high strength polymers, nuclear materials, electronic and photonic materials, nanostructured materials and synthesis and design of biomaterials.
Mechanical and Industrial Engineering

INDUSTRIAL ENGINEERING (AEINDBASC)

(Offered by the Department of Mechanical and Industrial Engineering. For a listing of Academic Staff in the Department, please refer to Chapter 1).

UNDERGRADUATE STUDENT COUNSELLOR:
Ms. Carla Baptista
Room MC109, Mechanical Engineering Building
416-978-6420

Industrial Engineering (IE) is a discipline that applies engineering principles to the design and operation of organizations. Industrial Engineering students learn to analyze, design, implement, control, evaluate, and improve the performance of complex organizations, taking into consideration people, technology, and information systems. Industrial engineers use operations research, information engineering, and human factors tools and methods to improve and optimize systems operations and performance.

Industrial engineers share the common goal of increasing an organization’s efficiency, profitability and safety in a variety of industries including health care, finance, retail, entertainment, government, information technology, transportation, energy, manufacturing, and consulting. Unlike traditional disciplines in engineering and the mathematical sciences, IE addresses the role of the human decision-maker as a key contributor to the inherent complexity of systems and the primary benefactor of the analyses.


The objective of the Industrial Engineering program curriculum is to educate engineers who:
• Employ effective analysis and design tools;
• Integrate perspectives into a systems view of the organization; and
• Understand both the theory and the practice of Industrial Engineering.

In the first two years of the curriculum, emphasis is placed on fundamental principles of engineering and core industrial engineering concepts. Tools taught in second year include: probability, psychology for engineers, fundamentals of object oriented programming, engineering economics and accounting, operations research, differential equations, statistics, human centered systems design, and data modeling.

In the third year, students learn various perspectives on the operation of organizations, including productivity, information, ergonomics, and economics. They also select technical electives allowing them to specialize in information engineering, operations research and human factors, and investigate other IE areas such as business process engineering, design of information systems and facility planning. These same courses may be taken as fourth-year technical electives (schedule permitting). Therefore, students may use their fourth year electives to pursue their specialization further in depth, or to investigate other IE areas.

In fourth year, the central theme is the design and management of an organization as an integrated system. All students participate in an Integrated Systems Design course to design the business processes of an organization, and a Capstone Design course that requires students to draw on knowledge from all years of the IE program to tackle a real-world project with an industry partner. There is also a research thesis option.

Job opportunities for IE graduates are very diverse and offer challenging careers in a wide variety of industries, including consulting. Three prototypical jobs for new graduates include:
• Manage an organizational supply chain to ensure new products can be successfully introduced into global sales channels.
• Test the interaction features of a new software application.
• Identify increased capacity requirements necessary to accommodate the expected surgical volume of hospitals.

FIRST YEAR INDUSTRIAL ENGINEERING

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**SECOND YEAR INDUSTRIAL ENGINEERING**

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**THIRD YEAR INDUSTRIAL ENGINEERING**

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1. Practical Experience Requirement - As described in the beginning pages of this chapter, students are required to have completed a total of 600 hours of acceptable practical experience before graduation (normally during their summer periods).

2. At least two of the four (0.5 credit) Complementary Studies Electives to be taken between third and fourth year must be Humanities/Social Sciences courses (see the Complementary Studies section at the beginning of this chapter). Students are responsible for ensuring that each elective taken is approved. Please consult the electives list available on the Engineering Office of the Registrar’s website.

**PROFESSIONAL EXPERIENCE YEAR**

Students registered within this program, and all other undergraduate programs within the Faculty of Applied Science and Engineering, may elect to enrol and participate in the Professional Experience Year (PEY) program. The PEY program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a cooperating company. Details are described in the beginning of this chapter. For more information, consult the Professional Experience Year Office, 45 Wilcocks Street 2nd floor early in session 2F or 3F.

**FOURTH YEAR INDUSTRIAL ENGINEERING**
1. The Department is not able to schedule all fourth-year courses without conflict. However, students are required to select courses that allow for a conflict-free timetable.

2. At least one technical elective in each of the 4F and 4W session must be chosen from the provided listings. Students who want to take a technical elective substitute are required to obtain formal Departmental approval from the Undergraduate Office.

3. Industrial Engineering students are required to complete a two-term Capstone Design project, MIE490Y1Y, supervised by a licensed member of the University of Toronto teaching staff.

4. At least two of the four (0.5 credit) Complementary Studies Electives to be taken between third and fourth year must be Humanities/Social Sciences courses (see the Complementary Studies section at the beginning of this chapter). Students are responsible for ensuring that each elective taken is approved. Please consult the electives list available on the Engineering Office of the Registrar’s website.

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**FOURTH YEAR INDUSTRIAL ENGINEERING *OLD CURRICULUM***

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**Complementary Studies Elective (one):**

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1. The Department is not able to schedule all fourth-year courses without conflict. However, students are required to select courses that allow for a conflict-free timetable.

2. At least one technical elective in each of the 4F and 4W session must be chosen from the provided listings. Students who want to take a technical elective substitute are required to obtain formal Departmental approval from the Undergraduate Office.

3. Industrial Engineering students are required to complete a two-term Capstone Design project, MIE490Y1Y, supervised by a licensed member of the University of Toronto teaching staff.

4. At least two of the four (0.5 credit) Complementary Studies Electives to be taken between third and fourth year must be Humanities/Social Sciences courses (see the Complementary Studies section at the beginning of this chapter). Students are responsible for ensuring that each elective taken is approved. Please consult the electives list available on the Engineering Office of the Registrar’s website.


**Curriculum and Programs**

**GRADUATE PROGRAM IN INDUSTRIAL ENGINEERING**

The Department offers graduate study and research opportunities in a wide range of fields within Industrial Engineering. These include human factors engineering, information engineering, management science, manufacturing, operations research, systems design and optimization, reliability and maintainability engineering. Subject areas include: Queuing Theory, Cognitive Engineering, Human-Computer Interaction, Organizational Risk Management and Human Factors in Medicine. The programs available lead to M.Eng., M.A.Sc. and Ph.D. degrees. Evening courses are offered to accommodate participants who work full-time and are interested in an M.Eng. Additional information can be obtained from the Mechanical and Industrial Engineering Graduate Studies Office online at www.mie.utoronto.ca/graduate.

**MECHANICAL ENGINEERING (AEMECBASC)**

**UNDERGRADUATE STUDENT COUNSELLOR:**
Ms Carla Baptista  
Room MC109, Mechanical Engineering Building  
416-978-6420

The Mechanical Engineering profession faces unprecedented challenges and exciting opportunities in its efforts to serve the needs of society. The broad disciplinary base and design orientation of the field will continue to make the skills of the mechanical engineer crucial to the success of virtually all technical systems that involve energy, motion, materials, design, automation and manufacturing. The explosive growth in the availability of lower-cost, compact and high speed computing hardware and software is already revolutionizing the analysis, design, manufacture and operation of many mechanical engineering systems. Mechanical engineering systems are part of automotive engineering, robotics, fuel utilization, nuclear and thermal power generation, materials behaviour in design applications, transportation, biomechanical engineering, environmental control and many others.

To prepare Mechanical Engineers for the challenges of such a broad discipline, the program is designed to:

(i) Provide fundamental knowledge of the various subdisciplines;
(ii) Teach methodology and systems analysis techniques for integrating this knowledge into useful design concepts, and
(iii) Make graduates fully conversant with modern facilities, such as CAD/CAM and microprocessor control, by which design concepts can be produced and competitively manufactured.

The knowledge component includes the key subdisciplines of mechanics, thermodynamics, fluid mechanics, control theory, dynamics, material science and design. All are based on adequate preparation in mathematics and in such fundamental subjects as physics and chemistry.

Integration of this knowledge is accomplished in third and fourth year courses. Students select many upper-year courses from a list of electives, permitting them to choose subjects compatible with their individual interests. Most technical elective courses from one of five streams or subject areas: Manufacturing, Mechatronics, Solid Mechanics and Machine Design, Energy and Environment or Bioengineering. Students are encouraged to select a sequence of courses from two of the five streams, acquiring greater depth of knowledge in those areas. The fourth year Capstone Design course encompasses all aspects of the program as students complete a two-term design project for an industrial partner or client. Students also have the option of doing a one or two term thesis in the fourth year, allowing independent study and research with a university faculty member.

With this diverse background, virtually all industries seek the services of the practicing mechanical engineer as an employee or a consultant. Mechanical engineers are involved in the primary power production industry where hydraulic, thermal and nuclear energy is converted to electricity; in integrated manufacturing of automobiles and other equipment; in aircraft and other transportation systems; in the heating and air conditioning industry; in the design and manufacture of electronic hardware; in materials processing plants and many others industries.

For the modern mechanical engineer, the undergraduate program is only the first step in this educational process. An increasing number of graduates pursue advanced degrees in particular areas of specialization. Graduates entering industry can continue their education by participating in the graduate program. For further details please see the information following the program outline.

**FIRST YEAR MECHANICAL ENGINEERING**

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<tr>
<th>Core Required Courses</th>
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SECOND YEAR MECHANICAL ENGINEERING

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<td>Probability and Statistics with Engineering Applications</td>
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Winter Session - Year 2

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Complementary Studies

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PROFESSIONAL EXPERIENCE YEAR

Students registered within this program, and all other undergraduate programs within the Faculty of Applied Science and Engineering, may elect to enrol and participate in the Professional Experience Year (PEY) program. The PEY program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a cooperating company. Details are described in the beginning of this chapter. For more information, consult the Professional Experience Year Office, 45 Willcocks Street 2nd floor early in session 2F or 3F.

THIRD YEAR MECHANICAL ENGINEERING

Fall Session - Year 3

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<td>Fluid Mechanics I</td>
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<td>Numerical Methods I</td>
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<td>Circuits with Applications to Mechanical Engineering Systems</td>
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Stream Options (Choose two streams)

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1. In 4F, students will be required to take one additional course from each of the same two streams followed in third-year.

2. The Department is not able to schedule all third-year, stream courses without conflict. However, students are required to select courses that allow for a conflict-free timetable.

BIOENGINEERING

Students who are interested in completing a minor (6 courses) in Bioengineering should consult the beginning of this chapter for more information, and should also meet with the Undergraduate Student Counsellor. Students may complete this minor by the end of the fourth-year, Mechanical program by taking the following courses, however other combinations are possible:

- CHE353H1, Engineering Biology
- MIE331H1, Physiological Control Systems, and/or CHE354H1, Cellular and Molecular Biology
- ECE445H1, Neural Bioelectricity or ECE446H1, Sensory Communication or MIE343H1, Industrial Ergonomics & the Workplace or MIE439H1, Biomechanics I or MIE448H1, Engineering Psychology & Human Performance or MSE440H1, Biomaterial Processing and Properties
- MSE442H1, Surgical and Dental Implant Design
- MIE496Y1, Thesis (this must focus on bioengineering)
FOURTH YEAR MECHANICAL ENGINEERING

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<td>Control Systems I</td>
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<td>Thermal and Mechanical Design of Nuclear Power Reactors</td>
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<td></td>
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<td>Robotics</td>
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<td>* Mechatronics Systems:</td>
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<td>Operating Systems</td>
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<td>Industrial Ergonomics and the Workplace</td>
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<td>* Smart Materials and</td>
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<td>Systems Modelling and Simulation</td>
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<td>Reliability and</td>
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<tr>
<td>* Applied Fluid Mechanics</td>
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<td>Maintainability Engineering</td>
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<td>* Mechatronics Principles</td>
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<td>* Product Design</td>
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</table>

1. In 4F, students must take one required course (indicated above) from each of the same two streams followed in 3W.
2. Students are required to include at least one of the engineering design courses marked with a star (*) during the fourth year. It may be taken in either 4F or 4W.
3. In 4F, students may select an additional course from the Stream Courses list (above) to substitute for the technical elective.
4. Students may take only one of MIE422H1 (Automated Manufacturing) or AER525H1 (Robotics). AER525H1 (Robotics) is Limited Enrolment.
5. The Department is not able to schedule all fourth-year courses without conflict. However, students are required to select courses that allow for a conflict-free timetable.
6. Students are permitted to take at most two technical elective substitutes in their fourth-year, but are required to obtain formal Departmental approval from the Undergraduate Office.
7. At least two of the four (0.5 credit) Complementary Studies Electives to be taken between second and fourth year must he Humanities/Social Sciences courses (see the Complementary Studies section at the beginning of this chapter). An equivalent 1.0 course is also acceptable. Students are responsible for ensuring that each elective taken is approved. Please consult the electives list available on the Engineering Office of the Registrar’s website.

GRADUATE PROGRAM IN MECHANICAL ENGINEERING

The Department offers graduate study and research opportunities in a wide range of fields within Mechanical Engineering. These include applied mechanics, biomedical engineering, computer aided engineering, energy studies, fluid mechanics and hydraulics, materials, manufacturing, robotics, automation and control, design, surface sciences, thermodynamics and heat transfer, plasma processing, vibration, computational fluid dynamics, microfluidics and micromechanics, environmental engineering, thermal spray coatings, finite element methods, internal combustion engines and spray-forming processes. The programs available lead to M.Eng., M.A.Sc. and Ph.D. degrees. Evening courses are offered to accommodate participants who work full-time and are interested in an M.Eng. Additional information can be obtained from the Mechanical and Industrial Engineering Graduate Studies Office online at www.mie.utoronto.ca/graduate.
Mineral Engineering

LASSONDE MINERAL ENGINEERING PROGRAM (AELMEBASC)

UNDERGRADUATE STUDENT COUNSELLORS:
Ms. Shayni Clarke
Room GB105, Galbraith Building, 416-978-5905
E-mail: shayni@ecf.utoronto.ca
Ms. Teresa Miniaci
Room MB129, Lassonde Mining Building, 416-946-4095
Email: miniaci@ecf.utoronto.ca

UNDERGRADUATE STUDENT ADVISORS:
Professor John Hadjigeorgiou, Director, Lassonde Mineral Engineering Program
Ms. Nelly Pietropaolo
Room GB105, Galbraith Building

Mineral engineering encompasses those activities necessary to extract and process natural mineral resources. The Lassonde Mineral Engineering Program is comprehensive, covering topics from the entire scope of minerals engineering: from geology and mineral exploration, through analysis and design of surface and underground excavations, mechanical and explosive excavation of geological materials, planning and management of mines and quarries, processing of metallic, nonmetallic and industrial minerals, safety and environmental protection, and on to financial aspects of minerals operations. This wide range of topics means that the program is truly interdisciplinary, using concepts and techniques from mathematics, physics, chemistry, geology and economics; in the setting of the University of Toronto it is thus both interdepartmental and interfaculty, with the Departments of Civil Engineering, Geology and Materials Science and Engineering contributing to the program. As Toronto is a world centre for mining and mining finance, the program is able to maintain close links with the minerals industry, and thus invites recognised experts from various branches of the industry to deliver state-of-the-art treatment of specialised topics within the curriculum.

The first year of the four-year curriculum is similar to that of other engineering programs at the University. All subsequent years are unique to the Lassonde Mineral Engineering Program, with transfer into Year 2 of Mineral Engineering being permitted from both the General Engineering first year and other engineering programs. Year 2 concentrates on minerals engineering fundamentals, and years 3 and 4 comprise a minerals engineering core supplemented by technical electives. A wide range of technical electives are available, thereby allowing students to specialise should they so wish in one particular branch of minerals engineering. Students also study humanities and complementary studies electives in the final two years. Practical aspects of the program are presented through laboratory sessions, and students attend one survey and one geology field camp, each of two weeks duration. Students are encouraged and helped to obtain industrial experience during summer vacations, and have the opportunity to take a Professional Experience Year between years 3 and 4. Attractive entrance and in-course scholarships and bursaries are available, including the prestigious, competitively awarded Lassonde Scholarships.

Graduates obtain a comprehensive training in minerals engineering, and are well prepared for future challenges in the planning and financing of mineral and related engineering projects as well as for graduate study in mining, geological, or civil engineering. The program is accredited with the Canadian Engineering Accreditation Board.

PERSONAL PROTECTIVE EQUIPMENT

There will be many occasions where students are required to use Personal Protective Equipment (PPE) including safety footwear bearing the CSA Green Patch, hard hats, protective eyewear with side shields, tear away safety vests and ear protection. Students are required to purchase their own PPE. All field trips, laboratories, and other events require advance briefing on the nature of potential hazards and students are required to attend these briefings and to follow the provided instructions.

PRACTICAL EXPERIENCE REQUIREMENT

Students are required to have completed at least 600 hours of acceptable practical experience before graduation. This is normally acquired during the summer vacation periods or during a Professional Experience Year (PEY) internship.

PROFESSIONAL EXPERIENCE YEAR

Students registered in undergraduate programs within the Faculty of Applied Science and Engineering may elect to enrol and participate in the Professional Experience Year (PEY) Program. The PEY Program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a cooperating industry. Details are described at the beginning of this chapter. For more information, consult the PEY Office, 45 Willcocks Street 2nd Floor, early in session 2F or 3F.

SUMMER FIELD CAMP

An August Field Camp must be completed by all Lassonde Mineral Engineering students in the summer before Fourth Year. Results of the course are used to compute the Fourth Year Fall Session average. An extra fee is charged to cover part of the cost of transportation, food, and accommodation.
MINORS AND CERTIFICATE PROGRAMS

Several Engineering Minors and Certificate Programs are available and generally require the student to successfully complete a carefully selected slate of electives in their Fourth Year. Late in the Third Year Winter Session, students use an on-line pre-registration tool to indicate their preferred fourth-year electives. Students should review the various minor and certificate program requirements and attend the department’s information sessions in Third Year to ensure that the appropriate electives are taken in Fourth Year. Students should note that they can also complete the requirements of a minor or certificate program even after they have graduated, as long as the additional requirements are met within nine years of their initial registration in the BASc program. If completed after graduation, additional fees will be assessed, and a transcript will be issued with the amended courses and indication of completed minor or certificate program requirements.

JEFFREY SKOLL BASC/MBA PROGRAM

The Jeffrey Skoll Combined BASc/MBA Program allows qualified and selected students in the Faculty of Applied Science and Engineering to complete both a BASc and an MBA in a reduced time. Students will be admitted to the program prior to entering their fourth year of studies in the BASc program. Interested students should contact the Registrar’s Office early in the Third Year to obtain important information including application deadlines.

GRADUATE TRAINING IN MINERAL ENGINEERING

Students with the necessary qualifications (generally at least a B+ average in the final year of the undergraduate program) who wish to proceed to graduate studies may do so through the Lassonde Institute, an interdisciplinary research institute for engineering geoscience. The Department of Civil Engineering, the Department of Mechanical Engineering, the Department of Materials Science and Engineering, the Department of Geology, and the Collaborative Program in Geophysics are all collaborators in the Lassonde Institute.

The Engineering Departments offer programs leading to the MASc, MEng, and PhD degrees. Other Departments offer MSc and PhD degree programs. Additional information may be obtained at www.lassondeinstitute.utoronto.ca or the websites of the collaborating Departments.

FIRST YEAR MINERAL ENGINEERING

<table>
<thead>
<tr>
<th>Course</th>
<th>Lecture</th>
<th>Lab</th>
<th>Tut</th>
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<tbody>
<tr>
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<td>3</td>
<td>1</td>
<td>1</td>
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<tr>
<td>&amp; Practice I</td>
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<td>Ethics in Engineering</td>
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<td>Physical Chemistry</td>
<td>CHE112H1 F</td>
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<td>Mechanics</td>
<td>CIV100H1 F</td>
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<td>Calculus I</td>
<td>MAT186H1 F</td>
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<td>Linear Algebra</td>
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Winter Session - Year 1

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<tr>
<td>Earth Systems Science</td>
<td>CME185H1 S</td>
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<tr>
<td>Calculus II</td>
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SECOND YEAR MINERAL ENGINEERING

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<td>Fluid Mechanics I</td>
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<tr>
<td>Materials of the Earth</td>
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<td>2</td>
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<td>Introduction to the Resource Industries</td>
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<th>Course</th>
<th>Lecture</th>
<th>Lab</th>
<th>Tut</th>
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<tr>
<td>Probability Theory for Civil and Mineral Engineers</td>
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<tr>
<td>Engineering Mathematics II</td>
<td>CME362H1 S</td>
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<td>-</td>
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<td>Rock Forming Process</td>
<td>GLG207H1 S</td>
<td>2</td>
<td>3</td>
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<td>Surface Mining</td>
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Students must acquire two half or one full-year course equivalent of both CS and HSS credits by the end of Fourth Year.
THIRD YEAR MINERAL ENGINEERING

Fall Session - Year 3

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<td>Mining Environmental Management</td>
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Winter Session - Year 3

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CME358H1 - Survey CAMP (Civil and Mineral Practicals), is a two-week field-based course taken in the month prior to starting Third Year. The results of this course are used in computing the student's Third Year Fall Session Average. An extra fee is charged to cover part of the costs of food and accommodation.

Technical Electives must be chosen from the list shown under the Fourth Year curriculum table. Students must acquire two half or one full-year course equivalent of both CS and HSS credits by the end of Fourth Year.

FOURTH YEAR MINERAL ENGINEERING

Fall Session - Year 4

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<tr>
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Technical Electives

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<tr>
<td>Groundwater Flow and Contamination</td>
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<td>Sedimentary Geology</td>
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Winter Session - Year 4

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<td>Elective (HSS)</td>
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Choose two of the following

Technical Electives

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<td>Mineral Reserve and Material Resource</td>
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<td>Ventilation and Occupational Health</td>
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<tr>
<td>Borehole Geophysics for Engineers and Geoscientists</td>
<td>MIN540H1 S</td>
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</tbody>
</table>

JGP438H1, MIN320H1, MIN401H1, MIN430H1, MIN450H1, MIN470H1, and MIN540H1 are highly recommended to students interested in pursuing courses that are especially relevant to obtaining a background in mineral engineering. CIV250H1, CIV280H1, CIV523H1, and CIV549H1 are highly recommended to students interested in pursuing courses relevant to obtaining a background in geotechnical engineering.
EXPLANATION OF COURSE DESCRIPTIONS

On the following pages are brief outlines of the courses prescribed for students in the Faculty of Applied Science and Engineering, listed in alphabetical order of the prefixes. The suffix following the course number indicates the session in which the course is given; the second line of the description shows the program and year for which the course is prescribed, the number of hours of lectures, laboratory and tutorial work per week, and the weight units assigned to the course.

Sample

ECE461H1 S
Internetworking
IV- AECPEBASCC; IV - AECPEBASC, AEESCBASEC (elective) 3/3a/1a/0.50

ECE: Department of Electrical and Computer Engineering

461: Course number

H1: Half course, St George Campus

S: A second-session (winter) course.

F would indicate a first-session or fall course;

F/S would indicate that the course given in the first session is repeated in the second session (a student may take one or the other, but not both); Y would indicate a course that continues over both sessions, i.e., a year-long course.

For determination as to whether a course is considered core or a technical elective for your program, consult your program curriculum outline in Chapter 7.

3: three hours lectures/week

3a: 3 hours of laboratory occurring on alternating weeks

1a: 1 hour of tutorial occurring on alternating week

If a component of the course (i.e., lecture, laboratory or tutorial) timing is followed by an 'm', this means the component does not follow a weekly or alternating format. The professor of the course will explain the timing of the component in class.

0.50: equals one half credit

In addition to the 100-, 200-, 300- and 400-series courses, this Calendar also lists courses in the 500- and 1000-series. The 500-series courses are undergraduate courses that are also intended for graduate students; 1000-series are graduate courses that are open to undergraduate students by permission.

Many course descriptions include a statement of exclusions, prerequisites and co-requisites. The absence of such a statement does not imply that the course does not have such conditions. In these statements, the oblique symbol ("/") means “OR”, and the comma (";") means “AND”.

Any recommendation for textbooks should be considered as tentative only, and is subject to change. Students should therefore not purchase textbooks until they have been in attendance in the course, unless informed otherwise by their department.

Note: Selected Arts and Science courses appear in this calendar. Requisite and exclusion information listed for Arts and Science course may not apply to Engineering students. If you are unsure if you meet the requirement for a course you should speak with the Arts and Science department offering the course or your departmental counsellor. Further, Breadth and Distribution requirements listed for Arts and Science courses apply only to students registered in the Faculty of Arts and Science and do not apply to students registered in the Faculty of Applied Science and Engineering.

For a complete course listing of Arts and Science courses please refer to the Arts and Science Academic Calendar.
Actuarial Science

ACT370H1 S
Financial Principles for Actuarial Science II 3/-/-/0.50

Mathematical theory of financial derivatives, discrete and continuous option pricing models, hedging strategies and exotic option valuation. Prerequisite: ACT240H1 (minimum grade C); ACT245H1 (minimum grade C); ACT247H1 (minimum grade C); STA257H1, STA261H1; MAT237Y1. Exclusion: MGT438H1. Distribution Requirement Status: This is a Science course. Breadth Requirement: The Physical and Mathematical Universes (5).

ACT460H1 F
Stochastic Methods for Actuarial Science 3/-/-/0.50

Applications of the lognormal distribution, Brownian motion, geometric Brownian motion, martingales, Ito's lemma, stochastic differential equations, interest rate models, the Black-Scholes model, volatility, value at risk, conditional tail expectation. Prerequisite: ACT370H1; STA347H1. Distribution Requirement Status: This is a Science course. Breadth Requirement: The Physical and Mathematical Universes (5).

Applied Science and Engineering (Interdepartmental)

APM384H1 F
Partial Differential Equations 3/-/1/0.50

Boundary value problems and Sturm-Liouville theory for ordinary differential equations. Partial differential equations of first order, characteristics, Hamilton-Jacobi theory. Diffusion equations; Laplace transform methods. Harmonic functions, Green's functions for Laplace's equation, surface and volume distributions; Fourier transforms. Wave equation, characteristics; Green's functions for the wave equation; Huygens principle.

APM466H1 S
Mathematical Theory of Finance 3/-/-/0.50

Introduction to the basic mathematical techniques in pricing theory and risk management: Stochastic calculus, single-period finance, financial derivatives (tree-approximation and Black-Scholes model for equity derivatives, American derivatives, numerical methods, lattice models for interest-rate derivatives), value at risk, credit risk, portfolio theory. Prerequisite: APM346H1, STA347H1. Corequisite: STA457H1. Distribution Requirement Status: This is a Science course. Breadth Requirement: The Physical and Mathematical Universes (5).

Applied Mathematics

APM406H1 S
Mathematical Theory of Finance 3/-/-/0.50

Introduction to the basic mathematical techniques in pricing theory and risk management: Stochastic calculus, single-period finance, financial derivatives (tree-approximation and Black-Scholes model for equity derivatives, American derivatives, numerical methods, lattice models for interest-rate derivatives), value at risk, credit risk, portfolio theory. Prerequisite: APM346H1, STA347H1. Corequisite: STA457H1. Distribution Requirement Status: This is a Science course. Breadth Requirement: The Physical and Mathematical Universes (5).

APM466H1 S
Mathematical Theory of Finance 3/-/-/0.50

Introduction to the basic mathematical techniques in pricing theory and risk management: Stochastic calculus, single-period finance, financial derivatives (tree-approximation and Black-Scholes model for equity derivatives, American derivatives, numerical methods, lattice models for interest-rate derivatives), value at risk, credit risk, portfolio theory. Prerequisite: APM346H1, STA347H1. Corequisite: STA457H1. Distribution Requirement Status: This is a Science course. Breadth Requirement: The Physical and Mathematical Universes (5).

APS101H1 S
Computer Programming 3/2/1/0.50

An introduction to computer systems and problem solving using computers. Topics include: the representation of information, programming techniques, algorithms and program organization using objects, array and pointer-based data structures (including stacks, queues, linear lists, and trees) searching and sorting (basic computer-organization), operating systems, and applications. The laboratories reinforce the lecture topics and develop essential programming skills using Java.

APS104H1 S
Introduction to Materials and Chemistry 3/0.50/1/0.50

This is an introductory course in materials science and physical chemistry. Topics include: fundamentals of atomic, structure, the nature of bonding, crystal structure and defects, the laws of chemical thermodynamics (including a discussion of enthalpy and entropy), reaction equilibrium, and phase equilibria. These basic principles provide the foundation for an exploration of structure-property relationships in metals, ceramics, and polymers, with emphasis on mechanical properties.

APS105H1 F
Computer Fundamentals 3/2m/1m/0.50

This is an introductory course in materials science and physical chemistry. Topics include: fundamentals of atomic, structure, the nature of bonding, crystal structure and defects, the laws of chemical thermodynamics (including a discussion of enthalpy and entropy), reaction equilibrium, and phase equilibria. These basic principles provide the foundation for an exploration of structure-property relationships in metals, ceramics, and polymers, with emphasis on mechanical properties.

APS105H1 F
Computer Fundamentals 3/2m/1m/0.50

An introduction to computer systems and problem solving using computers. Topics include: the representation of information, programming techniques, programming style, basic loop structures, functions, arrays, strings, pointer-based data structures and searching and sorting algorithms. The laboratories reinforce the lecture topics and develop essential programming skills.
Course Descriptions

APS106H1 S
Fundamentals of Computer Programming
I-AECHEBASC, I-AECIVBASC, I-AEINDBASC, I-AELMEBASC, I-AEMECPBASC, I-AEEMSBASC
3/2/1/0.50
An introduction to computer systems and software. Topics include the representation of information, algorithms, programming languages, operating systems and software engineering. Emphasis is on the design of algorithms and their implementation in software. Students will develop a competency in the C programming language. Laboratory exercises will explore the concepts of both Structure-based and Object-Oriented programming using examples drawn from mathematics and engineering applications.

APS111H1 F
Engineering Strategies & Practice I
3/1/1/0.50
This course introduces and provides a framework for the design process. Students are introduced to communication as an integral component of engineering practice. The course is a vehicle for understanding problem solving and developing communications skills. This first course in the two Engineering Strategies and Practice course sequence introduces students to the process of engineering design, to strategies for successful team work, and to design for human factors, society and the environment. Students write team and individual technical reports and give presentations within a discussion group.

APS112H1 S
Engineering Strategies & Practice II
3/2/-/-/0.50
This course introduces and provides a framework for the design process, problem solving and project management. Students are introduced to communication as an integral component of engineering practice. The course is a vehicle for practicing team skills and developing communications skills. Building on the first course, this second course in the two Engineering Strategies and Practice course sequence introduces students to project management and to the design process in greater depth. Students work in teams on a term length design project. Students will write a series of technical reports and give a team based design project presentation.

APS150H1 F
Ethics in Engineering
-/-/-/-/0.05
An introduction to professional ethics and the Academic Code of Conduct. Topics include: the theory of ethics, professional code of ethics, ethics in the profession, proper use of intellectual property in the professional and in academic settings, plagiarism, the Academic Code of Conduct, and application of ethics in practice.

APS191H1 S
Introduction to Engineering
I-AEENGEBASC
1/-/-/-/0.15
This is a seminar series that will preview the core fields in Engineering. Each seminar will highlight one of the major areas of Engineering. The format will vary and may include application examples, challenges, case studies, career opportunities, etc. The purpose of the seminar series is to provide first year students with some understanding of the various options within the Faculty to enable them to make educated choices for second year. This course will be offered on a credit/no credit basis.

APS234H1 F
Entrepreneurship and Small Business
I-AEMINBUS
4/-/1/0.50
Complementary Studies elective
Part 1 of the 2 Part Entrepreneurship Program
The age of enterprise has arrived. Strategic use of technology in all sorts of businesses makes the difference between success and failure for these firms. Wealth creation is a real option for many and the business atmosphere is ready for you! Increasingly, people are seeing the advantages of doing their own thing, in their own way, in their own time. Entrepreneurs can control their own lives, structure their own progress and be accountable for their own success - they can fail, but they can not be fired! After all, engineers are the most capable people to be in the forefront of this drive to the business life of the next century. This course is the first of a series of two dealing with entrepreneurship and management of a small company. It is intended that the student would continue to take the follow up course APS432 as s/he progresses toward the engineering degree. Therefore, it is advisable that the descriptions of both courses be studied prior to deciding to take this one. This is a limited enrolment course. If the number of students electing to take the course exceeds the class size limit, selection of the final group will be made on the basis of the “Entrepreneur’s Test”. There will be a certificate awarded upon the successful completion of both courses attesting to the fact that the student has passed this Entrepreneurial Course Series at the University of Toronto. The course is based on real life issues, not theoretical developments or untried options. Topics covered include: Who is an entrepreneur; Canadian business environment; Acquisitions; Different business types (retail, wholesale, manufacturing, and services); Franchising; Human resources, Leadership, Business law; and many others. Several visitors are invited to provide the student with the opportunity to meet real entrepreneurs. There will be several assignments and a session project. It should be noted that the 5 hours per week would all be used for whatever is needed at the time, so tutorials will not normally happen as the calendar indicates them. Exclusion: CHE488H1/CIV488H1/ECE488H1/MI488H1/MSE488H1

APS301H1 F
Technology in Society and the Biosphere I
I-AECIVBASC, IV-AEESCBASEI, I-AEMINER, I-AEMINEN
3/-/1/0.50
Humansities and Social Science Elective
Core Course in the Environmental Engineering Minor
This course teaches future engineers to look beyond their specialized domains of expertise in order to understand how technology functions within human life, society and the biosphere. By providing this context for design and decision-making, students will be enabled to do more than achieve the desired results by also preventing or significantly reducing undesired consequences. A more preventively-oriented mode of practicing engineering will be developed in four areas of application: materials and production, energy, work and cities. The emphasis within these topics will reflect the interests of the class.
Course Descriptions

APS302H1 S
Technology in Society and the Biosphere II

I-AEMINENV
3/-/1/0.50

Humanities and Social Science Elective
This course examines the interactions between advanced technology and human life, society and the biosphere. Topics include: industrialization and the birth of rationality and technique; the computer and information revolution as symptom of a deeper socio-cultural transformation; other “post-industrial” phenomena; the transition from experience to information; technique as social force, life-milieu and system; and living with complex socio-technical systems. Prerequisite: APS301H1/APS203H1/APS103H1

APS304H1 S
Preventive Engineering and Social Development

I-AEMINENV
3/-/1/0.50

Humanities and Social Science Elective
The present intellectual and professional division of labour makes it next to impossible for specialists to deal with the consequences of their decisions that fall beyond their domains of expertise, thus institutionalizing an end-of-pipe approach to the many problems created by contemporary civilization. To turn this situation around, preventive approaches have been developed that use the understanding of how technology interacts with human life, society and the biosphere to adjust decision-making in order to achieve the desired results while at the same time preventing or reducing undesired effects. These preventive approaches can transform our materials and production systems, energy systems, workplaces and urban habitats to make contemporary ways of life more economically sound, socially viable and environmentally sustainable. Prerequisite: APS301H1/APS203H1/APS103H1, APS302H1

APS305H1 S
Energy Policy

III,IV-AEESCBASEJ, I-AEMINENV
3/-/1/0.50

Complementary Studies elective
Core Course in the Sustainable Energy Minor
Introduction to public policy including the role and interaction of technology and regulation, policy reinforcing/feedback cycles; procedures for legislation and policy setting at the municipal, provincial and federal levels; dimensions of energy policy; energy planning and forecasting including demand management and conservation incentives; policy institution, analysis, implementation, evaluation and evolution; Critical analyses of case studies of energy and associated environmental policies with respect to conservation and demand management for various utilities and sectors; policy derivatives for varied economic and social settings, developing countries and associated impacts. Exclusion: ENV350H1

APS310H0 F
Defining Energy Futures in India and Canada

3/1/-/0.50

The future of energy systems in India and Canada. A spectrum of current and emerging technologies used in providing energy and in its end use, including but not limited to electricity generation and transportation systems, are compared and contrasted re their applicability and barriers. Energy issues and challenges across the two countries; the role of energy in economic growth and in reducing poverty. Multi-variable analytic approach: technical aspects of the energy systems at an intermediate level of depth, but also economic analysis, environmental and sustainability issues, and social benefits. Case study examples of organizations bringing these technologies into use. India and Canada respectively in a global energy context relative to China, the U.S. and the Middle Eastern countries. Developing a framework for broader assessment of the context of engineering work –how engineering solutions and practices vary depending on the setting where the solutions are used. Possible collaborations between India and Canada, and between universities in the two countries, are explored. Offered through Summer Abroad Program. Duration of the course will be two to three calendar weeks, comprising approximately 42 hours of classroom instruction (up to 7 hours per day) and at least 3 field trips totaling 10 hours of instruction time. Total of 52 hours of instruction scheduled over 2-3 weeks. Exclusion: APS510H1

APS320H1 F
Representing Science on Stage

2/-/2/0.50

Humanities and Social Science Elective
An examination of representations of science/scientists in theatre. Reading and/or viewing of works by contemporary playwrights and related materials on science and culture. Critical essays; in-class discussion and scene study.

APS321H1 F
Representing Science and Technology in Popular Media

2/-/2/0.50

Humanities and Social Science Elective
Analytical approach to writing and style; representations of current scientific research and developments in the popular media; books by scientists aimed at non technical readers, reporting (including new media) on developments in science and technology. Rhetorical strategies for delivering technical information to non technical readers, including misrepresentations, analogy and metaphor. Focus on the popular media’s (mis)representations of climate science, nanotechnology, and bioengineering. Prerequisite: CHE397H1/ECE297H1/ECE299H1/ESC201H1/MSE390H1

APS322H1 S
Language and Power

2/-/2/0.50

Humanities and Social Science Elective
Analytical approach to writing and style. Study of persuasion in political, scientific and ethical contexts. Development of critical thinking skills. History of rhetoric viewing major contributors in context: Aristotle, Cicero, Medieval rhetoric, modern rhetoricians. Analysis of major scientific and political writing and speech. Prerequisite: CHE397H1/ECE297H1/ECE299H1/ESC201H1/MSE390H1

APS323H1 S
Entrepreneurship and Business Management

4/-/1/0.50

Complementary Studies elective
Part 2 of the 2 Part Entrepreneurship Program

This is part two of the Entrepreneurship course series. The student considering taking this course would typically plan to pursue a career in small business started by him/herself, or in a family enterprise. The skills acquired, however, are very useful in any business where a graduate might end up in his/her career, without the need for actually being an entrepreneur. Our approach to teaching is based on real-life business experiences and many years of successful practice of “what we preach”. The course contains very little theoretical work or academic approaches.
Course Descriptions

It is designed to familiarize you with the kinds of opportunities (problems) likely to be encountered in an entrepreneurial career. If you really want this lifestyle and are prepared to work hard, we will provide you with the practical knowledge and technical skills required to pursue this kind of career. Topics covered in this course include: Marketing and Sales; Legal issues; Financing the business; Human Resources challenges, the Business Plan and many other issues. Note that the course material may be adjusted between the two courses as required. We recognize the value of communication skills in both the classroom and in project reports. In fact, we require that you learn how to present yourself in a business-like manner. As and when appropriate, outside visitors from the business community will join in and contribute to the class discussions. The course deals with practical concepts, actual past and current events and is presented from the point of view of someone who has “done it all”. This means that what you hear is the real stuff. There will be several assignments and the preparation of a full Business Plan as the session project. It should be noted that the 5 hours per week would all be used for whatever is needed at the time, so tutorials will not normally happen as the calendar indicates them.

Prerequisite: APS234 - Entrepreneurship and Small Business
Exclusion: CHE488H1/CIV488H1/ECE488H1/MEIE488H1/MSE488H1

APS442H1 S Cognitive and Psychological Foundations of Effective Leadership
I-AEMINBUS
3/-/-/0.50

This course investigates the cognitive and psychological foundations of effective leadership. Students will explore current theories driving effective leadership practice including models of leadership, neurophysiological correlates of leadership and psychodynamic approaches to leadership. Students will learn and apply skills including mental modeling, decision-making, teamwork and self-evaluation techniques. This course is aimed at helping Engineering students to gain practical skills that will enhance their impact as leaders throughout their careers.

APS443H1 F Leadership and Leading for Groups and Organizations
I-AEMINBUS
2/-/1/0.50

Complementary Studies Elective

The course addresses student self-motivation to learn and prepare to do the work of leading by defining the process of leading and the guiding principles and actions of leaders (aspiring, competent and high performance leaders). Two learning frameworks provide practical tools to assist the student to understand the logic and demands of learning to become a competent leader of self and the organization. The student prepares to become a competent leader by undertaking to learn (understand and integrate) key skills, character attributes and purposeful behaviours. The course presents strategies for development of high performance organizations through high performance work systems taking into account: value-adding work; working together effectively; doing work in a virtuous manner; organizational culture; decision making; high performance timing; and orderly change processes. The course material is delivered through lectures, readings and in-class discussion. A textbook is in preparation and will be available in the Fall of 2011, in draft form. Students have an opportunity to meet high-level leaders from business and the community. Students will be required to submit written reflections on course content and a final paper.

On completing the course a student will be able to:
1) apply the thinking framework to analyzing problems and synthesizing solutions
2) summarize the characteristics of competent leaders
3) construct a comprehensive set of personal values, a personal vision statement and a personal mission statement
4) facilitate the creation of statements of values, vision and mission for groups and organizations
5) distinguish between leading and managing
6) critique the processes and function of organizations

APS510H1 F Innovative Technologies and Organizations in Global Energy Systems
IV-AEESCBASEF, I-AEMINBUS, I-AEMINENR
3/-/1/0.50

Complementary Studies elective

A broad range of global energy systems are presented including electricity generation, electricity end use, transportation and infrastructure. Discussions are based on two key trends: (a) the increasing ability to deploy technologies and engineering systems globally, and (b) innovative organizations, many driven by entrepreneurship (for profit and social) and entrepreneurial finance techniques. The course considers these types of innovations in the context of developed economies, rapidly developing economies such as India and China, and the developing world. The course will interweave a mix of industry examples and more in-depth case studies. The examples and cases are examined with various engineering, business and environmental sustainability analysis perspectives.

Prerequisite: Undergraduate economics course

APS520H1 S Technology, Engineering and Global Development
I-AEMINBUS
3/-/-/0.50

Complementary Studies elective

The role of technology and engineering in global development is explored through a combination of lectures, readings, case studies, and analysis of key technologies, including energy, information and communications technologies, water and healthcare. Topics include a brief history and basic theories of international development and foreign aid, major government and non-government players, emerging alternative models (social entrepreneurship, microfinance, risk capital approaches), major and emerging players in social venture capital and philanthropy, the role of financial markets, environmental and resource considerations/sustainable development, technology diffusion models and appropriate technologies.

APS530H1 S Appropriate Technology & Design for Global Development
I-AEMINENV, I-AEMINENR
3/-/-/0.50

Engineering design within the context of global society, emphasizing the needs of users in order to support appropriate, sustainable technology. A design project will comprise the major component of the course work. The course will take the approach of “design for X”. Students are expected to be familiar with design for functionality, safety, robustness, etc. This course will extend the students’ understanding of design methodologies to design for “appropriateness in developing regions”. Readings and discussions will explore the social, cultural, economic, educational, environmental and political contexts in which third world end users relate to technology. Students will then incorporate their deepened understanding of this context in their design project. The projects will be analyzed for functionality as well as appropriateness and sustainability in the third world context. Upon completion of the course, students should have a deeper appreciation of the meaning of appropriate technology in various international development sectors such
Aerospace Science and Engineering

**AER201H1 S**  
**Engineering Design**  
1/5/-/0.50  
II-AEESCBAEE  
Design of integrated, multidisciplinary systems is introduced through a major course project. Project selection and definition of functions and performance objectives for the open-ended design problem will take place early on by teams of students, while learning practical subjects of engineering in lectures and workshops. This process will lead to the preparation of project proposals consisting of identification of design objectives and constraints, generation and evaluation of potential approaches, selection of the most promising design concept, identification of product subsystems, and assignment of responsibilities to team members. Following project approval, the design process will comprise preliminary design, followed by detailed design, prototype construction and testing, and preparation of a final design report. Progress is evaluated weekly, culminating in a prototype demonstration and design review.

**AER210H1 F**  
**Vector Calculus & Fluid Mechanics**  
3/0.50/2/0.50  
II-AEESCBAEE  
The first part of this course covers multiple integrals and vector calculus. Topics covered include: double and triple integrals, derivatives of definite integrals, surface area, cylindrical and spherical coordinates, general coordinate transformations (Jacobians), Taylor series in two variables, line and surface integrals, parametric surfaces, Green's theorem, the divergence and gradient theorems, Stokes's theorem. The second part of the course provides a general introduction to the principles of continuum fluid mechanics. The basic conservation laws are derived in both differential and integral form, and the link between the two is demonstrated. Applications covered include hydrostatics, incompressible and compressible frictionless flow, the speed of sound, the momentum theorem, viscous flows, and selected examples of real fluid flows.

**AER301H1 F**  
**Dynamics**  
3/-/1/0.50  
III-IV-AEESCBAEE, IV-AEESCBAEE, I-AEINRAM  

**AER302H1 S**  
**Aircraft Flight**  
3/-/1/0.50  
III-IV-AEESCBAEE  
Basics of aircraft performance with an introduction to static stability and control. Topics covered include: Equations of Motion; Characteristics of the Atmosphere; Airspeed Measurement; Drag (induced drag, total airplane drag); Thrust and Power (piston engine characteristics, gas turbine performance); Climb (range payload); Tunrs; Pull-up; Takeoff; Landing (airborne distance, ground roll); Flight envelope (maneuvering envelope, gust load factors); Longitudinal and lateral static stability and control; Introduction to dynamic stability.

**AER303H1 F**  
**Aerospace Laboratory I**  
3/-/1/-/0.50  
III-IV-AEESCBAEE  
Students will perform a number of experiments in the subject areas associated with the Aerospace Option curriculum, and prepare formal laboratory reports.

**AER304H1 S**  
**Aerospace Laboratory II**  
3/-/1/-/0.50  
III-IV-AEESCBAEE  
Students will perform a number of experiments in the subject areas associated with the Aerospace Option curriculum, and prepare formal laboratory reports.

**AER307H1 F**  
**Aerodynamics**  
3/-/1/0.50  
III-IV-AEESCBAEE, IV-AEESCBAEE, IV-AEMECBASC  

**AER310H1 S**  
**Gasdynamics**  
3/-/1/0.50  
III-IV-AEESCBAEE  
Basic introduction to compressible gasdynamics. Includes some fundamental thermodynamics, thermal and caloric equations of state, derivation of Euler's equations by control volume approach. Also, includes the theory of steady flows in ducts with area changes, adiabatic frictional flows, duct flows with heat transfer, normal and oblique shock waves, Prandtl-Meyer expansion wave, moving shock and rarefaction waves, shock tubes, and wind tunnels. The lectures are supplemented by problem sets. Reference book: Anderson, J.D., Modern Compressible Flow with Historical Perspective. Prerequisite: AER202H1 “Fluid Mechanics”, or equivalent.)

**AER315H1 F**  
**Combustion Processes**  
3/-/1/0.50  
III-IV-AEESCBAEE  
Scope and history of combustion, and fossil fuels; thermodynamics and kinetics of combustion including heats of formation and reaction, adiabatic flame temperature, elementary and global reactions, equilibrium calculations of combustion products, and kinetics of pollutant
Course Descriptions

formation mechanisms; propagation of laminar premixed flames and detonations, flammability limits, ignition and quenching; gaseous diffusion flames and droplet burning; introduction to combustion in practical devices such as rockets, gas turbines, reciprocating engines, and furnaces; environmental aspects of combustion.
Prerequisite: CHE219H1 Engineering Thermodynamics, or equivalent

AER334H1 F
Numerical Methods I

3/-/1.50/0.50
This introductory course to numerical methods includes the following topics: polynomial interpolation, numerical integration, solution of linear systems of equations, least squares fitting, solution of nonlinear equations, numerical differentiation, solution of ordinary differential equations, and solution of partial differential equations. Tutorial assignments using the C programming language focus on engineering applications relevant to the background of students taking the course.

AER336H1 S
Scientific Computing

III,IV-AEESCBASEIA, IV-AEESCBASEF,
IV-AEESCBASEJ
3/-/1.50/0.50
An introduction is provided to numerical methods for scientific computation which are relevant to the solution of a wide range of engineering problems. Topics addressed include interpolation, integration, linear systems, least-squares fitting, solution of nonlinear equations and optimization, initial value problems, partial differential equations, and relaxation methods. The assignments make extensive use of MATLAB. Assignments also require knowledge of Fortran or C.

AER372H1 S
Control Systems

III,IV-AEESCBASEIA, III,IV-AEESCBASEJ
3/1.50/1/0.50

AER373H1 S
Mechanics of Solids and Structures

III,IV-AEESCBASEIA, IV-AEESCBASEF,
III,IV-AEESCBASEJ
3/-/1/0.50

AER406H1 S
Aircraft Design

IV-AEESCBASEIA
3/-/3/0.50
This course involves the detailed preliminary design of an airplane. Performance and mission specifications are given, as well as the engine’s characteristics. The class is divided into teams of three to four students who are guided to develop an airplane that can meet these specifications. Individual team members will specialize in areas such as “performance”, “structure”, “systems”, etc., although all team members should be conversant with each other’s results and methodology. Each week, a representative of each team presents a progress lecture on that team’s efforts, which is discussed and critiqued by the class. Also, the teams meet one-on-one with the professor and tutors to discuss specific design questions. At the end of the course each team will present a verbal and written report of sufficient detail to provide a compelling case for the feasibility of their proposed airplane. Text: Raymer, Daniel P., Aircraft Design: A Conceptual Approach, published by the AIAA.

AER407H1 F
Space Systems Design

IV-AEESCBASEIA, I-AEMINRAM
3/-/3/0.50
Introduction to the conceptual and preliminary design phases for a space system currently of interest in the Aerospace industry. A team of visiting engineers provide material on typical space systems design methodology and share their experiences working on current space initiatives through workshops and mock design reviews. Aspects of operations, systems, electrical, mechanical, software, and controls are covered. The class is divided into project teams to design a space system in response to a Request for Proposals (RFP) formulated by the industrial team. Emphasis is placed on standard top-down design practices and the tradeoffs which occur during the design process. Past projects include satellites such as Radarsat, interplanetary probes such as a solar sailer to Mars, a Mars surface rover and dextrous space robotic systems.
Prerequisite: AER201H1 and AER372H1

AER501H1 F
Advanced Mechanics of Structures

IV-AEESCBASEIA
3/-/1/0.50

AER503H1 S
Aeroelasticity

IV-AEESCBASEIA
3/-/1/0.50
Static aeroelastic phenomena are studied, including divergence of slender wings and control reversal. Various methods of solution are considered such as closed form, matrix format iteration and the Rayleigh-Ritz approach. A Study of vibration and flutter of wings and control surfaces is presented with particular emphasis on those parameters which affect flutter speed.
AER506H1 F
Spacecraft Dynamics and Control

IV-AEESCBASEA, I-AEMINRAM
3/-/1/0.50

Planar “central force” motion; elliptical orbits; energy and the major diameter; speed in terms of position; angular momentum and the conic parameter; Kepler’s laws. Applications to the solar system; applications to Earth satellites. Launch sequence; attaining orbit; plane changes; reaching final orbit; simple theory of satellite lifetime. Simple (planar) theory of atmospheric entry. Geostationary satellite; adjustment of perigee and apogee; east-west stationkeeping. Attitude motion equations for a torque-free rigid body; simple spins and their stability; effect of internal energy dissipation; axisymmetric spinning bodies. Spin-stabilized satellites; long-term effects; sample flight data. Dual-spin satellites; basic stability criteria; example-CTS. “active” attitude control; reaction wheels; momentum wheels; controlmoment gyros; simple attitude control systems.
Prerequisite: AER301H1 and AER372H1

AER507H1 F
Introduction to Fusion Energy

IV-AEESCBASEA, IV-AEESCBASEJ, IV-AEESCBASEP, IV-AEESCBASER, I-AEMINER
3/-/1/0.50

Nuclear reactions between light elements provide the energy source for the sun and stars. On earth, such reactions could form the basis of an essentially inexhaustible energy resource. In order for the fusion reactions to proceed at a rate suitable for the generation of electricity, the fuels (usually hydrogen) must be heated to temperatures near 100 million Kelvin. At these temperatures, the fuel will exist in the plasma state. This course will cover: (i) the basic physics of fusion, including reaction cross-sections, particle energy distributions, Lawson criterion and radiation balance, (ii) plasma properties including plasma waves, plasma transport, heating and stability, and (iii) fusion plasma confinement methods (magnetic and inertial). Topics will be related to current experimental research in the field.

AER510H1 S
Aerospace Propulsion

IV-AEESCBASEA
3/-/1/0.50

Scope and history of jet and rocket propulsion; fundamentals of air-breathing and rocket propulsion; fluid mechanics and thermodynamics of propulsion including boundary layer mechanics and combustion; principles of aircraft jet engines, engine components and performance; principles of rocket propulsion, rocket performance, and chemical rockets; environmental impact of aircraft jet engines.
Prerequisite: AER310H1 Gasdynamics

AER525H1 F
Robotics

IV-AEESCBASEA, IV-AEESCBASEF, IV-AEESCBASER, I-AEMINRAM
3/1.50/1/0.50

The course addresses fundamentals of analytical robotics as well as design and control of industrial robots and their instrumentation. Topics include forward, inverse, and differential kinematics, screw representation, statics, inverse and forward dynamics, motion and force control of robot manipulators, actuation schemes, task-based and workspace design, mobile manipulation, and sensors and instrumentation in robotic systems. A series of experiments in the Robotics Laboratory will illustrate the course subjects.

Biochemistry

BCB410H1 F
Applied Bioinformatics

IV-AEESCBASET
2/-/1/0.50

Practical introduction to concepts, standards and tools for the implementation of strategies in bioinformatics and computational biology.

Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

BCB420H1 S
Computational Systems Biology

I-AEMINBIO
Current approaches to using the computer for analyzing and modeling biology as integrated molecular systems. The course complements an introductory Bioinformatics course such as BCB441H1. (Enrolment limited.)

Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

BCH210H1 F
Biochemistry I: Proteins, Lipids and Metabolism

IV-AEESCBASEB
3/-/2/0.50

Proteins, enzymes, membranes and the metabolism of carbohydrates and lipids. This course is intended for students who are NOT taking BCH242Y1 as part of their program.
Prerequisite: (CHM138H1, CHM139H1)/CHM151Y1NOTE: CHM1** WITH COURSE EXCLUSION TO CHM138H1 AND CHM139H1
CHM138H1 ONLY. CHMA41H3/CHMA42H3 (UTSC) are equivalent to CHM138H1 ONLY. Students that have an SDF in CHM138H1/CHM139H1 are not permitted to take BCH210H1 until a final passing mark appears on the transcript.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

BCH441H1 F
Bioinformatics

I-AEMINBIO
This course covers computational methods and internet resources in modern biochemistry and molecular biology. The main topics include: sequence and genome databases, sequence alignment and homology search, use and interpretation of molecular structure, and phylogenetic analysis. Assignments focus on competence building with essential, web-based bioinformatics tools. Tutorials are optional and will be offered based on needs. For curriculum details see: www.biochemistry.utoronto.ca/undergraduates/courses/BCH441H/wiki/
Prerequisite: BCH210H1/BCH242Y1, BCH311H1/ MGY311Y1/(CSB349H1/BIO349H1)/PSL350H1 or special permission

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systems in the healthy and diseased human body. Application of clinical and biomedical engineering tools to model homeostasis and perturbations to normal function.

BME358H1 S
Molecular Biophysics

III,IV-AEESCBASET

Topics to be covered include: review of basic protein structure; molecular forces; thermodynamics of living systems; protein folding, physics of many-particle systems; open systems and chemical thermodynamics; Gibbs free energy and chemical potential; bioenergetics and molecular motors; electrical properties of living cells: Poisson-Boltzmann, membrane potential, cardiac cell and other excitable cells; chemical kinetics and reactions: mechanical properties of biomolecules; molecular manipulation techniques.

BME395H1 F
Biomedical Systems Engineering II: Cells and Tissues

III,IV-AEESCBASET, III,IV-AEESCBASET, I-AEMINBIO

This course focuses on the molecular biology of cells, building on BME105, and their integration into tissues and organs. It covers integrating cells into tissues; molecular genetic techniques; signalling at the cell surface and signalling pathways that control gene activity; integration of signals and gene controls, the eukaryotic cell cycle, cell birth, lineage and death; inflammation, wound healing and immunology. The course will be centered around the problems of tissue engineering and of other medical devices or therapeutic options. There will be considerable emphasis on learning to read the research literature.

BME396H1 S
Biomedical Systems Engineering III: Molecules and Cells

IV-AEESCBASET, III,IV-AEESCBASET, I-AEMINBIO

A quantitative approach to understanding cellular behaviour. Using engineering tools (especially derived from transport phenomena and chemical kinetics) to integrate and enhance what is known about mammalian cell behaviour at the molecular level. Specific topics include: receptor-ligand interactions, cell adhesion and migration, signal transduction, cell growth and differentiation. Examples from gene therapy, and cellular and tissue engineering are used. Prerequisite: BME395H1

BME428H1 F
Biomedical Systems Engineering IV: Computational Systems Biology

IV-AEESCBASET

The objective of this course is to introduce students to current computational methods in molecular biology and dynamic modeling that are used to analyze biological systems with quantitative reasoning. By the end of the course, the student should be able to: describe current methods in computational molecular biology; employ quantitative reasoning to analyze biological systems; analyze large biological datasets using machine learning and statistical methods; apply motif and evolutionary models to genome sequencing; analyze cell signaling networks by systems modelling approaches.
BME440H1 S
Biomedical Engineering Technology and Investigation

IV-AECHEBASC, III, IV-AECPEBASC, III, IV-AEELEBASC, I-AEMINBIO

An introduction to the principles of fundamental technologies used in biomedical engineering research including but not limited to tissue culture, protein assays or colourimetric enzymatic-based assays, spectroscopy, fluorescence microscopy, PCR, electrophoresis, DNA manipulation and transfection. Since these technologies enable the investigation of a wide range of research questions with important clinical implications, the main focus of the course is learning these technologies while subsequent application within the lab will allow evidence-based investigation into specific research questions. Scientific literature (both good and bad) pertaining to each technology will be reviewed as examples of conducting investigations. Prerequisite: CHE353H1, Engineering Biology

BME455H1 F
Cellular and Molecular Bioengineering II

IV-AECHEBASC, III, IV-AECPEBASC, III, IV-AEELEBASC, I-AEMINBIO

Quantitative approach to understanding cellular behaviour. Using engineering tools (especially derived from transport phenomena and chemical kinetics) to integrate and enhance what is known about mammalian cell behaviour at the molecular level. The course combines mathematical modeling with biology and includes numerical methods, factorial design, statistics, empirical models, mechanistic models and mass transfer. Specific topics include: receptor-ligand interactions, cell adhesion and migration, signal transduction, cell growth and differentiation. Examples from gene therapy, and cellular and tissue engineering are used. Prerequisite: CHE353H1 and CHE354H1

BME460H1 F
Biomaterial and Medical Device Product Development

IV-AEESCBASEB, IV-AEESCBASET

The objective of this course is to provide students with strategies by which they can “reverse engineer” medical device products intended for use as implantable devices or in contact with body tissue and fluids. A top-down approach will be taken where the regulatory path for product approval and associated costs with product development and validation are reviewed for different biomaterials and devices. This path is then assessed in the context of product specific reimbursement, safety, competitive positioning and regulatory concerns. Students will be required to use their existing knowledge of biomaterials and biocompatibility to frame the questions, challenges and opportunities with a mind to re-engineering products in order to capitalize on niche regulatory pathways. The resulting regulatory path gives a good idea of the kind of trial design the product must prevail in and ultimately the design characteristics of the device itself. The United States and Europe will be contrasted with respect to both their regulatory environment and reimbursement. Lastly, quantitative product development risks estimates are considered in choosing a product path strategy for proof of concept and approval.

BME479H1 F
Introduction to Biomedical Systems Engineering Design Concepts

IV-AEESCBASET

A seminar to introduce students to concepts in biomedical systems engineering design in preparation for BME489H1 - Biomedical Systems Engineering Design. Review of general design concepts in the context of biodesign practice. Discussion of issues related to biodesign, including regulatory processes, intellectual property, and global health. Students will be introduced to clients, identify a design project, and define their design problem. At the end of the term, students will deliver a draft “elevator pitch” for their project.

BME489H1 S
Biomedical Systems Engineering Design

IV-AEESCBASET

A capstone design project that provides students in the Biomedical Systems Engineering option with an opportunity to integrate and apply their technical knowledge and communication skills to solve real-world biomedical engineering design challenges. Students will work in small groups on projects that evolve from clinical partners, biomedical/clinical research and teaching labs, and commercial partners. At the end of the course, students submit a final design report and a poster for public exhibition.

BME510H1 S
Regenerative Medicine

IV-AEESCBASEB, IV-AEESCBASET, I-AEMINBIO

This course integrates relevant aspects of physiology, pathology, developmental biology, disease treatment, tissue engineering, and biomedical devices. The first part of the course will stress basic principles in each of these disciplines. The second portion of the course will integrate these disciplines in the context of specific organ systems. For example, the physiology of the cardiovascular system, the development of the system, cardiovascular disease, the relationship between developmental defects and adult disease, current disease treatment, cardiovascular devices, and the current progress in cardiovascular tissue engineering will be presented. The teaching material will be gathered from various textbooks and scientific journals. Whenever possible, experts in the relevant field will teach guest lectures. This integrative approach will be reflected by a problem-based learning approach to testing and a written report.

BME595H1 S
Medical Imaging

III, IV-AECPEBASC, III, IV-AEELEBASC, IV-AEESCBASET, IV-AEESCBASEB, I-AEMINBIO

This is a first course in medical imaging. It is designed as a final year course for engineers. It has a physical and mathematical approach emphasizing engineering concepts and design. It describes magnetic resonance and ultrasound and X-ray imaging in detail. These topics allow engineers to apply principles learned in the first two years in: computer fundamentals, dynamics, calculus, basic EM theory, algebra and differential equations, signals systems. It is a depth course complementing the kernels: communication systems (modulation), fields and waves (wave propagation) and on probability and random processes (Poisson and Gaussian noise). It will introduce students to the concept of measurement as an “inverse problem”. The laboratory will involve hands on NMR and Ultrasound measurements as well as image analysis of MRI data.
Cells and Systems Biology

CSB435H1 F
Regulatory Networks and Systems in Molecular Biology

IV-AEESCBASET

This course will expose students to several of the best-understood regulatory networks in molecular biology, as well as recent technological and methodological developments. Emphasis is on the mechanistic basis for these systems, methods and models for quantitative analysis of regulatory networks and the biological logic they encode.

Prerequisite: BCH311H1/CSB349H1/MGY311Y1

Distribution Requirement Status: This is a Science course

Breadth Requirement: Living Things and Their Environment (4)

CSB450H1 S
Proteomics in Systems Biology

IV-AEESCBASET

A discussion on current proteomic approaches to understand biological processes. The role of mass spectrometry, gel electrophoresis, protein-protein interaction and structural biology in understanding how proteins function in pathways and interaction networks will be discussed.

Prerequisite: BIO230H1/BIO240H1,

BIO241H1/BIO250Y1/BIO255H1/BIO255Y1, BCH210H1

Distribution Requirement Status: This is a Science course

Breadth Requirement: Living Things and Their Environment (4)

Chemical Engineering and Applied Chemistry

CHE112H1 F/S
Physical Chemistry

I-AECHEBASC, I-AECIVBASC,

I-AELMEBASC, I-AEMMSBASC

3/1/1/0.50

A course in physical chemistry. Topics discussed include systems and their states, stoichiometry, the properties of gases, the laws of chemical thermodynamics (calculations involving internal energy, enthalpy, free energy, and entropy), phase equilibrium, chemical equilibrium, ionic equilibrium, acids and bases, solutions, colligative properties, electrochemistry, and corrosion.

CHE113H1 S
Concepts in Chemical Engineering

I-AECHEBASC

3/1/3/0.50

This course provides first year students with an overview of the chemical industry, the chemical engineering profession, and introduces key concepts for the upcoming years of study. The chemical industry is the interface between natural resources (minerals, oil, gas, agricultural products, etc.) and the consumers of the higher value products derived therefrom. This diverse industry has both high volume-low unit value and low volume-high unit value products, and the manufacture of each type of product has its own challenges. The chemical engineering profession applies the scientific fundamentals through two key concepts: Unit Operations as well as Flux. The fundamental elements of stoichiometry and reaction kinetics are further extended to cover the concepts of yield, conversion and their specific applications to continuous and batch reactor systems. Analysis of electrical circuits is introduced, leading to nodal analysis of circuits. The application of resistance in series and capacitance is extended into chemical engineering problems involved, heat transfer, mass transfer and momentum transfer, as well as reaction engineering. The laboratory will reinforce these key chemical engineering principles.

CHE204H1 Y
Applied Chemistry III - Laboratory

II-AECHEBASC

This full year laboratory course will survey aspects of inorganic, organic and analytical chemistry from a practical point of view in a comprehensive laboratory experience. Theory, where applicable, will be interwoven within the laboratories or given as self-taught modules. Topics to be covered are inorganic and organic synthesis and analysis and will include elements of process and industrial chemistry and practice (including Green Chemistry).

CHE208H1 F
Process Engineering

II-AECHEBASC

3/-/2/0.50

An introduction to mass and energy (heat) balances in open systems. A quantitative treatment of selected processes of fundamental industrial and environmental significance involving phase equilibria, reaction and transport phenomena under both steady state and unsteady state conditions. Examples will be drawn from the chemical and materials processing industries, the energy and resource industries and environmental remediation and waste management.

Prerequisite: MAT188H1

CHE210H1 S
Heat and Mass Transfer

II-AECHEBASC

3/2/0.50

Fundamentals of heat and transfer, including conduction, convective heat transfer, natural convection, design of heat exchangers, Fick’s law of diffusion, analysis of mass transfer problems using Fick’s law and mass balances, and effect of chemical reactions on mass transfer. Particular attention is focused on convective heat and mass transfer coefficients as obtained in laminar flow, or from turbulent heat transfer correlations and analogies.

Prerequisite: CHE221H1

CHE211H1 F
Fluid Mechanics

II-AECHEBASC

3/-/2/0.50

Fundamentals of fluid mechanics including hydrostatics, manometry, Bernoulli’s equation, integral mass, linear momentum and energy balances, engineering energy equation, Moody chart, pipe flow calculations, flow measurement instruments and pumps, dimensional analysis, differential analysis of laminar viscous flow, and brief introductions to particle systems, turbulent flow, non-Newtonian fluids and flow in porous systems.
CHE213H1 S  
Applied Chemistry II - Organic Chemistry

II-AECHEBASC  
3/-/1/0.50

Topics include the structure, bonding and characteristic reactions of organic compounds including additions, eliminations, oxidations, reductions, radical reactions, condensation/hydrolysis and rearrangements. The chemical relationships and reactivities of simple functional groups are discussed with an emphasis placed on reaction mechanisms involving the formation of organic intermediates, chemicals and polymers. An introduction will be given on biologically relevant compounds such as carbohydrates, proteins, lipids and nucleic acids. Examples will be discussed which outline the usefulness of these reactions and chemicals within the broader chemical industry. Corequisite: CHE204H1Y

CHE220H1 F  
Applied Chemistry I - Inorganic Chemistry

II-AECHEBASC  
3/-/1/0.50

The Chemistry and physical properties of inorganic compounds are discussed in terms of atomic structure and molecular orbital treatment of bonding. Topics include acid-base and donor-acceptor chemistry, crystalline solid state, chemistry of main group elements and an introduction to coordination chemistry. Emphasis is placed on second row and transition metal elements.

CHE221H1 F  
Calculus and Numerical Methods

II-AECHEBASC  
3/2/2/0.50

Introduction to partial differentiation, multiple integrals, vector analysis, and numerical techniques with applications to process calculations, fluid mechanics and other transport phenomena. Topics covered include partial derivatives, chain rule, exact differentials, vector operators, Green’s Theorem, divergence theorem and Stokes’ Theorem. Computer laboratory work involves the application of numerical techniques and computer calculations to chemical engineering problems.

CHE222H1 S  
Applied Differential Equations

II-AECHEBASC  
3/-/2/0.50

Solution of differential equations using the D-operator, Laplace transform methods and vector-matrix techniques. Application of these techniques to problems of chemical engineering interest. Considerable emphasis will be placed on the formulation of the relevant differential equations and the identification of the appropriate boundary conditions. Prerequisite: MAT186H1, MAT187H1

CHE223H1 S  
Statistics

II-AECHEBASC  
3/-/1/0.50

Analysis of data using statistics and design of experiments. Topics include probability, properties of the normal distribution, confidence intervals, hypothesis testing, fitting equations to data, analysis of variance and design of experiments. The tutorial involves, in part, the application of commercial software to interpret experimental data, as obtained in Chemical Engineering laboratories. Prerequisite: MAT186H1, MAT187H1

CHE230H1 S  
Environmental Chemistry

II-AECHEBASC, I-AEMINENV  
3/-/2/0.50

The chemical phenomena occurring in environmental systems are examined based on fundamental principles of organic, inorganic and physical chemistry. The course is divided into sections describing the chemistry of the atmosphere, natural waters and soils. The principles applied in the course include reaction kinetics and mechanisms, complex formation, pH and solubility equilibria and adsorption phenomena. Molecules of biochemical importance and instrumental methods of analysis relevant to environmental systems are also addressed. (formerly EDC230H1S)

CHE249H1 F  
Engineering Economic Analysis

II-AECHEBASC, I-AEMINBUS  
3/-/1/0.50

Engineering analysis and design are not ends in themselves, but they are a means for satisfying human wants. Thus, engineering concerns itself with the materials used and forces and laws of nature, and the needs of people. Because of scarcity of resources and constraints at all levels, engineering must be closely associated with economics. It is essential that engineering proposals be evaluated in terms of worth and cost before they are undertaken. In this course we emphasize that an essential prerequisite of a successful engineering application is economic feasibility. Hence, investment proposals are evaluated in terms of economic cost concepts, including break even analysis, cost estimation and time value of money. Effective interest rates, inflation and deflation, depreciation and income tax all affect the viability of an investment. Successful engineering projects are chosen from valid alternatives considering such issues as buy or lease, make or buy, cost and benefits and funding alternatives. Both public sector and for-profit examples are used to illustrate the applicability of these rules and approaches.

CHE260H1 F  
Thermodynamics and Heat Transfer

II-AEECSBASE, I-AEMINENR  
3/0.50/1/0.50


CHE297Y1 Y  
Seminar Course: Communications Portfolio I

II-AECHEBASC  
-/-/0.25/0.00

Each student will develop a portfolio of communication assignments completed in other university courses. Contents of the portfolio will demonstrate among them a range of skills: individual and group work, written and oral communications; expository, persuasive and research-based writings, and iterative composition. Students will generate a critical reflection on the items included in the portfolio. Those whose communication work is not up to standard will be provided with opportunity for remedial work. The course will allow for integration of communication work across the curriculum. The course will be offered on a credit/no credit basis. Students who receive no credit for this course must retake it in year 3.
Course Descriptions

CHE298H1 F
Communication

II-AECHEBASC
3/-/2/0.25
Each student will make a large number of very short speeches developing skills for speaking to large and small groups. Many elements of public speaking are explored: voice, body language, timing, word selection, speech preparation, speech structure, audience and surroundings. Students will prepare and present overheard speeches. Extemporaneous speeches. Questions and answers. Interviewing.

CHE308H1 F
Chemical Processes for Energy Generation and Storage

IV-AEESCBASEF, III,IV-AEESCBASEJ
3/-/1/0.50
The chemistry and chemical engineering involved in various forms of power generation and storage: alternative liquid fuels, nuclear power, fuel cells, solar cells/photovoltaics. A team-taught course with instruction from leading experts within the Faculty. Lectures will be focused around the presentation and analysis of recent published accounts or a review of the state of the art, while providing the necessary background within each field to enable the students to make objective critiques of the topics discussed. Where applicable, the design of facilities and devices for the forms of generation or storage will be discussed.

CHE311H1 S
Separation Processes

III,IV-AECHEBASC
3/4/2/0.75
Staged equilibrium and rate governed separation processes for gases and liquids. Topics include equilibrium stage calculations, cascade separation, binary distillation, gas absorption and stripping, liquid-liquid extraction, membrane processes, adsorption and ion exchange. Experiments in fluid mechanics, heat transfer and related unit operations.

CHE322H1 S
Process Dynamics and Control

III,IV-AECHEBASC
3/0.25/2/0.50
The major goals of this course are to teach students how to model chemical processes and how to design control strategies for these processes. The first part of the course focuses on the types of interconnections encountered in chemical engineering, namely feedback, parallel and series connections, and their effect on the process dynamics. The second part of the course looks at the design of feedback, feedforward, cascade and multivariable control strategies for these processes and interprets these types of “engineered” interconnections in terms of the effect they have on the performance of the overall system. This course will make extensive use of interactive learning through computer simulation based on the Matlab software package and its associated Simulink block diagram simulation environment.

CHE323H1 F
Engineering Thermodynamics

III,IV-AECHEBASC, I-AEMINENR
3/4/2/0.50
Classical thermodynamics and its applications to engineering processes are introduced. Topics include: the concepts of energy, work and entropy; the first and second laws of thermodynamics; properties of pure substances and mixtures; the concepts of thermal equilibrium, phase equilibrium and chemical equilibrium; and heat engines and refrigeration cycles.

CHE324H1 F
Process Design

III,IV-AECHEBASC
3/4/2/0.75
This course presents the philosophy and typical procedures of chemical engineering design projects. The course begins at the design concept phase. Material and energy balances are reviewed along with the design of single unit operations and equipment specification sheets. The impact of recycles on equipment sizing is covered. Safety, health and environmental regulations are presented. These lead to the development of safe operating procedures. The systems for developing Piping and Instrumentation diagrams are presented. Process safety studies such as HAZOPS are introduced. Typical utility systems such as steam, air and vacuum are discussed. Project economics calculations are reviewed.

CHE326H1 F
Thermodynamics and Kinetics Laboratory

III,IV-AECHEBASC
-/4/-/0.25
This one term laboratory course involves experiments investigating thermodynamics and kinetics, complimenting two courses this term. Thermodynamic experiments include phase equilibrium and calorimetry, and kinetics experiment include investigations of rate constants and Arrhenius behaviour.

CHE332H1 F
Reaction Kinetics

III,IV-AECHEBASC
3/-/2/0.50
The rates of chemical processes. Topics include: measurement of reaction rates, reaction orders and activation energies; theories of reaction rates; reaction mechanisms and networks; development of the rate law for simple and complex kinetic schemes; approach to equilibrium; homogeneous and heterogeneous catalysis. Performance of simple chemical reactor types.

CHE333H1 S
Chemical Reaction Engineering

III,IV-AECHEBASC
3/-/0.50
Covers the basics of simple reactor design and performance, with emphasis on unifying the concepts in kinetics, thermodynamics and transport phenomena. Topics include flow and residence time distributions in various reactor types as well as the influence of transport properties (bulk and interphase) on kinetics and reactor performance. The interplay of these facets of reaction engineering is illustrated by use of appropriate computer simulations.

CHE334H1 F
Team Strategies for Engineering Design

III,IV-AECHEBASC
1/-/2/0.25
In this course, team strategies including how teams work, how to lead and manage teams, and decision making methodologies for successful teams will be taught in the context of engineering design. The development of problem solving and design steps will be undertaken. This course will be taught with an emphasis on team development and problem solving as it relates to the practice of process safety management in engineering and engineering design. The teams will develop a PFD and P&ID’s, as well as an operating procedure for a portion of the process. Thus, environmental and occupational health and safety becomes the vehicle through which the teamwork is performed.
CHE341H1 F
Engineering Materials

This course advances the understanding of the use of materials in engineering design, with special emphasis on corrosion and the effect of chemical environment on long term failure modes. Students will learn how to apply material property data to specify materials for load bearing applications, thermal and other non-structural applications, and chemical containment and transport. Topics will include strength of materials concepts, an introduction to computerized materials databases, material failure modes and criteria, principles of corrosion, and practical applications of corrosion prediction and mitigation. Students are required to design a component of their choice and do a detailed materials selection as a major design project.

CHE353H1 F
Engineering Biology

Using a quantitative, problem solving approach, this course will introduce basic concepts in cell biology and physiology. Various engineering modelling tools will be used to investigate aspects of cell growth and metabolism, transport across cell membranes, protein structure, homeostasis, nerve conduction and mechanical forces in biology. Exclusion: BME105H1

CHE354H1 S
Cellular and Molecular Biology

This course will cover the principles of molecular and cellular biology as they apply to both prokaryotic and eukaryotic cells. Topics will include: metabolic conversion of carbohydrates, proteins, and lipids; nucleic acids; enzymology; structure and function relationships within cells; and motility and growth. Genetic analysis, immunohistochemistry, hybridomics, cloning, recombinant DNA and biotechnology will also be covered. This course will appeal to students interested in environmental microbiology, biomaterials and tissue engineering, and bioproceses. Prerequisite: CHE353H1F

CHE374H1 F
Economic Analysis and Decision Making

Economic evaluation and justification of engineering projects and investment proposals. Cost estimation; financial and cost accounting; depreciation; inflation; equity, bond and loan financing; after tax cash flow; measures of economic merit in the private and public sectors; sensitivity and risk analysis; single and multi-attribute decisions. Introduction to micro-economic. Applications: retirement and replacement analysis; make-buy and buy-lease decisions; economic life of assets; capital budgeting; selection from alternative engineering proposals; production planning; investment selection.

CHE375H1 S
Engineering Finance and Economics

This course consists of three modules: 1) managerial accounting, 2) corporate finance and 3) macro economics. The first module, managerial accounting, will consist of an introduction to financial statements and double entry recordkeeping, then delve deeper into aspects of revenue, expenses, assets, debt and equity. The second module, corporate finance, will introduce the concept of risk and return, and the Capital Asset Pricing Model, and then delve deeper into capital budgeting, corporate financing, financial statement analysis and financial valuation. The third module, macro economics, will introduce global aspects of business, including economic, political, societal and technological, then discuss factors such as GDP, inflation, unemployment, interest rates, foreign exchange rates, fiscal debt/surplus and balance of payments, and their impact on the financials of a given country.

CHE390H1 F
Physical and Inorganic Chemistry

The objective of this course is to introduce fundamental chemistry required in order to understand environmental systems. The chemistry of inorganic compounds will be introduced in terms of atomic orbitals, molecular structure, periodic trends and coordination chemistry. The impact of pH, oxidation potential and complexion on chemical speciation will be described and related to chemistry in natural waters. Intermediate level concepts relevant to chemical kinetics such as rate laws and mechanisms will be presented and applied to photochemistry and atmospheric chemistry. Partitioning in multilayer systems will be discussed with emphasis on adsorption and chemistry in water/soil systems.

CHE391H1 F
Organic Chemistry and Biochemistry

This course examines the sources, structures, properties and reactions of organic chemicals with reference to their interactions with the environment. Industrial organic chemistry, biochemical compounds and relevant biochemical reactions will be discussed.

CHE397Y1 Y
Seminar Course: Communications Portfolio II

This course builds on the work begun in CHE297Y. Each student will develop a portfolio of communication assignments completed in other university courses. Contents of the portfolio will demonstrate among them a range of skills: individual and group work, written and oral communications; expository, persuasive and research-based writings, and iterative composition. Students will generate a critical reflection on the items included in the portfolio. Those whose communication work is not up to standard will be provided with opportunity for remedial work. The course will allow for integration of communication work across the curriculum. Students who complete this course will be prepared to make presentations which are a part of the capstone course, CHE430Y Chemical Plant Design. The course will be offered on a credit/no credit basis. Students who receive no credit for this course must retake it in year 4.
In this course, lectures and seminars will be given by practicing engineers who will cover the legal and ethical responsibility an engineer owes to an employer, a client and the public with particular emphasis on environmental issues.

**CHE412H1 S**  
**Advanced Reactor Design**  
IV-AECHEBASC, IV-AEESCBASEJ  

**CHE430Y1 F**  
**Chemical Plant Design**  
IV-AECHEBASC  
Students work in teams to design plants for the chemical and process industries and examine their economic viability. Lectures concern the details of process equipment and design.  
Prerequisite: CHE249H1, CHE324H1, and two of CHE311H1, CHE322H1, CHE333H1 or equivalent

**CHE451H1 S**  
**Petroleum Processing**  
IV-AECHEBASC, IV-AEESCBASEJ, I-AEMINENV  
This course is aimed at surveying the oil industry practices from the perspective of a block flow diagram. Oil refineries today involve the large scale processing of fluids through primary separation techniques, secondary treating plus the introduction of catalyst for molecular reforming in order to meet the product demands of industry and the public. Crude oil is being shipped in increasing quantities from many parts of the world and refiners must be aware of the properties and specifications of both the crude and product slates to ensure that the crude is a viable source and that the product slate meets quality and quantity demands thus assuring a profitable operation. The course content will examine refinery oil and gas operations from feed, through to products, touching on processing steps necessary to meet consumer demands. In both course readings and written assignments, students will be asked to consider refinery operations from a broad perspective and not through detailed analysis and problem solving.

**CHE462H1 S**  
**Food Engineering**  
IV-AECHEBASC, I-AEMINBIO  
The quantitative application of chemical engineering principles to the large-scale production of food. Food processing at the molecular and unit operation levels. The chemistry and kinetics of specific food processes. The application of chemical engineering unit operations (distillation, extraction, drying) and food specific unit operations such as extrusion, thermal processing refrigeration/freezing.

**CHE466H1 F**  
**Bioprocess Engineering**  
IV-AECHEBASC, IV-AEESCBASEB, I-AEMINBIO, I-AEMINENV  
An introduction to the biological and engineering principles relevant to the processing of biological materials and to processing using biological agents, such as cells, enzymes or antibodies. Topics to be covered include elementary microbiology, enzyme kinetics, immobilization of biocatalysts, bioreactor design/analysis and bioseparation processes.  
Prerequisite: CHE353H1

**CHE467H1 F**  
**Environmental Engineering**  
IV-AECHEBASC, IV-AEESCBASEO, I-AEMINENV  
Core Course in the Environmental Engineering Minor A course which treats environmental engineering from a broad based but quantitative perspective and covers the driving forces for engineering activities as well as engineering principles. Models which are used for environmental impact, risk analysis, health impact, pollutant dispersion, and energy system analysis are covered.

**CHE469H1 S**  
**Fuel Cells and Electrochemical Conversion Devices**  
IV-AECHEBASC, IV-AEESCBASEJ, I-AEMINENV  
The objective of this course is to provide a foundation for understanding the field of electrochemical conversion devices with particular emphasis on fuel cells. The topics will proceed from the fundamental thermodynamic in-system electrodics and ionic interaction limitations to mass transfer and heat balance effects.  
Prerequisite: CHE469H1  
Exclusion: MIE517H1

**CHE470H1 F/S**  
**Special Topics in Chemical Engineering**  
IV-AECHEBASC  
A course covering selected topics in Chemical Engineering, not covered in other electives. Different topics may be covered each year depending on the interest of the Staff and students. May not be offered every year.  
Limited enrolment: permission of the Department required.
CHE471H1 F
Modelling in Chemical Engineering

IV-AECHEBASC, IV-AEESCBASEJ
3/-/1/0.50

This course outlines the methodology for the modelling of physical systems and its applications. Topics will include a review of physical laws, selection of balance space, compartmental versus distributed models, and applications of the conservation laws including force, and energy balances for both discrete and continuous systems at the level of algebraic and ordinary differential equations. The course covers a wide range of applications including environmental issues, biochemical processes, biomedical systems, material science, transport phenomena, and unit operations.

*This course will not be offered in 2011-2012*

CHE561H1 S
Risk Based Safety Management

IV-AECHEBASC, IV-AEESCBASEF
3/-/1/0.50

This course provides an introduction to Process Safety Management. The historical drivers to improve safety performance are reviewed and the difference between safety management and occupational health and safety is discussed. National and international standards for PSM are reviewed. Risk analysis is introduced along with techniques for process hazard analysis and quantification. Consequence and frequency modelling is introduced. Risk based decision making is introduced, and the course concludes with a discussion of the key management systems required for a successful PSM system.

CHE562H1 F
Chemical Properties of Polymers

IV-AECHEBASC, IV-AEESCBASE, IV-AEESCBASET, I-AEMINBIO, IV-AEMMSBASC
3/-/1/0.50

Several methods of polymer synthesis and characterization are discussed. This includes a discussion on the mechanism of step polymerization and chain polymerization by radical or ionic techniques. Further detail is provided on emulsion vs. Solution vs. Bulk polymerization methods and the associated kinetics of polymerization. Several polymer characterization techniques are introduced, including gel permeation chromatography, differential scanning calorimetry, thermal gravimetric analysis, among others. Exclusion: MSE330H1, CHM426H1

CHE564H1 S
Pulp and Paper Processes

IV-AECHEBASC, I-AEMINBIO, I-AEMINENV
3/-/1/0.50

The processes of pulping, bleaching and papermaking are used to illustrate and integrate chemical engineering principles. Chemical reactions, phase changes and heat, mass and momentum transfer are discussed. Processes are examined on four scales: molecular, diffusional, unit operations and mill. In the tutorial each student makes several brief presentations on selected topics and entertains discussion.

CHE565H1 F
Aqueous Process Engineering

IV-AECHEBASC, IV-AEESCBASEJ, IV-AELMEBASC, I-AEMINENV, IV-AEMMSBASC
3/-/1/0.50

Application of aqueous chemical processing to mineral, environmental and industrial engineering. The course involves an introduction to the theory of electrolyte solutions, mineral-water interfaces, dissolution and crystallization processes, metal ion separations, and electrochemical processes in aqueous reactive systems. Applications and practice of (1) metal recovery from primary (i.e. ores) and secondary (i.e. recycled) sources by hydrometallurgical means, (2) treatment of aqueous waste sources by hydrometallurgical means, (2) treatment of aqueous waste streams for environmental protection, and (3) production of high-value-added inorganic materials.
Course Descriptions

CHE568H1 S
Nuclear Engineering

Breadth Requirement: The Physical and Mathematical Universes (5)
Recommended Preparation: CHM317H1
Prerequisite: CHM310H1
Application of theory.
Pressure, degradation rates, partitioning. Lab experiments involve the measurement of pollutants in soil, water, air, and biological tissues. Analysis of environmental samples using chromatography and spectroscopy. The course emphasizes the application of chemical principles to environmental problems.
Exclusion: MIE414H1

CHE575H1 F
Mechanical Properties of Bio-Composites and Biomaterials

Breadth Requirement: The Physical and Mathematical Universes (5)
Recommended Preparation: CHM317H1
Prerequisite: CHM220H1/CHM225Y1, CHM238Y1, CHM325H1
The course provides an overview on mechanical properties of biological materials, biomaterials for biomedical applications, and bio-fibre reinforced composites based on renewable resources with a focus on their viscoelastic and dynamic behaviour. General principles related to elasticity, linear viscoelasticity, and composite reinforcement theory will be introduced. Some testing and measurement techniques for these properties will be also discussed.

Chemistry

CHM325H1 S
Introduction to Inorganic and Polymer Materials Chemistry

Prerequisite: CHM247H1/CHM249H1, CHM220H1/CHM225Y1, CHM210H1
Recommended Preparation: CHM325H1, CHM338H1
Chemical and physical properties of materials. Synthesis and characterization of inorganic and polymer materials. Application of principles to environmental problems.
Exclusion: MIE414H1

CHM410H1 F
Analytical Environmental Chemistry

I-AEMINENV
An analytical theory, instrumental, and methodology course focused on the measurement of pollutants in soil, water, air, and biological tissues and the determination of physical/chemical properties including vapour pressure, degradation rates, partitioning. Lab experiments involve application of theory.
Prerequisite: CHM310H1
Recommended Preparation: CHM317H1
Breadth Requirement: The Physical and Mathematical Universes (5)

CHM415H1 S
Topics in Atmospheric Chemistry

IV-AECHEBASC, I-AEMINENV
This course builds upon the introductory understanding of atmospheric chemistry provided in CHM210H. In particular, modern research topics in the field are discussed, such as aerosol chemistry and formation mechanisms, tropospheric halogen chemistry, the chemistry of climate including cloud formation and geoengineering, biosphere-atmosphere interactions, the chemistry of remote environments, air pollution health effects. Reading is from the scientific literature; class discussion and presentations are emphasized.
Prerequisite: (CHM220H1/CHM225Y1),CHM210H1
Recommended Preparation: PHY138Y1/PHY140Y1/(PHY131H1, PHY132H1)/(PHY151H1, PHY152H1)
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

CHM426H1 F
Polymer Chemistry

IV-AEESCBASEO
Prerequisite: CHM220H1/CHM225Y1, CHM247H1/CHM249H1
Recommended Preparation: CHM325H1
Breadth Requirement: The Physical and Mathematical Universes (5)

CHM434H1 F
Advanced Materials Chemistry

IV-AEESCBASEO
A comprehensive investigation of synthetic methods for preparing diverse classes of inorganic materials with properties intentionally tailored for a particular use. Begins with a primer on solid-state materials and electronic band description of solids followed by a survey of archetypical solids that have had a dramatic influence on the materials world, some new developments in materials chemistry and a look at perceived future developments in materials research and technology. Strategies for synthesizing many different classes of materials with intentionally designed structures and compositions, textures and morphologies are then explored in detail emphasizing how to control the relations between structure and property of materials and ultimately function and utility. A number of contemporary issues in materials research are critically evaluated to appreciate recent highlights in the field of materials chemistry - an emerging sub-discipline of chemistry.
Prerequisite: CHM325H1, CHM338H1
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

CHM446H1 S
Organic Materials Chemistry

IV-AEESCBASEO, I-AEMINBIO
This course covers design, synthesis, characterization and application of organic materials. Emphasis is placed on classic examples of organic materials including semiconducting polymers, molecular devices, self-assembled systems, and bioconjugates, as well as recent advances from the literature.
Prerequisite: CHM247H1/CHM249H1, CHM220H1/CHM225Y1
Recommended Preparation: CHM325H1, CHM342H1/CHM343H1, CHM346H1
Distribution Requirement Status: This is a Science course
Civil Engineering

CIV100H1 F
Mechanics


The principles of statics are applied to composition and resolution of forces, moments and couples. The equilibrium states of structures are examined. Throughout, the free body diagram concept is emphasized. Vector algebra is used where it is most useful, and stress blocks are introduced. Stress force diagrams, bending moment diagrams and stress-strain relationships for materials are discussed. Stress and deformation in axially loaded members and flexural members (beams) are also covered.

Prerequisite: CME210H1.

CIV102H1 F
Structures and Materials - An Introduction to Engineering Design

I-AEESCBASC

An introduction to the art and science of designing structures. Topics include: 1) material bodies that sustain or resist force, work, energy, stress and strain; 2) the properties of engineering materials (strength, stiffness, ductility); 3) simple structural elements; 4) engineering beam theory; 5) stability of columns; 6) the practical problems which constrain the design of structures such as bridges, towers, pressure vessels, dams, ships, aircraft, bicycles, birds and trees; and 7) design methods aimed at producing safe, functional, efficient and elegant structures.

Prerequisite: CHE112H1.

CIV201H1 F
Introduction to Civil Engineering

II-AECIVBASC

A field-based course introducing students to current and historical civil engineering works in the urban and natural environments, highlighting the role of the Civil Engineer in developing sustainable solutions. It will run the Tuesday through Thursday immediately following Labour Day, with follow-up assignments coordinated with the course CIV282 Engineering Communications I. Students must have their own personal protective equipment (PPE). One night will be spent at the University of Toronto Survey Camp near Minden, Ontario.

Prerequisite: CME210H1.

CIV209H1 S
Civil Engineering Materials

II-AECIVBASC

Deals with the basic principles necessary for the use and selection of materials used in Civil Engineering and points out the significance of these in practice. Fundamentals which provide a common basis for the properties of various materials are stressed. The laboratory time is devoted to demonstrations illustrating the fundamentals covered in lectures.

CIV214H1 S
Structural Analysis I

II-AECIVBASC

This course provides an introduction to the nature of loads and restraints and types of structural elements, and then reviews the analysis of statically determinate structures. Shear and moment diagrams for beams and frames are considered, along with influence lines, cantilever structures, three-pin arches, cables and fatigue. Virtual work principles are viewed and applied to various structural systems. An introduction to the analysis of indeterminate structures is made, and the Portal method is applied to the analysis of building frames under lateral loads. Displacement methods of an analysis including moment distribution are also studied.

Prerequisite: MAT188H1, CIV210H1/CME210H1

CIV220H1 F
Urban Engineering Ecology

II-AECIVBASC, III, IV-AECPHEBASC, III, IV-AELEBASC, III, IV-AEINDBASC, III, IV-AEMEBASC, I-AEINENV


Prerequisite: CHE112H1.
Exclusion: EDV220H1

CIV235H1 S
Civil Engineering Graphics

II-AECIVBASC

Fluency in graphical communication skills as part of the civil engineering design process is emphasized. Drawings are prepared making use of freehand sketching, drafting equipment and commercially available computer drafting programs. Topics in descriptive geometry are covered to develop spatial visualization skills. Drawing procedures and standards relevant to Civil Engineering projects to be covered include layout and development of multiple orthographic views, sectional views, dimensioning, and pictorial views. Class projects, assignments and lecture examples demonstrate how graphical skills fit into the overall design process.

CIV250H1 S
Hydraulics and Hydrology

II-AECIVBASC

The hydrologic processes of precipitation and snowmelt, evapotranspiration, ground water movement, and surface and subsurface runoff are examined. Water resources sustainability issues are discussed, including water usage and water shortages, climate change impacts, land use impacts, and source water protection. Conceptual models of runoff and basics of hydrologic modelling are developed, including runoff hydrographs, the unit hydrograph method and the Rational method. Methods for statistical analysis of hydrologic data, concepts of risk and design, and hydrological consequences of climate change for design are introduced. Principles of open channel hydraulic...
Course Descriptions

are applied to design of lined and unlined channels. Energy and momentum principles are studied with application to channel transitions, critical flow, choked flow, hydraulic jumps, and gradually varied flow. Methods for natural channel design and channel restoration are examined.

Exclusion: EDV250H1.

CIV280H1 F Management of Construction 3/-/2/0.50

II-AECIVBASC, IV-AEESCBASEI
An introduction to the management of construction projects including: the nature of the industry, project delivery alternatives, legal and ethical considerations, the Safety Act and construction regulations, labour relations, construction contracts, risk distribution, project planning and scheduling, estimating and bidding, controlling of time, cost and quality, accounting leading to financial statements, dispute resolution, as well as new and evolving concepts in managing construction.

Exclusion: CIV320H1.

CIV282H1 F Engineering Communications I 1/-/1/0.20

II-AECIVBASC
This course develops students’ communications skills focusing on the specific skills required for work in foundational civil engineering. Target communication areas include: Oral Presentation; Logical Argument; Document Preparation; Sentence and Discourse Control; and Visual Design. The course will build capacity in support of specific assignments delivered in other courses in the same term.

CIV300H1 F/S Terrestrial Energy Systems 3/-/2/0.50

IV-AECEBASC, IV-AECIVBASC, III,IV-AEEPEBASC, IV-AEESCBASEF, III,IV-AEINDBASC, III,IV-AEMECBASC, I-AEMINER, I-AEMINENV
Core Course in the Sustainable Energy Minor Various earth systems for energy transformation, storage and transport are explored. Geological, hydrological, biological, cosmological and oceanographic energy systems are considered in the context of the Earth as a dynamic system, including the variation of solar energy received by the planet and the redistribution of this energy through various radiative, latent and sensible heat transfer mechanisms. It considers the energy redistribution role of large scale atmospheric systems, of warm and cold ocean currents, the role of the polar regions, and the functioning of various hydrological systems. The contribution and influence of tectonic systems on the surface systems is briefly introduced, as well the important role of energy storage processes in physical and biological systems, including the accumulation of fossil fuel reserves.

Exclusion: EDV300H1.

CIV301H1 S Design of Hydro and Wind Electric Plants 3/-/2/0.50

IV-AEESCBASEF, III,IV-AEESCBASEJ
Introduction to the applications of turbo-machinery. Description of typical wind and hydroelectric plants; different types of turbo-machines. Fundamental fluid mechanics equations, efficiency coefficients, velocity triangles, characteristic curves, similarity laws, specific speed, vibration, cavitation of hydraulic turbines, pump/turbines; variable speed machines. Estimation of main dimensions of machine units, machine house, waterways, electrical and civil structure; transients and stability. Layout of electric and storage plants. Major and auxiliary equipments and systems. Small and mini plants. Case studies.

Exclusion: EDV901H1.

CIV312H1 F Steel and Timber Design 3/-/2/0.50

III,IV-AECIVBASC
An introduction to structural engineering design. Topics discussed include safety and reliability, load and resistance, probability of failure, performance factors, and material properties. A study of basic steel design examines tension members, compression members, beams, framing concepts and connections. Plasticity and composite action in steel structural systems are also discussed. Timber design aspects include beams, compression members and connections.

Prerequisite: CIV214H1, CIV235H1.

CIV313H1 S Reinforced Concrete I 3/-/2/0.50

III,IV-AECIVBASC
An introduction to the design of reinforced concrete structures. Concrete technology, properties of concrete and reinforcing steel, construction practice, and general code requirements are discussed. Analysis and design of members under axial load, flexure, shear, and restraint force are examined in detail. Other aspects of design covered include control of cracks, minimum and maximum reinforcement ratios, fire resistance, durability, distress and failure, and design of formwork and shoring.

Prerequisite: CIV312H1.

CIV321H1 F Transportation I - Introduction to Urban Transportation Systems 3/-/1/0.50

III,IV-AECIVBASC, IV-AELMEBASC
Building on CME321, more complex aspects of geotechnical analysis and design are considered. Soil identification and classification and laboratory- and field-based soil index tests; correlations of index test results to engineering properties. Coupled shear and volume change, soil deformations; serviceability limit state design of shallow and deep foundations, bored excavations. Soil-structure interaction; tie backs and reinforced earth. Laboratories for soil identification and classification, confined triaxial compression (drained and undrained tests), and reinforced earth model.

Prerequisite: CIV321H1 or CME321H1.

Exclusion: CIV424H1.

CIV324H1 S Geotechnical Engineering II 3/1/1/0.50

III,IV-AECIVBASC, IV-AELMEBASC
Building on CME321, more complex aspects of geotechnical analysis and design are considered. Soil identification and classification and laboratory- and field-based soil index tests; correlations of index test results to engineering properties. Coupled shear and volume change, soil deformations; serviceability limit state design of shallow and deep foundations, bored excavations. Soil-structure interaction; tie backs and reinforced earth. Laboratories for soil identification and classification, confined triaxial compression (drained and undrained tests), and reinforced earth model.

Prerequisite: CIV321H1 or CME321H1.

Exclusion: CIV424H1.

CIV331H1 F Transport I - Introduction to Urban Transportation Systems 3/-/1/0.50

III,IV-AECIVBASC
This course introduces the fundamentals of transportation systems and the application of engineering, mathematical and economic concepts and principles to address a variety of transportation issues in Canada. Several major aspects of transportation engineering will be addressed, including transportation planning, public transit, traffic engineering, geometric design, pavement design and the economic, social and environmental impacts of transportation. The course focuses on urban transportation engineering problems.
CIV332H1 S
Transport II - Performance
 III,IV-AECIVBASC
 3/-/1/0.50
This course focuses on the fundamental techniques of transportation systems performance analysis with emphasis on congested traffic networks. Topics include transportation demand, supply and equilibrium, traffic assignment, network equilibrium, and system optimality, traffic flow theory, shockwaves, highway capacity analysis, introduction to deterministic and stochastic queuing analyses, intersection signal control types and related timing methods, and traffic simulation. The course also provides an introduction to basic elements of Intelligent Transportation Systems (ITS).

CIV340H1 S
Municipal Engineering
 III,IV-AECIVBASC
 3/-/2/0.50
Municipal service systems for water supply and wastewater disposal, land development, population forecasting, and demand analysis. Water supply: source development, transmission, storage, pumping, and distribution networks. Sewerage and drainage, sewer and culvert hydraulics, collection networks, and storm water management. Maintenance and rehabilitation of water and wastewater systems, and optimization of network design. Design projects. Prerequisite: EDV250H1 or CIV250H1.

CIV342H1 F
Water and Wastewater Treatment Processes
 IV-AECEHBASEC, III,IV-AECIVBASC,
I-AEMINBIO, I-AEMINENV
 3/1/-/0.50
Principles involved in the design and operation of water and wastewater treatment facilities are covered, including physical, chemical and biological unit operations, advanced treatment and sludge processing. Exclusion: CIV354H1

CIV352H1 F
Structural Design I
 IV-AEESCBASEF, III,IV-AEESCBASEI
 3/-/2/0.50
The course covers the analysis of determinate and indeterminate structures, with application of the principles to the design of steel bridges. The nature of loads and structural safety is considered, with reference to the Canadian Highway Bridge Design Code. Shear and bending moment diagrams for beams and frames are reviewed, as is the deflection of beams (by various methods) and the deflection of trusses. Classical bridge types, such as arches, trusses and suspension bridges are analyzed. Analysis tools studied include: Influence Lines, virtual work, fatigue, displacement methods for the analysis of indeterminate structures (including moment distribution for continuous beams), plus solution by computer frame analysis programs. The behaviour and design of basic steel members covers: tension members, compression members, beams, beam-columns and simple connections. Plastic analysis is introduced and applied to continuous beams. The expertise gained in structural analysis and steel design is then applied in a steel bridge design project. Prerequisite: CIV102H1 or equivalent.

CIV355H1 F
Urban Operations Research
 III,IV-AEESCBASEI
 3/-/2/0.50
This course focuses on quantitative methods and techniques for the analysis and modelling of urban transportation and service systems. Major topics include probabilistic modelling, queueing models of transport operations, network models, mathematical programming and simulation. The application of these methods to modeling various components of the urban transportation system (including road, transit and pedestrian facilities) and to the planning and design of logistically-oriented urban service systems (e.g., fire and police departments, emergency medical services, etc.) is emphasized.

CIV357H1 S
Structural Design 2
 IV-AEESCBASEF, III,IV-AEESCBASEI
 3/-/2/0.50
Building on the "Structural Design I" course, further analysis tools for indeterminate structural systems are studied with generalized flexibility and stiffness methods. Loadings due to force, support displacement, temperature change and member prestrain are covered. Timber design aspects include material properties, beams, compression members and simple connections. The behaviour and design of basic reinforced concrete elements covers concrete properties and members under axial load, shear and bending. Other practical aspects of design incorporated are crack control, minimum and maximum reinforcement ratios, durability, formwork and shoring. The aptitude for structural analysis and concrete design is then tested in a low-rise, reinforced concrete building design project. Prerequisite: CIV352H1

CIV359H1 S
Intelligent Transportation Systems
 IV-AEESCBASEF, III,IV-AEESCBASEI
 3/-/1/0.50
This course focuses on modern techniques to optimize the performance of a transportation system with emphasis on traffic networks in congested urban areas. The course introduces the broad components of Intelligent Transportation Systems then moves into more in-depth analysis of advanced traffic management and information systems as a core component of ITS. The course covers both basic fundamentals as well as advanced techniques. Topics include history of ITS, ITS user services and subsystems, ITS interoperability and system architecture, enabling technologies for ITS, introduction to telecommunication technologies for ITS, introduction to control theory for transportation systems, traffic flow modeling, static and dynamic transportation network analysis, incident detection, freeway control, and surface street network control. Some advanced topics such as the use of artificial intelligence in ITS will also be introduced.

CIV367H1 F
Building Science
 IV-AECEHBASEC, III,IV-AECIVBASC,
I-AEMINENR, I-AEMINENV
 3/1/-/0.50
The fundamentals of the science of heat transfer, moisture diffusion, and air movement are presented. Using these fundamentals, the principles of more sustainable building enclosure design, including the design of walls and roofs are examined. Selected case studies together with laboratory investigations are used to illustrate how the required indoor temperature and moisture conditions can be maintained using more durable and more sustainable designs. Exclusion: CIVS75H1.

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CIV380H1 S
Sustainable Energy Systems

III, IV-AECIVBASC, IV-AEESCBASEI
3/-/1/0.50
This course will provide students with knowledge of energy demand and supply from local to national scales. Topics include energy demands throughout the economy, major energy technologies, how these technologies work, how they are evaluated quantitatively, their economics and their impacts on the environment. In addition, the ever changing context in which these technologies (and emerging technologies) are being implemented will be outlined. Systems approaches including life cycle assessment, will be refined and applied to evaluate energy systems. A particular focus will be placed on analysis of energy alternatives within a carbon constrained economy.
Prerequisite: CIV375H1, CIV220H1.
Corequisite: CME368H1

CIV382Y1 Y
Civil Engineering Communication Portfolio

III, IV-AECIVBASC
-/-/0.25/0.00
Students will assemble a portfolio of communication assignments drawn from their second and third year Civil Engineering courses as a showcase of their ability to meet the graduate attributes for communication. The student will demonstrate competence in discipline specific written, oral, and visual communication through the selection of assignments for the portfolio. Each entry will be framed by a short introduction speaking to the context of the work and its significance in the portfolio. Students whose communication work is not up to standard will be provided with opportunities for revision. The course will be offered on a credit/no credit basis; students who receive no credit must retake the course in year 4.

CIV416H1 F
Reinforced Concrete II

IV-AECIVBASC, IV-AEESCBASEI
3/-/2/0.50
This course covers the behaviour and ultimate strength of reinforced concrete structures. Members subjected to flexure, axial load, shear and torsion are treated. Detailing of reinforcement, the design of floor systems and the design of shear walls are covered. An introduction to the seismic design of reinforced concrete structures is made. Emphasis is given to the relationship between recent research results and current building codes. A brief treatment of the behaviour and design of masonry walls is included.
Prerequisite: CIV313H1.

CIV420F1 F
Construction Engineering

IV-AECIVBASC
3/-/2/0.50
This course considers the engineering aspects of construction including earthmoving, equipment productivity, fleet balancing, formwork design, shoring, hoisting, aggregate production, equipment operating costs, and modular construction. Several construction projects will be reviewed to demonstrate methods and processes. Students will be expected to visit construction sites, so safety boots and hard hats are required.

CIV440H1 S
Environmental Impact and Risk Assessment

IV-AECHEBASC, IV-AECIVBASC, IV-AEESCBASEF, IV-AEESCBASEJ, IV-AELMEBASC, IV-AEMECBASC, I-AEMINENR, I-AEMINENV
3/-/1/0.50
Core Course in the Environmental Engineering Minor. The process and techniques for assessing and managing the impacts on and risks to humans and the ecosystem associated with engineered facilities, processes and products. Both biophysical and social impacts are addressed. Topics include: environmental assessment processes; environmental legislation; techniques for assessing impacts; engineering risk analysis; health risk assessment; risk management and communication; social impact assessment; cumulative impacts; environmental management systems; the process of considering alternative methods for preventing and controlling impacts; and stakeholder involvement and public participation. Examples are drawn from various engineering activities and facilities such as energy production, chemical production, treatment plants, highways and landfills.

CIV455H1 F
Collaborative Design Project I

IV-AEESCBASEI
1/3/-/0.50
The first of two integrated design project courses that are focussed on a single problem that has both transportation and structural design elements. This course emphasizes transportation engineering design. However, consideration of structural engineering aspects are included, in preparation for the second course in the series. Emphasis is on an integrated design process from conceptual design through to a constructible plan which addresses the functional, economic, aesthetic and environmental aspects of the problem.

CIV456H1 S
Collaborative Design Project II

IV-AEESCBASEI
1/3/-/0.50
The second of two integrated design project courses that are focussed on a single problem that has both transportation and structural design elements. This course emphasizes structural engineering design. However, consideration of transportation engineering aspects are included, which are related to the first course in the series. Emphasis is on an integrated design process from conceptual design through to a constructible plan which addresses the functional, economic, aesthetic and environmental aspects of the problem.
Prerequisite: CIV455H1

CIV460H1 F
Engineering Project Finance and Management

IV-AEESCBASEF, IV-AEESCBASEI
3/-/1/0.50
This course deals with the structuring, valuing, managing and financing of infrastructure projects. The financing portion builds on material covered in Engineering Economics. Key topics include: structuring projects, valuing projects, the rationale for project financing (types of funds and financing), project viability and financial modeling, risk analysis, externalities and social cost benefit analyses. Financing of large scale projects by the public and private sectors as well as through public/private partnerships is treated in detail. Project management concepts, issues, and procedures are introduced. A series of case studies analyzing both successful and unsuccessful projects are examined.
Enrolment Limits: Civil Engineering students may take this course with prior permission from the Division of Engineering Science and the Department of Civil Engineering.
**Course Descriptions**

**CIV477H1 F/S**  
Special Studies in Civil Engineering  
IV-AECIVBASC  
3/-/1/0.50  
A course covering selected topics in Civil Engineering not covered in other electives. The topics, which may be different every year, are selected by Staff. Course may not be offered every year and there may be limited enrolment in particular years.  
Enrolment Limits: Permission of the Department of Civil Engineering is required.

**CIV488H1 S**  
Entrepreneurship and Business for Engineers  
I-AEMINBUS  
3/-/2/0.50  
A complete introduction to small business formation, management and wealth creation. Topics include: the nature of the Entrepreneur and the Canadian business environment; business idea search and Business Plan construction; Buying a business, franchising, taking over a family business; Market research and sources of data; Marketing strategies promotion, pricing, advertising, electronic channels and costing; The sales process and management, distribution channels and global marketing; Accounting, financing and analysis, sources of funding, and financial controls; The people dimension: management styles, recruiting and hiring, legal issues in employment and Human Resources; Legal forms of organization and business formation, taxation, intellectual property protection; the e-Business world and how businesses participate; Managing the business: location and equipping the business, suppliers and purchasing, credit, ethical dealing; Exiting the business and succession, selling out. A full Business Plan will be developed by each student and the top submissions will be entered into a Business Plan competition with significant cash prices for the winners. Examples will be drawn from real business situations including practicing entrepreneurs making presentations and class visits during the term. (Identical courses are offered in other Departments: MSE488H1, MIE488H1, ECE488H1 and CHE488H1.)  
Exclusion: APS234H1, APS432H1.

**CIV498H1 S**  
Group Design Project  
IV-AECIVBASC  
3/-/2/0.50  
The Group Design Project is a significant design experience that integrates the mathematics, basic sciences, engineering sciences, complementary studies, and detailed design aspects of the different civil engineering sub-disciplines.  
Prerequisite: CIV497H1.

**CIV499H1 F/S**  
Individual Project  
IV-AECIVBASC  
3/-/2/0.50  
Individual Projects are arranged between the student and a supervising faculty member. The individual project can have either a design project focus or a research focus. If the focus is on design then the design project can be either motivated by the CIV498H1 Group Design Project experience, or it can be entirely new. The student’s work must culminate in a final design report or a thesis, as well as an oral presentation. The grading of both the final written submission as well as the oral presentation is carried out by the supervising faculty member. The Individual Project may be undertaken in either the Fall (F) or Winter (S) Session, but not both (i.e., the Individual Project carries a maximum weight of 0.5; it cannot be made into a full year course)

**CIV501H1 S**  
Solid Mechanics II  
IV-AECIVBASC, IV-AEESCBASEI  
3/-/2/0.50  
This course provides a continuing study of the mechanics of deformable solids. Stress and equilibrium conditions, strain and compatibility conditions, stress-strain relations and yield/failure criteria are considered in the context of civil engineering materials. Two-and three-dimensional elasticity theory is developed, with an introduction to the use of tensor notation. Advanced topics in bending, shear and torsion of beams are also covered, as is elementary plate bending theory. The course concludes with a further development and application of energy methods including virtual work, potential energy, strain energy, and related approaches.  
Prerequisite: CIV210H1 or CME210H1.

**CIV513H1 S**  
Collaborative Engineering and Architectural Design Studio  
1/5/-/0.50  
Engineering and Architecture students are paired to form a design team for a specified building design project. Lectures are given on design development, aspects of structural system design, the relationship of structure to program and function, modeling and drawing, digital modeling, as well as topics related to the specific term design project. Studio design experience to familiarize students with both the synergistic and divergent goals of the engineering and architectural design and to develop collaboration skills for optimizing the outcome of the interdisciplinary professional interaction. Architecture students in this joint studio are enrolled in ARC3016Y S.  
Prerequisite: CIV313H1/CIV352H1, CIV357H1.  
Enrolment Limits: Enrolment will be limited to students enrolled in the Yolles Design section of CIV498H. Graduate students may take this course by application only.

**CIV514H1 F**  
Concrete Technology  
IV-AECIVBASC, IV-AEESCBASEI  
3/-/2/0.50  
Material aspects of concrete production will be dealt with in the context of various performance criteria with emphasis on durability. The process of material selection, proportioning, mixing, transporting, placing and curing concrete will be the framework within which topics such as: the use of admixtures, choice of cements, environmental influences, methods of consolidation and testing techniques will be studied.

**CIV515H1 F**  
Introduction to Structural Dynamics  
IV-AECIVBASC, IV-AEESCBASEI  
3/-/1/0.50  
The concept of dynamic equilibrium and corresponding equation of motion will be introduced. The theoretical solution of a sngle degree of freedom system will be derived and the effects of various types of loads, such as impulse load, sinusoidal load, or random vibration on the structural response will be discussed. To solve dynamic problems of multi-degree of freedom (MDOF) systems, concepts of mass, stiffness, and damping matrix will be introduced, which will be followed by eigen value analysis and modal analysis. The concepts of Fourier Transformation will be introduced, which will be used to interpret dynamic responses of structures or dynamic nature of applied loads. Dynamic experiments of elastic systems will be demonstrated using an educational shaking table.  
Prerequisite: CIV312H1 and CIV313H1 or equivalent.

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Course Descriptions

CIV516H1 S
Public Transit Operations and Planning
IV-AECIVBASC, IV-AEESCBASEI, III, IV-AEESCBASEI
3/-/1/0.50
This course covers a broad range of topics in urban transit operations and planning, with special emphasis on best-practice strategies of modern transit systems. The course will help students: Learn the history of transit and its relationship to urban development, emerging challenges, transit role in society, and new trends and issues; Understand and analyze the factors that affect transit performance and demand; Identify and analyze transit operational and planning problems; Identify possible solutions at the operational level (mostly short-term and line-based) and the strategic level (mostly long-term and network-based), and assess alternative solutions; Understand the relative performance of various transit modes (both conventional and new modes) and their domains of application; and gain knowledge of best-practice transit systems planning and emerging innovations.

CIV517H1 F
Prestressed Concrete
IV-AECIVBASC, IV-AEESCBASEI
3/-/-/0.50
An introduction to procedures for predicting the load-deformation response of prestressed concrete elements and structures with emphasis on how these procedures can be used in the design of new structures and in the evaluation of existing structures. Topics include: prestressing technology; control of cracking; response to axial load and flexure; response to shear and torsion; disturbed regions; restraint of deformations; design codes. Prerequisite: CIV313H1 or CIV357H1 or equivalent.

CIV518H1 S
Behaviour and Design of Steel Structures
IV-AECIVBASC, IV-AEESCBASEI
3/-/2/0.50
The behaviour and design of trusses, frames, members and connections in steel building and bridge structures is presented and design methods are developed. Ultimate strength, stability, and postbuckling are emphasized in topical examples including: plate girders, composite steel/concrete girders, second-order frame behaviour, high-strength bolted and welded framing connections. Design applications considering metal fatigue and brittle fracture, and methods of plastic analysis are also introduced. Canadian design standards and the Limit States Design concepts are used.

CIV519H1 F
Structural Analysis II
IV-AECIVBASC
3/-/2/0.50
The general flexibility and stiffness methods of analysis; multispans beams, trusses, frames and grids; loadings due to force, support displacement, temperature change and member prestrain; axial and flexural stability; basic plasticity. Topics in this course represent the basis for the finite element method of analysis. Prerequisite: CIV214H1.

CIV521H1 F
Rock Mechanics
IV-AECIVBASC
3/-/1/-0.50
This course provides general analytical tools and experimental methods that are used in rock mechanics. The lectures are complemented with laboratory experiments. Theoretical topics include: stress and strain, linear elasticity, failure modes and models of rocks, fracture of rocks, inelastic behavior of rock, seismic waves in rocks. Experiments include: preparation of rock samples, uniaxial compressive strength measurements, Brazilian disc tests for rock tensile strength, fracture toughness measurements with core-based rock samples. Prerequisite: CIV210H1/CME210H1

CIV523H1 S
Geotechnical Design
IV-AECIVBASC, IV-AEESCBASEI, IV-AELMEBASC
3/-/1/0.50
This course is built around a transportation project that contains all the essential geotechnical investigation and design elements and illustrates how they all come together on a project. The students will be taken through the entire design process from project initiation to construction. In essence, the project will include a bridge over a river with some property constraints requiring the use of a retaining wall as well as deep and shallow foundations and some groundwater control. The highway will require a soil cut. One section crosses a low-lying swampy area that will require embankment construction over deep soft soils. A short tunnel section is planned beneath a railway that cannot be taken out of service. A pavement design will be required along the entire route as well as materials testing and construction monitoring. Prerequisite: CIV321H1/CME321H1; equivalent or permission of instructor

CIV531H1 F
Transport Planning
IV-AECIVBASC, IV-AEESCBASEI, III, IV-AEESCBASEI, I-AEMINENR, I-AEMINENV
3/-/1/0.50
This course is intended to provide the student with the following: the ability to design and execute an urban transportation planning study; a working knowledge of transportation planning analysis skills including introductions to travel demand modelling, analysis of environmental impacts, modelling transportation - land use interactions and transportation project evaluation; an understanding of current transportation planning issues and policies; and an understanding of the overall process of transportation planning and its role within the wider context of transportation decision-making and the planning and design of urban areas. Person-based travel in urban regions is the focus of this course, but a brief introduction to freight and intercity passenger transportation is also provided. A “systems” approach to transportation planning and analysis is introduced and maintained throughout the course. Emphasis is placed throughout on designing transportation systems for long-run environmental, social, and economic sustainability. Prerequisite: CIV368H1 / CME368H1.

CIV541H1 S
Environmental Bioengineering
IV-AECIVBASC, I-AEMINBIO, I-AEMINENV
3/-/-/0.50
Principles involved in the design and operation of biologically-based treatment facilities are covered with considerations for energy efficiency and sustainability. The course includes water/wastewater biological unit operations, advanced treatment, sludge processing and composting, natural treatment systems and specialized bioengineered systems such as groundwater remediation and biological air treatment. Prerequisite: CIV342H1 or equivalent.
CIV549H1 F
Groundwater Flow and Contamination 3/-/1/0.50

IV-AECHEBASC, IV-AEIVBASC, IV-AELMEBASC, I-AEMINENV

CIV550H1 F
Water Resources Engineering 3/-/2/0.50

IV-AECHEBASC, IV-AEIVBASC, I-AEMINENV

CIV575H1 F
Studies in Building Science 3/-/2/0.50

IV-AEEESCBASE, IV-AEESCBASEJ
This course examines the basic principles governing the control of heat, moisture and air movement in buildings and presents the fundamentals of building enclosure designs. With this background, students are required to research advanced topics related to emerging areas of Building Science, and to write and present to the class an individual comprehensive paper related to their research. Lectures for this course will be jointly offered with those of CIV375H1. Exclusion: CIV375H1.

CIV576H1 S
Sustainable Buildings 3/-/1/0.50

IV-AEIVBASC, IV-AEEESCBASE, IV-AEEESCBASEJ, I-AEMINENV
Building systems including the thermal envelope, heating and cooling systems, as well as water and lighting systems are examined with a view to reducing the net energy consumed within the building. Life-cycle economic and assessment methods are applied to the evaluation of various design options including considerations of embodied energy and carbon sequestration. Green building strategies including natural ventilation, passive solar, photovoltaics, solar water heaters, green roofs and geothermal energy piles are introduced. Following the application of these methods, students are introduced to efficient designs including LEED designs that lessen the impact of buildings on the environment. Exemplary building designs will be presented and analyzed. Prerequisite: CIV375H1/CIV575H1 or equivalent

CIV577H1 S
Infrastructure for Sustainable Cities 3/-/1/0.50

IV-AEIVBASC, IV-AEEESCBASEI, I-AEMINENV
Developing infrastructure for sustainable cities entails understanding the connection between urban morphology and physiology. This course uses a systems approach to analyzing anthropogenic material flow and other components of urban metabolism, linking them to the design of urban infrastructure. Elements of sustainable transportation, green buildings, urban climatology, urban vegetation, water systems and local energy supply are integrated in the design of sustainable urban neighbourhoods. Prerequisite: CIV340H1, [CIV375H1/CIV575H1], CIV531H1.

CIV1171H S
Principles of Earthquake Engineering and Seismic Design 3/-/-/-/-0.50

IV-AEEESCBASEI
The response of civil engineering structures to various time-dependent disturbances is studied. Multi-degree of freedom structures are examined with a view to the simplification of their analyses by reduction to as few degrees of freedom as is warranted. Response into the inelastic range of material resistance is considered. Matrix optimisation of analysis is used whenever advantageous and typical problems are solved with the aid of electronic computers. Enrolment Limits: This course may be taken by Civil Engineering students with prior permission of the Division of Engineering Science and the Department of Civil Engineering.

CIV1174H S
Finite Element Methods in Structural Mechanics 3/-/-/-/-0.50

IV-AEEESCBASEI
Review of required mathematical concepts. Thorough development of the displacement method of finite element analysis. Derivation of the element matrices for planes stress and strain, three dimensional, axisymmetric and plate bending elements. Introduction to nonlinear analysis. Application to structures using existing computer capabilities. Prerequisite: CIV519H1 or equivalent. Enrolment Limits: This course may be taken by Civil Engineering students with prior permission of the Division of Engineering Science and the Department of Civil Engineering.

Civil and Mineral Engineering

CME185H1 S
Earth Systems Science 3/2/1/0.50

I-AEIVBASC, I-AELMEBASC
This course introduces students to the basic earth sciences with an emphasis on understanding the impact of humans on the natural earth systems. Beginning with a study of the lithosphere, principles of physical geology will be examined including the evolution and internal structure of the earth, dynamic processes that affect the earth, formation of minerals and rocks and soil, ore bodies and fossil- energy sources. Next, the biosphere will be studied, including the basic concepts of ecology including systems ecology and biogeochemical cycles. The influence of humans and the built environment on these natural systems will also be examined with a view to identifying more sustainable engineering practices. Finally, students will study the oceans and the atmosphere and the physical, chemical and thermodynamic processes involved in climate change.
CME210H1 F
Solid Mechanics I

II-AECIVBASC, II-AELMEBASC
3/1.50/1.50/0.50

An introduction to the mechanics of deformable bodies. General biaxial and triaxial stress conditions in continua are studied, as are elastic stress, strain and deformation relations for members subjected to axial load, bending and shear. Properties of plane sections, moment-area theorems for calculating deflection, and Mohr’s circle representation of stress and of moment of inertia are examined, followed by a look at stability. Prerequisite: CIV100H1/CIV101H1, MAT186H1, MAT187H1
Exclusion: CIV210H1

CME261H1 F
Engineering Mathematics I

II-AECIVBASC, II-AELMEBASC
3/1/1/0.50

This course deals with both numerical methods for engineering analysis (solution of linear and non-linear equations, interpolation, numerical integration) and advanced topics in analytical calculus (multiple integrals and vector analysis). Within the numerical methods portion of the course emphasis is placed on problem formulation, solution algorithm design and programming applications. Within the analytical calculus portion emphasis is placed on the mathematical foundations of engineering practice and the interrelationship between analytical and numerical solution methods. Prerequisite: MAT188H1, MAT187H1
Exclusion: CIV261H1

CME263H1 S
Probability Theory for Civil and Mineral Engineers

II-AECIVBASC, II-AELMEBASC
3/-/2/0.50

Probability theory as the study of random phenomena in Civil and Mineral Engineering systems, including the definition of probability, conditional probability, Bayes’ theorem in discrete and continuous sample spaces. Common single and multivariate distributions. Mathematical expectation including mean and variance. Independence. An introduction to realizations of probability models and parameter estimation. Prerequisite: CIV263H1

CME270H1 F
Fluid Mechanics I

II-AECIVBASC, II-AELMEBASC
3/1.50/1.50/0.50

Fluid and flow characteristics, applications, dimensions and units. Fluid statics. One-dimensional flow including conservation of mass, energy and momentum. Introduction to dimensional analysis and similarity, laminar and turbulent flow, boundary layer concept, and flow about immersed objects. Calculation of flow in closed conduits and open channels. Exclusion: CIV270H1

CME321H1 F
Geotechnical Engineering I

III,IV-AECIVBASC, IV-AEESCBASEF, III,IV-AEESCBASEI, III,IV-AELMEBASC
3/1.50/1.50/0.50

An introduction to elements of geotechnical analysis and design. Shear strength at constant volume; ultimate limit state design of retaining walls, shored excavations, soil slopes, rafts, strip and spread footings, and piles and caissons. Compaction of granular soil; engineered fills for earth dams, roads, and backfills. Consolidation of fine grained soil; construction preloads and ultimate settlement predictions. Permeability, seepage analysis, and internal stability of granular soil; internal hydraulic design of coffer dams and zoned earth dams; construction dewatering. Site investigation and monitoring techniques in support of geotechnical design. Laboratories for unconfined compression, direct shear, compaction, consolidation, and seepage models. Prerequisite: CIV270H1/CME270H1, CIV210 H1/CME210 H1
Exclusion: CIV321H1

CME358H1 F
Survey CAMP (Civil and Mineral Practicals)

I,II,III,IV-AECIVBASC, III,IV-AELMEBASC
3/-/1/0.50

This two-week August field camp provides students with the opportunity to further their understanding of the vital interactions between the natural and the built environments. Through fieldwork, students gain hands-on experience in the use of various field instruments used by Civil and Mineral Engineers. The essentials of land surveying and the use of surveying instruments including Global Positioning Systems are taught as students carry out a series of field exercises that include route surveys, topographic surveys and construction surveys. Survey calculations, sources of error, corrections and adjustments are also introduced. In order to better understand our impact on the natural environment, students also perform several additional exercises. These may include the measurement of river flows, remote sensing of soil and rock, remediation of a borrow pit, and the evaluation of the renewable energy potential of the wind and solar radiation. Exclusion: CIV358H1

CME362H1 S
Engineering Mathematics II

III,IV-AECIVBASC, II-AELMEBASC
3/2/0.50

This course continues the study of numerical and analytical methods for civil engineering analysis. Analytical and numerical methods for solving ordinary differential equations are treated in some detail, followed by numerical solution methods for partial differential equations. The final major topic of the course deals with an introduction to optimization. Emphasis is placed throughout the course on problem formulation, solution algorithm design and programming applications. Prerequisite: CIV270H1
Exclusion: CIV362H1

CME368H1 F
Engineering Economics and Decision Making

III,IV-AECIVBASC, III,IV-AELMEBASC, I-AEMINBUS
3/-/1/0.50

The incorporation of economic and non-monetary considerations for making decision about public and private sector engineering systems in urban and other contexts. Topics include rational decision making; cost concepts; time value of money and engineering economics; microeconomic concepts; treatment of risk and uncertainty; and public project evaluation techniques incorporating social and environmental impacts including benefit cost analysis and multi-objective analysis. Exclusion: CIV368H1

Commerce
Computer Science

CSC180H1 F
Introduction to Computer Programming

I-AEESCBASE
The first of two courses that introduces students to programming and computational thinking, and prepares them for additional study across a breadth of programming fields. Students will learn to use the Python programming language to design and implement computational solutions to problems drawn from their 1F courses, and will explore new programming paradigms, algorithm design techniques, and data structures appropriate to these challenges. Specifically, this course aims to have students work with and understand profiling and runtime analysis, searching and sorting algorithms, and the use of recursion.

CSC190H1 S
Computer Algorithms and Data Structures

I-AEESCBASE
The second of two courses that introduces students to programming and computational thinking, and prepares them for additional study across a breadth of programming fields. Students will learn to use the C programming language to design and implement computational solutions to problems drawn from their 1S courses, and will explore new programming paradigms, algorithm design techniques, and data structures appropriate to these challenges. Specifically, this course aims to have students work with and understand linked lists, stacks, queues, trees, heaps, hashing, pointers (including function pointers) and arrays, data types and bit operations, and dynamic memory management.

RSM430H1 F
Fixed Income Securities (formerly MGT430H1)

IV-AEESCBASEF
2/-/-/0.50
Describes important fixed income securities and markets. The course emphasizes traditional bond and term structure concepts crucial to understand the securities traded in these markets. Students are required to work in the Rotman Financial Research & Trading Lab to solve the assigned problems using real time data.
Prerequisite: Rotman Commerce: RSM332H1; Actuarial Science: ACT349H1
Exclusion: MGT430H1
Distribution Requirement Status: This is a Social Science course
Breadth Requirement: Society and its Institutions (3)

RSM432H1 S
Risk Management for Financial Managers (formerly MGT432H1)

IV-AEESCBASEF
2/-/-/0.50
This course examines the ways in which risks are quantified and managed by financial institutions. The principal risks considered include market risk, credit risk and operational risk. The course also covers the evolution of bank regulation and the regulatory limits on risk taking.
Prerequisite: MGT337Y1/RSM333H1
Exclusion: MGT432H1
Distribution Requirement Status: This is a Social Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

RSM434H1 F/S
Financial Trading Strategies (formerly offered as RSM412H
Financial Trading Strategies)

IV-AEESCBASEF
2/-/-/0.50
This course will use finance theory applied with Excel applications to understand potential returns and risks inherent in particular investment/trading strategies. Learning-by-doing will be facilitated by simulation-based Rotman Interactive Trader cases focused on particular risks. This training will be analogous to using a flight simulator for learning to fly.
Prerequisite: RSM332H1
Exclusion: RSM412H Financial Trading Strategies
Distribution Requirement Status: This is a Social Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

CSC192H1 F
Computer Programming, Algorithms, Data Structures and Languages

I-AEESCBASE
3/3/-/0.50
An accelerated and combined version of CSC180H1 F and CSC190H1 S intended for students who have some previous programming experience (e.g. one year programming in Turing, Pascal, Java, C or similar languages.) Students will focus on problem decomposition and the use of programming paradigms appropriate to the problems being solved. Computational thinking is introduced as a means to solve problems through a focus on algorithm, data, and models of computation. Students will design and implement computational solutions to problems drawn from their 1F courses, and will explore new programming paradigms appropriate to these challenges. More advanced forms of computational thinking suitable for understanding and solving a wider variety of problems are introduced.

CSC309H1 F/S
Programming on the Web

IV-AEESCBASER
2/-/1/0.50
An introduction to software development on the web. Concepts underlying the development of programs that operate on the web; survey of technological alternatives; greater depth on some technologies. Operational concepts of the internet and the web, static client content, dynamic client content, dynamically served content, n-tiered architectures, web development processes, and security on the web. Assignments involve increasingly more complex web-based programs. Guest lecturers from leading e-commerce firms will describe the architecture and operation of their web sites.
Prerequisite: CSC209H1, CSC343H1/CSC228H1; CGPA 3.0/enrolment in a CSC subject POSt.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

CSC318H1 F/S
The Design of Interactive Computational Media

IV-AEESCBASER
2/-/1/0.50
User-centred design of interactive systems; methodologies, principles, and metaphors; task analysis. Interdisciplinary design; the role of graphic design, industrial design, and the behavioural sciences. Interactive hardware and software; concepts from computer graphics. Typography, layout, colour, sound, video, gesture, and usability enhancements. Classes of interactive graphical media; direct manipulation systems, extensible systems, rapid prototyping tools. Students work on projects in interdisciplinary teams. Enrolment limited, but non-computer scientists welcome.
Course Descriptions

Prerequisite: Any CSC half-course; CGPA 3.0/enrolment in a CSC subject POSI.
Recommended Preparation: CSC300H1 provides useful background for work in CSC318H1, so if you plan to take CSC300H1 then you should do it before CSC318H1.
Distribution Requirement Status: This is a Science course
Breadth Requirement: None

**CSC26H1 F**
**Programming Languages**

- **III, IV-AEPEBASC, III, IV-AELEBASC, IV-AEESCBASER**

Study of programming styles and paradigms. Included are object-oriented scripting functional and logic-based approaches. Languages that support these programming styles will be introduced. Languages treated include Python, Lisp or Scheme and Prolog.
Exclusion: CSC324H1

**CSC326H1 F/S**
**Introduction to Databases**

- **III, IV-AEPEBASC, III, IV-AELEBASC, IV-AEESCBASER**

Introduction to database management systems. The relational data model. Relational algebra. Querying and updating databases: the query language SQL. Application programming with SQL. Integrity constraints, normal forms, and database design. Elements of database system technology: query processing, transaction management.
Prerequisite: CSC165H1/CSC240H1/MAT(135H1,136H1)/MAT135Y1/MAT137Y1/MAT157Y1; CSC207H1; CGPA 3.0/enrolment in a CSC subject POSI. Prerequisite for Engineering students only: ECE345/CSC190/CSC192
Exclusion: CSC434H1.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

**CSC33H1 F/S**
**Algorithm Design, Analysis & Complexity**

- **2/-/1/0.50**

Standard algorithm design techniques: divide-and-conquer, greedy strategies, dynamic programming, linear programming, randomization, network flows, approximation algorithms. Brief introduction to NP-completeness: polynomial time reductions, examples of various NP-complete problems, self-reducibility. Students will be expected to show good design principles and adequate skills at reasoning about the correctness and complexity of algorithms.

NOTE: Although the courses CSC37H1 and CSC36H1 can be taken in any order, we recommend that CSC37H1 be taken first.
Prerequisite: CSC263H1/CSC265H1/CSC37H1; CGPA 3.0/enrolment in a CSC subject POSI.
Exclusion: CSC375H1, CSC364H1.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

**CSC384H1 F/S**
**Introduction to Artificial Intelligence**

- **IV-AEESCBASER, I-AEINRAM**

Theories and algorithms that capture (or approximate) some of the core elements of computational intelligence. Topics include: search; logical representations and reasoning; classical automated planning, representing and reasoning with uncertainty, learning, decision making (planning) under uncertainty. Assignments provide practical experience, both theory and programming, of the core topics.
Prerequisite: CSC324H1; STA247H1/STA255H1/STA257H1; CGPA 3.0/enrolment in a CSC subject POSI.
Exclusion: CSC484H1.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

**CSC401H1 S**
**Natural Language Computing**

- **IV-AEESCBASER**

Introduction to techniques involving natural language and speech in applications such as information retrieval, extraction, and filtering; intelligent Web searching; spelling and grammar checking; speech recognition and synthesis; and multi-lingual systems including machine translation. N-grams, POS-tagging, semantic distance metrics, indexing, on-line lexicons and thesauri, markup languages, collections of on-line documents, corpus analysis. PERL and other software.
Prerequisite: CSC207H1/CSC209H1/CSC228H1; STA247H1/STA255H1/STA257H1; CGPA 3.0/enrolment in a CSC subject POSI.
Recommended Preparation: MAT223H1/MAT240H1 is strongly recommended.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

**CSC411H1 F**
**Machine Learning and Data Mining**

- **IV-AEESCBASER, I-AEINRAM**

Prerequisite: CSC263H1/CSC265H1; MAT(135H1,136H1)/MAT137Y1/MAT157Y1, STA247H1/STA255H1/STA257H1, STA248H1/STA250H1/STA261H1; CGPA 3.0/enrolment in a CSC subject POSI.
Recommended Preparation: CSC336H1/CSC350H1.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

**CSC418H1 F/S**
**Computer Graphics**

- **2/-/1/0.50**

Identification and characterization of the objects manipulated in computer graphics, the operations possible on these objects, efficient algorithms to perform these operations, and interfaces to transform one type of object to another. Display devices, display data structures and procedures, graphical input, object modelling, transformations, illumination models, primary and secondary light effects; graphics packages and systems.

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Students, individually or in teams, implement graphical algorithms or entire graphics systems.
Prerequisite: CSC364H1/CSC350H1/CSC363H1/CSC364H1/CSC365H1/CSC367H1/CSC375H1/CSC378H1/CSC463H1.
MAT(135H1, 136H1)/MAT237Y1/MAT257Y1; CSC209H1/proficiency in C or C++; CGPA 3.0/enrolment in a CSC subject POSt. Prerequisite for Engineering students only: ECE345 or ECE352
Recommended Preparation: MAT237Y1, MAT244H1.
Distribution Requirement Status: This is a Science course Breadth Requirement: The Physical and Mathematical Universes (5)

CSC428H1 F/S
Human-Computer Interaction
IV-AEESC, I-AEIN
Understanding human behaviour as it applies to user interfaces: work activity analysis, observational techniques, questionnaire administration and unobtrusive measures. Operating parameters of the human cognitive system, task analysis and cognitive modelling techniques and their application to designing interfaces. Interface representations and prototyping tools. Cognitive walkthroughs, usability studies and verbal protocol analysis. Case studies of specific user interfaces.
Prerequisite: CSC318H1;
STA247H1/STA255H1/STA257H1/STA248H1/STA250H1/STA261H1/PSY201H1, PSY202H1/(SOC202H1, SOC300H1);
CSC209H1/proficiency in C++ or Java; CGPA 3.0/enrolment in a CSC subject POSt.
Recommended Preparation: A course in PSY; CSC209H1.
Distribution Requirement Status: This is a Science course Breadth Requirement: The Physical and Mathematical Universes (5)

CSC443H1 S
Database System Technology
IV-AEESC
Prerequisite: CSC343H1/CSC434H1, CSC369H1/CSC468H1.
CSC364H1/CSC373H1/CSC375H1; CGPA 3.0/enrolment in a CSC subject POSt.
Distribution Requirement Status: This is a Science course Breadth Requirement: The Physical and Mathematical Universes (5)

CSC444H1 F
Software Engineering I
IV-AEESC
The software development process. Software requirements and specifications. Software design techniques. Techniques for developing large software systems; CASE tools and software development environments. Software testing, documentation and maintenance.
Prerequisite: ECE344H1 or ECE353H1

CSC446H1 S
Computational Methods for Partial Differential Equations
2/-/1/0.50
Finite difference methods for hyperbolic and parabolic equations; consistency, convergence, and stability. Finite element methods for 2-point boundary value problems and elliptic equations. Special problems of interest.
Prerequisite: CSC351H1/CSC336H1 (75%)/equivalent mathematical background; MAT237Y1/MAT257Y1;
APM346H1/APM351Y1/(MAT244H1/2MAT67H1 and exposure to PDEs); CGPA 3.0/enrolment in a CSC subject POSt.
Distribution Requirement Status: This is a Science course Breadth Requirement: The Physical and Mathematical Universes (5)

CSC467H1 F
Compilers and Interpreters
III,IV-AEES, I-AEEL, III,IV-AEESC
Compiler organization, compiler writing tools, use of regular expressions, finite automata and context-free grammars, scanning and parsing, runtime organization, semantic analysis, implementing the runtime model, storage allocation, code generation.
Prerequisite: ECE352H1

Ecology and Evolutionary Biology

EEB214H1 S
Evolution and Adaptation
III,IV-AEES, III,IV-AEEL
Evolution and adaptation through natural selection. Concepts and application based on faunal life goals of habitat survival, food acquisition, predator avoidance, and reproduction. Topics include: speciation, mutation, co-evolution, symbiosis, pollination, parasitism, eusociality, and sexual and parental conflict. Essays, debates, and reading required.
For non-science students in all years and disciplines.
Exclusion: BIO120H1/BIO150Y1/ZOO214Y1/ZOO324Y1
Distribution Requirement Status: This is a Science course Breadth Requirement: Living Things and Their Environment (4)

Electrical and Computer Engineering

ECE101H1 F
Seminar Course: Introduction to Electrical and Computer Engineering
I,-/-/0.15
I-AEES, I-AEEL
This is a seminar series that will introduce first year students to the wealth of subjects within the field of Electrical and Computer Engineering. Instructors will be drawn from the various research groups within the Department. This course will be offered on a credit/no-credit basis. Credit will not be given to students who attend fewer than 70% of the seminars. Students who receive no credit for the course must re-take it in their 2F session. Students who have not received credit for this course at the end of their 2F session will not be permitted to register in session 2S.
ECE110H1 S
**Electrical Fundamentals** 3/2m/1m/0.50

I-AECPKABC, II-EELEBASC, I-AECPEBASC, I-AEENGBABC, I-AEINDBASC, I-AEMECBASC, I-AEMMSBASC

A simplified overview of the physics of electricity and magnetism: Coulomb's law, Gauss' law, Ampere's law, Faraday's law. Other topics include: physics of capacitors, resistors and inductors; an introduction to circuit analysis (resistive circuits, nodal and mesh analysis) and network theorems; natural and forced response of RL and RC circuits; sinusoidal steady-state analysis and power in AC circuits.

ECE159H1 S
**Fundamentals of Electric Circuits** 3/1.50/1/0.50

I-AEESCBASC

Topics include: DC linear circuit elements; DC linear circuit analysis; Kirchhoff's Laws and superposition; Thevenin and Norton equivalents; nodal analysis; operational amplifier; transient response of linear circuits; sinusoidal steady state analysis; phasors; power in AC circuits; frequency response; and resonance phenomena.

ECE212H1 F
**Circuit Analysis** 3/3a/2m/0.50

II-AECPKABC, II-EELEBASC


ECE216H1 S
**Signals and Systems** 3/-/-/0.50

II-AECPKABC, II-EELEBASC

Fundamental discrete- and continuous-time signals, definition and properties of systems, linearity and time invariance, convolution, impulse response, differential and difference equations, Fourier analysis, sampling and aliasing, applications in communications.

ECE221H1 S
**Electric and Magnetic Fields** 3/2a/1/0.50

II-AECPKABC, II-EELEBASC

The fundamental laws of electromagnetics are covered, including Coulomb's law, Gauss' law, Poisson's and Laplace's equations, the Biot-Savart law, Ampere's law, Faraday's law, and Maxwell's equations. Vector calculus is applied to determine the relationship between the electric and magnetic fields and their sources (charges and currents). The interaction of the fields with material media will be discussed, including resistance, polarization in dielectrics, magnetization in magnetic materials, properties of magnetic materials and boundary conditions. Other topics include: electric and magnetic forces, the electric potential, capacitance and inductance, electric and magnetic energy, magnetic circuits, and boundary-value problems.

ECE231H1 S
**Introductory Electronics** 3/3m/2m/0.50

II-AECPKABC, II-EELEBASC

An introduction to electronic circuits using operational amplifiers, diodes, bipolar junction transistors and field-effect transistors.

ECE241H1 F
**Digital Systems** 3/3m/-/0.50

II-AECPKABC, II-EELEBASC

Digital logic circuit design with substantial hands-on laboratory work. Algebraic and truth table representation of logic functions and variables. Optimizations of combinational logic, using “don’t cares.” Multi-level logic optimization. Transistor-level design of logic gates; propagation delay and timing of gates and circuits. The Verilog hardware description language. Memory in digital circuits, including latches, clocked flip-flops, and Static Random Access Memory. Set-up and hold times of sequential logic. Finite state machines - design and implementation. Binary number representation, hardware addition and multiplication. Tri-state gates, and multiplexers. There is a major lab component using Complex Programmable Logic Devices (CPLDs) and Field-Programmable Gate Arrays (FPGAs) and associated computer-aided design software.

ECE243H1 S
**Computer Organization** 3/3m/-/0.50

II-AECPKABC, II-EELEBASC


ECE244H1 F
**Programming Fundamentals** 3/2m/1m/0.50

II-AECPKABC, II-EELEBASC

Provides a foundation in programming using an object-oriented programming language. Topics include: classes and objects, inheritance, exception handling, basic data structures (lists, tree, etc.), big-O complexity analysis, and testing and debugging. The laboratory assignments emphasize the use of object-oriented programming constructs in the design and implementation of reasonably large programs.

ECE253H1 F
**Digital and Computer Systems** 3/3m/-/0.50

II-AECPKABC, II-EELEBASC

Digital system design principles. Logic circuits, logic synthesis. Registers, arithmetic circuits, counters, finite state machines, and programmable logic devices. Verilog hardware description language. Computer structure, machine language instruction execution and sequencing, addressing techniques. Processors, input/output techniques, and memory hierarchy. The laboratory work consists of exercises involving the design of logic circuits, and microprocessor systems. Modern computer-aided design tools and FPGA technology are used. Design aspects constitute a major portion of laboratory work. Exclusion: ECE341H1 and ECE370H1
ECE259H1 S
Electromagnetism
II-AEEESCBASE
3/-/0.50
The fundamental laws of electromagnetics are covered; including Coulomb's law, Gauss' law, Poisson's and Laplace's equations, the Biot-Savart's law, Ampere's law, Faraday's law, and Maxwell's equations. Field-matter interaction is studied, including polarization in dielectric materials and magnetization in magnetic materials. Circuit elements such as the resistor, capacitor and inductor are introduced from an electromagnetic point of view. Other topics include: electric and magnetic forces, the electric potential, capacitance and inductance, electric and magnetic energy, magnetic circuits, boundary-value problems and transmission-lines.

ECE297H1 S
Communication and Design
II-AECEPBASC, II-AEELBASC
1.50/3m/2m/0.50
An introduction to electrical and computer engineering design processes illustrated by the design and implementation of software systems. Creative development with appropriate organizational and reporting and recording activities, both oral and written, is emphasized. The general design cycle and pragmatic strategies used in the creation of small designs and larger systems are presented. These methods are implemented in practical lab work done in teams. Oral skills are developed in seminars and team discussions, by learning to handle questions, and by making formal presentations. Written skills are developed in reports related to the lecture and lab activities.

ECE302H1 F/S
Probability and Applications
III,IV-AECEPBASC, III,IV-AEELBASC
3/-/2m/0.50
Events, sample space, axioms of probability. Discrete and continuous random variables, distribution and density functions. Bernoulli trials, Binomial, geometric, Poisson, exponential and Gaussian distributions. Expectation, moments, characteristic function, correlation coefficient. Functions of random variables. Random vectors, joint distributions, transformations. Applications will be chosen from communication theory, estimation and hypothesis testing, and other areas of electrical engineering.
Prerequisite: MAT290H1 and MAT291H1 and ECE216H1
Exclusion: STA286H1

ECE311H1 F/S
Dynamic Systems and Control
III,IV-AECEPBASC, III,IV-AEELBASC
3/3m/1m/0.50
Prerequisite: MAT290H1 and MAT291H1 and ECE216H1

ECE314H1 F
Fundamentals of Electrical Energy Systems
III,IV-AECEPBASC, III,IV-AEELBASC, I-AEAMINER, I-AEAMINRM
3/3a/1m/0.50
Prerequisite: ECE212H1 and ECE221H1 and ECE231H1
Exclusion: ECE315H1

ECE316H1 F/S
Communication Systems
III,IV-AECEPBASC, III,IV-AEELBASC, IV-AEESCBAEB, IV-AESCBASER, IV-AEESCBAEB, IV-AEESCBASET, I-AEAMINRM
3/3a/1m/0.50
An introductory course in analog and digital communication systems. Analog and digital signals. Signal representation and Fourier transforms; energy and power spectral densities; bandwidth. Distortionless analog communication; amplitude, frequency and phase modulation systems; frequency division multiplexing. Sampling, quantization and pulse code modulation (PCM). Baseband digital communication; intersymbol interference (ISI); Nyquist's ISI criterion; eye diagrams. Passband digital communications; amplitude-, phase- and frequency-shift keying; signal constellations. Performance analysis of analog modulation schemes in the presence of noise. Performance analysis of PCM in noise.
Prerequisite: (MAT290H1 and ECE216H1) or (MAT389H1 and ECE355H1)

ECE318H1 S
Fundamentals of Optics
III,IV-AECEPBASC, III,IV-AEELBASC, IV-AEESCBASE, IV-AEESCBASE, IV-AEESCBAEB, IV-AEESCBASEB, IV-AEEESCBASEO, IV-AEESCBASET
3/3a/1m/0.50
Geometric Optics: Spherical surfaces, lenses and mirrors, optical imaging systems, matrix method, and aberrations. Polarization: Polarizer and polarizations, anisotropic materials, dichroism, birefringence, index ellipsoid, waveplates, optical activity, Faraday effect. Interference: superposition of waves, longitudinal and transverse coherence, Young's double-slit experiment, Michelson and Fabry-Perot interferometer, thin-films. Diffraction and Fourier Optics: diffraction theory, single and double slits, diffraction gratings, spatial filtering, basic optical signal processing. (Background preparation in ECE320H1 F - Fields and Waves, or ECE357H1 S - Electromagnetic Fields, is strongly recommended.)
Prerequisite: ECE221H1

ECE320H1 F
Fields and Waves
III,IV-AECEPBASC, III,IV-AEELBASC
3/3m/1m/0.50
Voltage and current waves on a general transmission line, reflections from the load and source, transients on the line, and Smith's chart. Maxwell's equations, electric and magnetic fields, wave equations, boundary conditions, plane wave propagation, reflection and transmission at boundaries, constitutive relations, dispersion, polarization; Poynting vector; waveguides.
Prerequisite: ECE221H1
Course Descriptions

ECE330H1 S  
Semiconductor and Device Physics  
IV-AECPBASC, III, IV-AEELEBASC  3/-2m/0.50

Wave and quantum mechanics, the Schrodinger equation, quantum wells and density of states. Quantum statistics, solid-state bonding and crystal structure. Electron waves, dispersion relation inside periodic media, Fermi level and energy bands. Physical understanding of semiconductors at equilibrium, intrinsic and extrinsic semiconductors and excess carriers. Prerequisite: ECE221H1 and ECE231H1. (Backround preparation in ECE320H1 - Fields and Waves is strongly recommended). Exclusion: MSE235H1

ECE331H1 F/S  
Analog Electronics  
III, IV-AECPBASC, III, IV-AEELEBASC, I-AEMINRAM  3/3a/1m/0.50

Transistor amplifiers, including: differential and multistage amplifiers, integrated circuit biasing techniques, output stage design and IC amplifier building blocks. Frequency response of amplifiers at low, medium and high frequencies. Feedback amplifier analysis. Stability and compensation techniques for amplifiers using negative feedback. Prerequisite: ECE212H1 and ECE231H1

ECE334H1 F/S  
Digital Electronics  
III, IV-AECPBASC, III, IV-AEELEBASC, IV-AEE filmmaker, I-AEMINRAM  3/3a/1m/0.50

Digital design techniques for integrated circuits. The emphasis will be on the design of logic gates at the transistor level. A number of different logic families will be described, but CMOS will be emphasized. Review of: device modeling, IC processing, and Spice simulation, simplified layout rules, inverter noise margins, transient response, and power dissipation, traditional CMOS logic design, transmission gates, RC timing approximations, input-output circuits, latches and flipflops, counters and adders, decoders and muxes, dynamic gates, SRAMs, DRAMs, and EEPROMs. Prerequisite: ECE241H1 and ECE231H1 or ECE253H1 and ECE360H1

ECE335H1 F  
Introduction to Electronic Devices  
IV-AECPBASC, III, IV-AEELEBASC  3/-2m/0.50

Electrical behaviour of semiconductor structures and devices. Metal-semiconductor contacts; pn junctions, diodes, photodetectors, LED’s; bipolar junction transistors, Ebers-Moll and hybrid-pi models; field effect transistors, MOSFET, JFET/MESFET structures and models; thyristors and semiconductor lasers. Prerequisite: MAT291H1 and ECE221H1 and ECE231H1. Exclusion: MSE235H1

ECE342H1 S  
Computer Hardware  
III, IV-AECPBASC, III, IV-AEELEBASC, IV-AEE filmmaker, I-AEMINRAM  3/3m/-/0.50

Arithmetic circuits, cubical representation of logic functions, digital system design, timing analysis, design of asynchronous circuits, testing of logic circuits. Prerequisite: ECE241H1 and ECE243H1

ECE344H1 F/S  
Operating Systems  
III, IV-AECPBASC, III, IV-AEELEBASC, IV-AEMECBASC, I-AEMINRAM  3/3m/-/0.50

Operating system structures, concurrency, synchronization, deadlock, CPU scheduling, memory management, file systems. The laboratory exercises will require implementation of part of an operating system. Prerequisite: ECE244H1 and ECE243H1

ECE345H1 F/S  
Algorithms and Data Structures  
III, IV-AECPBASC, III, IV-AEELEBASC, I-AEMINRAM  3/-2m/0.50

Design and analysis of algorithms and data structures that are essential to engineers in every aspect of the computer hardware and software industry. Review of background material (recurrences, asymptotics, summations, trees and graphs). Sorting, search trees and balanced search trees, amortized analysis, hash functions, dynamic programming, greedy algorithms, basic graph algorithms, minimum spanning trees, shortest paths, introduction to NP completeness. Prerequisite: ECE244H1

ECE349H1 F  
Introduction to Energy Systems  
III, IV-AEE filmmaker, III, IV-AEE filmmaker, I-AEMINENR, I-AEMINRAM  3/1.50/1/0.50


ECE350H1 S  
Semiconductor Electronic Devices  
III, IV-AEE filmmaker, III, IV-AEE filmmaker, IV-AEE filmmaker, I-AEMINRAM  3/1.50/1/0.50

An explanation of the basic operation, design and limitations of semiconductor electronic devices, such as diodes and transistors. The topics covered include: electrons in semiconductors, semiconductors in equilibrium, transport of carriers, p-n diodes, metal-semiconductor contacts, bipolar junction transistors, metal-oxide-semiconductor (MOS) capacitors, and MOS field effect transistors. In addition, optoelectronic devices (e.g. photodiodes, light emitting diodes and lasers), semiconductor heterostructures, nanostructures and transistor scaling will be discussed.

ECE352H1 F  
Computer Organization  
IV-AEESCBASE, III, IV-AEESCBASE, I-AEMINENR, I-AEMINRAM  3/-/3/0.50

A continuation of some of the topics introduced in ECE253F, Digital and Computer Systems. Synchronous and asynchronous sequential circuits, pipelining, integer and floating-point arithmetic, RISC processors.
ECE353H1 S  
Systems Software  
IV-AEESCBASEF, III, IV-AEEESCBASER, I-AEMINRAM  
Operating system structure, processes, threads, synchronization, CPU scheduling, memory management, file systems, input/output, multiple processor systems, virtualization, protection, and security. The laboratory exercises will require implementation of part of an operating system.

ECE354H1 S  
Electronic Circuits  
IV-AEEESCBASER, I-AEMINRAM  
3/1.50/0.50/0.50  
A course on analog and digital electronic circuits. Topics include single-stage amplifiers, current mirrors, cascode amplifiers and differential pairs. Amplifier frequency response, feedback and stability are also covered. Digital CMOS logic circuits are introduced.

ECE355H1 F  
Signal Analysis and Communication  
IV-AEESCBASEF, III, IV-AEEESCBASER  
3/-/2/0.50  
An introduction to continuous-time and discrete-time signals and systems. Topics include characterization of linear time-invariant systems, Fourier analysis, linear filtering, sampling of continuous-time signals, and modulation techniques for communication systems.

ECE356H1 S  
Linear Systems and Control  
IV-AEESCBASEO, III, IV-AEEESCBASER  
3/1.50/1/0.50  
Prerequisite: ECE355H1

ECE357H1 S  
Electromagnetic Fields  
III, IV-AEESCBASEP, III, IV-AEEESCBASER  
3/1.50/1/0.50  
An introduction to transmission line theory; voltage and current waves, characteristic impedance, reflections from the load and source, transients on the line, Smith’s chart, impedance matching. Fundamentals of electromagnetic theory: Maxwell’s equations, Helmholtz’s theorem, time retarded scalar and vector potentials, gauges, boundary conditions, electric and magnetic fields wave equations and their solutions in lossless and lossy medium. Plane wave propagation, reflection and transmission at boundaries. Constitutive relations and dispersion. Radiating dipole and waveguides.

ECE358H1 S  
Foundations of Computing  
IV-AEESCBASEF, IV-AEEESCBASER, I-AEMINRAM  
3/-/1.0/0.50  
Fundamentals of algorithm design and computational complexity, including: analysis of algorithms, graph algorithms, greedy algorithms, divide-and-conquer, dynamic programming, network flow, approximation algorithms, the theory of NP-completeness, and various NP-complete problems.

ECE359H1 F  
Energy Conversion  
IV-AEESCBASEF, III, IV-AEEESCBASEJ, I-AEMINRAM  
3/1.50/1/0.50  
Introduction to power processing, linear regulators, switch-mode power concepts, DC-DC converters, Voltage and current source inverters, coupled magnetic circuit concepts (properties of magnetic materials, Faraday’s Law for time varying fields, characterization and modeling of hysteresis and eddy current losses in magnetic materials, magnetic circuit model, topological dual principle), inductor circuit model, mult-winding transformer circuit model, multiwinding switch mode converters; flyback, forward and push-pull converters. Laboratories cover electrical energy conversion, magnetic devices, complex power flow and introduce appropriate measurement techniques.

ECE360H1 F  
Electronics  
IV-AEESCBASEF, III, IV-AEEESCBASER  
3/1.50/1/0.50  
An introduction to electronics. Basic electronic circuits: introductory frequency analysis, operational amplifiers, diodes, bipolar junction transistors, field-effect transistors, small-signal analysis, frequency response of single-stage circuits.

ECE361H1 F/S  
Computer Networks I  
III, IV-AECPEBASC, III, IV-AEELEBASC, IV-AEESCBASER, I-AEMINRAM  
3/3a/1a/0.50  
Layered network architectures; overview of TCP/IP protocol suite. Introduction to sockets; introduction to application layer protocols. Peer-to-Peer Protocols: ARQ; TCP reliable stream service; flow control. Data Link Controls: Framing; PPP; HDLC. Medium access control and LANs: Aloha; Ethernet; Wireless LANs; Bridges. Packet Switching: Datagram and virtual circuit switching; Shortest path algorithms; Distance vector and link state algorithms.  
Prerequisite: STA286H1 or ECE302H1  
Corequisite: ECE302H1. (Students must take the co-requisite, ECE302H1 in the same term as ECE361H, OR in a term before taking ECE361H1.)

ECE362H1 S  
Digital Signal Processing  
IV-AEESCBASEB, IV-AEEESCBASEP, III, IV-AEEESCBASER, IV-AEEESCBASEF, I-AEMINRAM  
3/1.50/1/0.50  
Review of sampling and discrete-time signals in one or more dimensions; linear shift-invariant systems; the Z-transform; the discrete-time Fourier transform; the discrete Fourier transform and computationally efficient implementations (fast Fourier transforms); general orthogonal representations; wavelet bases; discrete-time filters: finite and infinite impulse response filters; fixed-point implementations and finite word-length effects; multidimensional filters and multidimensional signal processing. Illustrative applications are drawn from audio and biomedical signal processing, communication systems, and image and video signal processing.  
Exclusion: ECE431H1

Course Descriptions
ECE410H1 F
Control Systems

III, IV-AECPBASC, III, IV-AEELEBASC, I-AEMINRAM

State space analysis of linear systems, the matrix exponential, linearization of nonlinear systems. Structural properties of linear systems: stability, controllability, observability, stabilizability, and detectability. Pole assignment using state feedback, state estimation using observers, full-order and reduced-order observer design, design of feedback compensators using the separation principle, control design for tracking. Control design based on optimization, linear quadratic optimal control, the algebraic Riccati equation. Laboratory experiments include computer-aided design using MATLAB and the control of an inverted pendulum on a cart.

Prequisite: ECE311H1
Exclusion: ECE557H1

ECE411H1 S
Real-Time Computer Control

III, IV-AECPBASC, III, IV-AEELEBASC, IV-AEESCBASEJ, IV-AEESECBASER, I-AEMINRAM

Digital Control analysis and design by state-space methods. Introduction to scheduling of control tasks using fixed-priority protocols. Labs include control design using MATLAB and Simulink, and computer control of the inverted pendulum using a PC with real-time software.

Prequisite: ECE311H1 or ECE356H1

ECE413H1 S
Energy Systems and Distributed Generation

III, IV-AECPBASC, III, IV-AEELEBASC, IV-AEESCBASEJ, IV-AEESECBASER, I-AEMINENR

Three-phase systems; steady-state transmission line model; symmetrical three-phase faults; power system stability; symmetrical components; unsymmetrical faults and fault current calculation; distribution network; equivalent steady-state model of voltage-sourced converter; distributed energy resources (DR); distributed energy storage; interface between DR and power system.

Prequisite: ECE314H1 or ECE315H1 or ECE349H1 or ECE359H1

ECE417H1 S
Digital Communication

III, IV-AECPBASC, III, IV-AEELEBASC, IV-AEESCBASER

Basic concepts of digital communication. Baseband data transmission, intersymbol interference, Nyquist pulse shaping, equalization, line coding, multi-path fading, diversity. Binary and M-ary modulation schemes, synchronization. Signal space concepts, optimum receivers, coherent and noncoherent detectors. Information theory, source encoding, error control coding, block and convolutional codes.

Prequisite: ECE302H1 and ECE316H1, or STA286H1

ECE419H1 S
Distributed Systems

III, IV-AECPBASC, III, IV-AEELEBASC, IV-AEESECBASER

Design issues in distributed systems: heterogeneity, security, transparency, concurrency, fault-tolerance; networking principles; request-reply protocol; remote procedure calls; distributed objects; middleware architectures; CORBA; security and authentication protocols; distributed file systems; name services; global states in distributed systems; coordination and agreement; transactions and concurrency control; distributed transactions; replication.

Prerequisite: ECE344H1 or ECE353H1

ECE422H1 S
Radio and Microwave Wireless Systems

III, IV-AECPBASC, III, IV-AEELEBASC, IV-AEESECBASER

Analysis and design of systems employing radio waves, covering both the underlying electromagnetics and the overall system performance aspects such as signal-to-noise ratios. Transmission/reception phenomena include: electromagnetic wave radiation and polarization; elementary and linear dipoles; directivity, gain, efficiency; integrated, phased-array and aperture antennas; beam-steering; Friis transmission formulas. Propagation phenomena include: diffraction and wave propagation over obstacles; multipath propagation in urban environments; atmospheric and ionospheric effects. Receiver design aspects include: receiver figures of merit, noise in cascaded systems, noise figure, and noise temperature. System examples are: fixed wireless access; mobile and personal communication systems; wireless cellular concepts; satellite communications; radar; radiometric receivers; GPS.

Prequisite: ECE320H1 or ECE357H1

ECE431H1 F/S
Digital Signal Processing

III, IV-AECPBASC, III, IV-AEELEBASC, I-AEMINRAM


ECE442H1 F
Introduction to Micro- and Nano-Fabrication Technologies

IV-AECPBASC, III, IV-AEELEBASC, IV-AEESECBASEO, IV-AEESECBASER, IV-AEESCBASER, I-AEMINRAM, IV-AEMMSBASER

An introduction to the fundamentals of micro- and nano-fabrication processes with emphasis on cleanroom practices. The physical principles of optical lithography, electron-beam lithography, alternative nanolithography techniques, and thin film deposition and metrology methods. The physical and chemical processes of wet and dry etching. Cleanroom concepts and safety protocols. Sequential micro-fabrication processes involved in the manufacture of microelectronic and photonic devices. Imaging and characterization of micro- and nano-structures. Examples of practical existing and emerging micro- and nano-devices. Limited enrollment.

Prequisite: ECE335H1 or ECE350H1
Course Descriptions

ECE445H1 F
Neural Bioelectricity

III, IV-AECPEBASC, III, IV-AEELEBASC, IV-AEESCBASEB, IV-AEESCBASEO, IV-AEESCBASER, I-AEMINBIO


ECE446H1 F
Sensory Communication

III, IV-AECPEBASC, III, IV-AEELEBASC, IV-AEESCBASEB, IV-AEESCBASEO, IV-AEESCBASER, I-AEMINBIO


ECE448H1 F
Biocomputation

III, IV-AECPEBASC, III, IV-AEELEBASC, IV-AEESCBASEB, IV-AEESCBASEO, IV-AEESCBASER, I-AEMINBIO

New technologies in molecular and cellular biology have allowed the collection of unprecedented amounts of biological data ranging from sequences to protein structures to gene expression. The need to synthesize knowledge from this abundant data is driving the convergence of the biological and computer sciences. This course will introduce the fundamental concepts and challenges in molecular biology and the computational and statistical approaches applied to model and address them. Course topics include basic concepts in molecular and structural biology, sequence-based algorithms (such as pairwise and multiple sequence alignment, statistical models), structure-based algorithms (such as energy models, homology modeling, threading), and systems biology algorithms (such as hierarchical and neural network clustering).

ECE451H1 S
VLSI Systems and Design

III, IV-AECPEBASC, III, IV-AEELEBASC, IV-AEESCBASER

An introduction to the design, verification and layout of VLSI circuits for complex digital systems. The focus is on CMOS technology, using custom and standard cell-based design flows, and covering both design and computer-aided design techniques. Topics covered include deep sub-micron design, clocking techniques, physical design, sub-system design, power, testing, simulation, placement/routing, synthesis, and test generation. The course has a major project component in which students design and produce a layout for a small microprocessor chip.

ECE454H1 F
Computer Systems Programming

III, IV-AECPEBASC, III, IV-AEELEBASC, IV-AEESCBASER

Fundamental techniques for programming computer systems, with an emphasis on obtaining good performance. Topics covered include: how to measure and understand program and execution and behaviour, how to get the most out of an optimizing compiler, how memory is allocated and managed, and how to exploit caches and the memory hierarchy. Furthermore, current trends in multicore, multithreaded and data parallel hardware, and how to exploit parallelism in their programs will be covered.

ECE461H1 F
Internetworking

III, IV-AECPEBASC, III, IV-AEELEBASC, IV-AEESCBASER

This course will cover the fundamentals of protocols for packet switching networks with emphasis on Internet type of networks including the following topics: the Internetworking concept and architectural model; data link layer (Ethernet and PPP); service interface; Internet addresses; address resolution protocol; Internet protocol (connectionless datagram delivery); routing IP datagrams; Internet control message protocol (error and control messages); subnet and superaddress extensions; ping program; traceroute program; user datagram protocol; reliable stream transport service (TCP); the socket interface; routing (GDP, EGP, IP, OSPF, HELLO); Internet multicasting; domain name system; applications such as HTTP, electronic mail, and SNMP; Internet security and firewall design; IPv6, RSVP, flows, and ISIP. Prerequisite: ECE361H1 F/S

ECE462H1 S
Multimedia Systems

III, IV-AECPEBASC, III, IV-AEELEBASC, IV-AEESCBASER

Topics in the engineering area of multimedia systems with particular emphasis on the theory, design features, performance, complexity analysis, optimization and application of multimedia engineering technologies. Topics include sound/audio, image and video characterization, compression, source entropy and hybrid coding, transform coding, wavelet-based coding, motion estimation, JPEG coding, digital video coding, MPEG-1/2 coding, content-based processing, and MPEG-7.
ECE463H1 S  Electric Drives
III,IV-AECPASPASC, III,IV-AEELEBASC, 3/3a/1m/0.50
III,IV-AEESCBASEJ, IV-AEESCBASER
Electro-mechanical mechanisms for force and torque production in rotating machines. DC machine theory and DC machine dynamics, synchronous machines and their dynamics, stepper motors. Introduction to space vectors and vector control of AC machines. Steady state and variable speed operation of the induction machine via V/f control.
Prerequisite: ECE314H1 or ECE315H1 or ECE349H1 or ECE359H1

ECE464H1 S  Wireless Communication
III,IV-AECPASPASC, III,IV-AEELEBASC, 3/3m/1m/0.50
IV-AEESCBASER
Prerequisite: ECE302H1 and ECE316H1, or STA286H1

ECE466H1 S  Computer Networks II
III,IV-AECPASPASC, III,IV-AEELEBASC, 3/3a/1m/0.50
IV-AEESCBASER
Traffic modeling; network calculus; traffic classification; traffic regulation: shaping, filtering, policing, leaky bucket; queueing systems; scheduling; quality of service: DiffServ and IntServ/RsVP; multi-protocol label switching; call admission control / congestion control; switching; pricing; optical networks.
Prerequisite: ECE361H1

ECE469H1 S  Optical Communications and Networks
IV-AECPASPASC, III,IV-AEELEBASC, 3/3m/1m/0.50
IV-AEESCBASER
This course provides an introduction to optical communication systems and networks at the system and functional level. Applications range from telecommunication networks (short to long haul) to computing networks (chip-to-chip, on chip communications, optical backplanes). Basic principles of optical transmission and associated components used for transmission of light and optical networks; system design tools for optical links; multi-service system requirements; optical network design tools (routing and wavelength assignment), network management and survivability.
Exclusion: ECE425H1 or ECE467H1

ECE470H1 S  Robot Modeling and Control
III,IV-AECPASPASC, III,IV-AEELEBASC, 3/3m/1m/0.50
IV-AEESCBASER, IV-AEESCBASET, I-AEINIRAM
Classification of robot manipulators, kinematic modeling, forward and inverse kinematics, velocity kinematics, path planning, point-to-point trajectory planning, dynamic modeling, Euler-Lagrange equations, inverse dynamics, joint control, computed torque control, passivity-based control, feedback linearization.
Prerequisite: ECE311H1 or ECE356H1
Exclusion: AER525H1

ECE472H1 F/S  Engineering Economic Analysis & Entrepreneurship
III,IV-AECPASPASC, III,IV-AEELEBASC, 3/1/-/0.50
I-AEINRBUS
The economic evaluation and justification of engineering projects and investment proposals are discussed. Cost concepts; financial and cost accounting; depreciation; the time value of money and compound interest; inflation; capital budgeting; equity, bond and loan financing; income tax and after-tax cash flow; measures of economic merit in the private sector; sensitivity and risk analysis. Applications: evaluations of competing engineering project proposals; replacement analysis; economic life of assets; lease versus buy decisions; break-even analysis; decision tree analysis. Entrepreneurship and the Canadian business environment will be discussed.

ECE488H1 F  Entrepreneurship and Business for Engineers
I-AEINBUS
A complete introduction to small business formation, management and wealth creation. Topics include: the nature of the Entrepreneur and the Canadian business environment; business idea search and Business Plan construction; Buying a business, franchising, taking over a family business; Market research and sources of data; Marketing strategies promotion, pricing, advertising, electronic channels and costing; The sales process and management, distribution channels and global marketing; Accounting, financing and analysis, sources of funding, and financial controls; The people dimension: management styles, recruiting and hiring, legal issues in employment and Human Resources; Legal forms of organization and business formation, taxation, intellectual property protection; the e-Business world and how businesses participate; Managing the business: location and equipping the business, suppliers and purchasing, credit, ethical dealing; Exiting the business and succession, selling out. A full Business Plan will be developed by each student and the top submissions will be entered into a Business Plan competition with significant cash prizes for the winners. Examples will be drawn from real business situations including practicing entrepreneurs making presentations and class visits during the term. (Identical courses are offered: MSE488H1F, MIE488H1F, CHE488H1S and CIV488H1S.)
Exclusion: APS234 and APS432

ECE496Y1 Y  Design Project
III,IV-AECPASPASC, III,IV-AEELEBASC
A full year capstone design project course intended to give students an opportunity to apply their technical knowledge and communication skills. Working in teams under the direct supervision of a faculty member, students develop a design project of their choice from an initial concept to a final working prototype. In the first session, a project proposal is submitted early on, followed by a project requirements specification. A
design review meeting is then held to review the proposed design. Lectures given during the first session will develop expertise in various areas related to design and technical communication. In the second session, the teams present their work in a number of ways, including an oral presentation, a poster presentation, a final demonstration at the Design Fair, an individual progress report, and a group final report. Course deliverables are evaluated by both the team’s supervisor and one of several course administrators.

ECE510H1 F Introduction to Lighting Systems
III, IV-AECEPBASC, III, IV-AEELBASC, IV-AEESCBASEJ, IV-AEESCBASER, I-AEMINER
An introduction to the physics of lighting systems (e.g. plasma physics, radiation spectrum, physics of light-emitting diodes) and the corresponding power electronic driver circuits (ballasts). The operating principles and the science behind different types of lamps are covered. These include incandescent, fluorescent, low and high pressure sodium, mercury, metal halide lamps and LED lighting systems. The designs and technical challenges of the electronic ballasts for each type of lighting source are discussed. Issues related to lighting regulations, layout, delivery, efficiency, control and the economic and environmental assessment of current lighting systems are briefly addressed. Prerequisite: ECE314H1 or ECE315H1 or ECE349H1 or ECE359H1

ECE512H1 F Analog Signal Processing Circuits
III, IV-AECEPBASC, III, IV-AEELBASC, IV-AEESCBASER
An overview of analog signal processing in both continuous-time and discrete-time. The design of analog filters including transfer function approximation using Matlab and implementation using active-RC, transconductance-C, and switched-capacitor circuits. Other topics include oversampling and noise in analog circuits. Prerequisite: ECE331H1 or ECE354H1

ECE516H1 S Intelligent Image Processing
II, IV-AECEPBASC, III, IV-AEELBASC, IV-AEESCBASER, I-AEMINRAM
This course provides the student with the fundamental knowledge needed in the rapidly growing field of Personal Cybernetics, including "Wearable Computing", "Personal Technologies", "Human Computer Interaction (HCI)", "Mobile Multimedia", "Augmented Reality", "Mediated Reality", "CyborgLogging," and the merging of communications devices such as portable telephones with computational and imaging devices. The focus is on fundamental aspects and new inventions for human-computer interaction. Topics to be covered include: mediated reality, Personal Safety Devices, lifelong personal video capture, the Eye Tap principle, collinearity criterion, comparametric equations, photoquantigraphic imaging, lightvector spaces, anti-homomorphic imaging, application of personal imaging to the visual arts, and algebraic projective geometry.

ECE521H1 S Inference Algorithms
III, IV-AECEPBASC, III, IV-AEELBASC, IV-AEESCBASER, IV-AEESCBASEB, IV-AEESCBASER
Squared error and the Gaussian probability distribution. Maximum likelihood estimation. Logistic regression, neural networks, radial basis function networks. Occam’s razor, validation, bagging, Bayesian techniques. Auto-encoders, principal components analysis, clustering. The EM algorithm, Markov factorization, Markov models, hidden Markov models, the forward-backward algorithm, the Viterbi algorithm. Factor graphs, Bayesian networks, variable elimination, the sum-product algorithm, the max-product algorithm. Estimating graphical models. Applications to image classification, image processing, object tracking, speech recognition, telecommunications and genomics. Prerequisite: STA286H1 or ECE302H1

ECE524H1 F Microwave Circuits
III, IV-AECEPBASC, III, IV-AEELBASC, IV-AEESCBASER
The wave equation; losses in conductors and dielectrics; RF and microwave transmission lines; transients on transmission lines; matching networks; planar transmission lines (microstrip, stripline, coplanar waveguide); design with scattering parameters; 3- and 4-port RF devices (power dividers/combiners, couplers, isolators & circulators); coupled lines and devices; microwave active circuits (RF amplifiers, mixers, and receiver front ends); RF and microwave filters. The hands-on laboratories engage students in the design, simulation, fabrication, and test of practical passive and active microwave circuits using industry-standard RF/microwave simulation tools and measurement systems. Prerequisite: ECE320H1 or ECE357H1

ECE525H1 S Lasers and Detectors
IV-AECEPBASC, III, IV-AEELBASC, IV-AEESCBASEO, IV-AEESCBASEP, IV-AEESCBASER
This course focuses on photonic components which generate or absorb light. Lasers: spontaneous and stimulated emission, gain and absorption, gain broadening; modulation dynamics, mode-locking, Q-switching; semiconductor lasers. Photodetectors: absorption, photo-generated currents, noise in detection. Prerequisite: One of ECE330/350H1 or PHY335/355H1, and one of ECE318/320/357H1 ECE318H1 can also be taken as a co-requisite instead of a pre-requisite.)

ECE527H1 F Photonic Devices
IV-AECEPBASC, III, IV-AEELBASC, IV-AEESCBASEJ, IV-AEESCBASEO, IV-AEESCBASEP, IV-AEESCBASER
Introduction to photonic components useful in many applications ranging from bio-photonics and sensors to optical communications. The students will gain a solid understanding of the fundamental phenomena involved in photonic devices operation and their design. Topics covered include: birefringent media such as liquid crystal displays; polarization states of light and its uses in device applications; interaction of light with matter and its influence in device performance; beams and resonators in free space optical systems; optical waveguides; periodic structures and optical thin films; waveguide couplers and splitters; nano-optics and plasmonic waveguides. (Background preparation in ECE318 - Fundamentals of Optics, or ECE320 - Fields and Waves, or ECE357 -
Course Descriptions

Electromagnetic Fields, is strongly recommended).

ECE530H1 S  
Analog Integrated Circuits  
III, IV-AECPBASEC, III, IV-AEELEBASC, IV-AEESCBASER  
2/3a/1m/0.50  
Prerequisite: ECE331H1 or ECE354H1

ECE532H1 S  
Digital Systems Design  
III, IV-AECPBASEC, III, IV-AEELEBASC, IV-AEESCBASER, I-AEMINRAM  
2/3m/-/0.50  
Advanced digital systems design concepts including project planning, design flows, embedded processors, hardware/software interfacing and interactions, software drivers, embedded operating systems, memory interfaces, system-level timing analysis, clocking and clock domains. A significant design project is undertaken and implemented on an FPGA development board.  
Prerequisite: ECE342H1 or ECE352H1

ECE533H1 F  
Advanced Power Electronics  
III, IV-AECPBASEC, III, IV-AEELEBASC, IV-AEESCBASEJ, IV-AEESCBASER, I-AEMINER  
3/-/1m/0.50  
This course covers system issues associated with the design of switched mode power supplies for telecommunication, computer network and information applications. Topics to be covered include: power processing architectures; steady state analysis and component ratings; control loop modelling and control loop design; EMC regulatory issues.  
Prerequisite: ECE314H1 or ECE315H1 or ECE349H1 or ECE359H1

ECE534H1 F  
Integrated Circuit Engineering  
III, IV-AECPBASEC, III, IV-AEELEBASC, IV-AEESCBASER  
2/3/-/0.50  
The course deals with the technology and design of analog, digital and RF integrated circuits, including exposure to computer aided IC design tools at the semiconductor process, device, and circuit layout level. Topics include: IC fabrication review, MOS IC process modules and components; RF (Bi) CMOS IC process modules and components; compact modelling, characterization and design automation; Bipolar/CMOS digital, analog, and RF IC building blocks; packaging and yield. The labs will expose students to the major design steps in the development of a multi-purpose (Bi) CMOS process.  
Prerequisite: (ECE331H1 or ECE334H1 or ECE354H1)and (ECE335H1 or ECE359H1)

ECE535H1 F  
Advanced Electronic Devices  
IV-AECPBASEC, III, IV-AEELEBASC, IV-AEESCBASER  
2/-/-/0.50  
Heterojunctions, SiGe, InP and GaSb HBTs. MOS device scaling and scaling limits, Dennard's constant field scaling rules, device characteristics and short channel effects. Charge quantization, gate stack, strain and substrate engineering in nanoscale MOSFETs. Nanoscale CMOS fabrication process flow, isolation methods, strategies to suppress short channel effects, stress memorization techniques. Technology CAD for process and device simulations. SPICE models for circuit simulation. SOI (Silicon on Insulator) technology, III-V FETs and graphene transistors. High Power Devices: LDMOS, AIGaN/GaN HEMTs.  
Prerequisite: ECE335H1 or ECE350H1

ECE537H1 F  
Random Processes  
III, IV-AECPBASEC, III, IV-AEELEBASC, IV-AEESCBASEF, IV-AEESCBASER  
3/-/2/0.50  
Introduction to the principles and properties of random processes, with applications to communications, control systems, and computer science. Random vectors, random convergence, random processes, specifying random processes, Poisson and Gaussian processes, stationarity, mean square derivatives and integrals, ergodicity, power spectrum, linear systems with stochastic input, mean square estimation, Markov chains, recurrence, absorption, limiting and steady-state distributions, time reversibility, and balance equations.  
Prerequisite: STA286H1 and ECE355H1 or ECE302H1  
Corequisite: ECE355H1 (can be taken at the same time as ECE537H1)

ECE540H1 S  
Optimizing Compilers  
III, IV-AECPBASEC, III, IV-AEELEBASC, IV-AEESCBASER  
2/3m/-/0.50  
Theoretical and practical aspects of building modern optimizing compilers. Topics: intermediate representations, basic blocks and flow graphs, data flow analysis, partial evaluation and redundancy elimination, loop optimizations, register allocation, instruction scheduling, interprocedural memory hierarchy optimizations. Students will implement significant optimizations within the framework of a modern research compiler. Experience in C programming required.

ECE552H1 F  
Computer Architecture  
III, IV-AECPBASEC, III, IV-AEELEBASC, IV-AEESCBASER, I-AEMINRAM  
3/-/1/0.50  
Prerequisite: ECE243H1 or ECE352H1
Praxis I follows from Praxis I and challenges students to apply, enhance, and refine their engineering design and communication skills. The design projects in Praxis II are both identified and defined by the students themselves, and focus on issues associated with the City of Toronto, its agencies and services, and its communities and citizens. In the first half of the course students, working in small teams, identify, frame, and document appropriate engineering challenges; in the second half they design, prototype, and present engineering solutions to a subset of those identified challenges. In support of these activities students continue to explore in greater depth the theories, tools, and practices of engineering design and communication. Praxis II culminates in an open showcase where students present their design solutions to representatives from interested governmental and non-governmental agencies, to their project stakeholders, and to the general public.

**Engineering Mathematics and Computation**

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<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>ECE557H1 F</td>
<td>Systems Control</td>
<td>3/1.50/1.0.50</td>
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<td>IV-AEESCBASE, IV-AEESCBASEB,</td>
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<td>IV-AEESCBASER, IV-AEESCBASET,</td>
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<td>I-AEMINRAM</td>
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State-space approach to linear system theory. Mathematical background in linear algebra, state space equations vs. transfer functions, solutions of linear ODE’s, state transition matrix, Jordan form, controllability, eigenvalue assignment using state feedback, observability, designing observers, separation principle, Kalman filters, tracking and the regulator problem, linear quadratic optimal control, stability. Laboratories cover the state space control design methodology.

**Computer Security**

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<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tr>
<td>ECE568H1 S</td>
<td>Computer Security</td>
<td>3/3m/-/0.50</td>
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<td>III,IV-AECPEBASC, III,IV-AEELEBASC,</td>
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<td>IV-AEESCBASER</td>
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As computers permeate our society, the security of such computing systems is becoming of paramount importance. This course covers principles of computer systems security. To build secure systems, one must understand how attackers operate. This course starts by teaching students how to identify security vulnerabilities and how they can be exploited. Then techniques to create secure systems and defend against such attacks will be discussed. Industry standards for conducting security audits to establish levels of security will be introduced. The course will include an introduction to basic cryptographic techniques as well as hardware used to accelerate cryptographic operations in ATM’s and webservers.

**Engineering, Society & Critical Thinking**

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<th>Course Code</th>
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<th>Credit Hours</th>
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<tr>
<td>ESC203H1 F</td>
<td>Engineering, Society &amp; Critical Thinking</td>
<td>3/-/1/0.50</td>
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Through this course, students will examine the interrelations of science, technology, society and the environment (STSE), emphasizing a humanities and social sciences perspective. Using topics in STSE as the context, students will consider established models of critical thinking and develop their own framework for analyzing socio-technical issues. Students will have the opportunity to apply tools learned through persuasive writing and formal debate. Upon completion of the course, students will have an understanding of how structured models of thinking can aid in the analysis and evaluation of thought, and should be able to apply tools of critical thinking in other contexts.

**Engineering Science Option Seminar**

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<th>Course Code</th>
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<th>Credit Hours</th>
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<tr>
<td>ESC301Y1 Y</td>
<td>Engineering Science Option Seminar</td>
<td>-/-/0.50/0.10</td>
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<tr>
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<td>III,IV-AEESCBASEA, III,IV-AEESCBASEF,</td>
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<td>III,IV-AEESCBASEI, III,IV-AEESCBASEJ,</td>
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<td>III,IV-AEESCBASEQ, III,IV-AEESCBASEP,</td>
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<td>III,IV-AEESCBASET, III,IV-AEESCBASET</td>
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The Option seminar supports option-related curriculum through discussion of ethics, philosophy and research in a seminar-based setting. Guest speakers, presentations and other special activities will highlight various topics of interest, including the present and future research related to the Option. This course will be offered on a pass/fail basis and the assessment will be based on active discussion within the seminar. Students will be encouraged to discuss their viewpoints on philosophical and ethical issues facing the Option, as well as future directions and opportunities. Occasionally, students from across options will be brought together for special discussions and activities related to research and the engineering profession.

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ESC410H1 S

Technology & Society Student Directed Seminar
3/-1/0.50

Humans and Social Science elective.

Through this course, students have the opportunity to propose a topic for exploration in the realm of technology and society studies to run as a student-led seminar course. Accepted course topics in any given year will be based on student interest. The student course leader(s) are expected to work with the course coordinator to create a full course plan, including learning objectives, course topics and methods of assessment. All participants are expected to contribute to the learning experience, through presentations, suggestions of readings and subtopics. The student directed seminar provides an opportunity to explore a topic of interest, and gain experience in course planning and delivery in a collaborative learning environment. Suggested topics may include engineering & international development, engineering education & outreach, the politicization of science, gender & technology, or cross-profession collaboration; however, students may propose any topic in the broad realm of technology and society studies. Deadlines for student directed seminar proposals and seminar registration will be publicized by the Division of Engineering Science.

ESC470H1 S

Energy Systems Capstone Design
3/-/5/0.50

A half-year capstone design course in which students work in small teams to apply the engineering design, technical, and communication skills learned previously, while refining their skills in teamwork and project management. The course focus is on innovative, entrepreneurial engineering design, that results in a functional prototype. Students identify, frame, and design solutions to problems that align with that focus, and the resulting designs are assessed on their engineering quality and design credibility. In addition, each student engages in individual critical reflection on their course activities, team performance, and on their growth as an engineering designer across their undergraduate program. Students are supported by a teaching team comprising both design and domain experts.

ESC471H1 F

Engineering Science Capstone Design
3/-/5/0.50

A half-year capstone design course in which students work in small teams to apply the engineering design, technical, and communication skills learned previously, while refining their skills in teamwork and project management. The course focus is on innovative, entrepreneurial engineering design, that results in a functional prototype. Students identify, frame, and design solutions to problems that align with that focus, and the resulting designs are assessed on their engineering quality and design credibility. In addition, each student engages in individual critical reflection on their course activities, team performance, and on their growth as an engineering designer across their undergraduate program. Students are supported by a teaching team comprising both design and domain experts.

ESC472H1 S

Electrical and Computer Capstone Design
3/-/5/0.50

A half-year capstone design course in which students work in small teams to apply the engineering design, technical, and communication skills learned previously, while refining their skills in teamwork and project management. The course focus is on innovative, entrepreneurial engineering design, that results in a functional prototype. Students identify, frame, and design solutions to problems that align with that focus, and the resulting designs are assessed on their engineering quality and design credibility. In addition, each student engages in individual critical reflection on their course activities, team performance, and on their growth as an engineering designer across their undergraduate program. Students are supported by a teaching team comprising both design and domain experts.

ESC490H1 F/S

Engineering Science Independent Study
3/-/6/0.50

Independent study courses are student initiated projects, open to Engineering Science students, which allow students to work one-on-one with a division faculty member. The student and supervising faculty member will develop a learning plan for the semester within the first week of term (Limited Enrollment).

ESC499H1 F/S

Thesis
3/-/6/0.50

Every student in Fourth Year Engineering Science is required to prepare a thesis on an approved subject. Instructions concerning the thesis requirements are issued during the Winter Session of Third Year and copies may be obtained in the Division office. The weight allocated to the thesis in each option is shown in the Fourth Year curriculum. Full year theses are graded after submission in the Winter Session and the grade included in the weighted average for that session only.

ESC499Y1 Y

Thesis
3/-/6/1.00

Every student in Fourth Year Engineering Science is required to prepare a thesis on an approved subject. Instructions concerning the thesis requirements are issued during the Winter Session of Third Year and copies may be obtained in the Division office. The weight allocated to the thesis in each option is shown in the Fourth Year curriculum. Full year theses are graded after submission in the Winter Session and the grade included in the weighted average for that session only.

Environment
Forestry

FOR308H1 F
Discovering Wood and its Role in Societal Development

Trees and their components have been used through the centuries for shelter, heat, entertainment, weapons, sport, furnishings, communication, food and medicines. This course explores the co-evolution of nature and culture by examining the social and economic impacts that the forest and its exploitation had in the development of societies throughout the ages. Focus will be on the cultural history of wood and products derived from it and its influence on developing societies from biblical times to modern day. The course will examine how wood's versatility and usefulness in varied applications has been discovered by society as needs for survival to austerity develop. The unique properties of woody materials will be examined to expose its ability to meet the varied demands of societies throughout the ages. This course will allow students to explore the place and role of wood derived products in sustainable society.

FOR310H1 S
Bioenergy from Sustainable Forest Management

Various earth systems for energy transformation, storage and transport are explored. Geological, hydrological, biological, cosmological and oceanographic energy systems are considered in the context of the Earth as a dynamic system, including the variation of solar energy received by the planet and the redistribution of this energy through various radiative, latent and sensible heat transfer mechanisms. It considers the energy redistribution role of large-scale atmospheric systems, of warm and cold ocean currents, the role of the polar regions, and the functioning of various hydrological systems. The contribution and influence of tectonic systems on the surface systems is briefly introduced, as well the important role of energy storage processes in physical and biological systems, including the accumulation of fossil fuel reserves.

Prerequisite: MAT135Y1/MAT137Y1/JMB170Y1/BIO120H1/BIO150Y1/C HM138H1/
CHM139H1/CHM151Y1/PHY138Y1/PHY140Y1/PHY131H1/PHY132
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

ENV350H1
Energy Policy and Environment

The course addresses: (1) physical, technological and economic aspects of energy and electricity systems and their associated environmental impacts; (2) current international, Canadian and Ontario energy policy; (3) technological, economic and political factors influencing policy which could significantly reduce environmental impacts of energy use.

Prerequisite: ENV221H1,ENV222H1/GGR222Y1/GGR222
Y1/JGE221Y1 or permission of Undergraduate Coordinator
Distribution Requirement Status: This is a Social Science course
Breadth Requirement: Society and its Institutions (3)

Geography

FOR409H1 S
Bioenergy and Biorefinery Technology

Technological advances and approaches in deriving biofuels and chemical feedstocks from forest and other biomass. Fundamental chemical attributes of biomass, as they affect the fuel value and potential for deriving liquid, solid and gaseous fuels and valuable chemicals for other applications will be discussed.

Recommended Preparation: Completion of at least 10 Science FCE's
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

FOR410H1 S
Bioenergy from Sustainable Forest Management

Socio-economic, technical, political and environmental issues associated with the utilization of forest biomass (e.g., harvesting residues, thinnings, salvage, short rotation woody crops) for a source of renewable energy.

Recommended Preparation: Completion of at least 6 Science FCE’s
Distribution Requirement Status: This is a Science course
Breadth Requirement: Society and its Institutions (3)
Course Descriptions

GGR220H1 S
The Spatial Organization of Economic Activity
I-AEMINBUS
2/-/1m/0.50
Focuses on theoretical and empirical topics aimed at describing, analyzing and explaining the spatial distribution of economic activity at macro- and micro-spatial-scales. Topics covered could include theories of regional economic growth and change, issues surrounding uneven development in space, the empirical definition of regional economic systems, and the measurement of economic growth and structural change.
Exclusion: GGR220Y1
Distribution Requirement Status: This is a Social Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

GGR221H1 S
New Economic Spaces
I-AEMINBUS
2/-/-/0.50
Provides an introduction to economic geography and economic geography theory from the 1970s on, illustrating the different ways that geographers have conceptualized the restructuring of resource industries, manufacturing and services. The crisis of Fordism and the rise of new production models will be given particular attention, along with the reorganization of finance, the rise of cultural industries and the globalization of commodity chains. New regimes of governance of the economy will also be considered.
Exclusion: GGR220Y1
Distribution Requirement Status: This is a Social Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

GGR225H1 S
Marketing Geography
I-AEMINBUS
2/-/1m/0.50
The problem of retail location. The spatial structure of consumer demand and retail facilities. Shopping centres and retail chains. Techniques for site selection and trade area evaluation, location strategies, retail planning.
Distribution Requirement Status: This is a Social Science course
Breadth Requirement: Society and its Institutions (3)

GGR347H1 F
Efficient Use of Energy (formerly JGE347H1)
I-AEMINENR
2/-/1m/0.50
Examines the options available for dramatically reducing our use of primary energy with no reduction in meaningful energy services, through more efficient use of energy at the scale of energy-using devices and of entire energy systems. Topics covered include energy use in buildings, transportation, industry, and agriculture.
Exclusion: GGR333H1, JGE347H1
Recommended Preparation: 8.0 FCE’s including first year Math and/or Physics
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

GGR348H1 S
Carbon-Free Energy (formerly JGE348H1)
I-AEMINENR
2/-/1m/0.50
Examines the options available for providing energy from carbon-free energy sources: solar, wind, biomass, nuclear, and fossil fuels with capture and sequestration of CO2. The hydrogen economy is also discussed.
Exclusion: GGR333H1, JGE348H1
Recommended Preparation: 8.0 FCE’s including first year Math and/or Physics
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

Geology

GLG206H1 F
Materials of the Earth
II-AELMEBASC
2/3/-/0.50
An overview of the structural, chemical and optical properties of minerals. Laboratories on the identification of minerals in hand specimen and thin section. A mandatory 2 day field trip in late September.
DR=SCI; BR=5
Prerequisite: (CHM138H1, CHM139H1)/CHM151Y1 is recommended
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

GLG207H1 S
Rock-forming Processes
II-AELMEBASC
2/3/-/0.50
Origin and classification of igneous, sedimentary and metamorphic rocks and their associated ore deposits. Emphasis is placed on formation of rock types in the context of plate tectonic theory, and the practical aspects of rock identification in hand sample and thin section.
Prerequisite: GLG206H1
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

GLG340H1 F
Introduction to Geological Field Methods
II-AELMEBASC
2/-/-/0.50
A ten-day field course in mid-May or late August. Students are introduced to field geology and to basic field measurement, mapping and documentation techniques (for example in the Espanola - Manitoulin Island area, west of Sudbury). Students are responsible for the cost of board and lodging and transport to and from the field area.
This is a summer session course and students must also register with the Department in the preceding term.
Prerequisite: GLG207H1, GLG216H1, GLG217H1 or permission of instructor
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

GLG345H1 S
Structural Geology
II-AELMEBASC
2/3/-/0.50
The development of geological structures at a variety of scales is examined using the concepts of stress, strain, material behaviour and tectonic setting. Laboratory work focuses on modern methods of structural analysis and their applications in geotechnical engineering and economic geology.
Prerequisite: GLG216H1 or CME185H1
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)
GLG360H1 F  
Sedimentary Geology  
IV-AELMEBASC  
2/3/-/0.50  
An introduction to the methods for studying sedimentary rocks in surface and subsurface. Petrographic description and classification of sedimentary rocks are dealt with in lectures and laboratory exercises, followed by a treatment of the principles of stratigraphic documentation and correlation, facies-analysis methods, and a brief description of depositional systems. 
Prerequisite: GLG207H1, GLG216H1/MIN 185H1 
Distribution Requirement Status: This is a Science course 
Breadth Requirement: The Physical and Mathematical Universes (5)

GLG42H1 F  
Mineral Deposits  
IV-AELMEBASC  
2/3/-/0.50  
Geology and geochemistry of ore deposits. Origin and interpretation; systematic ore mineralogy, in hand specimen and reflected light microscopy. 
Prerequisite: GLG207H1 
Distribution Requirement Status: This is a Science course 
Breadth Requirement: The Physical and Mathematical Universes (5)

GLG445H1 Y  
Advanced Geological Field Methods  
-/-/-/0.50  
Advanced geological mapping project in a challenging field environment. Students learn to compile existing geoscience data, create a geological map and prepare a professional final report on their activities and findings. Students are responsible for the costs of board, lodging and transportation for the 14-day field trip. 
This is a summer session course and students must also register with the Department during the preceding term. 
Prerequisite: GLG207H1, GLG340H1, GLG345H1 or permission of instructor 
Distribution Requirement Status: This is a Science course 
Breadth Requirement: The Physical and Mathematical Universes (5)

History and Philosophy of Science

In addition to the courses listed below, the Institute offers the following courses through the Faculty of Arts and Science. These courses are acceptable as Humanities/Social Science Electives in engineering programs: HPS210H1/HPS211H1 Scientific Revolutions, HPS201H1 Origins of Western Technology, HPS202H1 Technology in the Modern World, HPS390/91 History of Mathematics, HPS324H Natural Science and Social Issues. 
Details of these courses are published in March, with an updated edition in September.

HPS201H1 F  
Origins of Western Technology  
2/-/2/0.50  
Technology and its place in our culture from Antiquity to the beginnings of the Industrial Revolution. Relations between technology and science, religion, the arts, social institutions, and political beliefs. 
Distribution Requirement Status: This is a Humanities course 
Breadth Requirement: Society and its Institutions (3)

HPS202H1 S  
Technology in the Modern World  
2/-/2/0.50  
A survey of technical change and its social implications from the Industrial Revolution to the present. 
Recommended Preparation: HPS201H1 
Distribution Requirement Status: This is a Humanities course 
Breadth Requirement: Society and its Institutions (3)

HPS210H1 F  
Scientific Revolutions I (formerly HPS200Y1)  
2/-/1/0.50  
Case studies in the history of science from antiquity to 1800, including the revolutionary work of Copernicus, Kepler, Galileo, Descartes, Newton, Linnaeus, Lavoisier, and Herschel. The course is designed to be accessible to science students and non-scientists alike. 
Exclusion: HPS200Y1 
Distribution Requirement Status: This is a Humanities or Science course 
Breadth Requirement: Thought, Belief and Behaviour (2)

HPS211H1 S  
Scientific Revolutions II (formerly HPS200Y1)  
2/-/1/0.50  
Case studies in the history of science from 1800 to 2000, including Volta, Lyell, Darwin, Mendel, Einstein, Schrödinger, Watson, and Crick. The course is designed to be accessible to science students and non-scientists alike 
Exclusion: HPS200Y1 
Distribution Requirement Status: This is a Humanities or Science course 
Breadth Requirement: Thought, Belief and Behaviour (2)

HPS280H1 F/S  
History of Science  
2/-/1/0.50  
An introduction to the history of science, surveying major developments from antiquity to the present. (To be offered in the Fall Session)

HPS281H1 F/S  
History of Technology and Engineering Pre-Industrial Revolution  
2/-/1/0.50  
The origins of technology and engineering, from the civilizations of the Ancient World, Greece and Rome, through the Medieval World and the Renaissance. Emphasis on the developments of techniques and machines with an indication of the context in which these occur. (To be offered in the Winter Session).
The development of technology and engineering from the Industrial Revolution to the present. An historical overview emphasizing new machines, power sources, materials and processes, as well as communications. Some stress is laid on innovation within historical contexts, the changing relationship between science and technology, and the nature of engineering in history. (HPS281H1 S coordinates with this course, but it is not a pre-requisite.)

The emphasis in this course will be more on the history of engineers as workers, members of professional groups, and managers rather than engineering proper, although obviously engineering cannot be ignored when we talk about engineers' work. The aim of the course is to give an understanding of the heritage of engineers as participants in the economy and society.

This course seeks to understand the nature of engineering practice, which comprises complex social, intellectual, and technical actions at various stages from design to entrepreneurship. Building upon the history and social studies of technology, philosophy of engineering, business history, and management science, we introduce ways to analyze such complex actions.

The systemic nature of modern technology suggests that it has intimate interactions with society, human values, ideologies, and the economy. We will attempt to examine these interactions in history in order to promote reflection on ways in which technology and its evolution could be managed for the benefit of humankind.

Recommended Preparation: any half course in HPS at the 200-level Distribution Requirement Status: This is a Humanities course Breadth Requirement: Society and its Institutions (3)

An introduction to classical and modern methods of genetic analysis. Topics include Mendelian genetics, the genetics of human population and disease, genomics, and applications of genetics to human society.

Prerequisite: (BIO120H1+BIO130H1)/BIO150Y1
Corequisite: (BIO220H1+BIO230H1/BIO255H1)/(BIO240H1+BIO241H1)
Exclusion: BIO260H1, BIO207H5
Distribution Requirement Status: This is a Science course
Breadth Requirement: Living Things and Their Environment (4)

Joint Courses

This course introduces a brief overview of essential concepts in accounting and corporate finance. The first part of the course covers the fundamentals of accounting. We start by exploring the basic language of accounting and the fundamental concepts of financial reporting. Students learn to read and analyze basic financial statements including the statements of financial position, comprehensive income, changes in equity, and cash flows. We then introduce key management accounting concepts and explore various methods of costing for decision-making. The second part of the course covers the fundamentals of corporate finance. In the second half, students will learn how to make financial projections and how to value complex investment opportunities. Following this, students learn various techniques for controlling risk and how to determine the appropriate cost of capital. Finally, the course considers issues in cash flow management and overviews project valuation as it relates to corporate mergers.

Prerequisite: Departmental Engineering Economics Course
### Markers and Competitive Strategy

This course introduces the basic concepts, frameworks and methodologies useful to managers in crafting and executing entrepreneurial business strategies in technology-based companies. In the first part of the course, students gain an understanding of the external, internal, and dynamic environments of a business and the elements of a superior competitive position. In the second part, we focus on designing and delivering customer value, which involves strategic decisions about segmentation, targeting and positioning, and tactical decisions related to product introductions, marketing communications, distribution channels and pricing. In the third part of the course, we build on these fundamentals and examine challenges related to innovation and industry dynamics, such as industry life cycles, disruptive technologies, product renewal, and the relationship between R&D and commercialization.

### People Management and Organizational Behaviour

This module spans three inter-related topics: leadership, people management and organization behaviour. It provides students with both the theory and practice in how to design, lead and manage organizations. Topics include theories of leadership, strategy, ethics, designing organizations for rapid change and differing cultural environments, communication, job design, managing and motivating people, fostering creativity, and team work. In addition to traditional lectures, exercises and case studies will be used throughout.

### Mathematics

#### Linear Algebra

**MAT185H1 S**  
**Linear Algebra**  
3/-/1/0.50  
I-AEESCBASE  
Topics include: linear systems, matrix algebra, Rn as a vector space, a normed space and an inner-product space, linear transformations on Rn, eigenvalues, applications to circuits, mechanics and an introduction to computer methods.

**MAT186H1 F**  
**Calculus I**  
3/-/1.050  
I-AECHEBASC, I-AECIVBASC, I-AEMECBASC, I-AEMMSBASC  
Topics include: limits, differentiation, maximum and minimum problems, definite and indefinite integrals, application of integration in geometry, mechanics and other engineering problems.

**MAT187H1 S**  
**Calculus II**  
3/-1/0.50  
I-AEINDBASC, I-AELMEBASC, I-AEMECBASC, I-AEMMSBASC  
Topics include: techniques of integration, an introduction to differential equations, vector differentiation, partial differentiation, series and application to mechanics and other engineering problems.

**MAT188H1 F**  
**Linear Algebra**  
3/-1/0.50  
I-AEINDBASC, I-AEINDBASC, I-AELMEBASC, I-AEMECBASC, I-AEMMSBASC  
This course covers systems of linear equations, matrices, determinants, vectors, lines and planes in three dimensions, Rn, vector spaces, eigenvalues and eigenvectors as well as an introduction to products and applications.

**MAT194H1 F**  
**Calculus I**  
3/-1/0.50  
I-AEESCBASE  
Topics include: theory and applications of differential and integral calculus, limits, basic theorems and elementary functions.

**MAT195H1 S**  
**Calculus II**  
3/-1/0.50  
I-AEESCBASE  
An introduction to differential equations, techniques of integration, improper integrals, sequences, series, Taylor's theorem, as well as an introduction to functions of several variables and partial derivatives.

**MAT196H1 F**  
**Calculus A**  
3/-1/0.50  
I-AECPBASC, I-AEELEBASC, I-AEENGASC  
Topics include: limits and continuity, differentiation, maximum and minimum problems, definite and indefinite integrals, application of integration to geometry, mechanics and other engineering problems as well as an introduction to first order differential equations.

**MAT197H1 S**  
**Calculus B**  
3/-1/0.50  
I-AECPBASC, I-AEELEBASC, I-AEENGASC  
Topics include: techniques of integration, introduction to second order differential equations, sequences and series, vector-valued functions, functions of several variables, partial differentiation and applications to mechanics and other engineering problems.

Prerequisite: MAT196H1

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Course Descriptions

MAT234H1 S  
Differential Equations  
II-AEINDBASC, II-AEMECBASC  
3/-/1.50/0.50  

MAT290H1 F  
Advanced Engineering Mathematics  
II-AECPEBASC, II-AEELEBASC  
3/-/2m/0.50  
An introduction to complex variables and ordinary differential equations. Topics include: Laplace transforms, ordinary higher-order linear differential equations with constant coefficients; transform methods; complex numbers and the complex plane; complex functions; limits and continuity; derivatives and integrals; analytic functions and the Cauchy-Riemann equations; power series as analytic functions; the logarithmic and exponential functions; Cauchy's integral theorem, Laurent series, residues, Cauchy's integral formula, the Laplace transform as an analytic function. Examples are drawn from electrical systems.

MAT291H1 F  
Calculus III  
II-AECPEBASC, II-AEELEBASC  
3/-/2m/0.50  
The chain rule for functions of several variables; the gradient. Maxima and minima, Lagrange multipliers. Multiple integrals; change of variables, Jacobians. Line integrals, independence of path, Green's theorem. The gradient, divergence and curl of a vector field. Surface integrals; parametric representations, applications from electromagnetic fields, Gauss' theorem and Stokes' theorem.

MAT292H1 F  
Calculus III  
II-AEESCBASE  
3/-/2/0.50  
Existence and uniqueness of solution for first-order differential equations, general second-order linear ODEs, homogeneous equations, nonhomogeneous equations, variable coefficients, variation of parameters ODEs in matrix form, Fourier series, Fourier and Laplace transforms, optimization, single-variable functions, interpretation of problems in mathematical terms, multivariable functions, hessians, optimization in the presence of constraints, Lagrange multipliers, introduction to numerical methods, introduction to numerical and computational methods.

MAT294H1 F  
Calculus and Differential Equations  
II-AEMMSBASC  
3/-/2/0.50  
Partial differentiation, grad, div, curl, multiple integrals, line integrals, surface integrals, differential equations, first order differential equations, homogeneous linear differential equations, boundary conditions. Formulation of various problems relevant to materials and mining engineering - the concepts above are used.

MAT301H1 F/S  
Groups and Symmetries  
IV-AEESCBASEP, IV-AEESCBASER  
3/-/-/0.50  
Congruences and fields. Permutations and permutation groups. Linear groups. Abstract groups, homomorphisms, subgroups. Symmetry groups of regular polygons and Platonic solids, wallpaper groups. Group actions, class formula. Cosets, Lagranges theorem. Normal subgroups, quotient groups. Classification of finitely generated abelian groups. Emphasis on examples and calculations. Prerequisite: MAT224H1, MAT235Y1/MAT237Y1, MAT246H1/CSC236H1/CSC240H1. (These Prerequisites will be waived for students who have MAT257Y1) Exclusion: MAT347Y1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

MAT336H1 S  
Elements of Analysis  
III,IV-AEESCBASEF, IV-AEESCBASEP, IV-AEESCBASER  
3/-/-/0.50  
This course provides the foundations of analysis and rigorous calculus for students who will take subsequent courses where these mathematical concepts are central of applications, but who have only taken courses with limited proofs. Topics include topology of R^3, implicit and inverse function theorems and rigorous integration theory. Prerequisite: MAT223H1, MAT235Y1  
Exclusion: MAT257Y1, MAT337H1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

MAT363H1 S  
Introduction to Differential Geometry  
I-AEMINRAM  
3/-/-/0.50  
Geometry of curves and surfaces in 3-spaces. Curvature and geodesics. Minimal surfaces. Gauss-Bonnet theorem for surfaces. Surfaces of constant curvature. Prerequisite: MAT224H1, MAT237Y1/MAT235Y1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

MAT389H1 F  
Complex Analysis  
III,IV-AEESCBASEA, III,IV-AEESCBASEO, III,IV-AEESCBASER  
3/-/1/0.50  
Course examines the following: analytic functions, Cauchy-Reimann equations, contour integration, Cauchy's theorem, Taylor and Laurent series, singularities, residue calculus, conformal mapping, harmonic functions, Dirichlet and Neumann problems and Poisson integral formulas. Course includes studies of linear differential equations in the complex plane, including Bessel and Legendre functions. Exclusion: MAT290H1

MAT401H1 F  
Polynomial Equations and Fields  
IV-AEESCBASEP  
3/-/-/0.50  
Some courses at the 400-level are cross-listed as graduate courses and may not be offered every year. Please see the Departments graduate brochure for more details. Commutative rings; quotient rings. Construction of the rationals. Polynomial algebra. Fields and Galois theory: Field extensions, adjunction of roots of a polynomial. Constructibility, trisection.
of angles, construction of regular polygons. Galois groups of polynomials, in particular cubics, quartics. Insolvability of quintics by radicals.

Prerequisite: MAT301H1

Exclusion: MAT347Y1

Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)

**MAT402H1 S**

**Classical Geometries**

3/-/-/0.50

Euclidean and non-euclidean plane and space geometries. Real and complex projective space. Models of the hyperbolic plane. Connections with the geometry of surfaces.

Prerequisite: MAT301H1/MAT347Y1,
MAT235Y1/MAT237Y1/MAT257Y1

Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)

**Materials Science and Engineering**

**MSE101H1 F/S**

**Introduction to Materials Science**

3/1/0.50

I-AECEBASC, I-AECIVBASC, I-AEINDBASC, I-AELMEBASC, I-AEMECBASC, I-AEMMSBASC

This is an introductory course in materials science examining the fundamentals of atomic structure, the nature of bonding in materials, crystal structure and defects, and phase equilibria. These basic principles provide the foundation for an exploration of structure-property relationships in metals, ceramics, and polymers, with emphasis on mechanical properties. The properties of materials then form the basis for an introduction to materials selection in design.

Prerequisite: OAC/Grade 12 U Chemistry, Physics, and Calculus

Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)

**MSE160H1 S**

**Molecules and Materials**

3/-/-/0.50

I-AEESCBASE

This course will cover both the fundamentals and applications of molecular chemistry as it relates to the properties of materials. Fundamental topics will include: (1) the design of chemical structures and their relationship to optical and electronic properties; (2) the chemistry and physics of covalent and non-covalent bonding; (3) the relationship of atomic bonding to molecular geometry and local symmetry; (4) crystal structures of extended solids; and (5) extension of these principles to electronic structure, elasticity, and vector and tensor descriptions of materials properties. Applications to diverse areas of engineering will be discussed.

Exclusion: MSE260H1

**MSE202H1 F**

**Thermodynamics**

3/-/2/0.50

III,IV-AELMEBASC, II-AEMMSBASC

Enthalpy and energy balances of reactions and processes. Gibbs free energy and its use to determine equilibrium compositions for single phase and two phase systems. Introduction of Ellingham and pre-dominance area diagrams for solid-gas systems. Treatment of ideal and non-ideal solutions with the introduction of the concept of activity and activity coefficient. Binary and ternary phase diagrams and their applications to materials processing and materials properties.

**MSE217H1 S**

**Diffusion and Kinetics**

3/-/2/0.50

II-AEMMSBASC

The diffusion mechanisms in solids, liquids and gases are reviewed. The effects of imperfections in solids on diffusion rates are discussed. Topics include diffusion coefficient, Fick’s law, steady state and unsteady state diffusion. The course covers factors affecting the rate at which chemical reactions take place. The effects that temperature, concentration, pressure and catalysts have on reaction rates are discussed. Topics such as homogeneous versus heterogeneous reactions, order or reaction, and activation energy are also covered.

**MSE219H1 F**

**Structure and Characterization of Materials**

3/3/1/0.50

II-AEMMSBASC

Both the theoretical and experimental interpretation of the structure and chemistry of inorganic materials on various length scales will be examined. Crystalline and amorphous structure is discussed in terms of electronic structure of atoms, atomic bonding, atomic coordination and packing. Extended defects in crystalline solids will be covered. Experimental techniques for characterizing materials structure and chemistry will be described including: optical and electron microscopy, x-ray diffraction, scanning probe microscopy, Auger electron spectroscopy, x-ray photoelectron spectroscopy and secondary ion mass spectrometry.

Breadth Requirement: The Physical and Mathematical Universes (5)

**MSE235H1 S**

**Materials Physics**

3/-/1/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, II-AEMMSBASC


Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)
**Course Descriptions**

**MSE238H1 S Engineering Statistics**

II-AEMMSBASC 3/0.75/1.50/0.50

Topics will include elements of probability theory, hypothesis testing, discrete and continuous distribution, analysis of variance. Description of a sample of measurements. Sampling distributions, parameter estimation, hypothesis testing. Elements of regression analysis. Application from materials engineering area. (Half term course taught during first 6 weeks of term)

**MSE244H1 F Inorganic Materials Chemistry and Processing**

II-AEMMSBASC 3/2/1/0.50

An introduction to atomic and molecular structures, acid-base and redox reactions, transition metal complexes, systematic chemistry and physical properties of metals and elements in the periodic table. Examples of industrial practice from the metal processing industry and energy generation and storage technologies will also be discussed. The fundamentals of chemical analysis of inorganic compounds, by both classical “wet” volumetric analysis and instrumental methods are covered in the experiments.

**MSE245H1 S Organic Materials Chemistry and Properties**

II-AEMMSBASC 3/2/1/0.50


**MSE250H1 S Materials Selection in Design I**

II-AEMMSBASC 2m/2m/1m/0.25

The basic principles underlying the selection and design of engineering materials for different applications are identified. The application of Cambridge Engineering Selection computer software during material selection. Selected case studies. (Half term course taught during last 6 weeks of term)

**MSE270H1 F Materials Science**

II-AEMECBASC 3/0.75/1.50/0.50

Electrical, thermal, magnetic, optical properties of materials; Corrosion and degradation of materials; Phase transformation and strengthening mechanisms; Failure analysis and testing; Fatigue, creep, impact; Composite materials, special purpose materials. Prerequisite: MSE101H1

**MSE290H1 S Communications I**

II-AEMMSBASC 1/-/1/0.25

Students will select assigned reading packages from one of many areas of materials science and engineering. Written communication skills will be developed through iterative report writing.

**MSE301H1 S Mineral Processing**

I-AELMEBASC 3/1.50/1/0.50

The theory and practice of mineral beneficiation including particle size measurement, comminution, sizing, liquid-solid separation and ore concentration by gravity, magnetic methods and flotation. The course also includes the relevant aspects of mineralogy, surface chemistry and the movement of solid particles in liquid media. Prerequisite: MIN225H1

**MSE315H1 S Environmental Degradation of Materials**

I-AEMINENV, III,IV-AEMMSBASC 3/-/2/0.50

This course deals with four major areas: electrochemistry of low temperature aqueous solvents, the corrosion of materials, mechano-chemical effects in materials and corrosion prevention in design. Electrochemistry deals with thermodynamics of material-electrolyte systems involving ion-solvent, ion-ion interactions, activity coefficients, Nernst equation and Pourbaix diagrams, and rate theory through activation and concentration polarization. Corrosion of metallic, polymeric, ceramic, composite, electronic and biomaterials will be explored along with mechano-chemical effects of stress corrosion, hydrogen embrittlement and corrosion fatigue. Corrosion prevention in terms of case histories and the use of expert systems in materials selection.

**MSE316H1 S Mechanical Behaviour of Materials**

III,IV-AEMMSBASC 3/3/1/0.50

The mechanical behaviour of engineering materials including metals, alloys, ceramics and polymeric materials. The following topics will be discussed: macro- and micro-structural response of materials to external loads; load-displacement and stress-strain relationships, processes and mechanisms of elastic, visco-elastic, plastic and creep deformation, crystallographic aspects of plastic flow, effect of defects on mechanical behaviour, strain hardening theory, strengthening mechanisms and mechanical testing. Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)

**MSE318H1 F Phase Transformations**

III,IV-AEMMSBASC 3/3/1/0.50

Thermodynamics and phase stability. Free energy diagrams. Phase transformations in unary systems: primary crystallization, amorphization, crystallization of amorphous materials, recrystallization. Phase transformations in binary systems: solidification, precipitation from solid solution, binary invariant reactions. Diffusional transformations, nucleation and growth, diffusionless or martensitic transformations. Second order transformations. Spinodal, massive and order-disorder transformations. Influence of phase transformations on microstructure and properties. Distribution Requirement Status: This is a Science course
MSE330H1 F
Introduction to Polymer Engineering

This broad overview course begins with an introduction to polymer synthesis, followed by discussion of molecular structure, microstructure and material macrostructure of polymers leading to an understanding of polymer properties and performance. The important processing operations which are used to convert raw polymers into finished products will be discussed and some quantified. Brief consideration will be given to product design/material selection issues and the environmental implications of polymers. Several leading edge examples from the electronics, transportation and medical industries are introduced during the course.

Exclusion: CHE461H1

MSE332H1 F
Heat and Mass Transfer for Materials Processing


MSE342H1 F
Nanomaterials

An introduction to nanstructured materials. Topics include: the different classes of nanomaterials, synthesis and characterization methods, changes in physical properties on the nanometer scale, areas of application of nanostructured materials and materials issues in nanotechnology. (Quarter term course taught over the entire Fall term, worth .25 credits).

Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)

MSE343H1 F
Biomaterials

The course will provide an overview of the applications of materials (metals, polymers, ceramics, composites and modified tissue-based materials) for surgical implant fabrication. The important considerations in selection of materials for fabrication of these devices with an introduction to the biological responses expected with implantation will also be discussed. The concept of biocompatibility will be introduced as well as the essential elements of biology related to an understanding of this criterion for biomaterial selection and implant design. (Quarter term course taught over the entire Fall term, worth .25 credits).

Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)

MSE351H1 S
Design and Simulation of Materials Processes

Various phenomena involved in materials processing and design will be modeled using a software package based on the finite element method. Examples will include aspects of solid state diffusion, structural stress, heat transfer, fluid flow and chemical reactions. The problems will involve unsteady state as well as 3 dimensional systems. Multi-physics phenomena such as heating of an electric component by an electric current, resulting in a change in physical properties affecting thermal properties will also be introduced. The main objective of this course is to introduce students to the use of a commercial software package to solve fairly common but complex physical and chemical phenomena related to the materials industry.

Breadth Requirement: The Physical and Mathematical Universes (5)

MSE352H1 S
Biomaterials and Biocompatibility

The course presents an introduction to the field of biomaterials, covering also the relevant basics in materials science and biology. Topics include the physical and chemical principles of materials science, structure-property relations, biomaterials processing and degradation. Cell/tissue biomaterials interactions will be discussed as determinants of biocompatibility.

Exclusion: MSE452H1

MSE354H1 S
Materials in Manufacturing

Materials processing factors in manufacturing processes such as casting, mechanical forming, powder forming, joining and surface treatment (sprayed coatings, diffusion bonding, ion implantation etc). Materials strengthening in manufacturing. Thermo and mechanical processing. Selected case studies.

Exclusion: MSE452H1

MSE355H1 S
Materials Processing and Sustainable Development

Materials processing requires the use of raw materials and energy resources. Various materials processing methods are analyzed in terms of efficient use of raw materials and energy. The treatment and discharge of effluent streams in an environmentally sound manner are discussed. An introduction to life cycle analysis is also given.

MSE358H1 S
Structure and Characterization of Nanostructured Materials

This course deals with both the theoretical and experimental interpretation of the structure and chemistry of nanostructured materials. The structural characteristics of self-assembled clusters, nanoparticles, nanowires, nanotubes and quantum dots, as well as three-dimensional bulk nanocrystalline materials and their defect structures will be discussed in detail. Experimental techniques for characterizing their structure and chemistry will be described including electron microscopy, x-ray diffraction, Auger electron spectroscopy, x-ray photoelectron spectroscopy, secondary-ion mass spectroscopy and scanning probe
Course Descriptions

MSE390H1 F Communications II

COURSE IMPRINT: 13 IV-AEMMSBASC

The goals of Communication II are to i) gain in-depth knowledge of a specific area of work within a broader field of Materials Science and Engineering ii) read technical materials that will allow you to advance in the field iii) organize, write and present about the ideas of the field at a level of sophistication and clarity appropriate to university and iv) present clear, well-organized technical presentations.

MSE401H1 F Materials Selection in Design II

COURSE IMPRINT: 13 IV-AEMECBASC, IV-AEMMSBASC

The principles necessary for the selection of engineering materials suitable for a given application from the full range of materials available are developed through a series of case studies. Both the material properties and the capabilities of applicable fabrication processes are considered to identify the material and process which best satisfy the design requirements. Extensive use is made of an integrated materials properties and processes database system.

MSE408H1 S Energy Management in Materials Processing

COURSE IMPRINT: 13 I-AEMINENR, IV-AEMMSBASC

Basic materials processing flowsheets including primary processing and recycling of metals. Materials and energy balances of individual units and of overall process flowsheets. Use of computer software for flowsheet evaluation. Energy sources, transformations, utilization and requirements. Energy loss, recovery and re-use. Life cycle impact of materials processing on energy consumption and environment. Economic and environmental impacts due to the usage of various energy forms. Prerequisite: MSE202H1 or equivalent

MSE419H1 F Fracture and Failure Analysis

COURSE IMPRINT: 13 IV-AEMMSBASC

Fracture mechanisms and mechanics of solid materials. Topics include: nature of brittle and ductile fracture, macro-phenomena and micro-mechanisms of failure of various materials, mechanisms of fatigue; crack nucleation and propagation, Griffith theory, stress field at crack tips, stress intensity factor and fracture toughness, crack opening displacement, energy principle and the J-integral, fracture mechanics in fatigue, da/dn curves and their significance. Practical examples of fatigue analysis and fundamentals of non-destructive testing.

MSE421H1 S Solid State Processing and Surface Treatment

COURSE IMPRINT: 13 IV-AEMMSBASC

The fundamentals and technologies of mechanical forming (rolling, forging, extrusion, drawing, sheet-metal forming), sintering and powder forming, thermo-mechanical processing and heat treatment are discussed. Various means to enhance surfaces for the purposes of i) improving corrosion and erosion properties, ii) change mechanical, chemical or electric properties, iii) produce a visually more appealing surface are also covered. Techniques include galvanizing, hot dipping, nitriding, vapour deposition, plasma spraying.

MSE430H1 F Electronic Materials

COURSE IMPRINT: 23 IV-AEECSBASEO, IV-AEMMSBASC

Materials parameters and electronic properties of semiconductors are discussed as basic factors in the engineering of semiconductor devices. Materials parameters are related to preparation and processing methods, and thus to the electronic properties. The implications of materials parameters and properties on selected simple devices are discussed. Distribution Requirement Status: This is a Science course Breadth Requirement: The Physical and Mathematical Universes (5)

MSE431H1 S Forensic Engineering

COURSE IMPRINT: 23 IV-AEECSBASEO, IV-AEMMSBASC

The course provides participants with an understanding of scientific and engineering investigation methods and tools to assess potential sources, causes and solutions for prevention of failure due to natural accidents, fire, high and low speed impacts, design defects, improper selection of materials, manufacturing defects, improper service conditions, inadequate maintenance and human error. The fundamentals of accident reconstruction principles and procedures for origin and cause investigations are demonstrated through a wide range of real world case studies including: medical devices, sports equipment, electronic devices, vehicular collisions, structural collapse, corrosion failures, weld failures, fire investigations and patent infringements. Compliance with industry norms and standards, product liability, sources of liability, proving liability, defense against liability and other legal issues will be demonstrated with mock courtroom trial proceedings involving invited professionals to elucidate the role of an engineer as an expert witness in civil and criminal court proceedings. Prerequisite: MSE101H1/APS104H1/MSE260H1

MSE440H1 F Biomaterial Processing and Properties

COURSE IMPRINT: 23 IV-AEECSBASEO, IV-AEMMSBASC

Currently used biomaterials for formation of surgical implants and dental restorations include selected metals, polymers, ceramics, and composites. The selection and processing of these materials to satisfy biocompatibility and functional requirements for applications in selected areas will be presented. Materials used for forming scaffolds for tissue engineering, and strategies for repair, regeneration and augmentation of degenerated or traumatized tissues will be reviewed with a focus on biocompatibility issues and required functionality for the intended applications. Prerequisite: MSE101H1/APS104H1/MSE260H1

MSE442H1 S Surgical and Dental Implant Design

COURSE IMPRINT: 23 IV-AEECSBASEO, IV-AEECSBASET, IV-AEMECBASC, I-AEMINBIO, IV-AEMMSBASC

Case studies will be used to illustrate approaches for selection of biomaterials for fabrication of implants for specific applications in medicine and dentistry. Computational modeling for optimizing device design and the necessary post-design validation procedures for ensuring acceptable device performance will be discussed. Methods of manufacture to produce devices of desired form and with required in vivo characteristics will be reviewed. Design and fabrication of devices designed to be either biodegradable or non-biodegradable will be reviewed. The intent of the course is to illustrate the important
considerations in material selection and fabrication methods used for producing implants.  
Prerequisite: MSE440H1. For EngSci students, MSE352H1 is recommended.

**MSE450H1 F  
Plant Design for Materials Process Industries**  
**IV-AEMMSBASC**  
2/-/3/0.50  
Analysis of plant design factors involved in the processing of materials. Topics considered include the principles of plant design, optimal allocation of resources and costs, minimizing energy requirements for new plant designs, as well as process innovations for existing plants. A case study approach will be used, employing industrial examples. The course material will be reinforced by a plant tour, visit to an engineering office, and guest lectures by industry experts.

**MSE455H1 S  
Process Simulation and Computer Design**  
**IV-AEMMSBASC**  
3/-/2/0.50  
Various production processes use simulation software to shorten the route from the initial design to finished product. Simulation software provides the designer and practicing engineer with a powerful tool in the tasks of improving and optimizing the industrial processes. Expensive trials can be avoided and the quality of the finished product secured from the beginning of production. First, this course will cover the basics of the process simulation used in industrial setting. Subsequently, the course will focus on industrial process simulation software used extensively in foundry industry worldwide. Essential elements of CAD/CAM techniques will be covered. Numerical simulation of the filling and solidification in castings will be presented. Calculation of foundry processes with multiple production cycles will be analyzed. Another course feature will be the graphical presentation of the results on the screen. Limited enrolment.

**MSE459H1 F  
Synthesis of Nanostructured Materials**  
**IV-AEESCBASEO, IV-AEMMSBASC**  
3/2/-/0.50  
Various synthesis techniques to produce nanostructured materials will be introduced. These include methods involving the vapor phase (physical and chemical vapor deposition, organometallic chemical vapor deposition), the liquid phase (rapid solidification, spark erosion), the solid phase, (mechanical attrition, equal channel deformation) as well techniques producing these structures from solution (electrodeposition, electroless processing, precipitation). Secondary processing techniques to produce final products or devices will also be discussed. Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

**MSE462H1 S  
Materials Physics II**  
**IV-AEESCBASEO**  
2/-/1/0.50  
Electron quantum wave theory of solid-state materials will be introduced. Quantum phenomena in various materials systems, in particular nano materials, will be discussed. Electronic properties of materials such as charge transport, dielectric properties, optical properties, magnetic properties, and thermal properties will be discussed using appropriate quantum theory. Materials systems to be studied may include metals, semiconductors, organics, polymers, and insulators.

**MSE468H1 F  
Entrepreneurship and Business for Engineers**  
**I-AEMINBUS**  
3/-/2/0.50  
A complete introduction to small business formation, management and wealth creation. Topics include: the nature of the Entrepreneur and the Canadian business environment; business idea search and Business Plan construction; Buying a business, franchising, taking over a family business; Market research and sources of data; Marketing strategies promotion, pricing, advertising, electronic channels and costing; The sales process and management, distribution channels and global marketing; Accounting, financing and analysis, sources of funding, and financial controls; The people dimension: management styles, recruiting and hiring, legal issues in employment and Human Resources; Legal forms of organization and business formation, taxation, intellectual property protection; the e-Business world and how businesses participate; Managing the business: location and equipping the business, suppliers and purchasing, credit, ethical dealing; Exiting the business and succession, selling out. A full Business Plan will be developed by each student and the top submissions will be entered into a Business Plan competition with significant cash prizes for the winners. Examples will be drawn from real business situations including practicing entrepreneurs making presentations and class visits during the term. (Identical courses are offered: ECE488H1F, MIE488H1F, CHE488H1S and CIV488H1S.)  
Exclusion: APS234 and APS432

**MSE490H1 F  
Professional Ethics and Practice**  
**IV-AEMMSBASC**  
1/-/-/0.25  
The various roles of a practicing engineer in industry and society will be presented through a series of seminars. The lecturers will include practicing engineers from local companies and consulting firms and representatives from professional and technical societies.

**MSE498Y1 Y  
Design and Research Project**  
**IV-AEMMSBASC**  
-6/-/0.50  
The students, alone or preferably organized in small groups, select a project involving original research and design work which is normally closely related to the current work of a staff member, and in close collaboration with an external partner (e.g. local industry, hospital, government lab). The students conceive and carry out a research plan under the supervision of the academic staff member usually with an external liaison person as a resource person. The project must contain a significant design component. The project work may be carried out in the department, at the external site, or both locations. The final grade will be based on interim and final written reports, oral presentations at the end of each term and a final poster presentation.  
Prerequisite: permission of the Department  
Exclusion: CHM499Y1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

**MSE504H1 F  
Extractive Metallurgy**  
**I-AEMINBUS, I-AEMINENV, IV-AEMMSBASC**  
3/-/2/0.50  
Technologies and unit operations used in the production of light metals, non-ferrous and ferrous metals will be presented and analyzed. Emphasis will be placed on analyzing overall flow-sheets used by selected companies for the purpose of determining how overall process efficiency can be improved and the environmental impact reduced.
Methods and technologies used for metals recycling will also be discussed. Examples will be given from the steel, copper, nickel, zinc, aluminum and magnesium industries. The students will be exposed to a series of actual industrial case studies.

MSE550H1 S  
Advanced Physical Properties of Structural Nanomaterials  
IV-AEESCBASEJ, IV-AEESCBASEO, I-AEMECBASC  
This course deals with the physical properties of bulk nanostructured materials. Included are mechanical properties (elastic behavior, tensile and compressive strength, creep, wear and fatigue properties) electrical properties (electrical transport phenomena, electrical resistivity) magnetic properties (paramagnetic, diamagnetic, soft and hard ferromagnetic, superparamagnetic and antiferromagnetic properties), thermodynamic properties (interfacial enthalpy, thermal stability, phase transformations, heat capacity). The considerable differences observed for nanocrystalline solids compared to conventional polycrystalline and amorphous solids will be discussed in terms of the microstructural differences for these materials.  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

MSE558H1 S  
Nanotechnology in Alternate Energy Systems  
IV-AEESCBASEO, IV-AEMMSBASC  
The unique surface properties and the ability to surface engineer nanocrystalline structures renders these materials to be ideal candidates for use in corrosion, catalysis and energy conversion devices. This course deals with the fabrication of materials suitable for use as protective coatings, and their specific exploitation in fields of hydrogen technologies (electrolysis, storage, and fuel cells) linked to renewables. These new devices are poised to have major impacts on power generation utilities, the automotive sector, and society at large. The differences in observed electrochemical behavior between amorphous, nanocrystalline and polycrystalline solid materials will be discussed in terms of their surface structure and surface chemistry. A major team design project along with demonstrative laboratory exercises constitutes a major portion of this course. Limited Enrolment.

MSE561H1 F  
Engineered Ceramics  
IV-AEMMSBASC  
The unique combinations of physical, electrical, magnetic, and thermomechanical properties exhibited by advanced technical ceramics has led to a wide range of applications including automobile exhaust sensors and fuel cells, high speed cutting tool inserts and ball bearings, thermal barrier coatings for turbine engines, and surgical implants. This course examines the crystal and defect structures which determine the electrical and mass transport behaviours and the effects of microstructure on optical, magnetic, dielectric, and thermomechanical properties. The influence of these structure-property relations on the performance of ceramic materials in specific applications such as sensors, solid oxide fuel cells, magnets, and structural components is explored.

Mechanical and Industrial Engineering

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Fundamentals: Automation in material processing and handling - NC, robotics and automatically-guided vehicles; flexible manufacturing - group technology, cellular manufacturing and FMS; and computer-aided design - geometric modelling, computer graphics, concurrent engineering and rapid prototyping.

MIE222H1 S
Mechanics of Solids I
II-AEMECBASC
3/1.50/1.50/0.50

MIE230H1 F
Engineering Analysis
II-AEMECBASC
3/-/2/0.50

MIE231H1 F
Probability and Statistics with Engineering Applications
II-AEMECBASC
3/2/2/0.50

MIE236H1 F
Probability
II-AEINDBASC
3/-/2/0.50

MIE237H1 S
Statistics
II-AEINDBASC
3/1/2/0.50

MIE240H1 S
Human Centred Systems Design
II-AEINDBASC
3/-/2/0.50
Introduction to principles, methods, and tools for the analysis, design and evaluation of human-centred systems. Consideration of impacts of human physical, physiological, perceptual, and cognitive factors on the design and use of engineered systems. Basic concepts of anthropometrics, work-related hazards, shiftwork, workload, human error and reliability, and human factors standards. The human-centred systems design process, including task analysis, user requirements generation, prototyping, and usability evaluation. Design of work/rest schedules, procedures, displays and controls, and training systems; design for error prevention and human-computer interaction; design for aging populations. Prerequisite: MIE242H1 recommended

MIE242H1 F
Psychology For Engineers
II-AEINDBASC, I-AEMINBIO
3/3/-/0.50
Introduction to neuroanatomy and processes that are core to perception, cognition, language, decision making, and action. Use of experiments to test hypotheses concerning brain activities and computations. Conducting and reporting experimental research, use of elementary statistics, and satisfaction of research ethics requirements.

MIE250H1 F
Fundamentals of Object Oriented Programming
II-AEINDBASC
2/3/-/0.50
Introduction to object-oriented programming using the Java programming language with heavy emphasis on practical application; variable types; console and file input/output; arithmetic; logical expressions; control structures; arrays; modularity; functions; classes and objects; access modifiers; inheritance; polymorphism. Prerequisite: APS105/APS106 or equivalent

MIE253H1 S
Data Modelling
II-AEINDBASC
3/1/1/0.50
This course provides an understanding of the principles and techniques of information modelling and data management, covering both relational theory and SQL database systems (DBMS), as well as entity-relation conceptual modelling. The course also familiarizes the student with analytical applications (OLAP) and provides an introduction to XML data modelling. The laboratory focuses on database application development using SQL DBMS. OLAP queries and entity-relation data modelling. Prerequisite: MIE250H1
Course Descriptions

MIE258H1 F
Engineering Economics and Accounting

II-AEINDBASC, II-AEEMCBASC, I-AEMINBUS, III, IV-AEEMMSBASC
3/-/1/0.50

Engineering and economic accounting concepts needed in the design of engineering systems: time value of money, evaluation of cash flows, cost and managerial accounting concepts, defining alternatives, acceptance criteria, replacement analysis, depreciation and income tax, sensitivity and decision analysis, buy or lease, make or buy, production functions and relationship to cost functions. Introduction to financial engineering: fixed income securities, optimal portfolios, mean-variance optimization, portfolio theory, capital asset pricing model (CAPM) and derivatives (options, basic properties, risk management).
Prerequisite: MIE231H1 / MIE236H1 or equivalent

MIE262H1 F
Operations Research I: Deterministic OR

II-AEINDBASC
3/2/1/0.50

Introduction to deterministic operations research. Formulations of mathematical models to improve decision making; linear and integer programming; the simplex method; the revised simplex method; branch-and-bound methods; sensitivity analysis; duality; network models; network simplex method; Dijkstra's algorithm; basic graph theory; and deterministic dynamic programming.
Prerequisite: MAT186H1, MAT188H1

MIE263H1 S
Operations Research II: Stochastic OR

II-AEINDBASC
3/-/2/0.50

Prerequisite: MIE231H1 or MIE236H1

MIE297H1 S
Foundations of Design Portfolio

II-AEEMCBASC
3/-/2/0.50

Students will assemble a short design portfolio with items drawn from engineering courses and extra-curricular experience. The portfolio will demonstrate an understanding and application of basic principles of engineering design through a showcase of the student's best work. The portfolio will further demonstrate competence in written and oral communication through a brief summary of each item and an introduction to the portfolio. Students whose communication work is not up to standard will be provided with opportunities for remediation. The course will be offered on a credit/no credit basis; students who receive no credit must retake the course in year 3.

MIE301H1 F
Kinematics and Dynamics of Machines

III, IV-AEEMCBASC, I-AEMINRAM
3/-/2/0.50

Classifications of mechanisms, velocity, acceleration and force analysis, graphical and computer-oriented methods, balancing, flywheels, gears, gearedtrains, cams. Introduction to Lagrangian Dynamics: Lagrange's equations of motion, Hamilton's equations, Hamilton's principle.
Prerequisite: MIE100H1

MIE303H1 F
Mechanical and Thermal Energy Conversion Processes

IV-AEESCBASEF, III, IV-AEESCBASEJ
3/-/1/0.50

Engineering applications of thermodynamics in the analysis and design of heat engines and other thermal energy conversion processes within an environmental framework; Steam power plants, gas cycles in internal combustion engines, gas turbines and jet engines. Fossil fuel combustion, Alternative fuel combustions, fusion processes and introduction to advanced systems of fuel cells.

MIE312H1 F
Fluid Mechanics I

III, IV-AEEMCBASC
3/1/-/0.50

Prerequisite: MIE100H1, MAT234H1, MIE210H1

MIE313H1 S
Heat and Mass Transfer

III, IV-AEEMCBASC, I-AEMINENR
3/1.50/2/0.50

Exact and numerical analysis of steady and transient conduction in solids. Solutions of one-dimensional and multidimensional systems. Principles of convection and solutions under laminar and turbulent flow over flat plates and inside and over pipes. Free convection. Thermal radiation between multiple black and grey surfaces.
Prerequisite: MAT234H1, MIE210H1, MIE230H1, MIE312H1 or equivalent

MIE315H1 S
Design for the Environment

IV-AEESCBASEF, IV-AEESCBASEJ, III, IV-AEEMCBASC, I-AEMINENV
3/-/1/0.50

Life Cycle Assessment and Inventory and Impact Analysis for the measurement of environmental impacts of existing products and processes. Design for Environment principles for the reduction of environmental impacts in new product and process design. Major team-written term projects.

MIE320H1 S
Mechanics of Solids II

III, IV-AEEMCBASC
3/1.50/2/0.50

Three-dimensional stress transformation, strain energy, energy methods, finite element method, asymmetric and curved beams, superposition of beam solutions, beams on elastic foundations, buckling, fracture mechanics, yield criteria, stress concentration, plane stress and strain.
Prerequisite: MIE222H1

MIE331H1 S
Physiological Control Systems

IV-AECHEBASC, IV-AECEVBASC, III, IV-AECEPBASC, III, IV-AECELEBASC, III, IV-AEEMCBASC, I-AEMINBIOL, I-AEMINRAM
3/-/1/0.50

The purpose of this course is to provide undergraduate engineering students with an introduction to physiological concepts and selected physiological control systems present in the human body. Due to the
scope and complexity of this field, this course will not cover all physiological control systems but rather a selected few such as the neuromuscular, cardiovascular, and endocrine control systems. This course will also provide an introduction to the structures and mechanisms responsible for the proper functioning of these systems. This course will combine linear control theory, physiology, and neuroscience with the objective of explaining how these complex systems operate in a healthy human body. The first part of the course will provide an introduction into physiology and give an overview of the main physiological systems. The second part of the course will focus on the endocrine system and its subsystems, including glucose regulation, thyroid metabolic hormones, and the menstrual cycle. The third part of the course will include discussion on the cardiovascular system and related aspects such as cardiac output, venous return, control of blood flow by the tissues, and nervous regulation of circulation. The fourth and final section of the course will focus on the central nervous system, the musculoskeletal system, proprioception, kinaesthetic, and control of voluntary motion. Prerequisite: CHE353H1

MIE333H1 S Engineering Physics

III,IV-AEMECBASC 3/-/1.50/0.50
This course includes introduction to oscillations leading to periodic wave phenomena of importance to modern engineering methods and instrumentation design, specifically transverse and longitudinal waves, sound, resonance, interference, Doppler effects and phenomena encountered in supersonic speeds. Elementary quantum mechanics is introduced to extend concepts of wave theory to photons and matter waves, with a view to understanding advanced modern materials and devices/instruments encountered at the forefront of engineering practice, specifically properties of nanomaterials, the principles of operation of electronic, magnetic resonance and X-ray microscopes, and laser operation and the nature of laser light. Prerequisite: MAT186H1/MAT187H1

MIE334H1 F Numerical Methods I

III,IV-AEMECBASC 3/-/1.50/0.50
This introductory course to numerical methods includes the following topics: polynomial interpolation, numerical integration, solution of linear systems of equations, least squares fitting, solution of nonlinear equations, numerical differentiation, solution of ordinary differential equations, and solution of partial differential equations. Tutorial assignments using the C programming language focus on engineering applications relevant to the background of students taking the course.

MIE335H1 S Algorithms & Numerical Methods

III,IV-AEINDBASC 3/1/1/0.50

MIE341H1 S Mechanical Engineering Design

III,IV-AEMECBASC, I-AEMINRAM 3/3/1/0.50
Technical drawing including sketching. Computer-aided drafting and design analysis Mechanical components - nomenclature, function and selection. Mechanical dissection of selected mechanical devices. Group competitive conceptual design projects including technical reports, oral presentations and display posters.

MIE342H1 F Circuits with Applications to Mechanical Engineering Systems

III,IV-AEMECBASC 3/1.50/1/0.50
This course presents analysis of complex circuits and application of circuit principles to design circuits for mechanical engineering systems. Discussions will centre around circuits and instrumentation. In-depth discussions will be given on a number of topics: (1) Mechatronics design applications of circuit principles; (2) Network theorems, node-voltage, mesh-current method, Thévenin equivalents; (3) Operational amplifier circuits; (4) 1st and 2nd order circuits; (5) Laplace transform, frequency response; (6) Passive and active filter design (low- and high-pass filters, bandpass and bandreject filters); (7) Interface/readout circuits for mechanical engineering systems, sensors, instrumentation; (8) Inductance, transformers, DC/AC machines; (9) Digital circuit and data sampling introduction. Prerequisite: MAT186H1, MAT187H1

MIE343H1 F Industrial Ergonomics and the Workplace

III,IV-AEINDBASC, IV-AEMECBASC, I-AEMINBIO 3/3/-/0.50
The Biology of Work: anatomical and physiological factors underlying the design of equipment and work places. Biomechanical factors governing physical workload and motor performance. Circadian rhythms and shift work. Measurement and specification of heat, light, and sound with respect to design of the work environment. Prerequisite: MIE231H1/MIE236H1 or equivalent

MIE344H1 S Ergonomic Design of Information Systems

III,IV-AEINDBASC 3/3/-/0.50
The goal of this course is to provide an understanding of how humans and machines can be integrated with information systems. The focus will be on the design of human-machine interfaces, and on the analysis of the impact of computers on people. The course will also include coverage of usability engineering and rapid prototyping design, analysis of user mental models and their compatibility with design models, and quantitative modelling of human-computer interaction. Prerequisite: MIE240H1 or permission of the instructor

MIE345H1 F Case Studies in Ergonomics

III,IV-AEINDBASC 3/-/2/0.50
A detailed analysis will be made of several cases in which human factors methods have been applied to improve the efficiency with which human-machine systems operate. Examples will be chosen both from the area of basic ergonomics and from high technology. Emphasis will be placed on the practical use of material learned in earlier human factors courses. Prerequisite: MIE240H1
Course Descriptions

MIE346H1 S  
Analog and Digital Electronics for Mechatronics  
III,IV-AEMECBASC, I-AEMINRAM  
3/1.50/1/0.50  
A study of the fundamental behaviour of the major semiconductor devices (diodes, bipolar junction transistors and field effect transistors). Development of analysis and design methods for basic analog and digital electronic circuits and devices using analytical, computer and laboratory tools. Application of electronic circuits to instrumentamtion and mechatronic systems.  
Prerequisite: MIE230H1, MAT234H1, MIE342H1

MIE350H1 F  
Design and Analysis of Information Systems  
III,IV-AEINDBASC  
3/1/1/0.50  
Provides students with an understanding of the methods of information system analysis and design. These include methods for determining and documenting an organization's structure (FDD), activities, behaviours and information flows (DFDs, decision tables and trees, network diagrams, etc); model acquisition (data repositories), verification and validation. Methods such as SADT, RAD and prototyping will be covered. Students will acquire a working knowledge of various frameworks for analysis (e.g., information technology categories, system and application classifications, decision types, data vs information). Throughout the course, emphasis is placed on the importance of systems thinking and organizational culture in the analysis and design process. In the laboratory, students will use a CASE-based computer program (Visible Analyst) for the analysis and design of information systems for selected organizations. Students will be asked to work in teams to create a web-based information site and to document and present their development progress through the use of a structured project log.  
Prerequisite: MIE253H1

MIE354H1 F  
Business Process Engineering  
III,IV-AEINDBASC, I-AEMINBUS  
3/1/1/0.50  
This course focuses on understanding multiple perspectives for grouping, assessing, designing and implementing appropriately integrated and distributed information systems to support enterprise objectives. The emphasis is on understanding how Business Process Management techniques and tools can contribute to align an organization's business and information technology perspectives, as well as the characteristics of application and system types and the implications for their design, operation and support of information needs, including those associated with different platforms and technology infrastructure e.g., legacy systems, client/server, the Internet and World Wide Web including the emergence of a web-service-based service oriented architecture. Students will work in the laboratory to develop business processes that can be specified and executed by information systems supporting BPEL, a widely supported standard for describing web-service-based business process.  
Prerequisite: MIE253H1 or permission of the instructor

MIE360H1 F  
Systems Modelling and Simulation  
IV-AEESCBASEF, III,IV-AEINDBASC, I-IV-AEMECBASC  
3/2/1/0.50  
Principles for developing, testing and using discrete event simulation models for system performance improvement. Simulation languages, generating random variables, verifying and validating simulation models. Statistical methods for analyzing simulation model outputs, and comparing alternative system designs. Fitting input distributions, including goodness of fit tests. Role of optimization in simulation studies.  
Prerequisite: MIE231H1/MIE236H1 or equivalent

MIE363H1 S  
Resource and Production Modelling  
III,IV-AEINDBASC  
3/-/2/0.50  
Features of production/service systems and methods of modelling their operation; the material flow, information flow and control systems. Topics include process design, supply chain management, line balancing, material requirements planning, distribution requirements planning, and aggregate production planning. Basic deterministic and probabilistic inventory models will be covered, as well as the application of optimization methods to capacity planning decisions. Emphasis will be placed on the modelling aspects of operations management, as well as the application of analytical approaches in the solution of systems problems.  
Prerequisite: MIE231H1 / MIE236H1, and MIE262H1 or equivalent

MIE364H1 S  
Quality Control and Improvement  
IV-AECHEBASC, III,IV-AEINDBASC, I-IV-AEMECBASC  
3/1/2/0.50  
In manufacturing and service industries alike, quality is viewed as an important strategic tool for increasing competitiveness. Continuous quality improvement is a key factor leading to a company’s success. With more emphasis on quality, the cost and the product cycle time are reduced and the communication between producer and customer is improved. The course focuses on the following topics: introduction to quality engineering, TQM, quality standards, supplier-producer relations and quality certification, costs of quality, statistical process control for long and short production runs, process capability analysis and acceptance sampling.  
Prerequisite: MIE231H1/MIE236H1 or equivalent, MIE237H1

MIE365H1 F  
Operations Research III: Advanced OR  
IV-AEESCBASEF, III,IV-AEINDBASC  
3/2/1/0.50  
Design of operations research models to solve a variety of open-ended problems. Linear programming extensions are presented: goal programming, column generation, Danszig-Wolf decomposition, and interior point solution methods. Non-linear programming solution methods are developed: optimality conditions, quadratic programming and bi-level programming. Solutions to advanced stochastic models: stochastic programming, 2-person and n-person game theory, and Markov Decision Processes.  
Prerequisite: MIE262H1, MIE263H1

MIE367H1 S  
Cases in Operations Research  
IV-AEESCBASEF, III,IV-AEINDBASC  
3/-/2/0.50  
This course focuses on the integration of the results from earlier operations research courses and an assessment of the different methods with regard to typical applications. The course is taught using the case method. Students are expected to analyze cases based on real applications on their own, in small groups and during lecture sessions, and solve them using commercial software packages.  
Prerequisite: MIE263H1
### Course Descriptions

**MIE375H1 F**  
**Financial Engineering**  
III,IV-AEESC/BASEF  
3/1/0.50

This course provides a background in the fundamental areas in financial engineering including relevant concepts from financial economics. Major topics include interest rate theory, fixed income securities, bond portfolio construction term structure of interest rates, mean-variance optimization theory, the Capital Asset Pricing Model (CAPM), arbitrage pricing theory (APT), forwards and futures, and introduction to option pricing and structured finance.

**MIE376H1 S**  
**Mathematical Programming (Optimization)**  
III,IV-AEESC/BASEF  
3/2/1.050

This course deals with the formulation of optimization models for the design and operation of systems that produce goods and services, and the solution of such problems with mathematical programming methods, including linear programming: the simplex method, sensitivity analysis, duality, the revised simplex, column generation, Dantzig-Wolfe decomposition and linear programming with recourse; minimum cost network flows; dynamic programming; integer programming; non-linear programming models.

**MIE377H1 S**  
**Financial Optimization Models**  
III,IV-AEESC/BASEF  
3/1/1/0.50

This course deals with the formulation of optimization models for the design and selection of an optimal investment portfolio. Topics include Risk Management, Mean Variance Analysis, Models for Fixed Income, Scenario Optimization, Dynamic Portfolio Optimization with Stochastic Programming, Index Funds, Designing Financial Products, and Scenario Generation. These concepts are also applied to International Asset Allocation, Corporate Bond Portfolios and Insurance Policies with Guarantees.

**MIE397Y1 Y**  
**Design Portfolio**  
III,IV-AEESC/BCAS  
3/3/-/0.50

Students will assemble a comprehensive design portfolio with items drawn from engineering courses and extra-curricular experience. The portfolio will articulate and demonstrate an understanding and application of basic and advanced principles of engineering design through a showcase of the student’s best work. The portfolio shall also anticipate continued development of design skills through the capstone design courses and reflect on the transition to a career in engineering. The portfolio will demonstrate competence in written and oral communication through a brief summary of each item and an introduction to the portfolio. Students whose communication work is not up to standard will be provided with opportunities for remediation. The course will be offered on a credit/no credit basis; students who receive no credit must retake the course in year 4.

**MIE402H1 S**  
**Vibrations**  
IV-AEESC/BCAS, I-AEMIN/FE  
3/1/2/0.50


**MIE404H1 F**  
**Control Systems I**  
IV-AEESC/BCAS  
3/3/2/0.50


**MIE407H1 F**  
**Nuclear Engineering I: Reactor Physics and the Nuclear Fuel Cycle**  
IV-AEESC/BCAS, IV-AEMEC/BCAS, I-AEMIN/FE  
3/2/0.50

This course covers the basic principles of the neutronic design and analysis of nuclear power reactors. Topics include radioactivity, neutron interactions with matter, the fission chain reaction, nuclear reactors, neutron diffusion and moderation, the critical reactor equation, nuclear reactor fuels, nuclear fuel cycle and economics, nuclear waste management and non-proliferation. Prerequisite: MIE230H1 or equivalent Exclusion: CHE468H1

**MIE408H1 S**  
**Nuclear Engineering II: Thermal and Mechanical Design of Nuclear Power Reactors**  
IV-AEESC/BCAS, IV-AEMEC/BCAS, I-AEMIN/FE  
3/2/0.50

This course covers the basic principles of the thermo-mechanical design and analysis of nuclear power reactors. Topics include reactor heat generation and removal, nuclear materials, diffusion of heat in fuel elements, thermal and mechanical stresses in fuel and reactor components, single-phase and two-phase fluid mechanics and heat transport in nuclear reactors, and core thermo-mechanical design. Prerequisite: MIE407H1/MIE222H1, MIE312H1, MIE313H1 or equivalents Exclusion: CHE468H1

**MIE411H1 F**  
**Thermal Energy Conversion**  
IV-AEESC/BCAS, I-AEMIN/FE  
3/3/-/0.50

Engineering applications of thermodynamics in the analysis and design of heat engines and other thermal energy conversion processes within an environmental framework. Steam power plants, gas cycles in internal combustion engines, gas turbines and jet engines. Refrigeration, psychrometry and air conditioning. Fossil fuel combustion and advanced systems includes fuel cells. Prerequisite: MIE210H1, MIE313H1

**MIE414H1 F**  
**Applied Fluid Mechanics**  
IV-AEESC/BCAS  
3/3/-/0.50

This course builds upon the material introduced in Fluid Mechanics I and connects it to a wide range of modern technical applications of fluid flow. Applications include the design of pipe and microfluidic networks, transient flow phenomena, compressible flow and shocks, characteristics of pumps, open channel flow and an overview of flow measurement.
techniques. Lectures are complemented by laboratory experiments on
topics such as centrifugal pumps, flow transients and fluid flow in
microfluidic chips.
Prerequisite: MIE312H1

MIE418H1 S  
Fluid Mechanics II
2/3/2/0.50
IV-AECIVBASC, IV-AEMECBASC

This course covers the physical and mathematical principles underlying
some of the fundamental tools in fluid mechanics: Poiseuille’s law, the
Moody chart, creeping and inviscid flow approximations, boundary layer
theory, and lift/drag coefficients. Emphasis will also be placed on
appreciating the explicit (and often implicit) assumptions made. Lectures
are complemented by a computational fluid dynamics (CFD) laboratory
component, covering the basic theory and practical use of CFD. Students
will use an educational CFD package (FlowLab) to perform simulations
related to topics discussed in the lectures, and solve a fluids engineering
design problem.
Prerequisite: MIE312H1 or equivalent

MIE422H1 S  
Automated Manufacturing
2/3/-/0.50
IV-AEESCBASEF, IV-AEMECBASC,
I-AEMINRAM

Introduction to Computer Integrated Manufacturing. Definitions,
terminology. Organization of manufacturing systems. Introduction to NC
machines. Introduction to robotics. Types of robot motion. Robot
Interpolation, spline fits. Robot joint control. Flexible manufacturing
systems, justification. Robot cell design. Group technology. Design of
group technology cell. Programmable logic controllers. Limited
enrolment.
Prerequisite: MIE221H1 or equivalent

MIE438H1 S  
Microprocessors and Embedded Microcontrollers
2/3/-/0.50
IV-AEMECBASC, I-AEMINRAM

Review (number systems, CPU architecture, instruction sets and
subroutines); Interfacing Memory; Interfacing Techniques; Transistors
and TTL/CMOS Logic; Mechanical Switches & LED Displays; Interfacing
Analog, A/D & D/A Conversions; Stepper Motors & DC Motors; RISC
Technology and Embedded Processors; DAS Systems; Embedded
Microcontroller System Design; CPU-based Control.
Exclusion: ECE243H1, ECE352H1

MIE439H1 S  
Biomechanics I
3/2/-/0.50
IV-AEESCBASEB, III-V-AEESCBASET,
IV-AEMECBASC, I-AEMINBIO

Introduction to the application of the principles of mechanical engineering
- principally solid mechanics, fluid mechanics, and dynamics - to living
systems. Topics include cellular mechanics, blood rheology, circulatory
mechanics, respiratory mechanics, skeletal mechanics, and locomotion.
Applications of these topics to biomimetic and biomechanical design are
emphasized through a major, integrative group project.

MIE440H1 F  
* Mechanical Design: Theory and Methodology
2/2/1/0.50
IV-AEESCBASEF, IV-AEMECBASC

This course presents the engineering design process, with emphasis on
theory and methodology related to conceptual design. Methods for
enhancing creativity during conceptual design include using related and
unrelated stimuli during idea generation, design by analogy, particularly
biological analogies, and TRIZ/TIPS (theory of inventive problem
solving). Design for assembly and design for manufacturing, with
emphasis on design for injection molding, die casting and stamping, will
be integrated into the various stages of design. Design for other life-cycle
concerns, such as remanufacturing, and recycling will be introduced.
Prerequisite: MIE341H1, MIE221H1 or equivalent

MIE441H1 S  
* Design Optimization
3/2/-/0.50
IV-AEMECBASC

Problem definition and formulation for optimization, optimization models,
and selected algorithms in optimization. Design for Tolerancing, Design
for Manufacturing, and Design for Assembly. State of the are Computer
Aided Design packages are introduced with case studies. Emphasis is
placed on gaining practical skills by solving realistic design problems.
Prerequisite: MIE341H1, MIE222H1 or equivalents

MIE442H1 F  
Machine Design
3/1.50/3/0.50
IV-AEESCBASEJ, IV-AEMECBASC,
I-AEMINRAM

Introduction to the fundamental elements of mechanical design including
load determination, failure analysis under static and dynamic loads,
surface failure and the selection of engineering materials and
manufacturing processes. Consideration is given to the characteristics
and selection of machine elements such as bearings, shafts, couplings,
fatigue, impact, elastic instability, vibration, brittle failure, direct shear,
contact and bearing stresses, lubrication.
Prerequisite: MIE320H1

MIE443H1 S  
* Mechatronics Systems: Design and Integration
3/3/1/0.50
IV-AEMECBASC, I-AEMINRAM

The course aims to raise practical design awareness, provide pertinent
project engineering methodology, and generate a know-how core in
integration of complex automation. This course has mainly practical
content, and is integral and useful in the training and education of those
students who plan to be employed in areas related to intelligent
automation, as well as to the breadth of knowledge of all others. Although
emphasis will be on robotic-based automation (mechatronics), the
learning will be useful in all domains of system integration. This course
will introduce students to the basics of integration, methodology of
design, tools, and team project work. The course will be monitored based
on projects from a selected list of topics. The lectures will be in format of
tutorials as preparation and discussions on project related issues. A main
goal is to bring the methods, means and spirit of the industrial design
world to the class room. Emphasis will be on understanding the elements
of integration, methodology and approaches, and will involve numerous
case studies. Specifically the course will provide a practical step-by-step
approach to integration: specifications, conceptual design, analysis,
modeling, synthesis, simulation and bread-boarding, prototyping,
integration, verification, installation and testing. Issues of project
management, market, and economics will be addressed as well. Limited
Enrolment.
Course Descriptions

MIE444H1 F  
* Mechatronics Principles  
IV-AEMECBASC, I-AEMINRAM  
2/3/-/0.50  
This course provides students with the tools to design, model, analyze and control mechatronic systems (e.g., smart systems comprising electronic, mechanical, fluid and thermal components). This is done through the synergic combination of tools from mechanical and electrical engineering, computer science and information technology to design systems with built-in intelligence. The class provides techniques for the modeling of various system components into a unified approach and tools for the simulation of the performance of these systems. The class also presents the procedures and an analysis of the various components needed to design and control a mechatronic system including sensing, actuating, and I/O interfacing components.  
Prerequisite: MIE342H1, MIE346H1

MIE448H1 F  
Engineering Psychology and Human Performance  
IV-AEINDBASC, IV-AEMECBASC, I-AEMINBIO  
3/3/-/0.50  
An examination of the relation between behavioural science and the design of human-machine systems, with special attention to advanced control room design. Human limitations on perception, attention, memory and decision making, and the design of displays and intelligent machines to supplement them. The human operator in process control and the supervisory control of automated and robotic systems. Laboratory exercises to introduce techniques of evaluating human performance.  
Prerequisite: MIE231H1/MIE236H1/STA286H1 or equivalent required; MIE237H1 or equivalent recommended

MIE451H1 F  
Decision Support Systems  
IV-AEINDBASC  
3/1/1/0.50  
This course provides students with an understanding of the role of a decision support system in an organization, its components, and the theories and techniques used to construct them. The course will cover basic technologies for information analysis, knowledge-based problem solving methods such as heuristic search, automated deduction, constraint satisfaction, and knowledge representation.  
Prerequisite: MIE253H1, MIE350H1

MIE457H1 S  
Knowledge Modelling and Management  
IV-AEESCBASF, IV-AEINDBASC  
3/1/1/0.50  
This course explores both the modelling of knowledge and its management within and among organizations. Knowledge modelling will focus on knowledge types and their semantic representation. It will review emerging representations for knowledge on the World Wide Web (e.g., schemas, RDF). Knowledge management will explore the acquisition, indexing, distribution and evolution of knowledge within and among organizations. Emerging Knowledge Management System software will be used in the laboratory.  
Prerequisite: MIE253H1, MIE350H1

MIE459H1 S  
Organization Design  
IV-AEINDBASC  
4/-/-/0.50  
Study of design, innovation, change and implementation issues in both new and existing organizations. Consideration will be given to sociotechnical systems design methodology, work teams, support systems, project management, and union-management relations.

MIE463H1 F  
Organization Design  
IV-AEINDBASC  
3/-/2/0.50  
Integrated System Design is a capstone course that integrates the various perspectives of an integrated system taught in third year, including: Optimization, Quality, Management, Information, and Economics. The course approaches systems design from a Business Process perspective. Beginning with the Business Processes, it explores the concept of Business Process Re-engineering. It extends the concept of business processes to incorporate perspectives such as cost, quality, time, behaviour, etc. The second part of the course focuses on business process design tools. Namely, software tools to both design, simulate and analyse business processes. The third part of the course explores the application of process design to various domains. Guest speakers are used to provide domain background.  
Prerequisite: Fourth-year, Industrial Engineering standing

MIE464H1 S  
* Smart Materials and Structures  
IV-AEMECBASC, I-AEMINRAM  
3/2/-/0.50  
Smart materials are characterized by new and unique properties that can be altered in response to environmental stimuli. They can be used in a wide range of applications since they can exceed the current abilities of traditional materials especially in environments where conditions are constantly changing. This course is designed to provide an integrated introduction to smart materials and structures, and provide a strong foundation for further studies and research on these materials. Topics include: structure, processing, and properties of smart materials; dependence of properties on structure; processing and design; mechanical, thermal, electrical, magnetic and optical smart materials systems such as shape memory materials, electrostrictive materials, magnetostrictive materials, active polymers; design, modeling and optimization of smart materials systems using CAD and FEA software packages.  
Prerequisite: MSE101H1, MSE270H1/MSE235H1, MIE222H1/MSE316H1

MIE466H1 S  
Facility Planning  
III, IV-AEINDBASC  
3/-/2/0.50  
Fundamentals of developing efficient layouts of production/ service systems and determining optimal locations of facilities in a network. Activity relationships, manufacturing flow patterns, layout procedure types (construction and improvement algorithms), manual and computerized layout techniques, single and multiple facility location, and supply chain (location) network-distribution design.  
Prerequisite: MIE231H1/MIE236H1 or equivalent, MIE262H1
Course Descriptions

MIE469H1 S
Reliability and Maintainability Engineering
IV-AEESCBASEF, III-AEMECBASC
3/-/2/0.50
An introduction to the life-cycle costing concept for equipment acquisition, operation, and replacement decision-making. Designing for reliability and determination of optimal maintenance and replacement policies for both capital equipment and components. Topics include: identification of an items failure distribution and reliability function, reliability of series, parallel, and redundant systems design configurations, time-to-repair and maintainability function, age and block replacement policies for components, the economic life model for capital equipment, provisioning of spare parts.
Prerequisite: MIE231H1 / MIE236H1 or equivalent, MIE258H1

MIE479H1 F
Engineering Mathematics, Statistics and Finance Capstone Design
IV-AEESCBASEF
3/-/5/0.50
This will be a group project oriented course that focuses on the development of tools for solving a practical financial engineering problem. In particular, a decision support system will be developed that integrates both the mathematical and statistical modeling techniques learned in the option along with relevant computing technologies. Problems that contain a real-time economic decision making component will be emphasized, but does not necessarily or explicitly involve financial markets. An important goal of the capstone is the articulation of the requirements to non-specialists as an exercise in communication with non-technical members of an organization.

MIE488H1 F
Entrepreneurship and Business for Engineers
3/-/2/0.50
A complete introduction to small business formation, management and wealth creation. Topics include: the nature of the Entrepreneur and the Canadian business environment; business idea search and Business Plan construction; Buying a business, franchising, taking over a family business; Market research and sources of data; Marketing strategies promotion, pricing, advertising, electronic channels and costing; The sales process and management, distribution channels and global marketing; Accounting, financing and analysis, sources of funding, and financial controls; The people dimension: management styles, recruiting and hiring, legal issues in employment and Human Resources; Legal forms of organization and business formation, taxation, intellectual property protection; the e-Business world and how businesses participate; Managing the business: location and equipping the business, suppliers and purchasing, credit, ethical dealing; Exiting the business and succession, selling out. A full Business Plan will be developed by each student and the top submissions will be entered into a Business Plan competition with significant cash prices for the winners. Examples will be drawn from real business situations including practicing entrepreneurs making presentations and class visits during the term. (Identical courses are offered: ECE488H1F, MIE488H1F, CHE488H1S and CIV488H1S.) Exclusion: APS234 and APS432

MIE490Y1 Y
Capstone Design
IV-AEINDBASC
/-/-/4/1.00
An experience in engineering practice through a significant design project whereby student teams meet specific client needs through a creative, iterative, and open-ended design process. The project must include:
• The application of disciplinary knowledge and skills to conduct engineering analysis and design,
• The demonstration of engineering judgment in integrating economic, health, safety, environmental, social or other pertinent interdisciplinary factors,
• Elements of teamwork, project management and client interaction, and
• A demonstration of proof of the design concept.

MIE491Y1 Y
Capstone Design
IV-AEINDBASC
/-/-/4/1.00
An experience in engineering practice through a significant design project whereby students teams meet specific client needs through a creative, iterative, and open-ended design process. The project must include:
• The application of disciplinary knowledge and skills to conduct engineering analysis and design,
• The demonstration of engineering judgement in integrating economic, health, safety, environmental, social or other pertinent interdisciplinary factors,
• Elements of teamwork, project management and client interaction, and
• A demonstration of proof of the design concept.

MIE498H1 F/S
Research Thesis
IV-AEINDBASC, IV-AEMECBASC
/-/-/4/0.50
An opportunity to conduct independent research under the supervision of a faculty member in MIE. Admission to the course requires the approval of a project proposal by the Undergraduate office. The proposal must: 1) Explain how the research project builds upon one or more aspects of engineering science introduced in the student's academic program, 2) provide an estimate of a level of effort not less than 40 productive hours of work per term, 3) specify a deliverable in each term to be submitted by the last day of lectures, 4) be signed by the supervisor, and 5) be received by the Undergraduate Office one week prior to the last add day.

MIE498Y1 Y
Research Thesis
IV-AEINDBASC, IV-AEMECBASC
/-/-/4/1.00
An opportunity to conduct independent research under the supervision of a faculty member in MIE. Admission to the course requires the approval of a project proposal by the Undergraduate office. The proposal must: 1) Explain how the research project builds upon one or more aspects of engineering science introduced in the student's academic program, 2) provide an estimate of a level of effort not less than 40 productive hours of work per term, 3) specify a deliverable in each term to be submitted by the last day of lectures, 4) be signed by the supervisor, and 5) be received by the Undergraduate Office one week prior to the last add day.
MIE506H1 S
* MEMS Design and Microfabrication

IV-AEESCBASET, IV-AEMECBASC, I-AEMINRAM

This course will present the fundamental basis of microelectromechanical systems (MEMS). Topics will include: micromachining/microfabrication techniques, micro sensing and actuation principles and design, MEMS modeling and simulation, and device characterization and packaging. Students will be required to complete a MEMS design term project, including design modeling, simulation, microfabrication process design, and photolithographic mask layout. Prerequisite: MIE22H1, MIE342H1

MIE515H1 F
Alternative Energy Systems

IV-AECHCBASC, IV-AEESCBASEF, IV-AEMEBASC, I-AEMINREN, I-AEMINENV

This course covers the basic principles and design of selected alternative energy systems. Systems discussed include solar thermal systems, solar photovoltaic, wind technology, fuel cells, and energy storage. Limited enrolment. Prerequisite: MIE210H1, MIE312H1 and some knowledge of chemistry, or equivalent courses).

MIE516H1 F
Combustion and Fuels

IV-AECHCBASC, IV-AEESCBASEJ, IV-AEMECBASC, I-AEMINREN


MIE517H1 S
Fuel Cell Systems

IV-AECHCBASC, IV-AEESCBASEJ, IV-AEMECBASC, I-AEMINREN

Thermodynamics and electrochemistry of fuel cell operation and testing; understanding of polarization curves and impedance spectroscopy; common fuel cell types, materials, components, and auxiliary systems; high and low temperature fuel cells and their applications in transportation and stationary power generation, including co-generation and combined heat and power systems; engineering system requirements resulting from basic fuel cell properties and characteristics.

MIE518H1 S
Fundamentals of Aircraft Design

2/3/-/0.50

This course aims at developing strategies for improving/optimizing the design of entire mechanical systems, applying attributes of the mechanical engineering curriculum to open-ended multidisciplinary systems/assemblies. Topics include: the developing design process, introduction to integration in systems design, computer aided design of mechanical systems, computer aided analysis of entire systems, computer integrated manufacturing, concepts in integrated mechanical systems designs, performance evaluation and cost. Assessment is based on group design projects involving weekly progress meetings and presentations. Written reports, verbal presentations and scale models of sufficient detail to justify the feasibility of the selected design projects, accounting for originality, cost and the environment.

MIE520H1 F
Biotransport Phenomena

IV-AEESCBASET, IV-AEMECBASC

Application of conservation relations and momentum balances, dimensional analysis and scaling, mass transfer, heat transfer, and fluid flow to biological systems, including: transport in the circulation, transport in porous media and tissues, transvascular transport, transport of gases between blood and tissues, and transport in organs and organisms. Prerequisite: MIE312H1 /AER210H1 /equivalent

MIE540H1 S
* Product Design

IV-AEESCBASEF, IV-AEMECBASC

This course takes a 360° perspective on product design: beginning at the market need, evolving this need into a concept, and optimizing the concept. Students will gain an understanding of the steps involved and the tools utilized in developing new products. The course will integrate both business and engineering concepts seamlessly through examples, case studies and a final project. Some of the business concepts covered include: identifying customer needs, project management and the economics of product design. The engineering design tools include: developing product specifications, concept generation, concept selection, FAST diagrams, orthogonal arrays, full and fractional factorials, noises, interactions, tolerance analysis and latitude studies. Specific emphasis will be placed on robust and tunable technology for product optimization and generating product families. Critical Parameters will be developed using the Voice of the Customer (VOC), FAST diagrams and a House of Quality (HOQ). Prerequisite: MIE231H1/MIE236H1 or equivalent.

MIE542H1 S
Human Factors Integration

IV-AEINDBASC

The integration of human factors into engineering projects. Human factors integration (HFI) process and systems constraints, HFI tools, and HFI best practices. Modelling, economics, and communication of HFI problems. Examples of HFI drawn from energy, healthcare, military, and software systems. Application of HFI theory and methods to a capstone design project, including HFI problem specification, concept generation, and selection through an iterative and open-ended design process. Prerequisite: MIE240H1/ MIE1411H1/ equivalent or permission from the instructor.

MIE561H1 S
Healthcare Systems

IV-AEESCBASEF, IV-AEINDBASC, I-AEMINBIO

MIE 561 is a "cap-stone" course. Its purpose is to give students an opportunity to integrate the Industrial Engineering tools learned in previous courses by applying them to real world problems. While the specific focus of the case studies used to illustrate the application of Industrial Engineering will be the Canadian health care system, the approach to problem solving adopted in this course will be applicable to any setting. This course will provide a framework for identifying and resolving problems in a complex, unstructured decision-making environment. It will give students the opportunity to apply a problem identification framework through real world case studies. The case studies will involve people from the health care industry bringing current practical problems to the class. Students work in small groups preparing
Course Descriptions

a feasibility study discussing potential approaches. Although the course is directed at Industrial Engineering fourth year and graduate students, it does not assume specific previous knowledge, and the course is open to students in other disciplines.

MIE562H1 F
Scheduling

IV-AELMEBASC, IV-AEINDBASC 3/-/2/0.50

This course takes a practical approach to scheduling problems and solution techniques, motivating the different mathematical definitions of scheduling with real world scheduling systems and problems. Topics covered include: job shop scheduling, timetabling, project scheduling, and the variety of solution approaches including constraint programming, local search, heuristics, and dispatch rules. Also covered will be information engineering aspects of building scheduling systems for real world problems.
Prerequisite: MIE262H1

MIE566H1 F
Decision Analysis

IV-AELMEBASC, IV-AEINDBASC 3/-/2/0.50

The purpose of this course is to provide a working knowledge of methods of analysis of problem and of decision making in the face of uncertainty. Topics include decision trees, subjective probability assessment, multi-attribute utility approaches, goal programming, Analytic Hierarchy Process and the psychology of decision making.
Prerequisite: MIE231H1 / MIE236H1 or equivalent

Mineral Engineering

MIN225H1 F
Introduction to the Resource Industries

I-AELMEBASC 3/2/1/0.50

This course introduces the global resource industries in three parts. In Module 1, students learn about mineral resources in the economy, the origin of ore deposits, mineral exploration and processing techniques, land ownership and environmental issues. Engineering applications are emphasized. Exploration and development topics are investigated. Module 2 presents an introduction to modern mining engineering. The basics of both surface (open pit) and sub-surface mining is covered. Module 3 presents an introduction on the processing of mineral resources into metals. The course helps to develop communication skills through student presentations on current issues in the industry and through training in technical communications by faculty from the Engineering Communications Program. Training for AutoCad and an extensive communications module are provided in the laboratory section. Students will participate in a field trip to an operating mine. *Only students enrolled in the Lassonde Mineral Engineering program are eligible to participate in the 2nd year field trip.

MIN320H1 F
Explosives and Fragmentation in Mining

III,IV-AELMEBASC 3/-/1/0.50

This course covers the selection of modern industrial explosives, their history, physical properties, and safe handling, including an introduction to the theory of detonation, and rock response. Safety procedures in storage and transportation will be studied along with the monitoring and control of blast side effects. A field trip is associated with this course.

MIN350H1 S
Underground and Open Pit Mining

III,IV-AELMEBASC 3/-/1/0.50

Operational aspects of open pit and underground mine design and mine planning. Topics will include: open pit design and pit optimization; long term and short term planning considerations; underground mining methods for hard and soft rock; shaft sinking, hoisting and materials handling; equipment selection and optimization; industrial minerals production; mine safety and mine regulations; mining and the environment; mine personnel organization; ethics and professional issues.

MIN351H1 S
Underground Mining

I-AELMEBASC 3/-/1/0.50

Operational aspects of underground mine design and mine planning. Topics will include: underground mining methods for hard and soft rock; shaft sinking, hoisting and materials handling; equipment selection and optimization; mine safety and mine regulations; mine personnel organization; ethics and professional issues. Development and production costs associated with mining are an inherent aspect of this course.
Exclusion: MIN350H1

MIN400H1 F
Geology Field Camp for Engineers

IV-AELMEBASC

At Geology Field Camp, students will learn to incorporate geological observations into their engineering data sets. The course will focus on the recognition of rock types in the field, mapping of geological structures related to mineralization of potential economic importance, and field measurement techniques for obtaining rock engineering data. Students will learn how to make geological observations that are of critical importance to their success as mineral engineers, and to foster a sense of excitement and curiosity about the rocks that form the physical environment within which they will work as professionals. The course will be taught in the Sudbury region where there are several operating mines, numerous excellent field exposures of rocks related to the formation of the impact-related Sudbury structure, inexpensive accommodations, as well as unrelated older rock sequences typical of Archean greenstone belts where much of Canada’s mineral exploration takes place. Students attend the two week Geology Field Camp prior to the start of Fourth Year.
Course Descriptions

MIN401H1 S  
Mineral Reserve and Mineral Resource Estimation  
IV-AEESCBASEF, IV-AELMEBASC  
3/-/1/0.50  
Introduction to Mineral Resource and Mineral Reserve Estimation is an advanced level course that focuses on the stages of a mineral resource and mineral reserve estimation program from assembling the database through to reporting under industry guidelines. Major course topics include: statistical analysis of sampling data, geologic interpretation and deposit models; mineral resources estimation approaches and methods, mineral reserve estimation, classification of resources and reserves, and reporting under regulatory standards and industry guidelines for professional practice.

MIN429H1 S  
Engineering Rock Mechanics  
IV-AECIVBASC, III,IV-AELMEBASC  
3/-/1/0.50  
This course uses case studies to cover the practical aspects of rock engineering. Topics include: rock mass classification, shear strength of discontinuities, structurally controlled instability in tunnels, slope stability, factor of safety and probability of failure, analysis of rockfall hazards, in situ and induced stresses, rock mass properties, tunnels in weak rock, large powerhouse caverns in weak rock, rockbolts and cables, shotcrete support and blasting damage in rock.
Exclusion: CIV529H1.

MIN430H1 F  
Mining Environmental Management  
IV-AECIVBASC, IV-AEESCBASEF, III,IV-AELMEBASC, I-AEMINENV  
3/-/1/0.50  
This course provides an overview of the major aspects of mining environmental management from exploration, through design and development of the property, into operation, and final closure implementation. An applied approach is taken utilizing case studies and examples where possible. Participation and discussion is an integral part of the course. Topics include sustainable development, environmental impacts, designing for mitigation, environmental management systems and reclamation.

MIN450H1 F  
Mineral Economics  
IV-AELMEBASC  
3/-/1/0.50  
Course covers the evaluation of mineral projects, mining operations, and mining companies. Topics will include: discounted cash flow techniques including net present value (NPV), internal rate of return (IRR), net asset value (NAV); feasibility studies and due diligence reports; reserves and resources; data sources; metal prices and markets; cash flow modeling including revenue calculations, capital and operating costs, taxes, depreciation, inflation; risk and risk assessment, discount rates, red flags, checklists; financing. Guest lectures will provide industry insights into financing, fund raising, consulting, project control, and evaluation. There are two assignments: review of an annual report; due diligence report and net asset value calculation.
Prerequisite: CIV368H1/CME368H1

MIN466H1 F  
Mineral Project Design I  
IV-AELMEBASC  
2/2/1/0.50  
Mineral Project Design is a two-part capstone course that draws on all course materials developed in the first three years of the Mineral Engineering Curriculum. The course will culminate in the design of a mining or civil rock engineering project. In the first half of the course (F) students perform individual detailed case history analyses. Additional instruction in technical aspects of communication is provided during both semesters (preparing and writing technical reports, industry research and analysis, presentation skills, as well as other technical elements as required). These skills will form a foundation for students to use in industry. Critical non-technical aspects of rock engineering projects will also be examined, and guest speakers will present on specialized topics such as: cultural and social effects of rock engineering projects on communities and the environment; economic planning and impact; ethical considerations; aboriginal land claims, etc. The social license to operate will be emphasized. Students will receive a final grade at the end of each term course, but both courses must be taken in sequence. (MIN 467H1 F cannot be taken without successful completion of MIN 466H1 F)  
Prerequisite: MIN429H1, MIN350H1

MIN467H1 S  
Mineral Project Design II  
IV-AELMEBASC  
1/4/1/0.50  
Mineral Project Design is a two-part capstone course that draws on all course materials developed in the first three years of the Mineral Engineering Curriculum. Part II (S) focuses on the design of a mining or civil rock engineering project. Students will be grouped into teams and provided with one or more data sets and a design problem to solve. The end product is a major engineering design report and oral presentation (including several interim reports and presentations). Technical aspects will serve to examine a “cradle to grave” view of a project, from initial planning through to final closure and site remediation. The course will include an intensive two-day Professional Supervisors Short Course. Topics include: Discovering a commonality among supervisors and their key role in maintaining standards. The importance of sharing information and expectations about costs, production goals and business objectives are explored in the context of motivation. The necessity of successful communication skills and techniques are discussed and demonstrated to achieve behaviours on the job, producing consistent results. A reliable methodology for handling difficult situations is provided. The fundamental rationale for safety and loss control is presented as well as a relevant perspective on management structure. A workable code of conduct that is a guide to professional behaviour is developed. Students will receive a final grade at the end of each term course, but both courses must be taken in sequence (MIN 467H1 S cannot be taken without successful completion of MIN 466H1 F)  
Prerequisite: MIN466H1

MIN470H1 S  
Ventilation and Occupational Health  
IV-AECIVBASC, IV-AELMEBASC  
3/-/1/0.50  
Hydraulics of air flow through underground openings is studied leading to mine ventilation design calculations and ventilation network analysis. Related topics discussed in the course include: statutory regulations and engineering design criteria; application and selection of ventilation fans; auxiliary fan design; air conditioning (heating and cooling); dust and fume control; ventilation economics. Health hazards related to mine gasses, dust and radiation along with relevant statutory requirements are reviewed. Air quality and quantity measurement and survey techniques are presented.
Course Descriptions

Prerequisite: CIV270H1/CME270H1

**MIN511H1 F**
Integrated Mine Waste Engineering

**IV-AECIVBASC, IV-AELMEBASC**

3/-/0.50

The engineering design of conventional mine waste management systems, including tailings ponds, rock dumps, and underground mine backfill systems, is considered first. Emerging trends in integrated mine waste management systems, including paste stacking and "paste rock" on surface, and cemented paste backfill for underground mining will then be covered. Engineering case studies will be used throughout, and each case study will be evaluated in terms of how the mine waste systems used contribute to the economic and environmental sustainability of the mining operation.

**Prerequisite:** CME321H1

**MIN540H1 S**
Borehole Geophysics for Engineers and Geoscientists

**IV-AECIVBASC, IV-AELMEBASC**

3/-/0.50

The process of wireline logging of boreholes for mineral, hydrocarbon and groundwater exploration, geotechnical and environmental studies involve a number of measurement devices, or sondes. Some of these are passive measurement devices; others exert some influence over the rock formation being traversed. Their measurements are transmitted to the surface by means of wire line. Logging applications include the identification of geological environment, reservoir fluid contact location, fracture detection, estimate of hydrocarbon or water in place, determination of water salinity, reservoir pressure determination, porosity/pore size distribution determination, and reservoir fluid movement monitoring.

**Prerequisite:** CME321H1

**MIN565H1 S**
Design and Support of Underground Mine Excavations

**IV-AELMEBASC**

3/-/0.50

Geomechanical issues concerning the design of underground openings in hard rock are covered in the course: ground support [i.e. rock mass reinforcement] design, the dimensioning and sequencing of underground excavations and rock pillar design in hard rock applications. A review of modern concepts concerning rock and rock mass failure modes with application to support design is given. Both static and dynamic [rockburst] support design issues are addressed. Lastly instrumentation and monitoring techniques and backfill design and behaviour are also covered. Design issues are illustrated through the use of numerous field case studies.

**Prerequisite:** MIN429/CIV 529

**Exclusion:** BIO370Y5 (UTM)

Distribution Requirement Status: This is a Science course

Breadth Requirement: Living Things and Their Environment (4)

**Pharmacology and Toxicology**

**PCL201H1 S**
Introduction to Pharmacology and Pharmacokinetic Principles

**IV-AEECBCBASE, I-AEMINBIO**

3/-/1a/0.50

A general introduction to the principles of pharmacology and pharmacokinetics. Topics include chemical (drug) absorption, distribution, biotransformation, elimination; the calculation of dosages and pharmacokinetic parameters, variability in drug response, adverse drug reactions and special interest topics.

Corequisite: Recommended Co-requisites: BIO230H1/(BIO240H1, BIO241H1), CHM247H1/CHM249H1, PSL300H1/PSL301H1

Distribution Requirement Status: This is a Science course

Breadth Requirement: Living Things and Their Environment (4)

**PCL302H1 F**
Pharmacodynamic Principles

**I-AEMINBIO**

3/-/-/0.50

Topics include biological action of drugs on membranes, enzymes, receptors, neural and hormonal systems, transmission and modulation.

Prerequisite: BIO230H1/(BIO240H1, BIO241H1), CHM247H1/CHM249H1, PSL300H1/PSL301H1/PSL302Y1

Distribution Requirement Status: This is a Science course

Breadth Requirement: Living Things and Their Environment (4)

**Philosophy**

**PHL342H1 F**
Minds and Machines

**I-AEMINRAM**

3/-/-/0.50

Topics include: philosophical foundations of artificial intelligence theory; the computational theory of the mind; functionalism vs. reductionism; the problems of meaning in the philosophy of mind.

Prerequisite: 7.5 courses (in any field) with at least 1.5 in philosophy or COG250Y1

Distribution Requirement Status: This is a Humanities course

Breadth Requirement: Thought, Belief and Behaviour (2)

**Physics**

**PHY180H1 F**
Classical Mechanics

**I-AEECBCBASE**

3/1.50/1/0.50

Mechanics forms the basic background for the understanding of physics. This course on Classical, or Newtonian mechanics, considers the interactions which influence motion. These interactions are described in terms of the concepts of force, momentum and energy. Initially the focus is on the mechanics of a single particle, considering its motion in a
particular frame of reference, and transformations between reference frames. Then the dynamics of systems of particles is examined. Textbook: Physics for Scientists and Engineers vol. 1. 6th ed. by Serway and Jewett.

PHY293H1 F Waves and Modern Physics
II-AEESCBASE 3/1/1.0.50
The first half of the semester will give an introduction to the basic ideas of classical oscillations and waves. Topics include simple harmonic motion, forced and damped harmonic motion, coupled oscillations, normal modes, the wave equation, travelling waves and reflection and transmission at interfaces. The second half of the semester will first give an introduction to Einstein’s special relativity, including evidence for the frame-independence of the speed of light, time dilation, length contraction, causality, and the relativistic connection between energy and momentum. Then we will follow the historical development of quantum mechanics with the photo-electric and Compton effects, the Bohr atom, wave-particle duality, leading to Schrödinger’s equation and wave functions with a discussion of their general properties and probabilistic interpretation.

PHY294H1 S Quantum and Thermal Physics
II-AEESCBASE 3/1/1.0.50
The first half of the semester will continue with the development of quantum mechanics. Topics will include Shrödinger’s wave mechanics, tunneling, bound states in potential wells, the quantum oscillator, and atomic spectra. The second half of the semester will give an introduction to the basic ideas of classical statistical mechanics and radiation, with applications to experimental physics. Topics will include Boltzmann’s interpretation of entropy, Maxwell-Boltzman statistics, energy equipartition, the perfect gas laws, and blackbody radiation.

PHY327H1 F/S Advanced Physics Laboratory
III,IV-AEESCBASE, III,IV-AEESCBASEP 7/6/-0.50
Experiments in this course are designed to form a bridge to current experimental research. A wide range of experiments are available using contemporary techniques and equipment. In addition to the standard set of experiments a limited number of research projects are also available. Many of the experiments can be carried out with a focus on instrumentation.

PHY335H1 S Introduction to Quantum Mechanics
IV-AECPBASC, III,IV-AEELEBASC 2/-/1m/0.50
Review of elementary quantum mechanics, (photo-electric and Compton effects, Bohr model, de Broglie waves); some bound (harmonic oscillator, hydrogen atom) and unbound (potential barriers) solutions of the Schrodinger equation; probability interpretation; operators and the theory of measurement; expectation values and uncertainties; angular momentum (orbital and spin); magnetic resonance as an application. Exclusion: MSE235H1

PHY354H1 S Classical Mechanics
III,IV-AEESCBASE 2/-1/0.50
Symmetry and conservation laws, stability and instability, generalized coordinates, Hamilton’s principle, Hamilton’s equations, phase space, Liouville’s theorem, canonical transformations, Poisson brackets, Noether’s theorem. Prerequisite: (MAT244H1/MAT267H1), PHY254H1 Exclusion: PHY351H1 Distribution Requirement Status: This is a Science course Breadth Requirement: The Physical and Mathematical Universes (5)

PHY356H1 F Quantum Mechanics I
III,IV-AEESCBASEO, III,IV-AEESCBASEP, IV-AEESCBASEP 2/-1/0.50
The general structure of wave mechanics; eigenfunctions and eigenvalues; operators; orbital angular momentum; spherical harmonics; central potential; separation of variables; hydrogen atom; Dirac notation; operator methods; harmonic oscillator and spin. Prerequisite: (MAT223H1/MAT240H1), PHY250H1, (PHY256H1/CHM225Y1), (PHY256H1 recommended) Corequisite: MAT244H1 Exclusion: CHM326H1, PHY355H1 Distribution Requirement Status: This is a Science course Breadth Requirement: The Physical and Mathematical Universes (5)

PHY357H1 S Nuclear and Particle Physics
IV-AEESCBASEP 2/-1/0.50
The subatomic particles; nuclei, baryons and mesons, quarks, leptons and bosons; the structure of nuclei and hadronic matter; symmetries and conservation laws; fundamental forces and interactions, electromagnetic, weak, and strong; a selection of other topics, CP violation, nuclear models, standard model, proton decay, supergravity, nuclear and particle astrophysics. This course is not a prerequisite for any PHY 400-level course. Prerequisite: PHY356H1 Distribution Requirement Status: This is a Science course Breadth Requirement: The Physical and Mathematical Universes (5)

PHY358H1 S Atoms, Molecules and Solids
III,IV-AEESCBASEO, IV-AEESCBASEP 2/-1/0.50
Quantum theory of atoms, molecules, and solids; variational principle and perturbation theory; hydrogen and helium atoms; exchange and correlation energies; multielectron atoms; simple molecules; bonding and antibonding orbitals; rotation and vibration of molecules; crystal binding; electron in a periodic potential; reciprocal lattice; Bloch’s theorem; nearly-free electron model; Kronig-Penney model; energy bands; metals, semiconductors, and insulators; Fermi surfaces. This course is not a prerequisite for any PHY400-level course. Prerequisite: PHY356H1 Distribution Requirement Status: This is a Science course Breadth Requirement: The Physical and Mathematical Universes (5)
### Course Descriptions

**PHY392H1 S**  
**Physics of Climate**  
IV-AEESCBASEP  
2/-/-/0.50  

This course provides an introduction to climate physics and the earth-atmosphere-ocean system. Topics include solar and terrestrial radiation; global energy balance; radiation laws; radiative transfer; atmospheric structure; convection; the meridional structure of the atmosphere; the general circulation of the atmosphere; the ocean and its circulation; and climate variability.  
Prerequisite: (PHY231H1/PHY250H1), (MAT235Y1/MAT237Y1)  
Exclusion: PHY315H1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

**PHY395H1 S**  
**Physics of the Earth**  
III,IV-AECPEBASC, III,IV-AELEBASC, IV-AEESCBASEJ, IV-AEESCBASEP, IV-AEESCBASER, I-AEMINENR  
2/-/1/0.50  

Designed for students interested in the physics of the Earth and the planets. Study of the Earth as a unified dynamic system; determination of major internal divisions in the planet; development and evolution of the Earth's large scale surface features through plate tectonics; the age and thermal history of the planet; Earth's gravitational field and the concept of isostasy; mantle rheology and convection; Earth tides; geodetic measurement techniques, in particular modern space-based techniques.  
Prerequisite: PHY152H1/PHY254H1, MAT235Y1/MAT237Y1, MAT244H1 (or permission of instructor)  
Exclusion: PHY359H1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

**PHY407H1 F**  
**Computational Physics**  
IV-AEESCBASEP  
1/3/-/0.50  

This is an introduction to problem solving by computer where symbolic, numeric and graphical approaches are combined. The emphasis is on a range of ordinary and partial differential equations encountered in physics. Special functions, wave functions, Lagrangians and Monte Carlo methods are also considered.  
Prerequisite: PHY224H1/PHY250H1/PHY324H1  
Corequisite: Any third-year lecture course in Physics. PHY407H1 may be taken in third or fourth year.  
Exclusion: PHY307H1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

**PHY408H1 S**  
**Times Series Analysis**  
IV-AEESCBASEP  
1/2/-/0.50  

The analysis of digital sequences; filters; the Fourier Transform; windows; truncation effects; aliasing; auto and cross-correlation; stochastic processes, power spectra; least squares filtering; application to real data series and experimental design.  
Prerequisite: PHY407H1/PHY224H1/PHY250H1/PHY254H1/PHY324H1  
Corequisite: Any third-year lecture course in Physics  
Exclusion: PHY308H1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

**PHY427H1 F/S**  
**Advanced Physics Laboratory**  
IV-AEESCBASEO, IV-AEESCBASEP  
-/6/-/0.50  

Experiments in this course are designed to form a bridge to current experimental research. A wide range of experiments are available using contemporary techniques and equipment. In addition to the standard set of experiments, a limited number of research projects may be available.  
This laboratory is a continuation of PHY327.  
Prerequisite: PHY327H1

**PHY428H1 F/S**  
**Advanced Practical Physics II**  
IV-AEESCBASEP  
-/6/-/0.50  

This course is a continuation of PHY426H1, but students have more freedom to progressively focus on specific areas of physics, do extended experiments, projects, or computational modules.  
Prerequisite: PHY426H1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

**PHY429H1 F/S**  
**Advanced Practical Physics III**  
IV-AEESCBASEP  
-/6/-/0.50  

This course is a continuation of PHY428H1, but students have more freedom to progressively focus on specific areas of physics, do extended experiments, projects, or computational modules.  
Prerequisite: PHY428H1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

**PHY452H1 S**  
**Basic Statistical Mechanics**  
IV-AEESCBASEO, IV-AEESCBASEP  
2/-/-/0.50  

Classical and quantum statistical mechanics of noninteracting systems; the statistical basis of thermodynamics; ensembles, partition function; thermodynamic equilibrium; stability and fluctuations; formulation of quantum statistics; theory of simple gases; ideal Bose and Fermi systems.  
Prerequisite: PHY224H1/PHY324H1/PHY231H1/PHY331H1/PHY250H1/PHY252H1/PHY254H1/PHY256H1/ENV235H1  
Exclusion: PHY450H1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)

**PHY454H1 S**  
**Continuum Mechanics**  
IV-AEESCBASEP  
2/-/1/0.50  

The theory of continuous matter, including solid and fluid mechanics. Topics include the continuum approximation, dimensional analysis, stress, strain, the Euler and Navier-Stokes equations, vorticity, waves, instabilities, convection and turbulence.  
Exclusion: PHY459H1  
Distribution Requirement Status: This is a Science course  
Breadth Requirement: The Physical and Mathematical Universes (5)
Course Descriptions

PHY456H1 F
Quantum Mechanics II
IV-AEESCBASEP, IV-AEESCBASER
Quantum dynamics in Heisenberg and Schrödinger Pictures; WKB approximation; Variational Method; Time-Independent Perturbation Theory; Spin; Addition of Angular Momentum; Time-Dependent Perturbation Theory; Scattering.
Prerequisite: PHY356H1
Exclusion: PHY457H1
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

PHY460H1 S
Nonlinear Physics
IV-AEESCBASEP
The theory of nonlinear dynamical systems with applications to many areas of physics. Topics include stability, bifurcations, chaos, universality, maps, strange attractors and fractals. Geometric, analytical and computational methods will be developed.
Prerequisite: PHY354H1
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

PHY483H1 F
Relativity Theory I
IV-AEESCBASEP
Basis to Einstein's theory: differential geometry, tensor analysis, gravitational physics leading to General Relativity. Theory starting from solutions of Schwarzschild, Kerr, etc.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

PHY484H1 S
Relativity Theory II
IV-AEESCBASEP
Applications of General Relativity to Astrophysics and Cosmology. Introduction to black holes, large-scale structure of the universe.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

PHY485H1 F
Lasers and Modern Optics
IV-AEESCBASEO, IV-AEESCBASEP
Maxwell's equations in media, basic optics and imaging, manipulations of polarization, coherence and diffraction theory, Gaussian beams, laser resonators, simple semiclassical laser theory. End-of-year student seminars from the range of modern areas of research, e.g., laser cooling, photonic bandgap structures, extreme optics, quantum information, and other topics.
Prerequisite: PHY350H1, PHY356H1
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

PHY487H1 F
Condensed Matter Physics
IV-AEESCBASEO, IV-AEESCBASEP,
IV-AEESCBASER
Introduction to the concepts used in the modern treatment of solids. The student is assumed to be familiar with elementary quantum mechanics. Topics include: crystal structure, the reciprocal lattice, crystal binding, the free electron model, electrons in periodic potential, lattice vibrations, electrons and holes, semiconductors, metals.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

PHY489H1 F
Introduction to High Energy Physics
IV-AEESCBASEP
This course introduces the basics of fundamental particles and the strong, weak and electromagnetic forces that govern their interactions in the Standard Model of particle physics. Topics include relativistic kinematics, conservation laws, particle decays and scattering processes, with an emphasis on the techniques used for calculating experimental observables.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

PHY492H1 F
Advanced Atmospheric Physics
IV-AEESCBASEA, IV-AEESCBASEP
A preparatory course for research in experimental and theoretical atmospheric physics. Content will vary from year to year. Themes may include techniques for remote sensing of the Earth's atmosphere and surface; theoretical atmosphere-ocean dynamics; the physics of clouds, precipitation, and convection in the Earth's atmosphere.
Exclusion: PHY498H1
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

PHY493H1 S
Seismology
IV-AEESCBASEP
This course covers wavefield and ray approximation methods for imaging the interior of the Earth, including hydrocarbon reservoirs and mineral deposits, using seismology.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)

PHY494H1 F
Geophysical Imaging: EM and Potential Fields
IV-AEESCBASEP
How to investigate Earth structure at depths ranging from metres to tens of kilometres using gravity, magnetic, electrical, electromagnetic and nuclear geophysical methods. Current methodologies and the theoretical basis for them are presented.
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)
## Course Descriptions

### PHY495H1 F
**Research Topic in Geophysics**

IV-AEESCBASEP  2/-/-/0.50

A research project done in consultation with an individual staff member on a geophysics-related topic leading to a detailed written report and oral presentation. The course will also involve weekly lectures where the student will be introduced to various geophysical research methods and current research topics in geophysics.

Corequisite: PHY395H1/PHY493H1/PHY494H1

Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)

### Physiology

### PSL300H1 F
**Human Physiology I**

IV-AEESCBASEB, I-AEMINBIO  3/-/1m/0.50

Principles of neurophysiology, endocrinology and reproductive physiology for students enrolled in Life Science programs.

Prerequisite: BIO130H1/BIO150Y1; CHM138H1; MAT100-series/PHY100 series

Exclusion: PSL201Y1, PSL302Y1

Distribution Requirement Status: This is a Science course

Breadth Requirement: Living Things and Their Environment (4)

### Statistics

### STA286H1 S
**Probability and Statistics**

II-AEESCBASE  3/-/1/0.50

A course in probability and statistics for Engineering Science students focusing on building solid probabilistic and statistical foundations. Topics include: sample space, events, definitions of probability, conditional probability, Bayes' theorem, important classes of discrete and continuous random variables and their distributions, joint, conditional, and marginal distributions, expectation, moment generating and characteristic functions, transformations of random variables, central limit theorem and approximations. Graphical methods, quantile plots, point and interval estimation of population parameters, method of maximum likelihood. Hypotheses testing, simple and multiple regression, correlation analysis, and introduction to Bayesian statistics. Minitab software is used to solve some assignment problems in the course.

### STA302H1 F
**Methods of Data Analysis I**

III,IV-AEESCBASEF  3/-/-/0.50


Prerequisite: STA248H1/STA255H1/STA261H1/ECO220Y1(70%)/ECO227Y1

### STA347H1 F
**Probability**

III,IV-AEESCBASEF  3/-/-/0.50

An overview of probability from a non-measure theoretic point of view. Random variables/vectors; independence, conditional expectation/probability and consequences. Various types of convergence leading to proofs of the major theorems in basic probability. An introduction to simple stochastic processes such as Poisson and branching processes.

Prerequisite: STA247H1/STA255H1/STA257H1/ECO227; MAT223H1/MAT240H1; MAT235Y1/MAT237Y1/MAT257Y1 (Note: STA257H1 and MAT237Y1/MAT257Y1; (MAT223H1, MAT224H1)/MAT240H1 are very strongly recommended)

Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)

### STA410H1 F
**Statistical Computation**

IV-AEESCBASEF  3/-/-/0.50


Prerequisite: STA302H1, CSC108H1

Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)

### STA447H1 S
**Stochastic Processes (formerly STA348H1)**

IV-AEESCBASEF  3/-/-/0.50

Discrete and continuous time processes with an emphasis on Markov, Gaussian and renewal processes. Martingales and further limit theorems. A variety of applications taken from some of the following areas are discussed in the context of stochastic modeling: Information Theory, Quantum Mechanics, Statistical Analyses of Stochastic Processes, Population Growth Models, Reliability, Queuing Models, Stochastic Calculus, Simulation (Monte Carlo Methods).

Prerequisite: STA347H1

Exclusion: STA348H1

Distribution Requirement Status: This is a Science course

Breadth Requirement: The Physical and Mathematical Universes (5)