Faculty of Applied Science and Engineering

2016-2017 Calendar

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MESSAGE FROM THE DEAN

Welcome to the 2016–2017 academic year!

Whether you are beginning your studies or are a returning student, I am delighted you are part of our dynamic and diverse community of learners, researchers and innovators who make U of T Engineering Canada's premier engineering school and one of the world's best. Here, you have unparalleled opportunities to learn from renowned and dedicated professors, collaborate across disciplines to address complex challenges and develop the technical, leadership and entrepreneurial competencies you will need to succeed in today's competitive global environment. You can also pursue your interests and passions through our wide range of minors and certificates and our rich co-curricular activities, such as The Entrepreneurship Hatchery, the Blue Sky Solar Racing team and the SkuleTM Orchestra. I encourage you to explore, try new things and make the most of your undergraduate experience.

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. I encourage you to take advantage of the many resources available to you through our First Year Office, departmental offices (for upper-year students), Dean's Office and the Registrar's Office. Our passionate and committed faculty and staff can ensure your time here is successful, productive and rewarding, and we can provide advice and guidance to support you throughout your undergraduate years.

You can learn about events and opportunities during the year through our student and Faculty newsletters, town halls, information sessions, digital displays, the Engineering Society's website and The Cannon student e-newspaper. We welcome your feedback and invite you to share your thoughts and experiences at any time.

On behalf of the entire Faculty, I wish you all the best for a rewarding journey ahead.

Cristina Amon
Dean, Faculty of Applied Science & Engineering

Important Notices

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.

The University is required to report student-level enrolment-related data to the Ministry of Training, Colleges and Universities as a condition of its receipt of operating grant funding. The Ministry collects this enrolment data, which includes limited personal information such as Ontario Education Numbers, student characteristics and educational outcomes, in order to administer government postsecondary funding, policies and programs, including planning, evaluation and monitoring activities.

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
-University Assessment and Grading Practices Policy
-Policy on Official Correspondence with Students

More information about students' rights and responsibilities can be found at 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 ID numbers. The University assumes and expects that students will protect the confidentiality of their Person IDs.

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 admissions, registration, academic programs, university-related student activities, activities of student societies, safety, financial assistance and awards, graduation and university advancement, and reporting to government.

In addition, the Ministry of Training, Colleges, and Universities has asked that we notify you of the following: The University of Toronto is required to disclose personal information such as Ontario Education Numbers, student characteristics and educational outcomes to the Minister of Training, Colleges and Universities under s. 15 of the Ministry of Training, Colleges and Universities Act, R.S.O. 1990, Chapter M.19, as amended. The ministry collects this data for purposes such as planning, allocating and administering public funding to colleges, universities and other post-secondary educational and training institutions and to conduct research and analysis, including longitudinal studies, and statistical activities conducted by or on behalf of the ministry for purposes that relate to post-secondary education and training. Further information on how the Minister of Training, Colleges and Universities uses this personal information is available on the ministry's website.

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 McMurrich Building, room 104, 12 Queen's Park Crescent West, Toronto, ON, M5S 1A8.

Sessional Dates

SUMMER SESSION (F/S) 2016

Engineering Courses

April 11	Monday	First day students can enrol in Engineering Minor courses on ROSI (6 a.m.)
April 28	Thursday	Last day to pay/defer fees
May 2	Monday	F Session Engineering Minor courses begin
May 9	Monday	First Year T-Program classes begin
May 11	Wednesday	Courses removed for non-registered students
May 12	Thursday	Last day for waitlists for F Engineering Minor courses
May 15	Sunday	Deadline for students to enrol in F/Y/S Engineering Minor courses on SWS; Deadline for students to be enrolled in First Year T-Program courses
May 23	Monday	Victoria Day holiday: University closed
June 6	Monday	Last day to drop F courses (T-Program/F Session Engineering Minor) without academic penalty*. Requests to drop T-Program courses must be submitted to the First Year Office (GB170) by 4 p.m.
June 17	Friday	F Session Engineering Minor classes end
June 23	Thursday	First Year T-Program classes end
June 20 to June 24	Monday to Friday	Final examinations for F Session Engineering Minor courses
June 24 to June 29	Friday to Wednesday	Final examinations for First Year T-Program courses
June 27	Monday	S Session Engineering Minor courses begin
June 30	Thursday	Last day for waitlists for S Engineering Minor courses
July 1	Friday	Canada Day Holiday: University closed
July 4	Monday	Deadline to enrol in S Session courses in SWS
July 17	Sunday	Last day to drop Y Session courses without academic penalty*
July 25	Monday	Last day to drop S Session courses without academic penalty*
August 1	Monday	Civic holiday: University closed
August 15	Monday	S Session Engineering Minor classes end
August 16 to August 19	Tuesday to Friday	Final examination period for S Session Engineering Minor courses

(*) 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.

Arts & Science Courses

April 18	Monday	First day for Engineering students to enrol in Arts & Science summer courses (6 a.m.)
April 28	Thursday	Last day to pay/defer fees
May 9	Monday	Classes begin in F and Y courses
May 11	Thursday	Courses removed for non-registered students
May 15	Sunday	Deadline to enrol in F and Y courses on SWS
May 16 to May 20	Monday to Thursday	Late enrollment into Y courses (Registrar's Office only)
May 23	Monday	Victoria Day: University closed

June 6	Monday	Last day to drop F Session courses without academic penalty*
June 17	Friday	Classes end for F Session courses
June 20 to June 24	Monday to Friday	Final examinations for F Session courses
June 20 to June 24	Monday to Friday	Y Section Code Courses Break
June 27	Monday	Classes begin for S Session courses; Y courses resume
June 30	Thursday	Last day for waitlists for S courses
July 1	Friday	Canada Day holiday: University closed
July 4	Monday	Deadline to enrol in S Session courses on SWS
July 17	Sunday	Last day to drop Y Session courses without academic penalty*
July 25	Monday	Last day to drop S Session courses without academic penalty*
August 1	Monday	Civic holiday: University closed
August 8	Monday	Classes end S and Y Session courses
August 9 to August 15	Tuesday to Monday	Final examinations for S and Y courses

(*) 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. Review the refund schedules for refund dates, which are available at www.fees.utoronto.ca.

FALL SESSION (F) 2016

September 21Wednesday

Last day waitlists operational

July 20	Wednesday	First day for Engineering students to make changes to their personal timetable on SWS
July 20	Wednesday	First day for Engineering students to add Arts and Science (A&S) courses with reserved seating (6:00am)
August 10	Wednesday	First day for Engineering students to enrol in all Arts and Science (A&S) courses
August 4 August 9 August 11	Thursday Tuesday Thursday	No Course Enrolment dates (A&S)
August 18	Thursday	Last day to pay/defer fees
September 1	Thursday	Courses removed for non-registered students
September 5	Monday	Labour Day: University closed
September 5	Monday	Orientation programs for First Year students begin
September 8	Thursday	Engineering lectures in F and Y Session courses begin
September 9	Friday	eSIP & PEY Registration Begins (www.engineeringcareers.utoronto.ca)
September 12	Monday	Arts & Science lectures in F and Y Session courses begin
September 16	Friday	Last day to request transfer out of Engineering Science (First Year)
September 19	Thursday	Last day to register for PEY and eSIP
September 25	Sunday	Last day for Engineering students to enrol in A&S courses with reserved seating
September 25	Sunday	Last day for students to add or substitute any Fall Session (F) or Full Year (Y) courses on the SWS

Sessional Dates

September 26 to September 30	Monday Friday	Late enrolment for Y Section code courses only (Registrar's Office only)
October 3	Monday	Last day for students to apply to re-enrol for 2016 Winter Session
October 10	Monday	Thanksgiving Day: University closed
November 1	Tuesday	Examination timetable for F Session courses posted (tentative)
November 7	Monday	Last day for students to drop F 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*
November	TBA	Fall Convocation ceremony for the conferring of the Bachelor of Applied Science and Engineering Science degrees Please check (www.convocation.utoronto.ca) for details
December 6	Tuesday	Last day of Arts & Science classes; Last day to apply for a late withdrawal (LWD) from an A&S HSS/CS/Free Elective classes
December 7	Wednesday	Last day of lectures in F Session; All session work should be submitted by this date.
December 8	Thursday	Engineering Study Day
December 9 to December 20	Friday Tuesday	F Session Engineering examinations; Note: Examinations in courses offered by other Faculties may be held during other periods Engineering will hold exams on Saturdays and evenings during this period
December 12 to December 20	Monday Tuesday	F Session Arts & Science examinations
December 21 to January 1	Wednesday Sunday	University closed Winter holidays

(*) 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.

WINTER SESSION (S) 2017

January 5	Thursday	Lectures begin in S courses and resume in Y Session courses for Arts & Science
January 6	Thursday	PEY and eSIP online registration begins
January 9	Monday	Lectures begin in S courses and resume in Y Session courses for Engineering
January 12	Thursday	Last day to register for PEY and eSIP
January 15	Sunday	Last day waitlist is operational for S courses
January 15	Sunday	Last day to transfer out of Engineering Science (first year) to Track One/Core 8 Engineering programs
January 16	Monday	Lectures begin for T-Program courses
January 18	Wednesday	Last day for students to add or substitute S Session courses
February 21	Tuesday	Last day to drop Y (full year) courses without academic penalty* 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
February 20	Monday	Family Day: University closed
February 21 to February 24	Tuesday Friday	Reading Week: No lectures, tutorials or practicals
February 27	Monday	Examination timetable for S and Y Session courses posted (tentative)

March 13	Monday	Last day for students to drop S Session courses without academic penalty, including S Session courses taken in the Faculty of Arts & Science. Last day for students to transfer to part-time studies. Last day for students to withdraw from S Session without academic penalty* Last day for students to apply to re-enrol for 2017 Fall Session
April 5	Wednesday	(Arts & Science only) End of classes for S and Y Session courses in the Faculty of Arts & Science. Last day to apply for late withdrawal (LWD) from Arts and Science HSS/CS/Free Elective courses
April 13	Thursday	Last day for lectures in S Session; All session work should be submitted by this date
April 14	Friday	Good Friday: University closed
April 17 to April 28	Monday Friday	S and Y Session examinations (April 28 is reserved for examinations postponed by general emergency) Note: Examinations in courses offered by other faculties may be held outside of this period
April 10 to April 28	Monday Friday	S and Y session examination period for Arts & Science courses
*May 13	Friday	Application deadline for transfer between Engineering programs

(*) 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. Review the refund schedules for refund dates, which are available at www.fees.utoronto.ca.

SUMMER SESSION 2017 (TENTATIVE)

First-year Engineering Courses

May 2	Monday	First-year Engineering classes begin
May 22	Monday	Victoria Day: University Closed
June 23	Friday	First-year Engineering classes end
June 26 to June 29	Monday Thursday	Final examinations for first-year Engineering courses
June 26	Monday	S classes start/Y courses resume
August 7	Monday	Civic Holiday: University closed
August 18	Friday	S/Y classes end
August 21 to August 25	Monday to Friday	Final exam period for S/Y courses

THE FACULTY OF APPLIED SCIENCE AND ENGINEERING

ADMINISTRATIVE OFFICERS

OFFICE OF THE DEAN
Dean: Cristina Amon, Sc.D, FAAAS, FASEE, FASME, FIEEE, NAE, CAE, P.Eng.
Vice Dean, Undergraduate: Thomas W. Coyle, B.Sc, B.A., Sc.D.
Vice Dean, Graduate Studies: Markus Bussmann, B.A.Sc., M.A.Sc, Ph.D, P.Eng.
Vice Dean, Research: Edward (Ted) Sargent, B.Sc, Eng., Ph.D., P.Eng.
Associate Dean, Cross-Disciplinary Programs: Bryan W. Karney, B.A.Sc., M.Eng., Ph.D., FAAAS, P.Eng.
Chair, First Year: Micah Stickel, B.A.Sc., M.A.Sc., Ph.D.
Director, Office of the Dean: Christina da Rocha-Feeley, MLIS
Assistant Dean, Administration: Lisa Simpson-Camilleri, B.A.

OFFICE OF THE REGISTRAR
Faculty Registrar: Don MacMillan, B.A.; 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: Helen Bright, B.A. (Hon), MISt
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: Gillian Sneddon, B.A.

AN OVERVIEW

Founded in 1873, the Faculty of Applied Science and Engineering community includes more than 5,400 undergraduate and more than 2,100 graduate students, approximately 240 professors, 290 staff and more than 48,000 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 Physics
Biomedical Systems Engineering	Infrastructure Engineering
Electrical and Computer Engineering	Robotics Engineering
Energy Systems Engineering	
Engineering Mathematics, Statistics & Finance	

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 240 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, University of Toronto Institute for Aerospace Studies and 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, Earth Sciences, Mathematics, Philosophy and Physics—all in the Faculty of Arts and Science—make important contributions to the Engineering curriculum.

The Engineering Alumni Association, which all graduates belong to, 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 south 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, it 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 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.

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 Windows 7. The ECF WINDOWS servers also support labs in Civil, Lassonde Mineral, Mechanical and Industrial, Chemical, Materials Science, Engineering Science, Electrical and Computer Engineering. 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 from 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 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 a number of certificate options, including ELITE (Entrepreneurship, Leadership, Innovation, and Technology in Engineering), Robotics and Mechatronics, Sustainable Energy, Advanced Manufacturing, Sustainable Aviation,

and Advanced Water Technologies & Process Design
Master of Engineering (M.Eng.) in Biomedical Engineering: focuses on the design and commercialization of biomedical devices
Master of Engineering in Cities Engineering and Management (M.Eng. C.E.M.)
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 www.engineering.utoronto.ca.

SPECIAL STUDENTS

An individual who wishes to enrol as a special student or non-degree (not proceeding to a 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 deadline listed in the Calendar. Failure to pay by this date will result in the cancellation of registration.

UNDERGRADUATE ENROLMENT AS OF NOVEMBER 1, 2015

Program	Year 1	Year 2	Year 3	Year 4	Total
Full-Time Enrolment					
Chemical Engineering	130	151	146	131	558
Civil Engineering	99	125	103	111	438
Computer Engineering	88	192	134	107	521
Electrical Engineering	136	192	190	216	734
Engineering Science	322	197	163	212	894
Industrial Engineering	64	124	100	91	379
Lassonde Mineral Engineering	40	21	27	30	118
Materials Engineering	56	50	48	41	195
Mechanical Engineering	118	203	197	203	721
Track One - General Engineering	220	NA	NA	NA	220
Total Full Time	**1,273**	**1,255**	**1,108**	**1,142**	**4,778**
Part-Time Enrolment					
Chemical Engineering	5	5	1	3	14
Civil Engineering	4	1	2	14	21
Computer Engineering	1	12	2	9	24
Electrical Engineering	3	16	5	11	35
Engineering Science	2	1	2	11	16
Industrial Engineering	3	9	3	8	23
Lassonde Mineral Engineering	1	1	0	1	3
Materials Engineering	4	0	0	3	7

Mechanical Engineering	2	3	6	9	20
Track One - General Engineering	2	NA	NA	NA	4
Total Part-time	**27**	**48**	**21**	**69**	**165**

Program	Year 1	Year 2	Year 3	Year 4	Total
Special Students					**13**
International Foundation Program					**25**
Professional Experience Year					**787**
Total Undergraduates	**1,300**	**1,303**	**1,129**	**1,211**	**5,768**

ACADEMIC STAFF OF THE FACULTY

Aerospace Science and Engineering

TITLED PROFESSOR AND DIRECTOR

D.W. Zingg, B.A.Sc., M.A.Sc., Ph.D., F.C.A.S.I., A.F.A.I.A.A., F.C.A.E., P.Eng., Tier I Canada Research Chair in Computational Aerodynamics and Environmentally-Friendly Aircraft Design and J. Armand Bombardier Foundation Chair in Aerospace Flight

PROFESSOR AND ASSOCIATE DIRECTOR

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

ASSOCIATE DIRECTOR

C.J. Damaren, B.A.Sc., M.A.Sc., Ph.D., F.C.A.S.I., A.F.A.I.A.A., P.Eng.

ASSOCIATE PROFESSOR, TEACHING STREAM AND UNDERGRADUATE COORDINATOR

J.W. Davis, B.A.Sc., M.A.Sc., Ph.D., P.Eng.

PROFESSORS EMERITI

J.D. DeLaurier, B.S.(ILL), M.S.(STAN), Ph.D.(STAN)
J.B. French, B.A.Sc, M.Sc. (Birmingham) Ph.D., F.R.S.C., F.C.A.S.I., F.R.S.A., P.Eng., Member of Order of Canada
J.J. Gottlieb, B.Sc., M.Sc.(SASK), Ph.D., F.C.A.S.I., P.Eng.
A.A. Haasz, B.A.Sc., M.A.Sc., Ph.D., F.C.A.S.I., P.Eng.
J.S. Hansen, B.A.Sc., M.A.Sc., Ph.D.(WATERLOO), P.Eng.
P.C. Hughes, B.A.Sc., M.A.Sc., Ph.D., M.B.A. (York, 1996), F.C.A.S.I., F.C.A.E., A.F.A.I.A.A., P.Eng.
G.W. Johnston, B.A.Sc., M.A.Sc., Ph.D., F.C.A.S.I.
L.D. Reid, B.A.Sc., M.A.Sc., Ph.D., F.C.A.S.I., F.A.I.A.A., P.Eng.
P.C. Stangeby, B.Sc., M.Sc., DIPL.-SCI., D.Phil.(OXON), F.A.P.S., F.R.S.C.
P.A. Sullivan, B.E.(N S W), M.E.(N S W), D.I.C., Ph.D.(LOND), F.C.A.S.I., P.Eng.
R.C. Tennyson, B.A.Sc., M.A.Sc., Ph.D., F.C.A.S.I., P.Eng.

TITLED PROFESSOR

S.P. Sampath, B.Eng.(MYSORE), M.Eng. (IISc), Ph.D. (Sask), MBA (McGill), F.C.A.E., NSERC/Pratt & Whitney Canada Executive Industrial Research Chair

TITLED ASSOCIATE PROFESSORS

T.D. Barfoot, B.A.Sc., Ph.D., P.Eng., Tier II Canada Research Chair in Autonomous Space Robotics
P.B. Nair, B. Tech. (IIT BOMBAY), M.Tech. (IIT BOMBAY), Ph.D. (SOUTHAMPTON) Tier II Canada Research Chair in Computational Modeling and Design Optimization Under Uncertainty

PROFESSORS

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A. Guenther, M.S.(HANNOVER), Ph.D.(ETH)
G.A. Jamieson, B.S.(ILL), M.A.Sc.(TORONTO), Ph.D.(TORONTO), P.Eng
G. Nejat, B.A.Sc.(TORONTO), Ph.D.(TORONTO), P.Eng.
L. You, B.Sc.(PEKING), M.Sc.(PEKING), Ph.D.(CUNY)

ASSOCIATE PROFESSORS, TEACHING STREAM

J. Bazylak, B.Sc.(SASK), P.Eng.
D.M. Frances, B.A.Sc.(TORONTO), M.A.Sc.(TORONTO), Ph.D.(TORONTO), P.Eng.
M. Mackay, B.A.Sc. (QUEEN'S), Ph.D.(TORONTO)

ASSISTANT PROFESSORS

A. Bilton, B.A.Sc.(TORONTO), M.S.(MIT), Ph.D.(MIT)
E. Diller, B.S.(CWRU), M.S.(CWRU), Ph.D.(CMU)
B. Donmez, B.S.(BOGAZICI), M.S.(IOWA), Ph.D.(IOWA)
M. Kim, B.A.Sc.(TORONTO), M.Sc(TORONTO), Ph.D.(TORONTO)
E.Young, PhD.(TORONTO),M.A.Sc (COLUMBIA), B.A.Sc (COLUMBIA)

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

ADJUNCT AND STATUS-ONLY PROFESSORS

S. Armstrong, B.Sc.(WESTMINISTER), M.A.(TORONTO)
N. Atalla, B.Eng., M.Eng.(UNIV TECH COMPIEGNE), Ph.D.(FLORIDA ATLANTIC)
J. Bookbinder, B.A.(SAN DIEGO), M.B.A.(TORONTO), M.S., Ph.D.(CALIFORNIA)
D. Cameron, B.A.Sc.(TORONTO), M.A.Sc.(TORONTO), LL.B.(TORONTO), P.Eng.
E. Croft, B.A.Sc.(UBC), M.A.Sc.(WATERLOO), Ph.D.(TORONTO)
I. Dincer, B.Sc.(SELCUK), 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. Honarvar, B.Sc.(TEHRAN), M.A.Sc.(WATERLOO), Ph.D.(TORONTO)
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 ACAD OF SCI)
M. Metcalfe, B.A.Sc.(TORONTO), M.S.(STANFORD), Ph.D.(STANFORD)
K. Michaelian, Ph.D. (SIMON FRASER)
M. Moles, B.A.(CAMBRIDGE), Ph.D.(CAMBRIDGE), M.B.A.(MCMASTER), P.Eng.
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)
K. Sefiane, D.E.A.(ENSSPICAM, FRANCE), Ph.D.(AIX-MARSEILLE III, FRANCE)
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

2014-2015 Professor Jonathan Rose (Electrical and Computer)
2013-2014 Professor Greg Evans (Chemical)
2012-2013 Professor Evan Bentz (Civil Engineering)
2011-2012 Professor Jonathan Rose (Electrical and Computer)
2010-2011 Professor James S. Wallace (Mechanical and Industrial)
2009-2010 Professor Ali Sheikholesmani (Electrical and Computer)
2008-2009 Professor John Carter (Electrical and Computer)
2007-2008 Professor Tarek S. Abdelrahman (Electrical and Computer)
2006-2007 Professor Raviraj Adve (Electrical and Computer)
2005-2006 Professor Frank Kschischang (Electrical and Computer)
2004-2005 Professor C.R. Ethier (Mechanical and Industrial)
2003-2004 Professor K.D. Pressnail (Civil)
2003-2004 Professor Z.G. Vranesic (Electrical and Computer)
2002-2003 Professor D.C.S. Kuhn (Chemical)
2001-2002 Professor B.W. Karney (Civil)
2000-2001 Professor A.N. Sinclair (Mechanical and Industrial)
1999-2000 Professor S. McCahan (Mechanical and Industrial)
1998-1999 Professor P.G. Gulak ((Electrical and Computer)
1997-1998 Professor G.T. Will (Civil)
1996-1997 Professor S.J. Thorpe (Metallurgy and Materials Science)
1995-1996 Professor T.C. Kenney (Civil)
1994-1995 Professor Y.L. Cheng (Chemical)
1993-1994 Professor A.W. Neumann (Mechanical)
1992-1993 Professor J.M. Lee (Metallurgy and Materials Science)
1991-1992 Professor M.V. Sefton (Chemical)
1990-1991 Professor W.L. Cleghorn (Mechanical)
1989-1990 Professor P.J. Foley (Industrial)
1988-1989 Professor A.S. Sedra (Electrical)
1988-1989 Professor M.P. Collins (Civil)
1987-1988 Professor I. McCausland (Electrical)
1986-1987 Professor D. Basmadjian (Chemical)
1985-1986 Professor W.H. Vanderburg (Industrial)
1984-1985 Professor W.H. Burgess (Chemical)
1984-1985 Professor D.G.B. Boocock (Chemical)
1983-1984 Professor D.F. James (Mechanical)

EARLY CAREER TEACHING AWARD
2014-2015 Professor Micah Stickel (Electrical and Computer
2012-2013 Professor Timothy Chan (Mechanical and Industrial)
2012-2013 Professor Jason Anderson (Electrical and Computer)
2011-2012 Professor Micah Stickel (Electrical and Computer)
2010-2011 Professor Sean V. Hum (Electrical and Computer)
2009-2010 Professor Glenn Hibbard (Material Science and Engineering)
2008-2009 Professor Craig A. Simmons (Mechanical and Industrial)
2007-2008 Professor Hani Naguib (Mechanical and Industrial)
2006-2007 Professor Wei Yu (Electrical and Computer)
2005-2006 Professor Ali Sheikholeslami (Electrical and Computer)
2004-2005 Professor Evan Charles Bentz (Civil)
2003-2004 Professor D.P. Gauvreau (Civil)
2002-2003 Professor P. Aarabi (Electrical and Computer)
2001-2002 Professor R. Ben Mrad (Mechanical and Industrial)
2001-2002 Professor B. Abdulahi (Civil)
2000-2001 Professor C.M. Yip (IBBME)
1999-2000 Professor J.R. Long (Electrical and Computer)
1998-1999 Professor B. McCabe (Civil)

Early Career Teaching Award not issued for the 2013-2014 academic year.

SUSTAINED EXCELLENCE IN TEACHING AWARD
2013-2014 Professor Glenn Gulak (Electrical and Computer)
2012-2013 Professor Tarek Abdelrahman (Electrical and Computer)

CENTRES AND INSTITUTES

BIOZONE

Director: Dr. Sean Caffrey
Website: www.biozone.utoronto.ca

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 the use of natural resources, reuse waste material, remediate contaminated water and land, sustain robust and healthy ecosystems, curtail disease and 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 biology that has been made in recent years—particularly in genome science and genome analysis tools—while focusing on urgent societal needs in energy, environment and health.

BioZone arose from informal collaborations within the Department of Chemical Engineering and Applied Chemistry and across the campus. It has grown to include nine faculty members, which includes their research groups and collaborators. Extensive renovations on the third and fourth floor of Wallberg were completed in 2013; the changes add significant and enhanced research space and strength in areas of protein characterization, mass spectrometry, enzymology, bioprocess engineering and biocatalysis.

CENTRE FOR ADVANCED COATING TECHNOLOGIES (CACT)

Director: Javad Mostaghimi
Website: http://www.mie.utoronto.ca/labs/cact/

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 35 researchers, including professors from both departments, research staff members, post-doctoral fellows, visiting scientists and graduate students.

CACT conducts fundamental research—both numerical and experimental—in the areas of thermal spray coating and plasma processing. CACT works closely with industries, universities and research institutions. Research partners have included Pratt & Whitney Canada, Sulzer-Metco, Plasco Energy Group, GE Global R&D, Questor Technology Inc., Mercedes Benz Canada Inc., Perkin Elmer International, Magna and leading universities in Canada, United States, Japan, France, Italy and Germany.

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 and atmospheric, to name a few. Photoacoustics is a field that encompasses conversion of optical (laser) energy to thermal, elastic and acoustic/ultrasonic processes with wide applications in instrumentation and non-destructive/non-invasive inspection science and technologies.

CADIFT activities offer opportunities in interdisciplinary research that encompass 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, environmental, materials science and health sector applications.

For a full description of current CADIFT research, please visit our website.

CENTRE FOR ADVANCED NANOTECHNOLOGY

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

Nanotechnology is a multidisciplinary field for the design, fabrication and application of nanometer-scale materials, structures and devices. The field may involve the disciplines of 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 the fabrication of electronic and photonic devices with sizes that range from a few nanometers to the sub-micron range; 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 begun to show their promise for the fields of 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 Applied Science & 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 nanotechnology research institutions throughout the world.

The main objectives of the Centre, which was established in 1997, include advances in research in both theoretical and experimental methods for a new generation of nanoelectronic and nanophotonic materials, structures and devices; the education and training of a new generation of highly-qualified personnel for industry and academia; collaboration with other members of the academic and industrial community and the establishment of specialized resources and expertise in this expanding field for the scientific community and government.

CENTRE FOR GLOBAL ENGINEERING (CGEN)

Director: Yu-Ling Cheng
Website: http://cgen.utoronto.ca

Some of the world's most complex challenges relate to the provision of healthcare and basic needs in resource-constrained settings. The Centre for Global Engineering (CGEN) is a unique, multidisciplinary unit that works to bring engineering knowledge and talent at the University of Toronto together towards solving some of these pressing challenges.

Based in the Faculty of Applied Science and Engineering, CGEN empowers our students through graduate and undergraduate teaching programs and provides unique opportunities for our students and faculty by stimulating collaborative, multi-disciplinary and innovative research initiatives. We bring together the people and resources necessary to develop appropriate and sustainable solutions for reducing global poverty.

CENTRE FOR MANAGEMENT OF TECHNOLOGY AND ENTREPRENEURSHIP

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

Interdisciplinary and collaborative in nature, the Centre for Management of Technology and Entrepreneurship’s researchers work to measure operations and future developments to improve service industries' performance with a focus on the financial service industry. To meet global competition, this industry needs to conduct research into improvements in productivity, efficiency and effectiveness while developing new technology for the future. The way that technological change in the environment, jobs, education, global competitiveness and society will be best served in the future is through entrepreneurship and innovation, the latter crucial for Canada and its financial services industry. Investment strategies, risk and real options valuation are another branch of this work.

The Faculty of Applied Science and Engineering has pioneered the institution of a teaching program for students who want to start businesses and create wealth and employment for Canadians—there are nine such courses now. The Centre operates research programs in management of technology, innovation, productivity improvements and financial engineering. Founded in 1991, this initiative can now stake claim to over 260 completed projects at all levels of complexity and intellectual challenge (BASc, MEng, MASc and PhD). The entrepreneurial development of students—both at undergraduate and graduate levels—is a priority.

Almost all of the Centre’s research projects involve industrial sponsors; the work has a significant practical component and could, and often does, lead to direct benefits to industry and Canadians. The Centre also carries out mathematical modelling and financial engineering research.

INSTITUTE FOR SUSTAINABLE ENERGY (CSE)

Director: Aimy Bazylak
Associate Director: Joshua Taylor
Website: energy.utoronto.ca

The University of Toronto Institute for Sustainable Energy (ISE) is a catalyst that facilitates interactions and collaborations to advance the development of cleaner and more efficient energy in Canada. The motivation behind the Institute was to advance the tremendous amount of research already underway throughout the University in a wide variety of energy-related fields and to tackle the most challenging problems facing sustainable energy through a multidisciplinary approach.

The ISE 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 net technologies, policy work, computational sustainability, materials science or other routes.

The Institute is a focal point for energy research, collaboration, news and events. An increasingly important role for the unit is the coordination and administration of funding initiatives and connecting researchers to Canadian energy companies.

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

Director: Michael Jong Kim
Website: http://cmore.mie.utoronto.ca

The Centre for Maintenance Optimization and Reliability Engineering's (C-MORE) research is driven by close interactions with industry—in particular, with MORE consortium members and 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 offered an annual eight-day certificate program in Physical Asset Management to 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). ITS is a growing global phenomenon that combines a broad range of diverse technologies that are applied to transportation to save lives, money and time.

The range of technologies involved includes micro-electronics, communications and computer informatics. 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 or a single department or agency. Instead, the field includes a number of departments, agencies and jurisdictions and a rapidly expanding worldwide market.

Access to this market is vital to transportation and related technology sectors. In addition to direct transport benefits, a healthy ITS industry also has a number of non-traffic-related societal benefits, which include the stimulation of new information technology-based industries and the creation of new markets and jobs. ITS is more than just intelligent solutions on the road. It is a new strategic direction for national and international economies.

To train the next generation of ITS professionals, the University of Toronto offers a comprehensive ITS research and development program, which includes the ITS Testbed. The Testbed is composed of a University-based R&D centre 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 Greater Toronto Area.

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.

INSTITUTE OF BIOMATERIALS AND BIOMEDICAL ENGINEERING

Director: Christopher Yip
Website: http://ibbme.utoronto.ca/

Biomedical engineering is an interdisciplinary field that integrates the principles of biology with those of engineering, the physical sciences, and mathematics to create solutions to problems in the medical/life sciences.

Through its faculty (90+), staff and students, and through close collaboration with faculty from 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 M.A.Sc./Ph.D. graduate program. At the undergraduate level, the Institute educates students in the biomedical systems engineering major in Engineering Science and bioengineering and biomedical engineering minor programs.

An active undergraduate summer student program offers both employment and a structured educational experience within the Institute's research laboratories. IBBME houses a unique and innovative Teaching Laboratory for training undergraduate students in the use of state-of-the-art bioanalytical, imaging, and biomedical engineering tools, techniques, and platforms. A sophisticated Design Studio, fully equipped with rapid prototyping tools and electronic test and measurement platforms, is available in support of the biomedical engineering undergraduate design and capstone courses.

Graduate students registered directly into the Institute, or in collaborating graduate departments, proceed towards M.A.Sc., M.H.Sc., M.Eng. (Biomedical Engineering), M.Sc. or Ph.D. degrees in engineering, dentistry, medicine, or the physical or life sciences, enabling careers in industry, government, and academia.

The Institute has a Clinical Engineering concentration within its Ph.D. program, which complements its two-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, Lassonde Mining Building, and Donnelly Centre for Cellular and Biomolecular Research on the St. George Campus, with a unique satellite facility housing the Translational Biology and Engineering Program of the Ted

Rogers Centre for Heart Research in the MaRS2 Discovery Tower.

Approximately 50 per cent of our core faculty have laboratories located in other university departments and hospitals. These laboratories serve as centres for development of experimental and clinical techniques, tools and instrumentation; real-time and interactive computer applications; innovative biomaterials; functional replacements for biological tissues and simulations for electrochemical and physiological models. Many IBBME faculty are appointed in departments in the Faculty of Applied Science and Engineering, Medicine, as well as hospital research institutes.

TORONTO NANOFABRICATION CENTRE (TNFC)

Director: Harry E. Ruda
Website: www.tnfc.utoronto.ca

The Toronto Nanofabrication Centre (TNFC) is the University of Toronto's main centre for micro- and nanofabrication. The Centre promotes collaborative research with strategic partners and provides researchers with access to state-of-the-art equipment.

For the past 15 years, the Centre has attracted over 100 researchers from across the University of Toronto, various universities in southern Ontario and industrial partners. In 2012, more than 200 internal and external users made regular use of the facility. TNFC also facilitates educational opportunities and information-exchange events. Last year, the Centre supported three credit courses within the Faculty of Applied Science & Engineering and facilitated hands-on training sessions for more than 80 users.

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

Acting Director: Professor Brent Sleep
Website: www.lassondeinstitute.utoronto.ca

The Lassonde Institute of Mining is an interdisciplinary research institute at the University of Toronto. Created with the financial assistance of the Canadian mineral industry and Dr. Pierre Lassonde, the Institute conducts leading-edge research, and trains graduate students and professionals in mineral, mining and process engineering.

As an international centre of excellence in mining research, the Institute brings together mining, civil, materials, and chemical engineers, as well as geophysicists, geologists, geochemists, and environmental scientists, who collaborate in cross-disciplinary research projects. The Institute focuses on a wide range of issues, including mineral resource identification through to mine planning, excavation, extraction, and processing.

INSTITUTE FOR LEADERSHIP EDUCATION IN ENGINEERING (ILead)

Director: Doug Reeve
Website: ilead.engineering.utoronto.ca

ILead offers transformative learning opportunities, so that engineering students can enhance their leadership capabilities and professional success. We empower the whole engineer to maximize their potential and contributions. ILead recognizes that complex human relationships are critical to effective engineering practice. Through a suite of academic courses and co-curricular programs, we engage students on four levels of leadership learning: self, team, organizational and societal leadership. Undergraduates have the ability to earn a Certificate in Engineering Leadership. Our vision is "engineers leading change to build a better world."

INSTITUTE FOR ROBOTICS AND MECHATRONICS (IRM)

Director: Goldie Nejat
Website: http://www.irm.utoronto.ca/

Robotics and mechatronics are key, rapidly growing fields in research and industry. The aim of the Institute for Robotics and Mechatronics (IRM) is to bring world-class expertise to the University of Toronto to advance the fields of robotics and mechatronics through collaborative, interdisciplinary research projects and innovative training programs. One of the primary objectives of IRM is to coordinate the large number of academic and research activities already underway in the Faculty. The assembly of a number of research groups will enhance cross-disciplinary research and initiatives, as well as enhance the visibility of our researchers and our Faculty nationally and internationally. IRM also facilitates the commercialization of technology and the design of high-calibre training programs focused on robotics and mechatronics at both the graduate and undergraduate levels.

PULP & PAPER CENTRE

Director: Honghi Tran
Website: www.pulpandpaper.utoronto.ca

A strategic material produced from a renewable resource, paper is critical to our civilization. Paper has been of paramount importance in the transmission and storage of information necessary to science and literature. It has also enabled the creation of modern business and industry. Even in the modern world, paper, in partnership with electronic information systems, is essential. Wood pulp is raw material not only for paper, but for thousands of structural, absorbent and packaging products that are so completely embedded in 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 factors make our country a major force in the pulp and paper world.

The Pulp & Paper Centre at the University of Toronto, which exists within the umbrella of the Department of Chemical Engineering and Applied Chemistry, was founded in 1987. Although the Centre has grown and changed with the challenges that face the industry, its mission since inception has been to stimulate research and support teaching in pulp and paper science and engineering, and to encourage collaborative research with industry partners.

For the past 28 years, the Centre has hosted a continuous series of 11 university-industry research consortia that have traditionally focused on energy and chemical recovery, and have more recently broadened in focus to include biofuel combustion and biorefinery research projects which seek to convert forest biomass and mill effluents into alternative sources of energy. This work has increased the competitiveness of the Canadian pulp and paper industry and its suppliers by improving energy and chemical recovery efficiency, improving operational safety, increasing equipment reliability and efficiency, increasing utilization of biofuels, reducing environmental impact, and lowering the carbon footprint. This long-lasting partnership has supported the research of many professors, researchers and students and, over the years, has engaged over 50 different companies. The present consortium on energy and chemical recovery involves 14 professors and over 30 graduate students and postdoctoral fellows from 4 university departments, and 20 industry partners from 8 countries.

The Centre continues to enrich students' educational experience through interesting and relevant research projects, seminar programs, professional development programs, annual research meetings, and international exchanges. The Pulp and Paper centre is also well integrated with the Pulp and Paper Technical Association of Canada's (PAPTAC) student chapter, providing ample opportunity for networking within the industry. Technical and engineering problems are illuminated and rigorous research methodologies are applied to investigate the underlying critical phenomena. This has made the University a significant source of expertise for the pulp and paper industry and their suppliers in Canada and the world, and has created a unique learning environment for students.

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 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. Additionally, the Centre offers the opportunity for student involvement at the graduate and undergraduate levels.

Recent research projects include: exposure of urban populations to particulate matter; toxicity of vehicle emissions; influence of particles on cloud formation and climate; and the development of novel methods to analyze atmospheric pollutants.

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

UNIVERSITY OF TORONTO TRANSPORTATION RESEARCH INSTITUTE (UTTRI)

Chair: Eric Miller
Website: uttri.utoronto.ca

UTTRI is an initiative that brings the considerable depth and breadth of University of Toronto research to bear on real-world urban transportation problems from perspectives of engineering, humanities and science. It is a solution-oriented think-tank that fills a critical gap between traditional academic basic research, professional consulting and public sector transportation planning and operations.

Building upon our research expertise and working relationships with both the public and private sectors, UTTRI seeks solutions to pressing problems facing our cities, such as cost-effective suburban transit systems, politically acceptable road pricing systems for network performance, dynamic real-time control of road and transit systems for capacity maximization, improved urban logistics systems for goods movements, improved urban and street design for walk and cycling and more.

How we design, build and operate our cities will directly determine our economic prosperity, environmental sustainability, health and social well-being. Major transportation challenges can be solved and major new opportunities can be exploited only through coordination and integration of multiple areas of research. The raison d'etre of UTTRI is to provide the coordination and integration needed to support large-scale, high-impact research, provide the foundation for a comprehensive central hub for transportation-related research at the University of Toronto and to support research partnerships the University of Toronto establishes with other institutions around the world.

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 was officially established in January 2012 with Dr. Kamran Behdinan as its founding director. The aim of UT-IMDI is to create, in partnership with industry, a unique Project-Based Learning (PBL) environment.

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 the networking opportunities provided by the institute, students develop links with industry, and, as a result, better position themselves for future careers. The design experience gained from the Institute is 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 Online Student Profile. 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: 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)
-Advanced Functions (MHF4U)
-Calculus & Vectors (MCV4U)
-Chemistry (SCH4U)
-Physics (SPH4U)
-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 (with Calculus), physics, and chemistry. For more information, visit: www.discover.engineering.utoronto.ca.

Other Applicants

Information on admission requirements for applicants from outside of Canada is available on the Enrolment Services website: www.adm.utoronto.ca/adm. All applicants are required to have completed senior level courses in mathematics (with Calculus), 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 Letters of Permission from their home Universities and are working towards degrees at their home institutions. A non-refundable processing fee of $90 will be charged.

Non-degree students must meet any prerequisites for the courses they wish to take. Candidates whose first language is not English are required to meet an appropriate standard in a recognized Test of English Facility (e.g. TOEFL, MELAB) in addition to meeting the academic requirements.

Canadians and Permanent Residents interested in taking courses as a non-degree student should contact the Engineering Undergraduate Admissions Office at ask@ecf.utoronto.ca or call 416-978-0120.

International students interested in studying at U of T should contact the Centre for International Experience at inbound.exchange@utoronto.ca or call 416-946-3739.

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Below is a list, sorted alphabetically according to the emphasized words, of all APSC scholarships, awards, prizes, grants and loans.

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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
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J. Edgar **McAllister** Foundation Student Awards Program
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Vera Catherine **Noakes** Scholarship
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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
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James A. **Gow** Admission Scholarship
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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
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Donald C. **Leigh** Memorial Scholarship
James Turner **MacBain** Scholarship
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The Hal **Major** Memorial Admission Award
J. Edgar **McAllister** Foundation Admission Awards
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Norman **Ramm** Scholarship
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C. William **Daniel** Leadership Awards
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Dharma Master Chuk Mor Memorial Scholarship
R.A. **Downing** Scholarship in Civil Engineering
ECE Alumni Scholarship
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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 **Hamilton** Scholarship
John Karl **Hergovich** Memorial Scholarship
Dr. John G. **Hogeboom** Scholarship
Johannes Michael **Holmboe** Undergraduate Summer Research Fellowship
Philip H. **Jones** Scholarship
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Dietmar **Koslowski** Memorial Bursary in Electrical Engineering
Frankie **Kwok** Memorial Scholarship
Ronald Paul **Manning** Scholarships
Eric **Miglin** Scholarship
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Samer **Mutlak** Memorial Award
Barry James **O'Sullivan** Grant
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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
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Civil Engineering Admission Scholarships
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John Pearson **Duncan** Admission Award (Brant County)
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Engineering Science Alumni Admission Scholarships
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Joey and Toby **Tanenbaum** Admission Scholarships
Chung **Tsang** Memorial Admission Scholarship
Wallberg **Admission** Scholarship
Elliott M. **Wilson** Scholarship
W.J.T. **Wright** Admission Scholarship

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NON-OSOTF IN-COURSE SCHOLARSHIPS AND GRANTS
Henry G. **Acres** Medal
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AMD Electrical and Computer Engineering Scholarship
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Donald L. **Angus** Scholarship in Mechanical Engineering
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Wellington Thomas **Ashbridge** Memorial Bursaries
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Baptie Scholarship
Jack and Barbara **Baron** Scholarship
Ben **Bernholtz** Memorial Prize in Operational Research
Rob and Sky **Biceyskis** Scholarship
OPWA Ontario Chapter Bruce **Brunton** Award
The Edith Grace **Buchan** Summer Research Fellowship
The **Burge-Connell** Bursary
Carman **Burton** Bursary
Norman E. **Byrne** Award
Canadian Society of Industrial Engineering Scholarship
Canadian Society for Chemical Engineering Medal
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The Wallace G. **Chalmers** Engineering Design Scholarship
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Chemical Engineering Undergraduate Scholarshop
Chemical Engineering Undergraduate Summer Fellowship
Chemical Institute of Canada Book Prize (Toronto Section)
CISC/Walters Inc. Scholarship
5T6 **Civils** Scholarship
Ross L. **Clark** Memorial Scholarship
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Dan **Cornacchia**/Ernst & Young Scholarship
Crocker Foundation Bursaries
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Gavin **Dass** Memorial Scholarship
Davis + Henderson Hatchery Award
Hanna Wejtko **De Angelis** CIV6T0 Scholarship
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Earl H. **Dudgeon** Bursary
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William **Dunbar** Memorial Scholarship
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B. Conrad **Hansen** Memorial Award Fund
Sydney George **Harris** Bursary
Glenn and Richard **Hauck** Memorial Scholarship
S. **Haberer** Energy Systems Scholarship in Engineering Science
Dr. Arthur **Herrmann** Memorial Award
Mackay **Hewer** Memorial Prize
Hill & Schumacher Entrepreneur Award
General D.M. **Hogarth** Bursary
Otto **Holden** Scholarship
William V. **Hull** Scholarship
Husky Injection Molding Systems Ltd. Award(s)
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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
KGHM International Ltd. Scholarship
Konrad Group Scholarship
Kordellas-Tripp Foundation Engineering Award
Catherine **Lacavera** Hatchery Award
Lacavera Prize for Entrepreneurship
Lassonde Scholarships
Lassonde Bursaries
Stavros **Leventis** Award
Charles A. **Lowry** Prize
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John Dixon **Campbell** Memorial Prize
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J. R. **MacCoon** Footsteps Grant
The Elsie Gregory **MacGill** Memorial Scholarship
The Alexander **MacLean** Scholarship
MacLennan-MacLeod Memorial Prize
Salim **Majdalany** Scholarship
Steven **Mann** Award in Wearable Computing
Charles Gordon **Manning** Prize
Oscar J. **Marshall** Scholarship
J. Edgar **McAllister** Foundation Bursaries
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The Garnet W. **McKee-Lachlan** Gilchrist Scholarship in Engineering Science
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Marlene **Metzger** CIV6T0 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
Otegbade Scholarship for Students from Africa
PACE Project Design Award
Gary L. **Palmer** Memorial Scholarship
Dr. John Hamilton **Parkin**
Parsons Scholarship in Civil Engineering
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
Ontario **Professional** Engineers Foundation for Education In-course Scholarships
Ontario **Professional** Engineers Foundation for Education Gold Medal for Academic Achievement
Ewing **Rae** Undergraduate Scholarship
Ransom Scholarship in Chemical Engineering
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J.E. **Reid** Memorial Prize
Russell **Reynolds** Memorial Scholarship
Dagmar **Rinne** Scholarship
The Bertrand G.W. **Robinson** Award
The Richard **Rowland** Memorial Scholarship
Mary and Mario **Ruggiero** Scholarship
Margaret Agnes **Runciman** and James Dempsey Runciman Bursary
Don **Salt** Memorial Scholarships
Paul **Santerre** Undergraduate Biomedical Engineering Legacy Scholarship
Frederick W. **Schumacher** Scholarship
Marcia Lamont **Scott** CIV4T7 Scholarship
Second Mile Engineer Award
Adel S. **Sedra** Bursary Fund
Adel S. **Sedra** Gold Medal
Rudolph **Seidl** Memorial Award In Mechanical Engineering
The Joseph **Seidner** Bursary Fund
Som **Seif** Scholarship
John W. **Senders** Award in Imaginative Design
The **Shaw** Design Scholarships
Gordon R. **Slemon** Capstone Design Award in Electrical & Computer Engineering
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**
Dr. Chris **Twigge-Molecey** Scholarship in Mechanical Engineering
James W. and H. Grattan **Tyrrell** Memorial Scholarship in Civil Engineering
UMA 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
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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 that 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 for students

entering their first year in the Faculty and OSOTF In-Course Scholarships/Awards and non-OSOTF In-Course Scholarships and Grants.

THE NATIONAL SCHOLARSHIP PROGRAM

University of Toronto National Scholarships are awarded to students who demonstrate superior academic performance, original and creative thought and exceptional achievement in a broad context. The National Scholars are students 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 this 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 are awarded in a given year. The National Scholarships cover tuition and incidental fees for four years of undergraduate study, first-year residence support and include an additional, renewable monetary award. The annual value of each student's scholarship is determined on the basis of individual financial circumstances.

UNIVERSITY OF TORONTO SCHOLARS PROGRAM

The University of Toronto Scholars Program recognizes outstanding students at admission and on an ongoing basis. There are approximately 350 admission awards, valued at $6,000 each, which may be held in conjunction with admission awards students may receive from their college/faculty. Outstanding students are automatically considered 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 approximately 100 scholarships at each level. These in-course awards are worth $1,500 each and are tenable with other in-course scholarships.

PRESIDENT'S SCHOLARS OF EXCELLENCE PROGRAM

Approximately 50 of the most highly-qualified students who apply to first year of direct entry undergraduate studies will be distinguished as President’s Scholars of Excellence. This distinction includes a $10,000 entrance scholarship in first year, guaranteed access to meaningful part-time on-campus employment during second year and guaranteed access to an international learning opportunity during a student’s university studies.

Additional features may be offered by the admitting faculty, which will be communicated in the student's admission letter. Outstanding students are automatically considered for these scholarships. The scholarship is tenable only in the faculty that makes the offer. Payment of the award is conditional on full-time registration at the University in the fall of the year the award is granted; retention of the higher-year opportunities attached to the award requires a student’s continuing full-time registration in good standing.

PRESIDENT'S ENTRANCE SCHOLARSHIP PROGRAM

All applicants that meet the following criteria will receive admission scholarship(s) totalling at least $2,000. The scholarship will be issued from either the University, faculty or department. No application is required. Eligibility criteria:

- Canadian citizens or permanent residents
- Studying at a secondary school or CEGEP in Canada
- Have completed the courses required for admissions, including prerequisites, with "A" standing
- Admission average is 92 per cent 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. The University will ensure unmet needs are met for full-time students (in both terms of an academic year) who are assessed by OSAP as requiring maximum assistance and whose assessed needs are not fully covered by government aid. Full-time 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 the UTAPS application: http://www.adm.utoronto.ca/. First-year applicants should submit their online UTAPS applications by late February so they can be considered for need-based admission awards.

Scholarships and Financial Aid

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 per cent 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 eligible students. Information and applications are available from the Career Centre. Further information can be found at http://www.careers.utoronto.ca/content/work-campus.

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 Enrolment Services and 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 per cent. 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 Enrolment Services.

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 pay for 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. 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 demonstrated 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 designated by the Faculty 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 and Fall Sessions 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 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 and the family and friends of Fernando Agostinelli. The scholarship was created to honour Fernando's many contributions in the field of structural engineering. The award is issued on the basis of financial need and academic merit to a full-time student entering their first year of Civil Engineering studies. In addition, qualities of character and leadership as demonstrated through extra-curricular activities/community involvement are 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 their first year of studies in any program in the Faculty and is based on 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 to a Computer Engineering student and is based on financial need, academic achievement in the prerequisite courses as well as a demonstrated commitment to community service.

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 Industrial Engineering and is based on 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 their first year of studies 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 awarded on the basis of financial need and academic merit to a student entering into the Faculty of Applied Science and Engineering.

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 their first year of Chemical Engineering. Preference is given to students who have achieved a 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 per cent 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 (CivE 4T5) two awards are established in the Department of Civil Engineering. One award is 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 either first-year Electrical or Computer Engineering (alternated annually between the two programs) who demonstrates financial need. Academic merit is also 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 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.

J. Edgar McAllister Foundation Student Awards Program
Provided by the bequest of the late J. Edgar McAllister, B.A.Sc., numerous awards, varying in amounts, are available to students entering or continuing in Mechanical, Electrical, Mining or Chemical Engineering and who demonstrate financial need.

Motorola Foundation Scholarships
Established in 1996 through the generosity of the Motorola Foundation, two awards are available for students entering first year of either Electrical or Computer Engineering and are based on financial need. Academic standing is also considered.

Vera Catherine Noakes Scholarship
Established in 2001, this scholarship is to be awarded to a student entering first year of any undergraduate program in Engineering on the basis of financial need. Preference is given, when 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 granted to a student entering any undergraduate program in the Faculty who demonstrates financial need and excels academically. Preference is given to students with disabilities.

Robert John Richardson Memorial Scholarship
Established in 2002 from the estate of the late Robert John Richardson (5T0), this scholarship is awarded to a student entering the first year of any undergraduate engineering program and is based on 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 per cent) 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 and is based on financial need, academic achievement and demonstrated leadership skills in high school through participation in team sports and/or student affairs. Community involvement will also be considered.
The award may be renewed for second year provided at least 75 per cent standing is maintained and that the awardee remains deserving.

Leon Rubin Scholarships
Established in 1997 through the generosity of William F. McLean, a number of scholarships are available for students entering first-year Chemical Engineering and is based on financial need. Academic standing is also 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
A gift of the family and friends of the late Robert Sangster (ElecE 4T9), 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 and is based on 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 Civil Engineering. Financial need and academic merit is considered.

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 first-year Chemical Engineering and Applied Chemistry. Financial need, academic achievement, extra-curricular involvement in high school through participation in team sports (with an emphasis on sportsmanship) and/or community service is considered.

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 (MMS 5T6) in memory of his mother, the late Jean Wallace. The award is granted to one or two students entering first-year Materials Engineering and is based on financial need. Academic achievement and demonstrated leadership qualities through both school and community involvement are also considered. If no suitable candidate is found at the admissions level, the award, based on the same criteria, may be granted to a student completing first-year Materials Engineering. 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 is given on the basis of academic achievement to student(s) entering the Edward S. Rogers Sr. Department of Electrical and Computer Engineering. Extra-curricular activities, including a focus on design, may also be considered.

The Bi-cultural Admission Scholarship
The Professional Engineers Wives' Association established an admission scholarship of the value of the income from the fund that is awarded 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 year of high school in Ontario. The first award was made in June 1983.

Calgary Skule™ Admission Scholarship
Granted to one or more students entering the first year (full-time) of any program in the Faculty. Recipient(s) are selected on the basis of promising leadership ability as evidenced by extra-curricular/community involvement. Academic ability is also 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 Chemical Engineering and Applied Chemistry, are open to students entering the first year of the program and is based on 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 and is based on academic excellence. Some awards may 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 Civil Engineering and is based on academic merit. Preference is given to students who demonstrate leadership in the community and through extra-curricular activities.

Dean's Merit Award
Established in 2015, the Dean's Merit Award is given to students entering first year of any undergraduate program in the Faculty on the basis of academic merit.

Edward L. Donegan Scholarship in Engineering
Established in 2007 through a generous donation by Mr. Edward L. Donegan, this scholarship is awarded to student(s) entering the first year of any program in the Faculty. The scholarship is granted on the basis of demonstrated academic excellence (min. 85 per cent average on pre-requisite courses). Recipient(s) shall have demonstrated leadership in extra-curricular and community activities. Preference is 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 per cent. 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 $100 admissions award is provided in memory of the late John Pearson Duncan (2T6). It is granted to a student from a secondary school in Brant County entering the first year of any program in the Faculty. The student must achieve 80 per cent or greater on the subjects required for admission. Financial need and academic performance is considered with the provision that financial need not be an absolute requirement for the award. The first award was made in 1982.

Engineering Alumni Association Admission Scholarships
Five scholarships are annually 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:
-The William Ian MacKenzie Turner 2T5 Scholarship, named after a "Schoolman of Distinction," with a full value of $1,500
-Four Centennial Scholarships with a value of $1,000 each when entering first year

Engineering Science Alumni Admission Scholarships
These scholarships, established by the generosity of various donors, are awarded to two students entering the first year of the Engineering Science

program. Academic merit is considered and extra-curricular activities may be considered.

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 the first year of any Engineering program and are based on 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 Mechanical or Industrial Engineering and is based on academic merit. Preference is given to students who demonstrate leadership in the community and through extra-curricular activities.

U of T First Engineering Scholarship
Established in 2007, up to five awards, valued at $2,000 each, are awarded to students admitted to the first year of any program in the Faculty. Recipients must have a minimum 90 per cent in prerequisite 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 are granted on the basis of academic standing and preference is given to international students entering the first year of the Lassonde Mineral Engineering Program. If there are no suitable candidates in the 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, 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 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 (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. During 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 (2T4). The scholarship has a value of approximately $500 and is awarded to a 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 who has achieved outstanding marks (not less than an average of 80 per cent) on the Ontario Secondary school subjects prescribed for admission and who is entering the first year of the Civil Engineering program.

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 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 first-year examinations. 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 awarded to a student entering first-year Civil Engineering. Awarded based on academic credentials and leadership potential as demonstrated by involvement in student council activity, participation in athletics and community involvement.

Hatch Engineering Aboriginal Scholarship
This award, established in 2013 by a generous donation from Hatch Ltd., is awarded to an incoming first-year aboriginal student and is based on outstanding academic achievement and promise. The scholarship may be renewed for second, third and fourth year provided the student is eligible to proceed to the next academic year with a clear record.

Hatch Engineering Entrance Scholarship
This award, established in 2012 by a generous donation by Hatch Ltd., is given to an international student from Serbia entering the first year of any undergraduate program in the Faculty. The award is granted primarily to candidates who demonstrate outstanding academic achievement and promise. Consideration may also be given to performance at international competitions in areas such as math, physics and chemistry; demonstrated language proficiency; and evidence of extra-curricular activity and involvement. The scholarship may be renewed for each of the candidate's four years of study provided a minimum 80 per cent average is maintained each year.

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

The Murray Calder Hendry Scholarship
This award was established by the estate of Mrs. Grace Appel Hendry as a memorial to her husband, a 1905 graduate of this Faculty. It has a value of the income from a capital sum of $10,000 and the recipient must have attained an average of at least 75 per cent on the Ontario Secondary School subjects required for admission and be entering the first year of any course in the Faculty of Applied Science and Engineering. The first award issued during the 1962-1963 academic year.

Roy Jarvis Henry Admission Scholarships
The estate of the late Roy Jarvis Henry awards up to four scholarships 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 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 (MechE 4T1). This scholarship is granted on the basis of academic merit to a student entering first-year Mechanical Engineering. The scholarship is renewable for three years provided the recipient maintains minimum of 65 per cent 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 is given to a student (or students) entering first year, full-time studies in Civil Engineering and is based on outstanding academic merit. Preference is given to students who demonstrate leadership in the community and extra-curricular activities.

Albert and Rose Jong Entrance Scholarship
Established in 2006 through a generous donation by Dr. Roberta Jong, Dr. Raynard Jong and Dr. Winston Jong, this scholarship is awarded to a student entering the first year of either Electrical Engineering or Engineering Science. The scholarship is awarded on the basis of academic merit and financial need. Preference is given to students who demonstrate 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 awarded on the basis of outstanding academic ability to students entering or continuing in any program in the Faculty.

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 (EngBus 5T9), S.M. (MIT, 1961). The award, derived from the annual income, is granted to a student entering first-year Industrial Engineering. In addition to academic excellence, qualities of character and leadership as demonstrated in school and community activities are considered.

Helmut Krueger Undergraduate Admission Scholarship in Engineering
Established in 2013 through a generous donation by Helmut Krueger, this scholarship is awarded to one or more students entering the first year of any undergraduate program in the Faculty. Academic merit is 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 full-time students entering the first year in 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. Applicants must be Canadian Citizens or Permanent Residents and 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, based on academic excellence, entering first-year Engineering Science on a full-time basis. 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 (CivE 4T9) 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 first-year Civil Engineering. Financial need and demonstrated qualities of character and leadership are considered.

J. Edgar McAllister Foundation Admission Awards
Provided by the bequest of the late J. Edgar McAllister, numerous awards of varying amounts are available to students entering their first year of studies in Mechanical, Electrical, Mineral, or Chemical Engineering on the basis of financial need and high academic achievement in the prerequisite courses for admission.

Barbara McCann Tribute Scholarship
This award was established in 2015 by friends and family of Barbara McCann, along with a match from the Faculty of Applied Science and Enginering, to commemorate Barbara's retirement as Faculty Registrar. The award is given to a student (preferably female) entering First Year of any undergraduate program in the Faculty on the basis of academic merit and demonstrated leadership**.**

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

Lachlan Dales McKellar Admission Scholarships
Provided by a bequest of the late Leona D. McKellar, one or more scholarships are given to students who 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 first-year Mechanical or Industrial Engineering. Academic merit in the prerequisite courses as well as involvement in extra-curricular activities is considered. 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 first-year Materials Engineering. Outstanding academic performance in the subjects required for admission and involvement in school and community activities is considered.

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 Industrial Engineering program and is based on academic merit. Preference is given to students who demonstrate 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 $1,500 each and are designated, where possible, to both a male and female student. They are awarded to the candidates who are well-rounded students and exhibit leadership characteristics.

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) and is based on academic standing.

John E. Richardson Engineering Award
This award was established in 2014 by the Boiler Inspection and Insurance Company of Canada and is given to a student in Second, third, or fourth year

who has declared a business minor; selection will be made on the basis of financial need and scholarly merit.

Edward S. Rogers Sr. Admission Scholarships
These awards are 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 studies in the Edward S. Rogers Sr. Department of Electrical and Computer Engineering and are based on academic achievement and extra-curricular activities. Some awards may be renewable.

Edward A. Rolph Scholarships
Established in 1994 by the estate of Edward A. Rolph and Kathryn S. Rolph, these scholarships are granted to one or more first-year Engineering students and are based on academic excellence. 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 awarded to a student entering their first year of studies in either Chemical Engineering and Applied Chemistry or 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, the Shaw Admission Scholarship is awarded to a student entering the first year of Engineering Science who demonstrates high academic achievement. Preference is given to students who possesses leadership skills and design capability as demonstrated in extra-curricular design projects and activities. The selection is 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 per cent overall average and continues in Engineering Science.

Julius D. Solomon Scholarship
Established in 2014 from the estate of the late Julius Dennison Solomon, this award is given to one or more students entering first or second year Civil Engineering and is based on academic merit.

Joey and Toby Tanenbaum Admission Scholarships
Established in 2007 through a generous donation by Joseph Tanenbaum, these awards, of varying amounts, are granted on the basis of academic merit to students entering the first year of Civil Engineering.

The Chung Tsang Memorial Admission Scholarship
This award, valued at $750, was established by Mrs. Pauline Tsang in cooperation with the Federation of Chinese Canadian Professionals Education Foundation in memory of John Hin Chung Tsang (ElecE 7T1) from. The award is granted to a student entering first-year Electrical Engineering 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 first-year Civil Engineering and is based on good academic standing and qualities of character and leadership.

Wallberg Admission Scholarship
A number of admission scholarships, each valued at $1,000, are annually awarded 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 per cent 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.

Elliott M. Wilson Scholarship
Established in 2015 from the estate of Elliott M. Wilson, this scholarship is awarded to student(s) erntering First Year of any undergraduate program in the Faculty of Applied Science and Engineering on the basis of academic merit.

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 was provided by the 67th University of Toronto Battery of the Canadian Army. The scholarship is annually awarded to a student entering first-year Civil Engineering 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 an engineering student in need of financial assistance. Academic standing is also 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 Industrial or Mechanical Engineering who is entering the BASc/MBA joint program and requires financial assistance. 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 individual should be a well-rounded student involved in extra-curricular activities, i.e., varsity athlete.

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 is granted to a student entering the second year of the Engineering Science Program and is based on financial need. Academic standing is also 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 and is based on financial need. Additionally, academic achievement in the program and particular ability and creativity in the field of transportation engineering, specifically third-year transportation engineering courses will also be considered. The recipient is expected to continue his or her studies in transportation engineering in their 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 their 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 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 have a high level of leadership potential. Additional preference is 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 and is based on financial need and academic achievement. Preference is given to female students who meet the criteria.

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 are granted to students completing their second or third year of Chemical Engineering and based on 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 and based on 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. 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 (CivE 8T3). Volpe 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 fourth-year 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 full-time student who has completed second year and is proceeding to third year (full-time) of any program and is based on financial need. Academic standing and extra-curricular/community involvement is also considered.

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 proceeding to fourth year of Electrical Engineering. Preference is 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.

The Sidney C. Cooper Scholarships
Through the generosity of Sidney C. Cooper (CivE 4T5) two awards have been established in the Department of Civil Engineering. One award is granted to a student entering first year and another to a student entering fourth year. The fourth-year award is made on the recommendation of the Chair on the basis of financial need. Academic achievement in the third-year work and a demonstrated interest (through summer employment) in construction engineering will also be considered.

George and Norma 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 two students in the Department of Materials Science and Engineering who have 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. The scholarship is awarded to a student entering second year of the Lassonde Mineral Engineering Program and is based on 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 is awarded to an undergraduate student in Civil Engineering and is based on 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, based on financial need, in either Electrical or Computer Engineering. 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, are distributed based on financial need. Academic ability and extra-curricular involvement within the undergraduate engineering community is also considered. Awards are made in consultation with the Engineering Society Executive.

Ford Electronics Scholarship
This scholarship, derived from the annual income of a capital donation made in 1997, was established through the generosity of Ford Electronics Manufacturing Corporation. It is granted to a student in financial need who is enrolled in the Electrical Engineering Program. Academic standing is also 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 that was participating in the Canadian Solar Tour to highlight alternative energy technology. The award is granted to an engineering student entering their second, third or fourth year of undergraduate studies and is based on 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 is also 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 is also 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 Engineering Science and proceeding into the 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 their third year in Engineering Science and is based on financial need. Academic achievement in the program is also considered. Preference is 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 scholarship is awarded to either a student entering second year who has shown progress and increased effort from the first to second semester or 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, based on financial need, is made to a student completing second year and one to a student completing third year. 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. A consummate professional, committed to excellence in all her ventures, Lisa 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, organizing the annual fun runs and multi-team participation at the YMCA Corporate Challenge. 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 Mechanical Engineering. The recipient is 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 1906 graduate of the Faculty, established an annual scholarship in his memory. The first award was made in the 1958-1959 academic year.

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 Mechanical Engineering on the basis of financial need and who has shown academic ability at the annual examinations of the third year.

John Karl Hergovich Memorial Scholarship
Established in 2011 through a generous donation by Eva Gerhardine Hergovich, this award is given to a student entering second-, third- or fourth-year Chemical Engineering and is based on financial need, academic ability and challenges faced with the same dignity and perseverance John Hergovich was known for during his time at U of T.

Dr. John G. Hogeboom Scholarship
Established in 2011 through a generous donation by the Hogeboom family, this award is given to a student who has completed first year of Track One and proceeding to second year of any engineering program. The award is made on the basis of financial need and outstanding academic achievement; exceptional character and demonstrated leadership involvement is also considered. Former Track One students proceeding to third or fourth year of any

engineering program will also be considered.

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 (ChemE 5T0). One or more fellowship(s) are available to student(s) completing years one, two or three and is based on 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 Civil Engineering and is based on financial need. Academic achievement in the program and particular ability and creativity in the field of Environmental Engineering is also 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 based on 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, is granted on the recommendation of the chair to a student completing their third year of Electrical and Computer Engineering. In addition to financial need, good academic standing is also considered. The first award was made in the 1987-1988 academic year.

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 their third year of Mechanical Engineering and based on financial need. Academic achievement and demonstrated leadership skills through participation in team sports and/or student affairs and community involvement will 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 are granted to students entering their fourth year of Electrical Engineering studies and based on 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 is given to students who have a history of good grades but experienced adversity during the third year due to illness or bereavement.

Eric Miglin Scholarship
This scholarship was established by Eric J. Miglin in 1997 on the occasion on his 25th reunion. Miglin is an Industrial Engineering graduate and was president of the Engineering Society in 1972. This award is granted to a student who has completed third year in any program in the Faculty and is based on financial need. Academic standing and active involvement in student and/or University government will 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 Civil Engineering and is based on financial need and academic ability.

Samer Mutlak Memorial Award
Samer Mutlak graduated from Industrial Engineering in 1988. On February 3, 1990, at the age of 23, he passed away after courageously fighting a two-year battle with cancer. 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. Samer took pride in being an industrial engineer. He is remembered fondly for his sense of humor. He was a good friend.

The award, derived from the annual income, is made on the recommendation of the department chair to a student completing third-year Industrial Engineering and is based on 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 is made to a student entering or proceeding in any undergraduate program in the Faculty on the basis of financial need. Applications should be through 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 and based on financial need. Academic standing, qualities of character, leadership and commitment to the profession will be considered. Not tenable with other awards.

Ryn Pudden Memorial Award
Through the generosity of her family, the Ryn Pudden Memorial Award was established in 1999 in Ryn's honour. The award is granted to a female student in Engineering Science who demonstrates financial need. Preference is given to students entering the third year of the Aerospace Option and 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 is made on the recommendation of the chair to a student completing the second year of Engineering Science and based on financial need. Good academic standing (not necessarily honours), qualities of character, leadership and commitment to the profession will also be considered. Preference is 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 is granted to a student entering fourth-year Civil Engineering and based on 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 their first, second or third year of Industrial Engineering and is based on 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 entering fourth year in each of the following three departments: Mineral Engineering, Chemical Engineering and Applied Chemistry and Mechanical and 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 1998-1999 academic year.

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, is granted to a student entering third-year Mechanical Engineering and is based on financial need. The recipient should also demonstrate 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 (CIV 6T0). The awards will be granted to three students entering first-year and three students entering fourth-year Civil Engineering on the basis of financial need and academic standing.

Gordon R. Slemon Scholarship
Established in 1997 through the generosity of Gordon R. Slemon, O.C., B.A.Sc., M.A.Sc., D.I.C.(Imperial College), Ph.D.,(London), D.Sc.(London), D.Eng.(Memorial), Hon.F.I.E.E., F.E.I.C., F.C.A.E., C.Eng., P.Eng., former chair of the Department of Electrical Engineering and former dean of the Faculty. The award is granted to a student entering third year of Electrical Engineering 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 is 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 second- or third-year 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 second year of Engineering Science and who are proceeding to third year in the Aerospace Option. Recipients are 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 to a student entering the third year of Lassonde Mineral Engineering and are based on financial need. Academic standing is also considered. The scholarship is renewable in 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 the Lassonde Mineral or Materials Engineering Program on the basis of financial need. Academic standing will also be considered.

Dr. Irving H. Spinner Scholarship in Chemical Engineering & Applied Chemistry
This scholarship, established in 2011 by family and friends of Dr. Irving H. Spinner, is awarded to a student in any year of Chemical Engineering on the basis of demonstrated financial need as well as significant involvement in extra-curricular activities within the University and local community. Candidates must have strong academic background and achieve a minimum overall 75% in the previous year.

The St. George's Society of Toronto Endowment Fund
This award, valued at $5,000, was established through a generous donation by the St. George's Society of Toronto. Several awards are available to students within the University, one of which is specifically for the Faculty of Applied Science and Engineering. In Engineering, the fund is awarded based on financial need and a minimum B average to an undergraduate or graduate student. Preference is given to in-course students.

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 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 Mechanical Engineering. In addition to academic excellence, qualities of character and financial need will also be considered. The first award was granted in the 1995-1996 academic year.

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 second-year Engineering Science and is based on financial need. Academic standing is also be considered. The selection is made by the chair of the Division. The first award was granted in the 1998-1999 academic year.

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 third- or fourth- year Materials Engineering and based on financial need and academic achievement. Additionally, 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 is given to students with demonstrated qualities of leadership. This scholarship is awarded on 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 the 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 (ElecE 2T5), 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 a student based on financial need who, having obtained Honours standing, ranks in first place on the results in Industrial Engineering's third-year examinations. Should the candidate hold an award of greater value, the award may be made to the next ranking candidate. The first award was made in the 1998-1999 academic year.

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 and is based on financial need and academic standing. The value of the award is derived from the annual income.

Lloyd George Webber Memorial Scholarship
This scholarship was established in 1997 in memory of Lloyd George Webber (ChemE 3T6). The award will be granted to a student completing third-year Chemical Engineering and Applied Chemistry and is based on financial need. Academic standing is also 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 went back to school part-time to work towards a degree in Industrial Engineering. Julie was a warm and caring person who always had a smile for everyone.

In honour of her memory, the scholarship is awarded to a student registered in any year of Industrial Engineering and is based on financial need, extra-curricular activities, demonstrated involvement in the Engineering Society and academic standing. Recommendations will be made by the departmental chair in consultation with the president of the Engineering Society.

Yolles-Bergmann Scholarship
This Civil Engineering scholarship was established in 1997 through the generosity of Yolles Partnership Inc. in recognition of the significant accomplishments of the Yolles Group, and, in particular, the contribution made to structural engineering by Mr. Morden Yolles and Mr. Roland Bergmann. The scholarship is awarded to a student proceeding to the fourth year of the program who achieved a high academic standing and who successfully completed a structural design project in their third year that demonstrated a creative interest and talent in linking structure and architecture. The evaluation of potential candidates is based on academic standing, a 250-word application to Yolles Partnership Inc., performance on a third-year project, interview with principals of Yolles and financial need. The departmental nomination is made in consultation with Mr. Morden Yolles and Mr. Andrew Bergmann, president of Yolles Group Inc.

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 third and fourth year, provided 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. (0T3). 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 1911-1923, 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 the military in March 1915, during his second year in the Faculty; he was killed in action at Passchendaele on November 6, 1917.

This annual scholarship is awarded to a second-year engineering honour student who ranked one of the first three in the annual examinations and adjudged the 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 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 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.

AMD Electrical and Computer Engineering Scholarship
Established in 2010 through a generous donation by AMD Canada, this scholarship is given to two students completing year three 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 are 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 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 Shoring & Caissons Ltd., this scholarship is awarded to full-time students completing second- or third-year Civil Engineering who specialize in structures and/or geotechnical. Academic achievement and extra-curricular activities are considered.

Donald L. Angus Scholarship in Mechanical Engineering
Established in 2014 through a generous donation by HH Angus, this award is given to a full-time student entering their third or fourth year of Mechanical Engineering with demonstrated leadership on a design intensive extra-curricular team or activity.

Rob and Sky Bicevskis Scholarship
This award was established in 2014 through a generous donation by Rob and Sky Bicevskis. The award is given to a full-time student entering their second, third or fourth year of studies in Engineering Science. There is an increasing demand for people who can work across boundaries and in many different fields. With the term polymath in mind, students will be selected based on academic merit and having demonstrated interests in a variety of fields through involvement in extra-curricular activities or volunteer experience, which could include sports, arts and cultural and/or international exchanges. On the recommendation of the chair of the division (or alternate).

OPWA Ontario Chapter Bruce Brunton Award
Established in 2000 by the Ontario Chapter of the American Public Works, the award is issued to a Civil Engineering student and is based on financial need and academic achievement sufficient enough to allow the student to proceed to the next year of the program. The value of the award is $2500.

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 demonstrated academic achievement and exemplary leadership within the University or broader community. The first award was issued 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 through 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 through the Undergraduate Grant Application Form.

Steven Ballan Scholarship in Civil Engineering
This scholarship, established through a generous donation by Steven Ballan, is awarded to a student completing second year Civil Engineering and is based on their aggregate performance on assignments in both Introduction to Civil Engineering and Construction Management, as recommended by the chair of the Department.

Bangia Kick-Start Award
This award was established in 2014 through a generous donation by Naresh Bangia. The award is given to a student entering third-year Engineering Science–Computer Engineering Option, on the basis of academic merit, entrepreneurial spirit, and extra-curricular and community involvement. In the inaugural year, 2014, and in celebration of the 20th anniversary of AJB Software Design Inc., there was a one-time only award for a student entering first-year Engineering Science.

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, up to $75, in the case of the holder of the scholarship.

The conditions of the award are that the scholarship is 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, obtained the highest aggregate percentage of marks in those subjects which are common to the first year curricula. The first award was issued during the 1925-1926 academic year.

Jack and Barbara Baron Scholarship
This scholarship is awarded to a student entering full-time second-year studies in any undergraduate program in the faculty after 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 their third year of Industrial Engineering who achieved the highest aggregate mark in 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 based on 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 Geology or Lassonde Mineral Engineering.

Consideration is 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 (ElecE 2T0) 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 $1,000 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 was also a graduate of U of T Mechanical Engineering. The award is made on the recommendation of the chair to a first-, second-, or third-year Mechanical Engineering student and is based on financial need, academic excellence and qualities of character as demonstrated by University and community activities.

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 achieved 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.

#2 Canadian Army University Course Award
Established in 2002, this award is granted to a student entering the third year of any undergraduate program and is based on 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 Industrial Engineering. 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 is made on the recommendation of the chair 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 Chemical Engineering who, having achieved Honours, receives the highest standing in third-year written and laboratory work. The first award was made on the results of the final examinations of 1947. From 1985 onwards, the cash portion of the prize has been provided by the Local Toronto Chapter of the Canadian Society for Chemical Engineering.

Centennial Senior Project Awards
The Centennial Thesis Awards were established in 1972-1973 in honour of the Faculty's centennial. To recognize excellence in a fourth-year thesis or capstone design project, one award is made annually to a student or team of students in each of the Faculty's nine degree programs. The decision is based on departmental recommendations. The award is in the form of a $500 prize and an accompanying certificate. Original funding was provided through the Office of the Dean and is continued through the generosity of the University of Toronto Engineering Alumni Association.

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 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.

Throughout his career, Wallace Chalmers (Mech 5T0) demonstrated a keen interest in design and perceived the need to place greater emphasis on the design aspect of engineering education.

The three awards (one issued in second year, one in third year, and one in fourth year) are given to students (or a team of students) in Mechanical or Industrial Engineering who demonstrate strong academic performance and design capabilities in design-intensive courses. Department recommendation and financial need is also considered.

CHE 8T2 Emerging Leaders Award in Chemical Engineering
This award was established in 2014 through donations by the ChemE Class of 8T2. The award is given to student in second-year Chemical Engineering who has shown the potential of becoming an exceptional leader through his/her ability to inspire others to action as demonstrated through involvement and leadership in engineering leadership development programs, student councils or clubs, community organizations and/or athletics.

Chemical Engineering Undergraduate Scholarship
This award was established in 2014 through a generous donation from an anonymous donor. The award is given to a student completing first, second or third year of Chemical Engineering on the basis of strong merit and a strong record of extra-curricular activities and/or community involvement. Department recommendation.

Chemical Engineering Undergraduate Summer Fellowship
This award was established in 2014 through a generous donation from an anonymous donor. The award is given to a student completing first, second or third year of Chemical Engineering on the basis of strong academic performance and a keen interest in research. The recipient would work on research projects under the supervision of Faculty members and/or graduate students over the course of the summer (May-August). Department recommendation.

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 Chemical Engineering who has shown the most improvement in a chemistry and/or chemistry-related program. The award does not necessarily go to the student who achieved the second-highest standing in a particular program.

CISC/Walters Inc. Scholarship
This award, valued at $2,000, 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 $3,000 open to students who have completed second-year Civil Engineering and are registered in the third year of the program.

Application is not required. The award is based on a recommendation by a selection committee composed of the Civil Engineering Undergraduate academic advisor and two other members of the teaching staff who are acquainted with third-year Civil Engineering students. 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 with the exception of OSOTF/OTSS awards. 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 Civil Engineering, 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 Civil Engineering. The scholarship is not tenable with other awards of $1,000 or higher value. Application is not required.

Class of 2004 Grant
This grant, established through the generosity of the Class of 2004 in their graduating year, is given to one or more undergraduate student(s) in the Faculty on the basis of financial need. Applications should be made on the Undergraduate Grant Application Form.

Class of 4T3 Engineering James Ham Award
This award was established in 2004 through the generosity of the members of the class of 4T3 in memory 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 to 1976, 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 five 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 per cent 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
The bursaries, established in 1997, are provided by the generosity of the Class of 4T7. Derived from the annual income, the bursaries are awarded to an engineering student in financial need. Applications should be made through 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 Civil Engineering and is based on financial need. Preference is given to students who excel academically. Additional preference is given to students who demonstrate leadership qualities as exhibited through student council activity, participation on Faculty/University teams and clubs, community involvement and 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.

Constant Temperature Control Ltd Scholarship
This scholarship was established through a generous donation by Constant Temperature Control Ltd. It is awarded to a student who achieved a high academic standing in their third year of studies and is proceeding into their fourth year of studies in engineering.

Dan Cornacchia/Ernst & Young Scholarship
This scholarship was established in 2012 through donations provided by Dan Cornacchia and matched by Ernst & Young. The award is given to a full-time student in Industrial Engineering who is participating in the Engineering Business Minor. Recipients are selected on the basis of strong academic merit; qualities of character and leadership may also be considered.

Crocker Foundation Bursaries
The income from a capital fund established from the estate of the late Beatrice Crocker Glazier in memory of her brother, James William Crocker, provides bursaries for students in the Faculty of Medicine and the Faculty of Applied Science and Engineering who are in need and are worthy of financial assistance. Applications should be made through the Undergraduate Grant Application Form.

CSA Group Award
This award was established through a generation donation by the Canadian Standards Association (doing business as CSA Group). The award is given to students in the Faculty on the basis of demonstrating excellence in courses which emphasize standards including: Chemical Engineering (CHE561–Risk-Based Process Safety Management) and Mechanical Engineering (MIE364–Methods of Qualify control and Improvement) and APS 112 (Engineering Strategies and Practices.

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 demonstrate a strong interest in theoretical physiology, either through classroom projects or summer research, and, additionally, should show an interest in the world around them. 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 should be submitted to the Department of Physiology by April 1.

Davis + Henderson Hatchery Award
This award was established in 2013 through a generous donation by Davis + Henderson Corporation. Recipients are selected based on the merit of their entrepreneurial ideas by recommendation of the Chair of the Hatchery Advisory Board.

Hanna Wejtko De Angelis CIV6T0 Scholarship
This scholarship was established in 2011 by the Department of Civil Engineering in honour of the first five 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 after having completed first year in any program in the Faculty, who achieves the third 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 was established in memory of Professor Roger E. Deane by his colleagues within the University and the geology profession; it is in commemoration of his distinguished contributions to geology. The scholarship is awarded annually to the students, full or part-time, who show the best performance at the department geological field camp.

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 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.

William J. Dowkes Undergraduate Summer Research Grant
Established in 2013 through a generous donation by Mr. William J. Dowkes, this research grant is awarded on the basis of financial need to students completing first, second or third year of any undergraduate program in the Faculty. Academic standing will also be considered. The research grant is given to students to work on research projects on campus during the summer under the supervision of faculty, staff, and/or graduate students within, or associated with, the Department of Chemical Engineering and Applied Chemistry.

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 through the Undergraduate Grant Application Form.

Duhamel Helsing Environmental Engineering Scholarship
This award was established in 2013 through a generous donation by Dr. Melanie Duhamel. The scholarship is awarded annually to a full-time student entering third or fourth year who is pursuing his or her studies with concentrated and focused attention on environmental and sustainability-oriented challenges. Candidates are selected on the basis of strong academic performance and demonstrated financial need.

William Dunbar Memorial Scholarship
Established in 2014 from the estate of the late William Dunbar, this scholarship is awarded to students in any year of the Mechanical Engineering program on the basis of outstanding academic achievement. Recommendation of the chair of the department.

Edward S. Rogers Sr. Department of Electrical & Computer Engineering Top Student Award
Awarded to the top 3 students with the highest GPA in both fall and winter terms in each program , Electrical end Computer Engineering in years 1, 2 and 3 - 18 awards in total annually. Students must have been full-time (minimum 5 courses) to be eligible.

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 through 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. A scholarship is awarded to a student in the first, second and third years on the annual examinations who, obtaining Honours, achieved the highest average percentage of marks in the year's written and laboratory subjects. The scholarships are open to engineering students. If the winner does not attend the Faculty during the session following the award, the right to the scholarship is forfeited and it will be issued 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 scholarship is awarded to a student entering their third year of any undergraduate program in the Faculty. The recipient must have achieved a minimum B average in second year. Preference is given to students who demonstrate significant community involvement and volunteer work. Additional preference is given to students who exhibit 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. The bursaries are awarded on the basis of academic achievement and financial need. Preference is given to third- and fourth-year students. Applications should be made through Undergraduate Grant Application Form.

5T3 (1953) Engineering Award
The Class of 5T3 established the 5T3 (1953) 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 full-time student entering second, third or fourth year in any program in the Faculty and is based on academic achievement. Recipients must demonstrate 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, is granted to a student who completes first year in any Engineering undergraduate program. The recipient must demonstrate qualities of leadership and character through involvement in extracurricular activities either within the University of Toronto or the community at large in addition to academic achievement. Nominations are 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 year three of Engineering Science. The scholarship is issued on the chair's recommendation on the basis of outstanding academic achievement and extra-curricular involvement.

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 full-time students entering third-year Engineering Science and is based on strong academic achievement and on 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.

Enwave Graduating Awards of Distinction
These awards were established in 2004 through the generosity of Enwave District Energy Limited. Four awards are issued every year. 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 are nominated by the chair of the respective department or designate. Selection is made on the basis of academic performance* in fourth year and the following:
-Chemical Engineering: preference given to students who demonstrated a particular aptitude for studies related to alternative energy technologies
-Electrical Engineering: preference given to students who demonstrated an aptitude for studies related to power generation and distribution
-Environmental Engineering (Minor): preference given to students who demonstrated an aptitude for studies related to environmental sustainability and sustainable development
-Sustainable Energy (Minor): preference 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 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). The prize was 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 Engineering Science student. 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 to 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 full-time student entering third- or fourth-year 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 Mechanical Engineering; the other is intended for a fourth-year student, but only if the student continues in Mechanical Engineering.

The selection is made on recommendation of the Chair of the Department from the four students with the highest average percentage of marks at the annual examinations in second and third year respectively. The student's general character, fitness for the profession and financial circumstances are given consideration. If a student wins one of the scholarships and changes program, or does not attend this University during the next following session, the award shall be made to another eligible student.

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 first-year Civil Engineering and is based on good academic standing and qualities of character and leadership. In order to receive the award the recipient must register in the second year of the program.

Andrew Forde Polymath Award
Established in 2012 through annual donations made by Andrew Forde, this award is given to a full-time engineering student proceeding to second, third, or fourth year and who excels in multiple areas of life beyond academics. Recipients must have demonstrated community involvement through being actively engaged in helping to strengthen the skills, competencies, and abilities of Afro-Caribbean people through history, culture, literature, empowerment, or thought. Minimum CGPA of 3.3 is required.

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 Civil Engineering. Students must have achieved high standing, with Honours, at the annual examinations.

Laura Chizuko Fujino Scholarship in Engineering Science
This scholarship was established in 2012 through a generous donation by Kenneth Carless Smith and Laura Chizuko Fujino. The award is given to a

female student entering the third- or fourth-year of the Electrical and Computer Engineering Option in the Division of Engineering Science and is based on academic achievement. Extra-curricular activities may also be considered.

Fujino/Smith Emergence Scholarship
This scholarship was established in 2015 through a generous donation by Kenneth Carless Smith and Laura Chizuko Fujino. The award is given to a tull-time student in First Year Engineering Science who receives the highest average grade after term 1F, is proceeding to the winter term in Engineering Science and who did not receive an entrance scholarship. Preference will be given to students who graduated from an Ontario high school.

Hugh Gall Award
The Hugh Gall Award was established in 1946 by the graduating 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 per cent without conditions, has entered second-year and requires financial assistance to continue. It is desirable, but not necessary, that the recipient not have already been given any other scholastic award or scholarship applicable to the second year and shows indications of a firm intention and ability to follow successfully the profession of engineering. Applications should be made using the In-course Bursary Form.

Kiran and Praveen Ghai Engineering Scholarship
This award was established through a generous donation by Dr. Shailly Jain and Mr. Sachin Ghai. The award is given to an undergraduate student in the Faculty of Applied Science and Engineering on the basis of academic merit and financial need.

Vern Gomes Memorial Award
Established by classmates and friends of the late J. Vernon Gomes, this award, of the approximate value of $65, is issued to the student entering fourth-year Electrical or Computer Engineering who, having obtained an average not lower than 60 per cent 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 1949 graduate of this Faculty. The award, which is the value of the annual income of a capital donation, is set up in perpetuity. It is made on the recommendation of the chair of the Department of Mechanical and Industrial Engineering and awarded to a student completing second-year Mechanical Engineering who has attained good academic standing, is of sound character and has limited financial resources to support the costs of his or her education. This 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 $5,800. It is granted to a student entering fourth-year Civil Engineering. The student must demonstrate academic excellence and show significant interest in municipal, environmental and construction 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 is 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 was 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 standings in the subjects needed for admission to the first year of the Materials Engineering program. The Guess In-Course Scholarships are awarded to students completing first-, second- or third- year of Materials Engineering and are made on the basis of achievement a minimum average of 75 per cent. Extra-curricular/leadership qualities may also be considered.

Frank Howard Guest Admission Bursary
Established in 1995, this bursary, based on academic achievement and financial need, is awarded to students entering the first year of any undergraduate program in the Faculty of Applied Science & Engineering.

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 and is based on academic standing and financial need. Applicants must complete the Undergraduate Grant Application form. Special attention is given to applicants who are participating in exchange programs in other universities and countries.

Norm and Nellie Hann Scholarship
Established in 2015 through a generous donation by Normal and Cornelia Hann, this award is given annually to a student who, after term 1F finds him/herself on academic probation (1F average less than 60%, or less than 55% if Engineering Science), and who has improved the most after fall term of 2nd year (term 2F average), an indication that they never gave up.

B. Conrad Hansen Memorial Award Fund
The fund was established in 1979 in memory of the late B. Conrad Hansen (ElecE 6T2). 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 second- or third-year Electrical or Computer Engineering.

Sydney George Harris Bursary
Established in 1994, the bursary is granted, on recommendation of the chair, to a student entering 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 students in financial need. The annual value is approximately $1,000.

Glenn and Richard Hauck Memorial Scholarship
Established in 2010, through a generous donation by Stephen and Linda Hauck, this scholarship is awarded to a student entering third-year Engineering Science who is facing challenges with dignity and perseverance and who participates in extra-curricular activities. Recommendation by the chair of the Division.

S. Haberer Energy Systems Scholarship in Engineering Science
Established in 2015 through an annual donation by Sean Haberer, this award is given to a full-time student proceeding to Third or Fourth Year of Engineering Science whose academic focus relates to Energy Systems. Recipients will be selected on the basis of academic standing. Participation in extra-curricular activities, including summer employment and PEY, related to energy systems will also be considered.

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 Mechanical Engineering 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. The prize is awarded to the student completing their fourth year of Chemical Engineering who achieved the highest standing in fourth-year courses related to environmental studies. The first award was made during the 1980-1981 academic year.

Hill & Schumacher Entrepreneur Award
This award was established in 2013 through a generous donation by the Hill & Schumacher Professional Corp. and is given to an undergraduate student in the Faculty who is associated with the Entrepreneurship Hatchery. The award is granted to a student or group of students who demonstrate strong design and entrepreneurial skills. This award is issued on the basis of outstanding business plan for an innovative product or service that seeks to solve “real-life problems” or improve the lives in a concrete and meaningful way.

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 and is based on financial need. Applicants must complete the Undergraduate Grant Application form.

Otto Holden Scholarship
Otto Holden, BASc, CE, DEng, 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 their fourth year of either Civil Engineering or Mechanical Engineering studies with Honours, achieves the highest aggregate marks in hydraulic engineering subjects in the program. The first award was made during the 1967-1968 academic year.

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 ranked first place in any program in third-year exams.

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 second-year Mechanical Engineering after successful completion of their first year in any program in the Faculty. The awards based on 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, valued at $2,000, 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 their third year in Electrical and Computer Engineering who earned 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, valued at $2,000, 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 their third year 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. Candidates' applications 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 full-time student entering their third or fourth year in Civil Engineering. Recipients must have achieved a minimum of 80 per cent 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 CIV6T5 Scholarship
This scholarship was established in 2011 by the Department of Civil Engineering in honour of the first five women to graduate from Civil Engineering, of which Sue Joel was one. The award, valued at $500, is given to a student entering their second year of Civil Engineering, having completed first year of any program in the Faculty, who achieves the fourth 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 1936-1944; Mechanical Engineering 1944-1975) and Engineering Archivist (1970) to students, alumni and the Faculty. Over his long and distinguished career, he also made contributions to U of T's Engineering Society and the Engineering Alumni Association. The award endorses Ted's great appreciation of the arts and, in particular, his love of music. The award is presented annually to a graduating engineering student who 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 of Alumni Relations, faculty member, 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.

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

KGHM International Ltd. Scholarship
This award was established in 2012 through a generous donation by KGHM International Ltd. The award is given to a full-time student entering their second, third or fourth year in any program in the Faculty, who is pursuing the Environmental Engineering Minor. The award is also based on 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).

Konrad Group Scholarship
This award was established in 2012 through a generous donation by Geordie Konrad, Konrad Group, and is given to a full-time student proceeding into their third or fourth year of studies in the Faculty and is based on strong academic achievement. Preference will be given to students who demonstrate an interest in software development based on course selection, extra-curricular activities and/or work terms.

Kordellas-Tripp Foundation Engineering Award
This award was established in 2015 through a generous donation by Nicolas Kordellas and Shirley Tripp. Nicolas Kordellas was a student from Greece who graduated from U of T Engineering in 1959. It was his grandfather, Andreas Kordellas, a very successful engineer in Lavrion, Greece, who inspired him to study Mechanical Engineering in Canada. This award is given to student(s) entering third or fourth year and is based on financial need and social awareness. To apply, a student must submit an application, which includes a personal statement that outlines his or her views on how society should function so humanist values are honoured.

Catherine Lacavera Hatchery Award
This award was established in 2014 through a generous donation by Catherine Lacavera and is to provide summer fellowships for student entrepreneurs enrolled in the Hatchery Entrepreneurship Program at the Faculty. Recipients will be selected based on the merit of their entrepreneurial ideas by recommendation of the chair of the Hatchery Advisory Board.

Lacavera Prize for Entrepreneurship
This prize was established in 2013 through a generous donation by Anthony Lacavera. Recipients are selected based on the merit of their entrepreneurial ideas by recommendation of the Chair of the Hatchery Board.

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. Several scholarships are granted on admission to the Lassonde Mineral Engineering Program or Lassonde Institute of Mining based on academic standing and qualities of character and leadership. The remaining scholarships are 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, Lassonde Bursaries have also been established. The bursaries are granted to students in any year of the Lassonde Mineral Engineering program and based on financial need. Applicants must complete the Undergraduate Grant Application form.

Stavros Leventis Award
Provided by Mrs. Elsha Leventis, classmates 6T8 and friends of the late Stavros Leventis, this award is given to a student in second- or third-year Electrical Engineering who, while maintaining a B average or better, contributed 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 Structures, Materials and Design (CIV101F).

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, Earl Charles Lyons (3T3). The award, which is set up in perpetuity, is of the value of the annual income of a capital donation. It awarded on the recommendation of the chair of the department of Mechanical & Industrial Engineering to a student completing the third-year Mechanical Engineering. In addition to honours standing, consideration is 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 issued during the 1983-1984 academic year.

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 during the 1991-1992 academic year.

J.R. MacCoon Footsteps Grant
Established in 2014 through a generous donation by Jacquelyn Rebecca MacCoon, this grant is given to a student who has enrolled in the T-Program and is proceeding to the summer session to complete first year. The grant is given to a student who has demonstrated financial need and experienced hardship during first year.

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 and is based on 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 alternates 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 (0T8) who retired in 1954. The scholarship is awarded to an outstanding student in GLG 318H and/or GLG319H in the Department of Geology, Faculty of Arts and Science or completing third-year 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 donated an annual prize in memory of their first class president, George MacLennan, who was killed in action in France in 1917, and 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 ranked highest in Calculus among those who obtain standing without condition at the annual examinations; or, in the event of more than one student obtained 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 the next year.

Salim Majdalany Scholarship
The scholarship was established by the family and friends of the late Salim Majdalany (B.A.Sc., 1980, Civil Engineering). The award is granted on academic standing to a student from Lebanon, Syria, Jordon, 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; however, priority is given to candidates from the Faculty of Applied Science and Engineering.

Steven Mann Award in Wearable Computing
Established in 2013 through a generous donation by Martine Rothblatt, this award is given to a third or fourth-year student who achieves the highest mark in a course on Wearable Computing (ECE516) taught by Steven Mann.

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; 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 full-time student in third year 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, which is intended to provide financial aid to students who require it in Mechanical, Chemical, Electrical, Computer, Lassonde Mineral or Materials Engineering. Applications 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 includes the applicant's academic background, 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 in any program on the basis of financial need. Applications should be made using 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 create a scholarship for a first-year Engineering Science student. The value of the scholarship is the annual income from the capital fund and is awarded to the student who ranks first in honours in first-year examinations in Engineering Science. If for any reason the student is ineligible to hold the scholarship, it will be awarded by reversion to the second-ranked student. To receive payment the winner must register in second-year Engineering Science. The scholarship was awarded for the first time 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. The scholarships are awarded by Governing Council to a student 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 second-year Engineering Science who has the highest aggregate standing at the examinations of the first and second years in the program provided the student obtains honours standing in second-year exams.

The Second Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship
This scholarship is awarded to the student who ranks second in second-year Engineering Science and achieves the highest aggregate standing in the first and second years of that course provided the student obtains honours standing in second-year exams.

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 the student obtains honours standing in second-year examinations.

Marlene Metzger CIV6T0 Scholarship
This scholarship was established in 2011 by the Department of Civil Engineering in honour of the first five 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 Civil Engineering, having completed first year of any program in the Faculty, who achieves the second-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 bursary, established in 2001, is awarded to a student in the Faculty of Applied Science and Engineering and is based on financial need. Applications should be made through 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 Kiyoaki Momose Memorial Scholarship
This scholarship in the amount of approximately $300 was bequeathed by Yoshiko Momose. The award is made to a student entering their penultimate or final year in Medicine, 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
This award is granted to a student or group of students who plan to attend the IIE annual conference. Students must have submitted a request to present a paper. The Faculty will select the student or group of students to represent it at IIE.

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.

As the sole member of his 1881 graduating class in Civil Engineering, 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.

The prize, the value of the annual income from $3,000, is awarded annually to the student in second-year Civil Engineering who achieved the highest aggregate percentage at the annual examinations of the first and second years of the program, provided the student achieved Honours standing second-year exams.

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

Peter L. Munro Memorial Scholarship
This fund was established in 1987 by family, friends and business associates of Peter L. Munro (Min 5T9). One award is granted on the recommendation of the chair of the Division of Mineral Engineering to a student completing their second or third year of studies and who demonstrate commitment to the Canadian mining industry. In addition to good academic standing, financial need and qualities of character and leadership will be considered. The first award issued during the 1987-1988 academic year.

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 assistance. Applications should be made through the Undergraduate Grant Application Form.

NACE International, Toronto Section, Prize
Every year, the Toronto Section of the National Association of Corrosion Engineers (NACE) provides one $200 prize the fourth-year engineering student whose thesis on the subject of corrosion science and engineering is considered to be of suitable quality and the most satisfactory. The first award issued in 1989-1990 academic year.

Nortel Institute Undergraduate Scholarship(s)
This scholarship is made possible through a donation from Nortel Networks Limited. The scholarship is awarded to students in their second or third year of studies in Applied Science and Engineering or Arts and Science and is based on financial need, academic merit and an essay. Candidates must submit an essay on the future of communications (maximum 500 words) along with two references. The application deadline is November 1. Applications are available at www.adm.utoronto.ca.

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, Mechanical, Chemical, Computer, or Environmental Engineering, with preference for Electrical, Mechanical or Chemical 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, strong oral and written communication skills, and 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.

Otegbade Scholarship for Students and Africa
This award was established in 2014 through a generous donation by Adediran Otegbade. The award is given to a student from Africa with preference for students that have shown a marked and consistent improvement from one academic year to the next, and for students involved in Skule activities including international student clubs and associations.

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 the use of PACE-sponsored software. Recipients may be in third or fourth 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 third-year Engineering Science and who demonstrates financial need and promise in their field as evidenced by year-to-year academic improvement.

The Dr. John Hamilton Parkin Scholarship
Established by family friends and colleagues in 1983, this award honours the late Dr. John Hamilton Parkin, a graduate and former faculty member of this Faculty.

His class of 1908-1911 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 wind tunnel (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.

Parsons Scholarship in Civil Engineering
Valued at $1000, this scholarship is offered in memory of the late Jack Spiegelman (CivE 5T1), Leuw Cather Canada Ltd.; Mr. Spiegelman was the former Director and Chief Transit Engineer of the Company.

The scholarship is awarded on the recommendation of the chair of the Department to a student entering fourth-year Civil Engineering who 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.

Paulin Memorial Scholarship
The Paulin Memorial Scholarship, provided through the generosity of the late Mr. Fred W. Paulin, a 1907 graduate of this Faculty, 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 obtained high-standing in the work of the first year in the Faculty of Applied Science and Engineering.

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 the remaining $25 is given 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 (each valued at $1500) to students in their first, second and third years of study 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.

Ewing Rae Undergraduate Scholarship
This award was established in 2013 through a generous donation by Ewing Rae. The scholarship is awarded to a full-time student who has completed their first year of any undergraduate program in the Faculty and is enrolled in either second-, third- or fourth-year Mechanical Engineering. The award is based on strong academic achievement; extra-curricular involvement will be considered.

Ransom Scholarship in Chemical Engineering
The Ransom Scholarship in the Chemical Engineering & Applied Chemistry 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 Chemical Engineering who achieved 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 the friends and colleagues of the late 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.

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 Electrical or Computer Engineering who, graduating with Honours, achieved the highest aggregate marks in electronic communication.

Russell Reynolds Memorial Scholarship
This award, established in 2001, is awarded to a student entering third-year Engineering Science. This student must have displayed high academic achievement. Preference is given to students who demonstrate financial need. This scholarship is not tenable with other awards.

Dagmar Rinne Scholarship
This scholarship was established in 2012 through generous donations by Inga Rinne and friends. The award is given to a student entering their third year of full-time studies in Industrial Engineering who has demonstrated the most improved academic standing from first to second year.

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 retiring, he returned to the University of Toronto and in November 1979 graduated with his Master of Engineering. Applications should be submitted through 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

Mechanical Engineering graduate. 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. The scholarship is awarded on the recommendation of the Chair to a student completing third year of Mechanical Engineering and who has a good overall academic record, intends to continue to fourth year and has demonstrated an interest in heating, ventilating and air conditioning.
By request of the donor, this award is restricted 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 second, third or fourth year of full-time Engineering Science studies.

Margaret Agnes Runciman and James Dempsey Runciman Bursary
This bursary was established in 2014 through the Estate of Margaret Agnes Runciman. The bursary is given to one or more undergraduate students in the Faculty on the basis of financial need. Preference is given to students in their second or third years of study. Application through the Undergraduate Grant Application.

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 provides two scholarships valued at $500 each. The scholarships are open to students in the third and fourth years of certain courses in the Faculty of Arts and Science and 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.

Paul Santerre Undergraduate Biomedical Engineering Legacy Scholarship
This award was established in 2013 by the Institute of Biomaterials and Biomedical Engineering (IBBME) to honour the career of Professor Paul Santerre. This scholarship is awarded to two students proceeding to second, third or fourth year and based on a demonstrated strong interest in biomedical engineering (i.e. pursuing a major in Biomedical Engineering Systems or a minor in Bioengineering). Additionally, candidates must be involved in any area of community service and/or extra-curricular activities, not just those related to biomedical engineering. Candidates must have achieved a minimum overall average of at least 80 per cent in the previous year. Awards are available for competitive renewal (i.e. incumbent students are eligible in subsequent years provided they meet the award criteria).

Frederick W. Schumacher Scholarship
The Frederick W. Schumacher Scholarship was 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 five 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 every 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 is comprised of a monetary prize and illuminated scroll that is presented to a student in their final year. 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, are granted to students in any year in Electrical and Computer Engineering on the basis of financial need. Applications 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 Mechanical Engineering until his

retirement in 1975. This award is given to a student who has achieved honours standing in the second year of Mechanical Engineering and has demonstrated a strong character and has financial need. Issued by departmental 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. For many years, Mr. Seidner contributed to the well-being of the construction industry. The annual income of the capital in the bursary fund, which was established in the Faculty of Applied Science and Engineering at the University of Toronto, is awarded to one or more deserving second or third year students in mechanical engineering in Ontario and 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. Applications should be submitted via the Undergraduate Grant Application Form.

Som Seif Scholarship
This award was established in 2013 through a generous donation by Som Seif. The award is given to full-time students in Industrial Engineering with preference to students who demonstrate an interest in business and/or entrepreneurship based on course selection and/or extra-curricular activities such as, but not limited to, the Hatchery or participation in external start-ups.

John W. Senders Award for Imaginative Design
This award was established in 2013 through a generous donation by John W. Senders and Ann Crichton-Harris. The award is given to a student or students who, in their graduating year, demonstrate an imaginative and successful application of engineering to the design of a medical device capable in generality of its application to restore normal human functions. The award is issued on the recommendation of the Multi-Disciplinary Capstone Lead Committee.

The Shaw Design Scholarship(s)
Established in 2002 through a generous donation by William and Barbra Shaw, these scholarships are awarded to students beginning their third year of Engineering Science. Preference is given to students who have achieved a high academic standing in the first two years of their studies. Additional preference will be given to students who demonstrate strong achievement in the second-year Engineering Design course and involved in extracurricular design projects. The selection is made by departmental nomination and announced at a suitable occasion, such as the annual Engineering Science dinner.

Gordon R. Slemon Capstone Design Award in Electrical and Computer Engineering
This award was established in 2013 through generous donations by the friends and family of Gordon R. Slemon. The award is given to student(s) in Electrical and Computer Engineering on the basis of completion of an exceptional fourth-year capstone design project.

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 suitability for the fellowship.

Professor James W. Smith Chemical Engineering Leaders of Tomorrow Award
This award was established in 2006 through generous donations 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; an additional donation was made 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 Chemical Engineering and Applied Chemistry who achieved the highest weighted average over 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 given 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 power plant 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 $1,000 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. James set high professional standards for himself and worked indefatigably in the enhancement of the careers of others. The first award was made in the 1983-1984 academic year.

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, obtained the highest aggregate marks in third-year examinations in the subjects that pertain 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 volunteer 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 engineers, and as 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.

Dr. Chris Twigge-Molecey Scholarship in Mechanical Engineering
This award was establish in 2012 through a donation by Mr. and Mrs. Chris Twigge-Molecey and is awarded to a student in any year of Mechanical Engineering on the basis of financial need, high academic merit and a demonstrated interest in sustainable energy.

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.

UMA Scholarship in Civil Engineering
Established in 1984 through the generosity of the UMA 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 1984-1985 session.

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 and valued at $1,500 each, are derived from the Wallberg bequest. They are awarded annually on the basis of academic standing. Four scholarships are awarded in first year and two 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 their second year of Materials Engineering studies and is based on academic achievement. Recipients must be Canadian citizens or permanent residents and must have achieved honours.

Paul Wilde ChemE 7T8 Award
This award was established in 2014 through a generous donation by William G. Timbers of Timbers Consulting Inc., on behalf of the Chemical

Engineering Class of 7T8. The award is given to a student entering their second, third, or fourth year of studies in Chemical Engineering and is based on financial need, academic ability and demonstrated qualities of selflessness akin to those of Paul Wilde as evident by extra-curricular involvement in support of others in the community. Recommendation of department chair or alternate.

The Stewart Wilson Award

This award, first made in 1965-1966, is available through the generosity of the Engineering Alumni Association. Its value fluctuates to cover the residence fee of New College. It is open to students who, proceeding into second- or third-year studies 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 winner shall reside in the New College residence during the academic year of the award.

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 former Assistant Dean and Secretary William Stewart Wilson. A medal is awarded to the student in each graduating course, who, attaining Honours, achieved the highest standing in the final year of the course. The first awards were issued during the 1962-1963 academic year.

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 1954-1955 academic year.

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 is given on the basis of academic merit to a full-time student proceeding to Second Year of Engineering Science.

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 157.

TUITION FEES

Method of Payment
Students will receive detailed instructions regarding the payment of fees in the summer. Students may also review fees information on the Student Accounts website: 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)/ACORN (www.rosi.utoronto.ca). Students may pay this invoice in-person at their banking institution through a teller or a banking machine.

*For instructions on how to use ROSI/ACORN see the Student Services and Resources section.

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 displayed on the invoice format of your account on ROSI. It consists of the first five characters of your surname (in capital letters) and ten 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: www.fees.utoronto.ca.

Official Registration

A minimum first installment of tuition fees (as shown on ROSI/ACORN) must be paid or fees must be deferred (through scholarship or OSAP) by a deadline in August (listed in the "Sessional Dates" section of this calendar and on the Office of the Registrar's website (www.undergrad.engineering.utoronto.ca) 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 "Late Registration" below).

You must pay the Minimum Payment to Register Amount displayed on your current session ROSI/ACORN invoice at least 3-5 business days (for an online payment at a major Canadian financial institution or by WU Union Global Pay service from outside of Canada) prior to the published registration deadline. Other types of payments can take up to 10 business days to be recorded in ROSI/ACORN. The recording of your Minimum Payment to Register amount on ROSI/ACORN will change your sessional registration status to “Registered”.

Verify Your Registration Status
Check to see if you are registered on ROSI/ACORN by logging into the website and reviewing the information displayed on the home screen in the “Registration” section. If your status is "Registered" for the current session, your registration is complete. If your status is "Invited to Register" 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 30 of each year). The outstanding balance of the account is subject to a monthly service charge of 1.5 per cent (19.56 per cent 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 five to seven business days from within Canada and 10 to 14 days from outside of Canada 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 2016-2017 session will be available on the Student Accounts website at www.fees.utoronto.ca in July 2016. Check www.fees.utoronto.ca for the finalized session fees once these are available. For reference, below are the amounts from the 2015-2016 academic year.

FULL-TIME STUDENTS, 2015-2016

DOMESTIC STUDENTS

Academic Year	I	II	III	IV
Academic Fee	$13,620.00	$13,620.00	$13,230.00	$13,230.00
Incidental Fees*	$1,548.92	$1,548.92	$1,548.92	$1,548.92

Total Fee (If paid in one installment)	$15,168.92	$15,168.92	$14,778.92	$14,778.92
Minimum First Installment	$9,859.80	$9,859.80	$9,606.30	$9,606.30

INTERNATIONAL STUDENTS

Academic Year	I	II	III	IV
Academic Fee	$43,540.00	$41,560.00	$39,670.00	$37,090.00
Incidental Fees*	$1,548.92	$1,548.92	$1,548.92	$1,548.92
University Health Insurance Plan (UHIP) Fees	$612.00	$612.00	$612.00	$612.00
Total Fee (If paid in one installment)	$45,700.92	$43,720.92	$41,830.92	$39,250.92
Minimum First Installment	$29,705.60	$28,418.60	$27,190.10	$25,513.10

PART-TIME AND SPECIAL STUDENTS, 2015-2016

DOMESTIC STUDENTS

Academic Year	I	II	III	IV
For each Engineering 0.5 course load	$1,362.00	$1,362.00	$1,323.00	$1,323.00
Incidental Fee (once annually)	$472.90	$472.90	$472.90	$472.90

INTERNATIONAL STUDENTS

Academic Year	I	II	III	IV
For each Engineering 0.5 course load	$4,354.00	$4,156.00	$3,967.00	$3,709.00
Incidental Fee (once annually)	$472.90	$472.90	$472.90	$472.90

*Non-academic incidental fees include: campus fees; student society fees; Engineering Career Centre; OSOTIF Student Aid, Endowment Fund Fee; Temporary study levy; ROSI access fee.

OTHER FEES

PEY Registration Fee (subject to annual approval – see engineeringcareers.utoronto.ca for details)	$950
eSIP Placement Fee (subject to annual approval – see engineeringcareers.utoronto.ca for details)	$250
Copy of documents in student information file (other than transcript)	$15
Copy of examination paper, per paper (non-refundable); Deadlines: Last day to request exam copies is October 15 for April-May and June Engineering Exams and February 15 for December Engineering Exams.	$15
Letter of Permission	$40

Re-checking marks, per course Deadlines: last day to request mark recheck is October 15 for April-May and June Courses and February 15 for December Courses (Note: Fee is refunded if an error is found)	$13
Re-enrolment Application	$25
Registration Letter	$ 8
-Each additional copy	$ 0.50
Special Student Application, per submission	$90
Student Card replacement -Obtain TCard replacement from TCard Office with photo ID	$12
Transcript request (each copy) (starting May 1, 2014) -Processed by UTTC (U of T Transcript Centre.) -Request transcripts online at: www.rosi.utoronto.ca	$12

* 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:

-Books and instruments per year: $1,500
-Fees (see fees schedule above)
-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: 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 can be found on the Student Accounts website: www.fees.utoronto.ca.

PENALTIES

Withdrawal from the University

Students who withdraw entirely from the University, thereby canceling their registration in a program (Degree POSt) on or after the published date for the first day of classes in the session, will be assessed a minimum charge of $256 in respect of academic fees.

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

Late Registration Re-instatement Fee

$61

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 (www.governingcouncil.utoronto.ca/policies/studentc.htm)

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. A collection of the most commonly requested services and offices is listed below.

OFFICE OF THE REGISTRAR

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

-Academic and personal advising
-Academic scheduling
-Course listings building and classroom locations
-Final exam copy and final course mark re-check requests
-Final exam viewing
-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

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 Office of the Registrar at registrar@ecf.utoronto.ca.

OFFICE OF THE FACULTY REGISTRAR

Faculty Registrar, Don MacMillan
Associate Registrar and Director, Admissions, Helen Bright
Associate Registrar, Student Services and Records, Khuong Doan
Associate Registrar, Director of Administrative Information System, Dan Pettigrew
Assistant Registrar, Admissions, Rosemary Guido
Assistant Registrar, Scholarships and Financial Aid, Pierina Filippone

35 St George Street, Room 157
Tel: 416-978-5896
Fax: 416-978-1866
registrar@ecf.utoronto.ca
Office hours: Monday 9:00 a.m.-4:00 p.m.; Tuesday 10:00 a.m.-5:00 p.m.; Wednesday-Friday 9:00 a.m.-4:00 p.m.

FIRST YEAR OFFICE

Assistant Director, First Year Academic Services, Leslie Grife
Assistant Director, First Year Student Success and Transition, Cori Hanson
First Year Advisor, Jennifer Michelle Fabro
First Year Assistant, Olha Fihol

35 St George Street, Room 170
Phone: 416-978-4625
firstyr@ecf.utoronto.ca
Office hours: Monday to Friday, 10:00 a.m.-4:30 p.m.

UNDERGRADUATE PROGRAM OFFICES

Upper-year students should contact their departmental undergraduate academic advisor for assistance related to their programs. Academic advisors can provide detailed guidance regarding course selections and options for your specific program, as well as assistance in interpreting Faculty policies and procedures.

CHEMICAL ENGINEERING
Jane Chung
Room 216A, Wallberg Building
416-978-5336
ugrad.chemeng@utoronto.ca

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

ELECTRICAL AND COMPUTER ENGINEERING
Linda Espeut
Room B600, Sandford Fleming Building
416-978-8570
askece@ecf.utoronto.ca

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

ENGINEERING SCIENCE
Sherry Lin (first- and second-year students)
Room 2110, Bahen Centre for Information and Technology
416-946-7351
nsci1_2@ecf.utoronto.ca

Brendan Heath (third- and fourth-year students)
Room 2110, Bahen Centre for Information and Technology
416-946-7352
nsci3_4@ecf.utoronto.ca

MECHANICAL AND INDUSTRIAL ENGINEERING
Carla Baptista
Room 109, Mechanical Building
416-978-6420
undergrad@mie.utoronto.ca

MATERIALS ENGINEERING
Maria Fryman
Room 140, Wallberg Building
416-978-1374
maria.fryman@utoronto.ca

STUDENT WEB SERVICE: ACORN/ROSI

www.rosi.utoronto.ca

ACORN stands for Accessible Campus Online Resource Network. For students, ACORN will replace the existing ROSI Student Web Service (SWS). For those unfamiliar with the existing system, it's where students enrol in courses, check fees and finances and do other records and registration tasks such as making updates to address and contact information. The purpose of ACORN is to provide a more convenient, personalized and guided experience for students using U of T's online services.

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 http://www.rosi.utoronto.ca/rosi_about.php.

Detailed information on ACORN can be found on their website, including a comprehensive Q & A section.

UNIVERSITY OF TORONTO PORTAL

www.portalinfo.utoronto.ca

The Portal connects you to the services and information you want and makes it easier to interact with your friends and the University. The Portal facilitates 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; the card 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 to replace a lost card.

LETTERS OF REGISTRATION

uoft.me/engletters

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 $8.00 with tax included. Payment must accompany the request; processing takes up to five business days. The Office of the Registrar cannot be responsible for letters lost or delayed in the mail.

TRANSCRIPTS

www.transcripts.utoronto.ca

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 through ACORN. 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 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/students/ecp.htm

ENGINEERING CAREER CENTRE

The Engineering Career Centre (ECC) has connected students with employers for over 30 years. We take great pride in our students and their abilities, which is why we work with each one to support their development into emerging professionals at every stage of their education —through workshops, counselling and coaching. ECC offers unique career development programs to introduce the country's best and most innovative students to industries.

These internship programs are beneficial to all parties involved. For employers, it means having eager and highly capable individuals on their team and is also an excellent way to access prospective employees. For students, these programs provide invaluable professional experience along with an opportunity to chart their career paths. In the last five years, more than 700 employers from over 24 countries have hired our students.

To learn more about our programs and services, see the Curriculum & Programs section and visit www.engineeringcareers.utoronto.ca.

UNIVERSITY OF TORONTO STUDENT LIFE

www.studentlife.utoronto.ca

The Division of Student Life brings coherence to complexity and creates opportunities to build skills, foster community and integrate learning. They connect life to learning.

Through their work and partnerships, every student has the opportunity to actively participate in university life; find connection, community, and friendship; encounter new ways of thinking and being in the world; and experience leadership, independence, and success.

Student Services and Resources

Academic Success Centre

www.asc.utoronto.ca

The Academic Success Centre is dedicated to ensuring you achieve your highest possible learning potential. Through lectures, workshops, groups, counselling and online assistance, 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

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

Accessibility Services
Robarts Library
455 Spadina Avenue, Suite 400
416-978-8060
TTY: 416-978-1902
Fax: 416-978-8246
disability.services@utoronto.ca
www.accessibility.utoronto.ca

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

Health and Wellness Centre
The new Health & Wellness Centre began offering University of Toronto students a single point of entry for access to all services previously offered through Health Services and Counselling and Psychological Services (CAPS). Feedback from students over the years and best clinical practices have prompted us to rethink the way health and mental health services are provided at the St. George campus.

All students needing physical or mental health care, travel medicine, immunizations, nutritional care, family planning or gynecological care, first aid and other services will find referrals in one space–staying on track with their current health care plan and getting new services that meet their needs.

Health and Wellness Centre
Koffler Student Services Centre
214 College Street
416-978-8070
www.studentlife.utoronto.ca/hwc

Centre for Community Partnerships
A resource for all three U of T campuses, 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.studentlife.utoronto.ca/ccp

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
North Borden Building
563 Spadina Avenue, Third Floor
416-978-8227
fnh.info@utoronto.ca
www.studentlife.utoronto.ca/fnh

Hart House
Hart House is the co-curricular centre of the University of Toronto: a place that welcomes both campus and community to explore cultural, intellectual and recreational activities. Aside from a wide array of events, lectures, live music and performances, Hart House offers classes for every interest from filmmaking and acting to archery and dance.

Open 365 days a year, our facilities include a range of impressive rooms for study, dining, recreation and socializing, a modern athletics and aquatics facility, a satellite farm location, the acclaimed Justina M. Barnicke Art Gallery, a dynamic theatre, complete wedding, meeting and event services as well as the top-rated Gallery Grill restaurant all housed within a stunning, neo-Gothic building.

Hart House
7 Hart House Circle
416-978-2452
www.harthouse.ca

Centre for International Experience (CIE)
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 pan (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 (CIE)
33 St. George Street
416-978-2564
cie.reception@utoronto.ca
www.studentlife.utoronto.ca/cie

Multi-Faith Centre
The Multi-Faith Centre exists to support the spiritual well-being of students, staff and faculty and to increase their 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.studentlife.utoronto.ca/mf

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
http://www.studentlife.utoronto.ca/hs

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:
-Office of Student Academic Integrity (OSAI)
-Antiracism and Cultural Diversity Office
-Campus Community Police
-Centre for International Experience (CIE)
-Equity @ U of T
-Family Care Office
-Freedom of Information & Protection of Privacy Office
-Information Commons
-Report Homophobia
-Sexual & Gender Diversity Office
-Sexual Harassment Office
-Summer Abroad
-University Ombudsperson
-Safety on Campus

ACADEMIC INTEGRITY, RESOURCES FOR STUDENTS

Centre for Teaching Support & Innovation

www.teaching.utoronto.ca
ctsi.teaching@utoronto.ca

All institutions of higher learning place a strong emphasis on integrity in both their teaching and research. This certainly holds true for the University of Toronto, which is governed by both a Code of Student Conduct and 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

www.antiracism.utoronto.ca
215 Huron Street, Room 603B
University of Toronto
Toronto, ON M5S 1A2

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; it 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

www.campuspolice.utoronto.ca
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

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.

CO-OP JAPAN PROGRAM

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.

EQ_ITY @ U OF T – WE NEED YOU IN IT!

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

www.familycare.utoronto.ca
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.fippa.utoronto.ca

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 (UTmail+) and general Internet access (browsers, wireless, UTORid password changes, etc.).

Student Services and Resources

Free AntiVirus Software Available! Antivirus software is available for free for all students, faculty and staff at U of T: www.antivirus.utoronto.ca.

INTERNATIONAL STUDENT EXCHANGES

www.cie.utoronto.ca
student.exchange@utoronto.ca

Cumberland House
Global Lounge, 33 St. George Street
416-978-1800

If you wish to study abroad during the academic year, you should visit the Global Lounge at the Centre for International Experience. The assistants in the Lounge can give you information and advice about the Student Exchange Program which organizes international and Canadian exchanges, and summer research opportunities 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 academic credit and an understanding of different cultures, heritages, values and lifestyles found across borders. While studying on exchange at a host university, 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 between December and February, depending on the program you choose. For more information please see the International Student Exchanges section in "Curriculums and Programs."

REPORT HOMOPHOBIA

http://sgdo.utoronto.ca/getting-help/anonymous-reporting/

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

www.sgdo.utoronto.ca
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 that 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. Confidential services are provided to those who have questions or concerns, educational needs, or are experiencing problems related to heterosexism or homophobia.

SEXUAL HARASSMENT OFFICE

www.sho.utoronto.ca

40 Sussex Avenue, 3rd floor
Telephone: 416-978-3908
Fax: 416-971-2289
Hours: Monday –Friday, 9:00 a.m. to 4:00 p.m.

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

www.status-women.utoronto.ca

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

SUMMER ABROAD PROGRAMS

www.summerabroad.utoronto.ca
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 a possible elective.

OFFICE OF THE UNIVERSITY OMBUDSPERSON

www.utoronto.ca/ombudsperson

McMurrich Building, Room 102, 12 Queen's Park Cres. West
Telephone: 416-978-4874
ombuds.person@utoronto.ca

As part of the University's commitment to ensure 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. The services of the Office are available by appointment at all three U of T campuses.

WALK-SMART

www.campuspolice.utoronto.ca/safety/walkSmart.htm

Telephone: 416-978-7233 (SAFE)

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 to Friday, 7:00 p.m. to 12:00 a.m. from September to April.

STUDENT ORGANIZATIONS

ENGINEERING SOCIETY

www.skule.ca

Sandford Fleming, B740, 10 King's College Rd.

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

skule.ca/clubs

ASSOCIATION OF PART-TIME UNDERGRADUATE STUDENTS (APUS)

www.apus.utoronto.ca

Student Services and Resources

All part-time undergraduate students on all three campuses of the University of Toronto are members of the Association of Part-time Undergraduate Students (APUS). The mission of 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 cannot 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 counsellor/advisor or the Associate Chair of 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 published deadline (see "Sessional Dates" listing at the beginning of the Calendar) with approval from their department's undergraduate counsellor/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 waste 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 an 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 below 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.

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

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 without academic penalty from a course caused by circumstances beyond the student's control.

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. Refer to section VII., 9. Promotion Regulations.

• 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/Governing_Council/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
-University Assessment and Grading Practices Policy
-Policy on Official Correspondence with Students

More information about students' rights and responsibilities can be found at: 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. Where ever in this Code an offence is describe 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.

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 submitted 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 knowingly 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
v) 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 any defect or irregularity in such procedures, shall not invalidate any subsequent proceedings of or before the Tribunal, unless the chair of the hearing considers that such failure, defect or irregularity resulted in a substantial wrong, detriment or prejudice to the accused. The chair will determine at the opening of the hearing whether there is going to be any objection to defect, failure or irregularity.
k) No degree, diploma or certificate of the University shall be conferred or awarded, nor shall a student be allowed to withdraw from a course from the time of the alleged offence until the final disposition of the accusation. However, a student shall be permitted to use University facilities while a decision is pending, unless there are valid reasons for the Dean to bar him or her from a facility. When or at any time after an accusation has been reported to the Dean, he or she may cause a notation to be recorded on the accusation, to indicate that the standing in a course and/or the student's academic status is under review. A student upon whom a sanction has been imposed by the Dean or the department chair or who has been convicted by the Tribunal shall not be allowed to withdraw from a course so as to avoid the sanction imposed.
l) A record of cases disposed and of the sanctions imposed shall be kept in the academic unit concerned and may be referred to by the Dean in connection with a decision to prosecute, or by the prosecution in making representations as to the sanction or sanctions to be imposed by the Tribunal, for any subsequent offence committed by the student. Information on such cases shall be available to other academic units upon request and such cases shall be reported by the Dean to the Secretary of the Tribunal for use in the Provost's annual report to the Academic Board. The Dean may contact the Secretary of the Tribunal for advice or for information on cases disposed of by the Tribunal.
m) Where a proctor or invigilator, who is not a faculty member, has reason to believe that an academic offence has been committed by a student at an examination or test, the proctor or invigilator shall so inform the student's Dean or department chair, as the case may be, who shall proceed as if he or she were an instructor, by analogy to the other provisions of this section.
n) In the case of alleged offences not covered by the procedures above and not involving the submission of academic work, such as those concerning forgery or uttering, and in cases involving cancellation, recall or suspension of a degree, diploma or certificate, the procedure shall be regulated by analogy to the other procedures of this section.

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.
If the student does not admit guilt, or if the department chair chooses, the matter shall be brought before the Dean.
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 such 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 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. Full-time students may take a CS or HSS elective course in any term starting in the summer after their initial registration, and subject to the rule above.

Part-time students may take a CS or HSS elective course in any term. 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.

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) i) To obtain Honours upon graduation a full-time student must achieve a cumulative average across years 2, 3 and 4 of between 79.5% and 87.49% 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."
ii) To obtain High Honours upon graduation, a full-time student must achieve a cumulative average across years 2, 3 and 4 of 87.5% or higher, and a weighted sessional fourth-year average of 82.5% or higher, excluding any required first year courses, repeated courses or 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:

Full-time Students

A full-time student who has a non-repeated session with a weighted Session Average of 60% or greater while maintaining a minimum 1.5 cumulative GPA will have their status improved by one academic standing category. For example: a student who has an academic status of “Repeat Probation” after one session with a weighted Session Average of 60% or better and a CGPA of 1.5 will have a new academic status of “Proceeding On Probation.” Note: full time session means four or more HCEss.

Part-time Students

Students who are in part-time studies will have probation status improved by one academic standing category after having completed the minimum number of sessions to have grades registered in four or more non-repeated HCEs with a composite average of 60% or greater and a CGPA of 1.5.

Upon Graduation

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.

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 except for students participating in the T-Program.

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 & 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 through 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

9. Designating credit courses as extra

With the approval of their department's undergraduate academic counsellor or Chair's designate for undergraduate studies, a student may elect to take an extra course. These courses cannot be used for degree program credit. Their marks are shown on the transcript but not included in the calculation of sessional averages. Any course taken by a student in a degree program that is not listed in the curriculum requirements for that program in the "Curriculum and Programs" section of the academic calendar will be designated as "EXT." This includes courses taken for interest or additional elective courses beyond what is prescribed in a program's curriculum.

The deadline for requesting any credit course be changed to an extra course is the same as that for dropping a course. The deadline for requesting an extra course be changed to a credit course (if applicable) is the same as that for adding a course.

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*

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).

*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.

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.

First Year Fall session - 1F Newly Admitted First Year Students

	Session Average				
Status at Start of Session	0	45%	50%	55%	60%
Clear	**Repeat Probation** Failed-May apply for re-admission	**Probation** Withdraw for 8 months and repeat 1F Session	**Probation** Proceed to 1W in T-Program or withdraw for 8 months and repeat 1F*	**Probation** Proceed to 1W on Probation, or T-Program or withdraw for 8 months and repeat 1F	**Clear** May Proceed-Pass or Honours

* 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

	Session Average		
Status at Start of Session	0	55%	60%
Clear	**Repeat Probation** Failed-Must withdraw for 8 months. Upon return, must repeat session	**Probation** Proceed on Probation	**Clear** May Proceed Pass or Honours
Probation	**Repeat Probation** Failed-Must withdraw for 8 months. Upon return, must repeat session		**Probation** Proceed on Probation
Repeat Probation	**Refused Further Registration** Failed - Not eligible to continue in the Faculty of Applied Science & Engineering		**Repeat Probation** Proceed on Repeat Probation

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

T-Program Winter Session - 1W

	Session Average	
Status at Start of Session	0	60%
On Probation in the T-Program	**Repeat Probation** Failed - May apply for re-admission	**Probation in the T-Program** Pass - May proceed to Summer Session on Probation in the T-Program*

*Condition: No repeated course may have a final mark less than 50%

T-Program Summer Session

	Session Average	
Status at Start of Session	0	60%

On Probation in the T-Program	**Repeat Probation** Failed - Must withdraw for 6 months. Upon return must repeat regular 1W.	**Probation** Pass - May proceed to 2nd year on Probation

*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

	Session Average			
Status at Start of Session	0	45%	55%	60%
Clear	**Repeat Probation** Failed - May apply for re-admission in a program with space	**Probation** Enrol in the T-Program or withdraw and repeat 1F - in a program with space	**Clear** Remain in Engineering Science or Transfer to another Engineering program*	**Clear** May Proceed - Pass, Honours or Transfer to any Program

*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

First Year Engineering Science Winter Session - 1W

	Session Average			
Status at Start of Session	0	50%	55%	65%
Clear	**Repeat Probation** Failed - Repeat session 1W immediately in a program with space (not Engineering Science or Track One)	**Probation** Transfer to a program with space on probation	**Clear** Transfer to another Engineering Program	**Clear** May Proceed-Pass or Honours-May remain in Engineering Science or Transfer to any program

*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

	Session Average		
Status at Start of Session	0	55%	60%
Clear	**Repeat Probation** Repeat session immediately when next offered	**Probation** Proceed on probation	**Clear** May proceed-Pass or Honours
Probation	**Repeat Probation** Failed-Repeat session immediately when next offered		**Probation** Proceed on Probation
Repeat Probation	**Refused Further Registration** Failed - Not eligible to continue in the Faculty of Applied Science & Engineering		**Repeat Probation** Proceed on Repeat Probation

Any Repeated Session

	Session Average	
Status at Start of Session	0	60%

Clear	**Refused Further Registration** Failed - Not eligible to continue in the Faculty of Applied Science & Engineering	**Clear** May Proceed
Probation	**Refused Further Registration** Failed - Not eligible to continue in the Faculty of Applied Science & Engineering	**Probation** Proceed on Probation
Repeat Probation	**Refused Further Registration** Failed - Not eligible to continue in the Faculty of Applied Science & Engineering	**Repeat Probation** Proceed on Repeat Probation

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. Often, programs are 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 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 has achieved less than a 60% session average in either term (1F or 1W) but who is eligible to proceed to second year may apply to enrol 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 with personal or extra-curricular activities. 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.

iv) No electronic or mechanical computing devices will be permitted.

d) Bilingual dictionaries may be used under the following conditions by students who have language difficulties:

i) The dictionary shall be submitted by the student for inspection by the presiding examiner.

ii) The dictionary must not contain any material other than that which was originally printed in it.

iii) The dictionary must be bilingual, i.e. contain the English equivalents of foreign words and vice versa, but no other material.

e) All coats and jackets should be placed on the back of each candidate's chair. All notes and books, pencil cases, turned-off cell phones, laptops, purses, and other unauthorized aids should be stored inside a candidate's knapsack or large bag, which should then be closed securely and placed under the candidate's chair. Candidates are required to place their watches or timepieces on the desk throughout the examination. Material placed on the desk may be inspected by invigilators. Candidates are NOT allowed to have a pencil case on their desk and any pencil cases found on desks will be searched. Candidates are not allowed to touch their knapsack or bag or the contents therein until the exam is over. Candidates are not allowed to reach into the pockets or any part of their coat or jacket until the exam is over.

f) For those examinations marked C in the timetable, a single aid-sheet may be prepared and taken by the candidate to the examination for his or her personal use only. This aid-sheet is a standardized form that must be downloaded from the Faculty website. Students must print the form onto an 8.5" x 11" piece of paper and print and sign their names in the places provided. Both sides of the sheet may be used.

g) For those examinations marked D in the timetable, a candidate may bring to the examination and use such books, notes, or other printed or written material as may be specified by the examiner.

h) For those examinations marked X in the timetable, a candidate may bring to the examination and use any books, notes, or other printed or written material.

3. Beginning the Examination

a) Only those candidates who are there to write the examination will be allowed in the room during the examination.

b) Candidates will be admitted to the examination room two minutes before the hour appointed for the examination. They shall proceed quietly to their desks, where they will find all necessary material for the examination, except authorized aids which may be brought into the room. (See 2 above.)

If the examiner considers it necessary, candidates may find on their desks with the examination paper special data such as log books, tabular data, curves or plans. Such special data are not to be written upon or marked in any way, and are to be returned with the answer books.

c) At the beginning of the examination period, answer books must be endorsed as follows: name and student number of the candidate, Faculty, course, instructor, date and room number. If more than one answer book is required, each must be endorsed when received and the books marked, "Book 1", "Book 2", and so on. The extra books are to be placed inside Book 1 when the candidate is through writing.

d) A candidate will not be permitted to leave the room during the first sixty minutes, nor to enter the room after that period. A candidate who arrives more than sixty minutes late will have to petition the Committee on Examinations for special consideration.

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 Faculty of Applied Science & 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 Examinations 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.

e) 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.

f) 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.

g) Each instructor must specify on session test and final examination papers the type of calculator permitted (see X (2) (c) above).

h) 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.

i) 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, downloaded from the Faculty's website, printed on an 8.5"x11" piece of paper. 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.

Type D Papers for which the candidate may bring to the examination and use such aids (in the form of printed or written material) as the examiner may specify. The nature of the permitted aids must be clearly specified at the top of the examination paper, and must be announced to the class by the examiner in advance of the examination.

Type X Papers for which the candidate may bring to the examination and use, any books, notes or other printed or written material, without restriction.

j) Any variation from the normal Faculty examination procedures (e.g. take-home examinations, pre-distribution of examination questions, zero-weight, low-weight, or no examinations in lecture courses, oral examinations, confidential examinations, multiple examinations in multi-section courses, examinations which are not of the standard 2.50-hour duration) requires on an annual basis the prior approval of the Committee on Examinations. Requests for approval of special examination arrangements should be made as early as possible in the session, and announcement to the class may not be made until the approval of the Committee on Examinations is obtained.

k) Normally multiple-choice questions are not used in final examinations conducted in the Faculty. In any event the Committee on Examinations must give its prior approval if the value of multiple choice questions exceed 25% of the total marks for any examination.

l) Group Evaluation

(i) In situations where a student's performance is evaluated by a student peer group, the results of such evaluation shall not constitute more than 25% of the final course mark.

(ii) In courses in which group work or group assignments are performed, the proportion of a student's final mark derived from undiscriminated evaluation of such group work or submission shall not exceed 25%, unless the Committee on Examinations has granted approval for a higher weighting of the undiscriminated group component. When such approval has been granted it shall remain in force so long as there is no change in the circumstances on which the original application was based or until the instructor requests approval for the arrangements.

m) Under no circumstances will students be permitted to evaluate their own work for credit in a course.

6. Instructors are responsible for the grading of the final exam and are expected to exercise their best judgment in assessing answers to examination questions and in determining final course marks. Any assessment of the performance of students is not to be based on any system of quotas or predetermined arbitrary limits.

7. a) Instructors shall submit their final course marks to the Committee on Examinations via the Registrar of the Faculty in conformity with a prescribed deadline.

b) The Chair of each department or division of the Faculty may elect to appoint a departmental marks review committee, to review results in courses offered by the department. If such a marks review procedure is carried out, instructors, after having submitting their marks to the Registrar of the Faculty, shall also report their results to the departmental committee. The departmental marks review committees are not authorized to make recommendations directly to instructors but may make recommendations to the Faculty's Committee on Examinations.

c) A student's final course mark is unofficial until approved by the Committee on Examinations.

The full text of the University Assessment and Grading Practices Policy is available at the following link: www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/grading.pdf

XII. PETITIONS AND APPEALS

I. Petitions

1. Petition forms are available on the Undergraduate Engineering website: uoft.me/petitions

There are three types of petitions:

i) Petition for Consideration in Course Work

A student who is unavoidably absent during the term and consequently misses any graded work should submit a term-work petition through the Engineering Portal within one week of the graded work. The petition must be accompanied by appropriate documentation.

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.

iii) Petition for Special Consideration

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.

II. Appeals

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 that 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. 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, free and complementary studies. 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 requires students build 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.

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. Introduction to the methodologies and thought process of the humanities and social sciences
2. Basic knowledge of engineering economics
3. Competence in oral and written communications,
4. 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: uoft.me/electives.

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 (including, but not limited to astronomy, physics, chemistry, biology, zoology, computer science and psychology). A course must be pre-approved as HSS-eligible by the Faculty before a student may enrol.

The HSS courses that are available to students are listed online at uoft.me/hss,

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 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, ECE472H1 F/S and 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 APS111H1 F and APS112H1 S Engineering Strategies & Practice I and II are required for all programs except Engineering Science, for which ESC101H1 F and ESC102H1 S, 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 who wish to take a course from an institution not listed 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 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 Office of the Registrar, located within the Galbraith building at 35 St. George Street (room 157). 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 $35 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.

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 4-month 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

ENGINEERING SUMMER INTERNSHIP PROGRAM (eSIP)

engineeringcareers.utoronto.ca/students/undergraduate-internship/esip/

222 College Street, Suite 106
416-946-3730
career@ecf.utoronto.ca

The Engineering Summer Internship Program (eSIP) is a paid summer co-op program offered through the Engineering Career Centre. It is available to eligible engineering students in year two or three of study, including engineering international students. eSIP is more akin to a traditional co-op placement, where students work for four months and thus serves as an introductory career development program for participants. 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 two 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.

PROFESSIONAL EXPERIENCE YEAR (PEY) INTERNSHIP PROGRAM

www.engineeringcareers.utoronto.ca

222 College Street, Suite 106

416-978-3881
pey@ecf.utoronto.ca

The Professional Experience Year (PEY) Internship Program offered through the Engineering Career Centre (ECC) allows students to apply their engineering knowledge to 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 prior to graduation.

The PEY internship program is more than 30-years old and has earned an outstanding reputation in both academic and industry circles. The program offers students an exceptional education, a range of engineering related career paths to choose from and strong, established industry partnerships. It also provides a strong practical foundation for individuals interested in completing graduate studies.

Students from a wide range of faculties and departments—Engineering, Computer Science, Mathematics, Toxicology, Pharmaceutical Chemistry, Commerce, and other Arts & Science programs—participate in PEY. Students register for the program in their second or third year of study and complete their internship during the following academic year. Almost 900 students are in placements at over 280 companies for the current PEY 2014-2015 internship year. Some of our past out-of-province and international placement locations include Alberta, British Columbia, Newfoundland, Belgium, Chile, India, Japan, Taiwan, Switzerland, United States, China, Hong Kong, Finland, Singapore, UK and Indonesia. The average internship salary for 2013-2014 was $46,200.

ENGINEERING COMMUNICATION PROGRAM

Director: Deborah Tihanyi

The Engineering Communication Program's mission is to help students recognize the role of communication in effective engineering. We create practices, programs and partnerships that enable students to become more confident and effective communicators, and thus, better engineers. We collaborate with students, faculty and industry to develop discipline-specific communication instruction that is integrated into the engineering curriculum and delivered through the Program's own credit and non-credit courses. The Engineering Communication Program also offers students one-to-one (or one-to-team) tutoring—both in person and online—to help develop ideas and improve communication skills.

THE JEFFREY SKOLL BASC/MBA PROGRAM (SKOLL PROGRAM)

The Jeffrey Skoll BASc/MBA program provides University of Toronto engineering students with the opportunity to pursue a Master of Business Administration (MBA) degree at the Rotman School of Management immediately after completion of their BASc. This program is unique in Canada. Students admitted into the program will be considered for a Skoll scholarship to partially offset the Rotman MBA tuition.

Why combine engineering and business? Today's engineers are often team leaders, project managers, company directors and entrepreneurs, and make a significant impact in the business world. The Skoll BASc/MBA program offers select students the opportunity to earn both technical and management qualifications, to become the next generation of leaders in business and industry.

How does the Skoll Program work? Students interested in the Skoll program must complete a Professional Experience Year (PEY) internship of at least 12 months during their BASc program. Students apply to the Rotman MBA program during their fourth year of Engineering studies. If offered admission into Rotman, students will then be considered for a Skoll scholarship. Students then continue on to finish their BASc, and in September of the same year, enter the Rotman MBA program.

How to apply? Only fourth-year Engineering students who have completed a PEY internship can apply to the Skoll program. Students apply directly to Rotman. Please visit the Skoll Program website for admission requirements and instructions. The annual deadline for applying is February 1.

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 enrol 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 Student Exchange Program offers students a variety of opportunities to study at partner institutions while gaining an understanding of different cultures, heritages, 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 to 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 deadlines occur between December and February each year, depending on your program of choice.

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. Many students follow non-structured exchange pathways to pursue minors in Arts & Science disciplines. See "Self-Initiated Minors" for more details.

CIE also offers two- to four-month international summer research opportunities for qualified students.

Funding is available on a needs basis for international opportunities. Select partner institutions offer guaranteed bursaries to students. Additional information is available through the CIE office. Detailed information about the exchange pathways can be found online.

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
University of Western Australia

Austria
University of Graz

Barbados
University of the West Indies (Cave Hill)

Brazil
Universidade Estadual Paulista Júlio de Mesquita Filho (UNESP)
University of Sao Paulo

Canada
McGill University
University of British Columbia

China
Beihang University
Chinese University of Hong Kong
Fudan University
Hong Kong University of Science & Technology
Peking University
Shanghai Jiao Tong University
Tianjin University
Tsinghua University
University of Hong Kong

The Czech Repbulic
Masaryk University

Denmark
University of Aarhus

England
Herstmonceux Castle (CUSAP)
King's College, London
Lancaster 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
French Institute for Advanced Mechanics (Cleront-Ferrand)
Lumiere University (Lyons II)
Lyons III Universite Jean Moulin
Paris I - Universite Pantheon Sorbonne
Paris II - Universite Pantheon Assas
Paris III - Universite Sorbonne Nouvelle
Paris IX - Paris Dauphine Sciences Po, Paris

Germany
DAAD Scholarship Program
Goethe University of Frankfurt
Humboldt University at Berlin
University of Bonn
University of Konstanz
University of Mannheim
University of Stuttgart
University of Ulm

India
India Institute of Technology, Kanpur
Indian Institute of Technology, Bombay

Ireland
Trinity College, Dublin

Israel
Hebrew University of Jerusalem
Technion-Israel Institute of Technology

Italy
University of Siena
University of Pavia (civil engineering graduate students)

Jamaica
University of the West Indies (Mona)

Japan
Chiba Institute of Technology
Hiroshima University
Keio University
Kyoto University
Nagoya University
Nihon University
Osaka University
University of Tokyo
Waseda University

Korea (South)
Korea University
Korean Advanced Institute of Science and Technology
Seoul National University
Yonsei University

Mexico
Technical University of Monterrey (NARETI)
University of Guadalajara (NARETI)

Netherlands
Delft University of Technology
University of Amsterdam

New Zealand
University of Auckland
University of Otago

Norway
University of Oslo

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

Thailand
King Mongkut's University of Technology Thonburi

Trinidad and Tobago
University of the West Indies (St. Augustine)

United States of America
Killam Fellowships Program
Marquette University (NARETI)
University of Illinois at Chicago (NARETI)

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.

POST CODE	DEGREE	PROGRAM
AE NDEG		Non-Degree Special Student
AEENGBASC		Track One - General Engineering
AECHEBASC	BASc	Chemical Engineering
AECIVBASC	BASc	Civil Engineering
AECPEBASC	BASc	Computer Engineering
AEELEBASC	BASc	Electrical Engineering
AEESCBASE	BASc in Eng.Sci	Engineering Science
AEESCBASEA	BASc in Eng.Sci	Engineering Science (Aerospace Engineering Option)
AEESCBASEF	BASc in Eng.Sci	Engineering Science (Engineering Mathematics, Statistics and Finance)
AEESCBASEI	BASc in Eng.Sci	Engineering Science (Infrastructure Engineering)
AEESCBASEJ	BASc in Eng.Sci	Engineering Science (Energy Systems Option)
AEESCBASEO	BASc in Eng.Sci	Engineering Science (Nanoengineering)
AEESCBASEP	BASc in Eng.Sci	Engineering Science (Physics)
AEESCBASER	BASc in Eng.Sci	Engineering Science (Electrical and Computer)
AEESCBASET	BASc in Eng.Sci	Engineering Science (Biomedical Systems Option)
AEESCBASEZ	BASc in Eng.Sci	Engineering Science (Robotics Engineering)
AEINDBASC	BASc	Industrial Engineering
AELMEBASC	BASc	Lassonde Mineral Engineering
AEMECBASC	BASc	Mechanical Engineering
AEMMSBASC	BASc	Materials Engineering
AEMINBIO		Minor in Biogengineering
AEMINBME		Minor in Biomedical Engineering
AEMINBUS		Minor in Engineering Business
AEMINENV		Minor in Environmental Engineering
AEMINENR		Minor in Sustainable Energy
AEMINNANO		Minor in Nanoengineering
AEMINRAM		Minor in Robotics and Mechatronics
AECERBUS		Certificate in Engineering Business
AECERCOM		Certificate in Communication
AECERENTR		Certificate in Entrepreneurship
AECERGLOB		Certificate in Global Engineering
AECERLEAD		Certificate in Engineering Leadership
AECERMINR		Certificate in Mineral Resources
AECERNUC		Certificate in Nuclear Engineering
AECERRRE		Certificate in Renewable Resources

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. No course that is counted for degree credit can be counted towards more than one minor or certificate;
4. 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;
5. 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;
6. Students must secure approval from their home department before selecting any elective outside their home department.

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 OR BME205H1**

2. One of:

i) CHE354H1 OR BME395H1**, or
ii) MIE331H1 OR BME350H1**

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) electives 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		Lect.	Lab.	Tut.	Wgt.
Core Requirement Courses					
Biomedical Systems Engineering I: Organ Systems	BME350H1 F	3	1	2	0.50
Engineering Biology	CHE353H1 F	2	-	2	0.50
Introductory Courses					
Biomedical Engineering Technology and Investigation	BME440H1 F	2	4	-	0.50
Water and Wastewater Treatment Processes	CIV342H1 F	3	1	1	0.50
General &Human Genetics	HMB265H1 F	2	-	1	0.50
History of Medicine I	HPS318H1 F	-	-	-	0.50
Psychology For Engineers	MIE242H1 F	3	3	-	0.50
Industrial Ergonomics and the Workplace	MIE343H1 F	3	3	-	0.50
Discovering Wood and its Role in Societal Development	FOR308H1 F	3	-	1	0.50
Human Physiology I	PSL300H1 F	3	-	1	0.50

Courses Offered in the Winter		Lect.	Lab.	Tut.	Wgt.
Core Requirement Courses					
Biomolecules and Cells	BME205H1 S	2	1.50	1	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50
Introductory Courses					
Biostatistics for Engineers	BME225H1 S	3	-	1	0.50
Introduction to Fundamental Genetics and its Applications	HMB201H1 S	2	-	1	0.50
History of Medicine II	HPS319H1 S	-	-	-	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50
Biomechanics I	MIE439H1 S	3	2	-	0.50
Introduction to Pharmacology and Pharmacokinetic Principles	PCL201H1 S	3	-	1	0.50
Bioethics (formerly PHL281Y1)	PHL281H1 S	-	-	-	0.50
Biomaterials and Biocompatibility	MSE352H1 S	3	-	1	0.50

Minor in Bioengineering (continued)

Minor in Bioengineering (continued)		Lect.	Lab.	Tut.	Wgt.
Advanced Courses					
Bioinformatics	BCH441H1 F	2	-	1	0.50
Biomedical Systems Engineering II: Cells and Tissues	BME395H1 F	2	1	2	0.50
Cellular and Molecular Bioengineering II	BME455H1 F	3	1.50	1	0.50
Bioprocess Technology and Design	CHE450H1 F	3	0.66	1	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	3	-	-	0.50
Environmental Biotechnology	CIV541H1 F	3	-	-	0.50
Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Sensory Communication	ECE446H1 F	3	1.50	1	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50
Green Urban Infrastructure: Sustainable City Forests	FOR421H1 F	2	-	-	0.50
The Immune System and Infectious Disease	IMM250H1 F	-	-	-	0.50
Microbiology I: Bacteria	MGY377H1 F	3	-	-	0.50
Biotransport Phenomena	MIE520H1 F	3	-	1	0.50
Engineering Psychology and Human Performance	MIE523H1 F	3	3	-	0.50
Biomaterial Processing and Properties	MSE440H1 F	3	-	1	0.50
Pharmacodynamic Principles	PCL302H1 F	3	-	-	0.50

Minor in Bioengineering (continued)		Lect.	Lab.	Tut.	Wgt.
Advanced Courses					
Computational Systems Biology	BCB420H1 S	2	-	2	0.50
Medical Imaging	BME595H1 S	2	3	1	0.50
Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Food Engineering	CHE462H1 S	3	-	1	0.50
Modelling in Biological and Chemical Systems	CHE471H1 S	3	-	1	0.50
Biocomposites: Mechanics and Bioinspiration	CHE475H1 S	3	-	1	0.50
Pulp and Paper Processes	CHE564H1 S	3	-	1	0.50
Organic Materials Chemistry	CHM446H1 S	2	-	-	0.50
Innovation and Manufacturing of Sustainable Materials	FOR424H1 S	2	-	1	0.50
Bioenergy and Biorefinery Technology	FOR425H1 S	2	-	2	0.50
The Immune System and Infectious Disease	IMM250H1 S	-	-	-	0.50
Healthcare Systems	MIE561H1 S	3	-	2	0.50
Surgical and Dental Implant Design	MSE442H1 S	3	-	1	0.50

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, BME350H1, BME395H1 and MSE352H1 are only open to Engineering Science Students.

MINOR IN BIOMEDICAL ENGINEERING (AEMINBME)

Specifically designed for undergraduate engineering students interested in applying their engineering knowledge to applications in health care, the Biomedical Engineering Minor is a specialized program that emphasizes opportunities in fields ranging from medical technology innovation, medical diagnostics, health care delivery, pharmaceutical and therapeutic technologies, health regulatory and policy development, medical diagnostic technologies, to biomedical devices and bioinformatics. The Biomedical Engineering Minor will prepare students for direct entry into the applied biomedical engineering industry with a particular specialization in biomedical technology innovation. Students who successfully complete the Biomedical Engineering Minor will be trained and specialize in areas of bioinstrumentation, biostatistics, biomedical laboratory techniques, biological and biomedical imaging, biomaterials development and processing, biomechanics and rehabilitation technologies, biosystems and quantitative physiology, and cellular, tissue and molecular engineering. To help select complementary BME courses that are best aligned with their career objectives, students are provided with a faculty mentor upon registration in the Minor and are encouraged to attend the co-curricular Biomedical Engineering Seminar Series. All Engineering undergraduates starting from Year 1 through to degree completion are eligible to pursue the Biomedical Engineering Minor, with the exception of students in the Engineering Science Biomedical Systems Engineering Option.

The requirements for a Bioengineering Minor in the Faculty of Applied Science and Engineering are the successful completion of the following:

1. CHE353H1 - Engineering Biology
2. MIE331H1 - Physiological Control Systems
3. BME440H1 - Biomedical Engineering Technology and Investigation
4. MIE439H1 - Biomechanics
5. One (1) of the following fourth year courses:
   i. BME499Y1 - Applied Research in Biomedical Engineering
   ii. BME498Y1 - Biomedical Engineering Capstone Design

Notes:

- Entry into BME498Y1 or BME499Y1 requires permission from the Associate Director of Undergraduate Studies.
- A Biomedical Engineering Minor student may take both courses (BME499Y1, BME498Y1) but only one may count towards the minor.
- For those Engineering Science students who transferred into another program, BME205H1 can replace CHE353H1 and is an eligible pre-requisite for MIE331H1.

Minor in Biomedical Engineering

Courses Offered in the Fall		Lect.	Lab.	Tut.	Wgt.
Courses to be taken in Year Three					
Engineering Biology	CHE353H1 F	2	-	2	0.50
Courses to be taken in Year Four					
Biomedical Engineering Technology and Investigation	BME440H1 F	2	4	-	0.50
One (1) of the following:					
Biomedical Engineering Capstone Design	BME498Y1 Y	2	3	-	1.00
Applied Research in Biomedical Engineering	BME499Y1 Y	-	7	-	1.00

Courses Offered in the Winter		Lect.	Lab.	Tut.	Wgt.
Courses to be taken in Year Three					
Physiological Control Systems	MIE331H1 S	3	1	1	0.50
Courses to be taken in Year Four					
Biomechanics I	MIE439H1 S	3	2	-	0.50
One (1) of the following:					
Biomedical Engineering Capstone Design	BME498Y1 Y	2	3	-	1.00
Applied Research in Biomedical Engineering	BME499Y1 Y	-	7	-	1.00

Notes:

-The above is a recommendation of the scheduling of minor courses but may not fit into each departments academic scheduling for a student's major. It is recommended that students wishing to complete the Biomedical Engineering Minor visit the Biomedical Engineering Undergraduate Programs Office for assistance, or speak with their program advisor.

- A Biomedical Engineering Minor student may take both courses (BME498Y1, BME499Y1) but only one may count towards their minor.*

*Students from the department of Material Science Engineering cannot take both BME498Y1 and BME499Y1.

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, MIE358H1)

2. JRE300H1 - (CS Elecitve)

3. JRE410H1 - (CS Elective)

4. JRE420H1 - (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.

****NOTE**

Effective the summer term of 2014, GGR221H1 –New Economic Spaces is no longer an eligible elective for the Engineering Business Minor. If you took the course prior to the summer term of 2014, you may still request to count this towards your minor. If the course is taken after this time, it will not count towards the minor.

Minor in Engineering Business

Courses offered in the Fall		Lect.	Lab.	Tut.	Wgt.
Engineering Economics Course					
Engineering Economic Analysis	CHE249H1 F	3	-	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Engineering Economics and Decision Making	CME368H1 F	3	-	1	0.50
Engineering Economic Analysis &Entrepreneurship	ECE472H1 F	3	-	2	0.50
Engineering Economics and Accounting	MIE258H1 F	3	-	1	0.50
Required Courses					
Fundamentals of Accounting and Finance	JRE300H1 F/S	3	-	1	0.50
Markets and Competitive Strategy	JRE410H1 F/S	2	2	-	0.50
People Management and Organizational Behaviour	JRE420H1 F/S	3	1	-	0.50
Elective Courses					
Entrepreneurship and Small Business	APS234H1 F	4	-	1	0.50
Engineering Leadership	APS343H1 F	2	2	-	0.50
Positive Psychology for Engineers	APS444H1 F	3	-	-	0.50
The Power of Story: Discovering Your Leadership Narrative	APS445H1 F	2	-	1	0.50
Financial Engineering	APS502H1 F	3	-	-	0.50
Innovative Technologies and Organizations in Global Energy Systems	APS510H1 F	3	-	1	0.50
Entrepreneurship and Business for Engineers	ECE488H1 F	3	-	2	0.50
Introduction to Economics	ECO100Y1 Y	-	-	-	0.50
Discovering Wood and its Role in Societal Development	FOR308H1 F	3	-	1	0.50
Entrepreneurship and Business for Engineers	MIE488H1 F	3	-	2	0.50
Entrepreneurship and Business for Engineers	MSE488H1 F	3	-	2	0.50
Business Process Engineering	MIE354H1 F	3	2	-	0.50
Business Ethics	PHL295H1 F	-	-	-	0.50

Courses offered in the Winter		Lect.	Lab.	Tut.	Wgt.
Engineering Economics Course					
Engineering Economic Analysis &Entrepreneurship	ECE472H1 S	3	-	2	0.50
Required Courses					
Fundamentals of Accounting and Finance	JRE300H1 F/S	3	-	1	0.50
Markets and Competitive Strategy	JRE410H1 F/S	2	2	-	0.50
People Management and Organizational Behaviour	JRE420H1 F/S	3	1	-	0.50
Elective Courses					
Engineering Leadership	APS343H1 S	2	2	-	0.50
Entrepreneurship and Business Management	APS432H1 S	4	-	1	0.50
Cognitive and Psychological Foundations of Effective Leadership	APS442H1 S	3	-	-	0.50
Technology, Engineering and Global Development	APS420H1 S	3	-	-	0.50
Leadership in Project Management	APS446H1 S	3	-	-	0.50
Entrepreneurship and Business for Engineers	CHE488H1 S	3	-	2	0.50
Entrepreneurship and Business for Engineers	CIV488H1 S	3	-	2	0.50
Introduction to Economics	ECO100Y1 Y	-	-	-	0.50
Geography of Innovation	GGR251H1 S	-	-	-	0.50
Marketing Geography	GGR252H1 S	2	-	1	0.50
The Engineer in History	HPS283H1 S	2	-	1	0.50
Understanding Engineering Practice: From Design to Entrepreneurship	HPS321H1 S	2	-	-	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 development. This includes energy use and production for transportation, for space cooling and heating demands, and electrical production (from both alternative and conventional sources), energy distribution and storage, and extends to energy conservation, price, greenhouse gas production 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

2. One of:
i) APS305H1
ii) ENV350H1

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) electives 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 Sustainable Energy

Courses offered in the Fall		Lect.	Lab.	Tut.	Wgt.
Core Requirement Courses					
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50
Energy Policy and Environment	ENV350H1 F	-	-	-	0.50
Introductory Courses					
Technology in Society and the Biosphere I	APS301H1 F	3	-	1	0.50
Thermodynamics and Heat Transfer	CHE260H1 F	3	0.50	1	0.50
Engineering Thermodynamics	CHE323H1 F	3	-	2	0.50
Environmental Engineering	CHE467H1 F	3	-	1	0.50
Building Science	CIV375H1 F	3	0.33	2	0.50
Fundamentals of Electrical Energy Systems	ECE314H1 F	3	1.50	1	0.50
Introduction to Energy Systems	ECE349H1 F	3	1.50	1	0.50
Efficient Use of Energy (formerly JGE347H1)	GGR347H1 F	2	-	1	0.50
Advanced Courses					
Introduction to Fusion Energy	AER507H1 F	3	-	1	0.50
Innovative Technologies and Organizations in Global Energy Systems	APS510H1 F	3	-	1	0.50
Petroleum Processing	CHE451H1 F	3	-	-	0.50
Elements of Nuclear Engineering	CHE566H1 F	3	-	1	0.50
Transport Planning	CIV531H1 F	3	-	1	0.50
Introduction to Lighting Systems	ECE510H1 F	3	-	2	0.50
Power Electronics: Converter Topologies	ECE514H1 F	3	1.50	1	0.50
Nuclear Reactor Theory and Design	MIE407H1 F	3	-	2	0.50
Alternative Energy Systems	MIE515H1 F	3	-	1	0.50
Combustion and Fuels	MIE516H1 F	3	-	1	0.50
Extractive Metallurgy	MSE404H1 F	3	-	2	0.50

Courses Offered in the Winter		Lect.	Lab.	Tut.	Wgt.
Core Requirement Courses					
Terrestrial Energy Systems	CIV300H1 S	3	-	2	0.50
Energy Policy	APS305H1 S	3	-	1	0.50
Introductory Courses					
Environmental Pathways and Impact Assessment	CHE460H1 S	3	-	2	0.50
Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Bioenergy from Sustainable Forest Management	FOR310H1 S	2	-	1	0.50
Carbon-Free Energy (formerly JGE348H1)	GGR348H1 S	2	-	1	0.50
Thermal Energy Conversion	MIE311H1 S	3	3	-	0.50
Heat and Mass Transfer	MIE313H1 S	3	1.50	2	0.50
Materials Processing and Sustainable Development	MSE355H1 S	2	-	1	0.25
Physics of the Earth (Formerly PHY395H1)	JPE395H1 S	-	-	-	0.50
Advanced Courses					
Appropriate Technology &Design for Global Development	APS530H1 S	3	-	-	0.50
Fuel Cells and Electrochemical Conversion Devices	CHE469H1 S	3	-	1	0.50
Nuclear Engineering	CHE568H1 S	3	-	1	0.50
Sustainable Buildings	CIV576H1 S	3	-	1	0.50
Infrastructure for Sustainable Cities	CIV577H1 S	3	-	1	0.50
Energy Systems and Distributed Generation	ECE413H1 S	3	1.50	1	0.50
Electric Drives	ECE463H1 S	3	1.50	1	0.50
Power Electronics: Switch-Mode Power Supplies	ECE533H1 S	3	1	1	0.50
Bioenergy and Biorefinery Technology	FOR425H1 S	2	-	2	0.50
* Thermal and Machine Design of Nuclear Power Reactors	MIE408H1 S	3	-	2	0.50
Fuel Cell Systems	MIE517H1 S	3	-	1	0.50
Energy Management in Materials Processing	MSE408H1 S	3	-	1	0.50
Nanotechnology in Alternate Energy Systems	MSE458H1 S	3	-	2	0.50

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.

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. One (1) courses from the following:
1. APS301H1
2. ESC203H1
3. ENV221H1
4. GGR223H1

2. One (1) courses from the following:
1. CIV220H1

2. CIV440H1
3. CHE460H1
4. CHE467H1

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) electives 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.
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 Environmental Engineering 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 Environmental Engineering

Courses Offered in the Fall		Lect.	Lab.	Tut.	Wgt.
Core Requirement Courses					
Technology in Society and the Biosphere I	APS301H1 F	3	-	1	0.50
Environmental Engineering	CHE467H1 F	3	-	1	0.50
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50
Multidisciplinary Perspectives on Environment (formerly ENV222Y1)	ENV221H1 F	-	-	-	0.50
Engineering and Society	ESC203H1 F	2	-	2	0.50
Introductory Courses					
Chemistry of Environmental Change	CHM210H1 F	2	-	1	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50
Building Science	CIV375H1 F	3	0.33	2	0.50
Energy Policy and Environment	ENV350H1 F	-	-	-	0.50
Discovering Wood and its Role in Societal Development	FOR308H1 F	3	-	1	0.50
Advanced Courses					
Aqueous Process Engineering	CHE565H1 F	3	-	1	0.50
Transport Planning	CIV531H1 F	3	-	1	0.50
Environmental Biotechnology	CIV541H1 F	3	-	-	0.50
Groundwater Flow and Contamination	CIV549H1 F	3	-	1	0.50
Water Resources Engineering	CIV550H1 F	3	-	2	0.50
Studies in Building Science	CIV575H1 F	3	-	2	0.50
Green Urban Infrastructure: Sustainable City Forests	FOR421H1 F	2	-	-	0.50
Alternative Energy Systems	MIE515H1 F	3	-	1	0.50
Integrated Mine Waste Engineering	MIN511H1 F	3	-	1	0.50
Extractive Metallurgy	MSE404H1 F	3	-	2	0.50

Courses Offered in the Winter		Lect.	Lab.	Tut.	Wgt.
Core Requirement Courses					
Environmental Pathways and Impact Assessment	CHE460H1 S	3	-	2	0.50
Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Environment, Society and Resources (formerly GGR222H1)	GGR223H1 S	-	-	-	0.50
Introductory Courses					
Environmental Chemistry	CHE230H1 S	3	-	2	0.50
Environmental Chemistry	CHM310H1 S	2	-	-	0.50
Hydraulics and Hydrology	CIV250H1 S	3	1.50	1	0.50
Terrestrial Energy Systems	CIV300H1 S	3	-	2	0.50
Interdisciplinary Environmental Studies (formerly ENV222Y1)	ENV222H1 S	-	-	-	0.50
Design for the Environment	MIE315H1 S	3	-	1	0.50
Environmental Degradation of Materials	MSE315H1 S	3	-	2	0.50
Advanced Courses					
Technology in Society and the Biosphere II	APS302H1 S	3	-	1	0.50
Preventive Engineering and Social Development	APS304H1 S	3	-	1	0.50
Technology, Engineering and Global Development	APS420H1 S	3	-	-	0.50
Appropriate Technology &Design for Global Development	APS530H1 S	3	-	-	0.50
Modelling in Biological and Chemical Systems	CHE471H1 S	3	-	1	0.50
Pulp and Paper Processes	CHE564H1 S	3	-	1	0.50
Analytical Environmental Chemistry	CHM410H1 S	2	4	-	0.50
Topics in Atmospheric Chemistry	CHM415H1 S	2	-	-	0.50
Sustainable Buildings	CIV576H1 S	3	-	1	0.50
Infrastructure for Sustainable Cities	CIV577H1 S	3	-	1	0.50
Innovation and Manufacturing of Sustainable Materials	FOR424H1 S	2	-	1	0.50
Mining Environmental Management	MIN430H1 S	3	-	1	0.50

MINOR IN NANOENGINEERING (AEMINNANO)

Course Requirements for the Minor in Nanoengineering

Nanoengineering, and its underlying science and engineering skills, has now become embedded in academic and industrial sectors spanning the electronics industry, communications, sustainable and legacy energy, medical diagnostics and devices, micro electrical mechanical systems, and new materials for the automotive, aviation, and manufacturing sectors. The minor provides students with an understanding of both the structure and the application of nanomaterials and includes a range of electives connected to their core programs.

The requirements for the Minor in Nanoengineering in the Faculty of Applied Science and Engineering are the successful completion of the following courses:

1) Choose one (1) of:
- MSE219H1 –Structure and Characterization of Materials
- MSE358H1 –Structure and Characterization of Nanostructured Materials

2) ECE442H1 –Introduction to Micro- and Nano-Fabrication Technologies

3) Four (4) other electives from the list of Nanoengineering designated courses or departmental thesis and design courses 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 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) Advanced elective courses towards the 4 elective courses IF the Thesis or Design course is strongly related to environmental engineering. This requires approval by the Environmental Engineering Minor Director.
d. Some Departments may require students 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 Nanoengineering 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.

Introductory Courses

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Introduction to Electronic Devices	ECE335H1 F	3	-	2	0.50

Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Biomedical Engineering and Omics Technologies	BME346H1 S	2	4	-	0.50
Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50
Atoms, Molecules and Solids	PHY358H1 S	2	-	1	0.50

Advanced Courses

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Biomedical Engineering Technology and Investigation	BME440H1 F	2	4	-	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	3	-	-	0.50
Intermediate Inorganic Chemistry	CHM338H1 F	-	-	-	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50
Advanced Electronic Devices	ECE535H1 F	3	1.50	1	0.50
Electronic Materials	MSE430H1 F	2	-	1	0.50
Synthesis of Nanostructured Materials	MSE459H1 F	3	2	-	0.50
Advanced Physics Laboratory	PHY427H1 F	-	6	-	0.50
Quantum Mechanics II	PHY456H1 F	2	-	1	0.50
Laser Physics	PHY485H1 F	2	-	-	0.50
Condensed Matter Physics	PHY487H1 F	2	-	-	0.50

Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Biocomposites: Mechanics and Bioinspiration	CHE475H1 S	3	-	1	0.50
Introduction to Inorganic and Polymer Materials Chemistry	CHM325H1 S	2	-	-	0.50
Modern Physical Chemistry	CHM328H1 S	-	-	-	0.50
Lasers and Detectors	ECE525H1 S	3	-	2	0.50
Innovation and Manufacturing of Sustainable Materials	FOR424H1 S	2	-	1	0.50
Macromolecular Materials Engineering	MSE432H1 S	3	-	-	0.50
Materials Physics II	MSE462H1 S	2	-	1	0.50
Advanced Physical Properties of Structural Nanomaterials	MSE550H1 S	3	2	1	0.50
Nanotechnology in Alternate Energy Systems	MSE558H1 S	3	0.50	1	0.50
* MEMS Design and Microfabrication	MIE506H1 S	3	1.50	1	0.50
Fuel Cell Systems	MIE517H1 S	3	-	1	0.50
Advanced Physics Laboratory	PHY427H1 S	-	6	-	0.50
Relativistic Electrodynamics	PHY450H1 S	2	-	1	0.50
Statistical Mechanics	PHY452H1 S	2	-	-	0.50

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
(ii) ECE311H1
(iii) ECE356H1
(iv) MIE404H1
(v) AER372H1
(vi) BME344H1

2. One of:
(i) AER525H1
(ii) ECE470H1
(iii) MIE422H1
(iv) MIE443H1
(v) MIE444H1

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 contstraints:

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

Fall Courses		Lect.	Lab.	Tut.	Wgt.
Dynamics	AER301H1 F	3	-	1	0.50
Biomedical Systems Engineering I: Organ Systems	BME350H1 F	3	1	2	0.50
Communication Systems	ECE316H1 F	3	1.50	1	0.50
Algorithms and Data Structures	ECE345H1 F	3	-	2	0.50
Mechanical Engineering Design	MIE243H1 F	3	2	2	0.50
Kinematics and Dynamics of Machines	MIE301H1 F	3	3	2	0.50

Winter Courses		Lect.	Lab.	Tut.	Wgt.
Communication Systems	ECE316H1 S	3	1.50	1	0.50
Algorithms and Data Structures	ECE345H1 S	3	-	2	0.50
Systems Software	ECE353H1 S	3	3	-	0.50
Foundations of Computing	ECE358H1 S	3	-	1	0.50
Communication Systems	ECE363H1 S	3	1.50	1	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50
Analog and Digital Electronics for Mechatronics	MIE346H1 S	3	1.50	1	0.50

Advanced Courses

Fall Courses		Lect.	Lab.	Tut.	Wgt.
Space Systems Design	AER407H1 F	-	3	-	0.50
Introduction to Artificial Intelligence	CSC384H1 F	2	-	1	0.50
Machine Learning and Data Mining	CSC411H1 F	2	-	1	0.50
Control Systems	ECE410H1 F	3	1.50	1	0.50
Digital Signal Processing	ECE431H1 F	3	1.50	1	0.50
Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Digital Signal Processing	ECE455H1 F	3	1.50	1	0.50
Systems Control	ECE557H1 F	3	1.50	1	0.50
Machine Design	MIE442H1 F	3	1.50	3	0.50
* Mechatronics Principles	MIE444H1 F	2	3	-	0.50

Winter Courses		Lect.	Lab.	Tut.	Wgt.
Mobile Robotics and Perception	AER521H1 S	3	1.50	1	0.50
Data-based Modelling for Prediction and Control	CHE507H1 S	3	-	1	0.50
Introduction to Artificial Intelligence	CSC384H1 S	2	-	1	0.50
Human-Computer Interaction	CSC428H1 S	2	-	1	0.50
Real-Time Computer Control	ECE411H1 S	3	1.50	1	0.50
Intelligent Image Processing	ECE516H1 S	3	3	-	0.50
Inference Algorithms and Machine Learning	ECE521H1 S	3	-	2	0.50
Digital Systems Design	ECE532H1 S	3	3	-	0.50
Geometry of Curves and Surfaces	MAT363H1 S	3	-	-	0.50
Microprocessors and Embedded Microcontrollers	MIE438H1 S	2	3	-	0.50
* Mechatronics Systems: Design and Integration	MIE443H1 S	2	5	-	0.50
Micro/Nano Robotics	MIE505H1 S	3	3	-	0.50
* MEMS Design and Microfabrication	MIE506H1 S	3	1.50	1	0.50

Notes

•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.

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 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 consultthe department concerned regarding the availability of courses.

Certificate Programs in the Faculty of Applied Science and Engineering

CERTIFICATE IN ENGINEERING BUSINESS (AECERBUS)

Successful completion of an Engineering Certificate is included on transcripts. Note that no course counted for degree credit, can be counted for more than one minor or certificate.

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. All undergraduate Engineering students except students in the Engineering Science Mathematics, Statistics and Finance Option are eligible to participate in this minor course of study.

The requirements of an Engineering Business Certificate in the Faculty of Applied Science and Engineering are the successful completion of the following courses:

CERTIFICATE COURSES

Economics Courses		Lect.	Lab.	Tut.	Wgt.
Choose one of:					
Engineering Economic Analysis	CHE249H1 F	3	-	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Engineering Economics and Decision Making	CME368H1 F	3	-	1	0.50
Engineering Economic Analysis &Entrepreneurship	ECE472H1 F/S	3	-	2	0.50
Engineering Economics and Accounting	MIE258H1 F	3	-	1	0.50
Engineering Economics and Accounting	MIE358H1 F	3	-	1	0.50

Electives		Lect.	Lab.	Tut.	Wgt.
Choose two of :					
Fundamentals of Accounting and Finance	JRE300H1 F/S	3	-	1	0.50
Markets and Competitive Strategy	JRE410H1 F/S	2	2	-	0.50
People Management and Organizational Behaviour	JRE420H1 F/S	3	1	-	0.50
One choice above can be replaced by one of the following:					
Entrepreneurship and Business for Engineers	CHE488H1 S	3	-	2	0.50
Entrepreneurship and Business for Engineers	CIV488H1 S	3	-	2	0.50
Entrepreneurship and Business for Engineers	ECE488H1 F	3	-	2	0.50
Entrepreneurship and Business for Engineers	MIE488H1 F	3	-	2	0.50
Entrepreneurship and Business for Engineers	MSE488H1 F	3	-	2	0.50

****NOTE**

Students may only receive credit on their transcript for one of the Engineering Business Certificate, the Entrepreneurship Certificate, or the Engineering Business Minor.

CERTIFICATE IN COMMUNICATION (AECERCOM)

This certificate creates an opportunity for interested students to gain specialized expertise and recognition for a personal and professional commitment to enhanced communication skills. With the certificate, participating students can establish communication expertise through courses that expand on communication practices in contexts beyond engineering, deepen theoretical understanding of communication, and facilitate professional development in writing, oral communication, and critical thinking.

Students in all disciplines are eligible to participate in this Certificate.

Students in the Communication Certificate must successfully complete a minimum of 3 courses from the list outlined below:

CERTIFICATE IN COMMUNICATION

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Language and Meaning	APS281H1 S	2	-	2	0.50
Representing Science on Stage	APS320H1 F	2	-	2	0.50
Representing Science and Technology in Popular Media	APS321H1 F	2	-	2	0.50
Language and Power	APS322H1 S	2	-	2	0.50
Engineering and Science in the Arts	APS325H1 F	2	-	2	0.50
Critical Thinking and Inquiry in Written Communication	INI304H1 S	-	-	-	0.50
Word and Image in Modern Writing	INI305H1 S	-	-	-	0.50
Editing	INI310H1 F	-	-	-	0.50

- Availability of the courses (including the foundational courses) for timetabling purposes is not guaranteed; the onus is on the student to ensure compatibility with their timetable.
- If a student is pursuing both the Communication Certificate and a Minor that lists the course, the courses listed above can only be counted towards either the certificate or the minor, not both.

CERTIFICATE IN ENGINEERING LEADERSHIP (AECERLEAD)

Successful completion of an Engineering Certificate is included on transcripts. Note that no course counted for degree credit, can be counted for more than one minor or certificate.

Leadership education is about learning how to effectively handle complex, human challenges that often mean the difference between success and failure. Engineers are taught to think analytically and systematically. Leadership skills build on these strengths to make you a more effective engineer. More than just important, they are critical. This certificate recognizes a demonstrated focus in leadership courses provided jointly through the Faculty of Applied Science and Engineering and the Institute for Leadership Education in Engineering. Students in all disciplines are eligible to participate in this Certificate.

Students in the Engineering Leadership Certificate must successfully complete a minimum of 3 courses from the list outlined below:

CERTIFICATE COURSES

Courses		Lect.	Lab.	Tut.	Wgt.
Choose 3 of the following:					
Engineering Leadership	APS343H1 F/S	2	2	-	0.50
Cognitive and Psychological Foundations of Effective Leadership	APS442H1 S	3	-	-	0.50
Positive Psychology for Engineers	APS444H1 F	3	-	-	0.50
The Power of Story: Discovering Your Leadership Narrative	APS445H1 F	2	-	1	0.50
Leadership in Project Management	APS446H1 S	3	-	-	0.50
The Art of Ethical &Equitable Decision Making in Engineering	APS447H1 S	3	-	-	0.50

**NOTE

- Availability of the courses (including the foundational courses) for timetabling purposes is not guaranteed; the onus is on the student to ensure compatibility with their timetable.
- Students must secure approval from their home department before selecting any elective outside their departmental approved list.
- If a student is pursuing both the Engineering Leadership Certificate and the Engineering Business Minor, the courses listed above can only be counted towards either the certificate or the minor, not both.

CERTIFICATE IN ENTREPRENEURSHIP, INNOVATION AND SMALL BUSINESS (AECERENTR)

Successful completion of an Engineering Certificate is included on transcripts. Note that no course counted for degree credit, can be counted for more than one minor or certificate.

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:

CERTIFICATE COURSES

Required		Lect.	Lab.	Tut.	Wgt.
Entrepreneurship and Small Business	APS234H1 F	4	-	1	0.50
Entrepreneurship and Business Management	APS432H1 S	4	-	1	0.50

Economics Elective		Lect.	Lab.	Tut.	Wgt.
Choose one of:					
Engineering Economic Analysis	CHE249H1 F	3	-	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Engineering Economics and Decision Making	CME368H1 F	3	-	1	0.50
Engineering Economic Analysis &Entrepreneurship	ECE472H1 F/S	3	-	2	0.50
Engineering Economics and Accounting	MIE258H1 F	3	-	1	0.50
Engineering Economics and Accounting	MIE358H1 F	3	-	1	0.50

****NOTE**

Students may only receive credit on their transcript for one of the Engineering Business Certificate or the Entrepreneurship Certificate, or the Engineering Business Minor.

CERTIFICATE IN GLOBAL ENGINEERING (AECERGLOB)

Successful completion of an Engineering Certificate is included on transcripts. Note that no course counted for degree credit, can be counted for more than one minor or certificate.

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:

CERTIFICATE COURSES

Courses		Lect.	Lab.	Tut.	Wgt.
Choose two of:					
Innovative Technologies and Organizations in Global Energy Systems	APS510H1 F	3	-	1	0.50
Technology, Engineering and Global Development	APS420H1 S	3	-	-	0.50
Appropriate Technology &Design for Global Development	APS530H1 S	3	-	-	0.50

Courses		Lect.	Lab.	Tut.	Wgt.
Choose one of:					
Anthropology of the Contemporary World (formerly ANT204Y1)	ANT204H1 F	-	-	-	0.50
Ecological Worldviews	ENV333H1 F	-	-	-	0.50
Global Cities	GGR216H1 F	-	-	-	0.50
Globalization and Urban Change	JGI216H1 S	-	-	-	0.50
Politics of Development: Issues and Controversies	POL201Y1 Y	2	-	1	0.50
Introduction to International Relations	POL208Y1 Y	2	-	1	0.50
Canada and Globalization (formerly UNI220Y1)	UNI268H1 S	3	-	-	0.50

****NOTE**

If a student is pursuing both the Global Engineering Certificate and either the Sustainable Energy Minor or the Environmental Engineering Minor, the courses listed above can only be counted towards either the certificate or the minor, not both.

CERTIFICATE IN MINERAL RESOURCES (AECERMINR)

Successful completion of an Engineering Certificate is included on transcripts. Note that no course counted for degree credit, can be counted for more than one minor or certificate.

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. There is a real demand for qualified professionals in all engineering sectors (electrical, mechanical, materials, chemical, civil, environmental, etc.) to be integrated into the mining sectors. The proposed Mineral Resources Certificate aims to provide an exposure to the mineral resources sector of interested candidates. It further aims to bring closer together Lassonde Mineral Engineering students with other students and provides a window to state of the art research in mining.
Students in all disciplines except the Lassonde Mineral Engineering Program are eligible to participate in this Certificate.

Note: All three courses are technical courses, not CS or HSS. Students may take these as either a Free Elective or as a Technical Elective with the approval of their home department.

Students will receive the Mineral Resources Certificate upon completion of the following 3 courses as outlined below:

CERTIFICATE COURSES

Required		Lect.	Lab.	Tut.	Wgt.
Introduction to the Resource Industries	MIN225H1 F	3	2	1	0.50
Surface Mining	MIN250H1 S	3	-	1	0.50
Underground Mining	MIN351H1 S	3	-	1	0.50

****NOTE**

Special Consideration: Some students undertake significant experiences, such as internships, and arguably learn more about mineral resource engineering during those placements than in a typical course. On a case-by-case basis, the LMEP office will permit such placements to replace a course in fulfilling the requirements of the Mineral Resources Certificate. In all cases when such an exception is to be made, a major report documenting the student's activities, duties, learnings, and reflections during the placement will be required. The final decision for the acceptability of this experience requirement will be made through the LMEP Programs Office.

Notes:
- Availability of the courses (including the foundational courses) for timetabling purposes is not guaranteed; the onus is on the student to ensure compatibility with their timetable.
- Students must secure approval from their home department before selecting any elective outside their departmental approved list.

CERTIFICATE IN NUCLEAR ENGINEERING (AECERNUC)

Successful completion of an Engineering Certificate is included on transcripts. Note that no course counted for degree credit, can be counted for more than one minor or certificate.

Nuclear energy constitutes an important component of the energy mix in most national energy strategies, and its proportion will likely increase in response to growing challenges related to fossil-driven climate change. Modular nuclear systems power space craft and remote sites on earth. Future nuclear power systems will address current concerns regarding safety and the environment, and significant breakthroughs are likely in fusion technology. This certificate provides recognition for an interdisciplinary focus on nuclear systems. Students in all disciplines are eligible to participate in this Certificate.

The requirements for a Nuclear Engineering Certificate in the Faculty of Applied Science and Engineering are the successful completion of the following courses:

CERTIFICATE COURSES

Courses		Lect.	Lab.	Tut.	Wgt.
Elements of Nuclear Engineering	CHE566H1 F	3	-	1	0.50
Choose two of:					
Introduction to Fusion Energy	AER507H1 F	3	-	1	0.50
Nuclear Engineering	CHE568H1 S	3	-	1	0.50
Nuclear Reactor Theory and Design	MIE407H1 F	3	-	2	0.50
* Thermal and Machine Design of Nuclear Power Reactors	MIE408H1 S	3	-	2	0.50

**NOTE

- Availability of the courses (including the foundational courses) for timetabling purposes is not guaranteed; the onus is on the student to ensure compatibility with their timetable.
- Students must secure approval from their home department before selecting any elective outside their departmental approved list.
- If a student is pursuing both the Nuclear Engineering Certificate and the Sustainable Energy Minor, the courses listed above can only be counted towards either the certificate or the minor, not both.

CERTIFICATE IN RENEWABLE RESOURCES ENGINEERING (AECERRRE)

Successful completion of an Engineering Certificate is included on transcripts. Note that no course counted for degree credit, can be counted for more than one minor or certificate.

The Faculty of Forestry has expertise in sustainable resource management and bio-economics, sustainable energy production, green manufacturing and sustainable communities. This grouping of courses developed for engineering students reflects the strong interconnections between their work and various branches of Engineering. The Certificate provides recognition for a demonstrated focus in renewable resources. Students in all disciplines are eligible to participate in this Certificate.

Students in the Renewable Resources Engineering Leadership Certificate must successfully complete a minimum of 3 courses from the list outlined below:

CERTIFICATE COURSES

Courses		Lect.	Lab.	Tut.	Wgt.
Choose three of:					
Biocomposites: Mechanics and Bioinspiration	CHE475H1 S	3	-	1	0.50
Discovering Wood and its Role in Societal Development	FOR308H1 F	3	-	1	0.50
Green Urban Infrastructure: Sustainable City Forests	FOR421H1 F	2	-	-	0.50
Innovation and Manufacturing of Sustainable Materials	FOR424H1 S	2	-	1	0.50
Bioenergy and Biorefinery Technology	FOR425H1 S	2	-	2	0.50

****NOTE**

- Availability of the courses (including the foundational courses) for timetabling purposes is not guaranteed; the onus is on the student to ensure compatibility with their timetable.
- Students must secure approval from their home department before selecting any elective outside their departmental approved list.
- If a student is pursuing both the Renewable Resources Engineering Certificate and a Minor that lists the course, the courses listed above can only be counted towards either the certificate or the minor, not both.

First Year

CHAIR, FIRST YEAR
Associate Professor, Teaching Stream, Micah Stickel, B.A.Sc., M.A.Sc., Ph.D.

ASSISTANT DIRECTOR, FIRST YEAR ACADEMIC SERVICES
Leslie Grife, B.A. (Hons), M.Ed.

ASSISTANT DIRECTOR, FIRST YEAR STUDENT SUCCESS AND TRANSITION
Cori Hanson, B.Sc. (Hons), M.Ed.

FIRST YEAR ADVISOR
Jennifer Fabro

FIRST YEAR COORDINATOR
Olha Fihol

Room 170, Galbraith Building
416-978-4625, firstyear@ecf.utoronto.ca
www.firstyear.engineering.utoronto.ca

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 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 Engineering 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

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.	Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Orientation to Engineering	APS100H1 F	1	-	1	0.25	Computer Fundamentals	APS105H1 S	3	2	1	0.50
Engineering Chemistry and Materials Science	APS110H1 F	3	1	1	0.50	Engineering Strategies &Practice II	APS112H1 S	2	2	-	0.50
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50	Introduction to Engineering	APS191H1 S	1	-	-	0.15
Mechanics	CIV100H1 F	3	-	2	0.50	Electrical Fundamentals	ECE110H1 S	3	1	2	0.50
Calculus I	MAT186H1 F	3	-	1	0.50	Calculus II	MAT187H1 S	3	-	1	0.50
Linear Algebra	MAT188H1 F	3	1	1	0.50	Dynamics	MIE100H1 S	3	-	2	0.50

Approved Course Substitutions

1. Students are able to substitute MAT186H1 with the online calculus course APS162H1.
2. Students are able to substitute MAT187H1 with the online calculus course APS163H1.
3. Students are able to substitute APS110H1 with the online course APS164H1.

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.

APS1XXH1 Engineering Chemistry and Materials Science

APS111H1 Engineering Strategies & Practice I

MAT186H1 Calculus I

MAT188H1 Linear Algebra

CIV100H1 Mechanics

Students who must repeat MSE101H1 or CHE112H1 will enrol in one of the sections offered in the Winter Session, if scheduling permits.

The courses offered in the Summer Session are:

APS106H1 Fundamentals of Computer Programming and APS105

APS112H1 Engineering Strategies & Practice II

ECE110H1 Electrical Fundamentals

MAT187H1 Calculus II

MIE100H1 Dynamics

MSE101H1 Materials Science

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.

Biomaterials and Biomedical Engineering

INSTITUTE OF BIOMATERIALS AND BIOMEDICAL ENGINEERING

Undergraduate & Graduate Programs Office

Mining Building, RM 332, (416) 978-7209

Email: undergrad.ibbme@utoronto.ca

Biomedical engineering is an interdisciplinary field that integrates the principles of biology with those of engineering, the physical sciences, and mathematics 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.

At the undergraduate level, the Institute educates students in the biomedical systems engineering major in engineering science, and bioengineering and biomedical engineering minor programs. An active undergraduate summer student program offers both employment and a structured educational experience within the Institute's research laboratories. IBBME houses a unique and innovative Teaching Laboratory for training undergraduate students in the use of state-of-the-art bioanalytical, imaging, and biomedical engineering tools, techniques, and platforms. A sophisticated Design Studio fully equipped with rapid prototyping tools, and electronic test and measurement platforms is available in support of the biomedical engineering undergraduate design and capstone courses.

Graduate students registered directly into the Institute, or in collaborating graduate departments, proceed towards MASc, MHSc, MEng (Biomedical Engineering), MSc or PhD degrees in engineering, dentistry, medicine, or the physical or life sciences, enabling careers in industry, government, and academia. The Institute has a Clinical Engineering concentration within its PhD program, which complements its two-year MHSc 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 Lassonde Mining Building, and the Donnelly Centre for Cellular and Biomolecular Research on the St. George Campus, with a unique satellite facility housing the Translational Biology and Engineering Program of the Ted Rogers Centre for Heart Research in the MaRS2 Discovery Tower. Approximately 50 per cent of our core faculty have laboratories located in other university departments and hospitals. These laboratories serve as centres for development of experimental and clinical techniques, tools and instrumentation; real-time and interactive computer applications; innovative biomaterials; functional replacements for biological tissues and simulations for electrochemical and physiological models. Many IBBME faculty are appointed in departments in the Faculty of Applied Science and Engineering, Medicine, as well as hospital research institutes.

Chemical Engineering and Applied Chemistry

UNDERGRADUATE PROGRAM IN CHEMICAL ENGINEERING (AECHEBASC)

Undergraduate Student Counsellor
Jane Chung
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Email: ugrad.chemeng@utoronto.ca

Chemical Engineering is that 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 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

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Orientation to Engineering	APS100H1 F	1	-	1	0.25
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50
Physical Chemistry	CHE112H1 F	3	1	1	0.50
Mechanics	CIV100H1 F	3	-	2	0.50
Calculus I	MAT186H1 F	3	-	1	0.50
Linear Algebra	MAT188H1 F	3	1	1	0.50

Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Engineering Strategies &Practice II	APS112H1 S	2	2	-	0.50
Concepts in Chemical Engineering	CHE113H1 S	3	1	3	0.50
Calculus II	MAT187H1 S	3	-	1	0.50
Introduction to Materials Science	MSE101H1 S	3	1	1	0.50

Approved Course Substitution

1. Students are able to substitute MAT186H1 with the online calculus course APS162H1.
2. Students are able to substitute MAT187H1 with the online calculus course APS163H1.
3. Students are able to substitute APS110H1 with the online course APS164H1.

Second Year Chemical Engineering

Fall Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Applied Chemistry III - Laboratory	CHE204H1 Y	-	6	-	0.50
Process Engineering	CHE208H1 F	3	-	2	0.50
Fluid Mechanics	CHE211H1 F	3	-	2	0.50
Applied Chemistry I - Inorganic Chemistry	CHE220H1 F	3	-	1	0.50
Calculus and Numerical Methods	CHE221H1 F	3	-	2	0.50
Engineering Economic Analysis	CHE249H1 F	3	-	1	0.50
Communication	CHE299H1 Y	-	-	2	0.25

Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Applied Chemistry III - Laboratory	CHE204H1 Y	-	6	-	0.50
Heat and Mass Transfer	CHE210H1 S	3	-	2	0.50
Applied Chemistry II - Organic Chemistry	CHE213H1 S	3	-	1	0.50
Applied Differential Equations	CHE222H1 S	3	2	1	0.50
Environmental Chemistry	CHE230H1 S	3	-	2	0.50
Communication	CHE299H1 Y	-	-	2	0.25

Practical Experience Requirement

- 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

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Engineering Thermodynamics	CHE323H1 F	3	-	2	0.50
Process Design	CHE324H1 F	3	4	1	0.75
Thermodynamics and Kinetics Laboratory	CHE326H1 F	-	4	-	0.25
Reaction Kinetics	CHE332H1 F	3	-	2	0.50
Technical Elective[1]					0.50
Complementary Studies/Humanities and Social Sciences Elective[2]					0.50

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Separation Processes	CHE311H1 S	3	4	2	0.75
Process Dynamics and Control	CHE322H1 S	3	-	2	0.50
Chemical Reaction Engineering	CHE333H1 S	3	-	2	0.50
Team Strategies for Engineering Design	CHE334H1 S	1	-	2	0.25
and one of:					
Technical Elective[1]					0.50
Complementary Studies/Humanities and Social Sciences Elective[2]					0.50

Fourth Year Chemical Engineering

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Chemical Plant Design	CHE430Y1 F	2	-	6	1.00
Complementary Studies/Humanities and Social Sciences Elective[2]					0.50
Technical Elective[1]					0.00
and one of:					
Thesis	CHE499Y1 Y	-	7	-	1.00
Technical Elective[1]					0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Professional Practice	CHE403H1 S	2	-	-	0.00
Technical Elective[1]					0.50
Technical Elective[1]					0.50
Free Elective[3]					0.50
Complementary Studies/Humanities and Social Sciences Elective[2]					0.50
and one of:					
Thesis	CHE499Y1 Y	-	7	-	1.00
Technical Elective[1]					0.50

[1] In years 3 and 4, students must complete a total of 6 Technical Electives (or 4 Technical Electives and CHE499Y1: Thesis). See section below for more information.
[2] In years 3 and 4, students must complete a total of 4 Complementary Studies/Humanities and Social Sciences (CS/HSS) Electives, at least 2 of which must be Humanities and Social Sciences. Refer to the Registrar's Office website for a list of pre-approved CS/HSS Electives.
[3] In years 3 and 4, students must complete 1 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

The thesis (CHE499Y1) is a full-year (Fall and Winter Sessions) thesis that requires approval from the department and research project supervisor.

TECHNICAL ELECTIVES

Students may take any of the Technical Elective courses listed in the table below, or from any of the technical Engineering Minors (excluding the Minor in Engineering Business). Students wishing to pursue an Engineering Minor should take their core courses as technical electives in terms 3F and 3S. For more information on the various Minors, please see the sections of the Calendar relating to these programs.

Technical Electives

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Biomedical Engineering Technology and Investigation	BME440H1 F	2	4	-	0.50
Cellular and Molecular Bioengineering II	BME455H1 F	3	1.50	1	0.50
Engineering Materials	CHE341H1 F	3	-	1	0.50
Engineering Biology	CHE353H1 F	2	-	2	0.50
Bioprocess Technology and Design	CHE450H1 F	3	0.66	1	0.50
Petroleum Processing	CHE451H1 F	3	-	-	0.50
Environmental Engineering	CHE467H1 F	3	-	1	0.50
Special Topics in Chemical Engineering	CHE470H1 F	3	-	1	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	3	-	-	0.50
Aqueous Process Engineering	CHE565H1 F	3	-	1	0.50
Elements of Nuclear Engineering	CHE566H1 F	3	-	1	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50
Building Science	CIV375H1 F	3	0.33	2	0.50
Groundwater Flow and Contamination	CIV549H1 F	3	-	1	0.50
Water Resources Engineering	CIV550H1 F	3	-	2	0.50
Alternative Energy Systems	MIE515H1 F	3	-	1	0.50
Combustion and Fuels	MIE516H1 F	3	-	1	0.50
Biomaterial Processing and Properties	MSE440H1 F	3	-	1	0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Advanced Reactor Design	CHE412H1 S	3	-	1	0.50
Environmental Pathways and Impact Assessment	CHE460H1 S	3	-	2	0.50
Food Engineering	CHE462H1 S	3	-	1	0.50
Fuel Cells and Electrochemical Conversion Devices	CHE469H1 S	3	-	1	0.50
Special Topics in Chemical Engineering	CHE470H1 S	3	-	1	0.50
Modelling in Biological and Chemical Systems	CHE471H1 S	3	-	1	0.50
Biocomposites: Mechanics and Bioinspiration	CHE475H1 S	3	-	1	0.50
Data-based Modelling for Prediction and Control	CHE507H1 S	3	-	1	0.50
Risk Based Safety Management	CHE561H1 S	3	-	1	0.50
Pulp and Paper Processes	CHE564H1 S	3	-	1	0.50
Nuclear Engineering	CHE568H1 S	3	-	1	0.50
Topics in Atmospheric Chemistry	CHM415H1 S	2	-	-	0.50
Hydraulics and Hydrology	CIV250H1 S	3	1.50	1	0.50
Terrestrial Energy Systems	CIV300H1 S	3	-	2	0.50
Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Bioenergy from Sustainable Forest Management	FOR310H1 S	2	-	1	0.50
Innovation and Manufacturing of Sustainable Materials	FOR424H1 S	2	-	1	0.50
Bioenergy and Biorefinery Technology	FOR425H1 S	2	-	2	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50
Quality Control and Improvement	MIE364H1 S	3	1	2	0.50
Fuel Cell Systems	MIE517H1 S	3	-	1	0.50

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 Curtis - Clarke
Room GB105, Galbraith Building, (416) 978-5905
E-mail: shayni@civ.utoronto.ca

UNDERGRADUATE STUDENT ADVISORS:
Prof. Amer Shalaby
Associate Chair, Undergraduate

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

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Orientation to Engineering	APS100H1 F	1	-	1	0.25
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50
Physical Chemistry	CHE112H1 F	3	1	1	0.50
Mechanics	CIV100H1 F	3	-	2	0.50
Calculus I	MAT186H1 F	3	-	1	0.50
Linear Algebra	MAT188H1 F	3	1	1	0.50

Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Engineering Strategies &Practice II	APS112H1 S	2	2	-	0.50
Earth Systems Science	CME185H1 S	3	2	1	0.50
Calculus II	MAT187H1 S	3	-	1	0.50
Introduction to Materials Science	MSE101H1 S	3	1	1	0.50

Approved Course Substitution

1. Students are able to substitute MAT186H1 with the online calculus course APS162H1.
2. Students are able to substitute MAT187H1 with the online calculus course APS163H1.
3. Students are able to substitute APS110H1 with the online course APS164H1.

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

Fall Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Technology in Society and the Biosphere I	APS301H1 F	3	-	1	0.50
Introduction to Civil Engineering	CIV201H1 F	-	-	-	0.20
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50
Management of Construction	CIV280H1 F	3	-	2	0.50
Engineering Communications I	CIV282H1 F	1	-	1	0.20
Solid Mechanics I	CME210H1 F	3	1.50	1.50	0.50
Engineering Mathematics I	CME261H1 F	3	1	1	0.50
Fluid Mechanics I	CME270H1 F	3	1.50	1	0.50

Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Civil Engineering Materials	CIV209H1 S	3	2	2	0.50
Structural Analysis I	CIV214H1 S	3	-	2	0.50
Civil Engineering Graphics	CIV235H1 S	-	6	-	0.50
Hydraulics and Hydrology	CIV250H1 S	3	1.50	1	0.50
Probability Theory for Civil and Mineral Engineers	CME263H1 S	3	-	2	0.50
Engineering Mathematics II	CME362H1 S	3	-	2	0.50

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

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Steel and Timber Design	CIV312H1 F	3	-	2	0.50
Transport I - Introduction to Urban Transportation Systems	CIV331H1 F	3	-	1	0.50
Water and Wastewater Treatment Processes	CIV342H1 F	3	1	1	0.50
Building Science	CIV375H1 F	3	0.33	2	0.50
Civil Engineering Communication Portfolio	CIV382Y1 Y	-	-	0.25	0.00
Geotechnical Engineering I	CME321H1 F	3	1	1	0.50
Survey CAMP (Civil and Mineral Practicals)	CME358H1 F	-	-	-	0.50
Engineering Economics and Decision Making	CME368H1 F	3	-	1	0.50

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Reinforced Concrete I	CIV313H1 S	3	-	2	0.50
Geotechnical Engineering II	CIV324H1 S	3	1	1	0.50
Transport II - Performance	CIV332H1 S	3	-	1	0.50
Municipal Engineering	CIV340H1 S	3	-	2	0.50
Sustainable Energy Systems	CIV380H1 S	3	-	1	0.50
Civil Engineering Communication Portfolio	CIV382Y1 Y	-	-	0.25	0.00
Complementary Studies Elective (CS) / Humanities and Social Sciences Elective (HSS)					0.50

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 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, 222 College Street, Suite 106 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

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Free Elective					0.50
Free Elective					0.50
Complementary Studies Elective (CS) / Humanities and Social Sciences Elective (HSS)					0.50
Choose two technical electives from the following list:					
Engineering Biology	CHE353H1 F	2	-	2	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50
Reinforced Concrete II	CIV416H1 F	3	-	2	0.50
Construction Engineering	CIV420H1 F	3	-	2	0.50
Special Studies in Civil Engineering	CIV477H1 F	3	-	1	0.50
Individual Project	CIV499H1 F	-	-	3	0.50
Concrete Technology	CIV514H1 F	3	-	2	0.50
Introduction to Structural Dynamics	CIV515H1 F	3	-	1	0.50
Prestressed Concrete	CIV517H1 F	3	-	-	0.50
Structural Analysis II	CIV519H1 F	3	-	2	0.50
Rock Mechanics	CIV521H1 F	3	1	-	0.50
Transport Planning	CIV531H1 F	3	-	1	0.50
Environmental Biotechnology	CIV541H1 F	3	-	-	0.50
Groundwater Flow and Contamination	CIV549H1 F	3	-	1	0.50
Water Resources Engineering	CIV550H1 F	3	-	2	0.50
Engineering Rock Mechanics	MIN429H1 F	3	1	1	0.50
Integrated Mine Waste Engineering	MIN511H1 F	3	-	1	0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Group Design Project	CIV498H1 S	-	-	3	0.50
Free Elective					0.50
Complementary Studies Elective (CS) / Humanities and Social Sciences Elective (HSS)					0.50
Choose two technical electives from the following list:					
Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Terrestrial Energy Systems	CIV300H1 S	3	-	2	0.50
Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Special Studies in Civil Engineering	CIV477H1 S	3	-	1	0.50
Individual Project	CIV499H1 S	-	-	3	0.50
Solid Mechanics II	CIV510H1 S	3	-	2	0.50
Public Transit Operations and Planning	CIV516H1 S	3	-	1	0.50
Behaviour and Design of Steel Structures	CIV518H1 S	3	-	2	0.50
Geotechnical Design	CIV523H1 S	3	-	1	0.50
Sustainable Buildings	CIV576H1 S	3	-	1	0.50
Infrastructure for Sustainable Cities	CIV577H1 S	3	-	1	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50
Mining Environmental Management	MIN430H1 S	3	-	1	0.50
Ventilation and Occupational Health	MIN470H1 S	3	-	1	0.50
Borehole Geophysics for Engineers and Geoscientists	MIN540H1 S	3	-	1	0.50

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. Mary Miceli

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: http://www.ece.utoronto.ca/curriculum-streams. 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: https://magellan.ece.toronto.edu

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: http://www.ece.utoronto.ca/graduates-home/

FIRST YEAR COMPUTER ENGINEERING

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.	Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Orientation to Engineering	APS100H1 F	1	-	1	0.25	Computer Fundamentals	APS105H1 S	3	2	1	0.50
Engineering Chemistry and Materials Science	APS110H1 F	3	1	1	0.50	Engineering Strategies &Practice II	APS112H1 S	2	2	-	0.50
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50	Seminar Course: Introduction to Electrical and Computer Engineering	ECE101H1 S	1	-	-	0.15
Mechanics	CIV100H1 F	3	-	2	0.50						
Calculus I	MAT186H1 F	3	-	1	0.50	Electrical Fundamentals	ECE110H1 S	3	1	2	0.50
Linear Algebra	MAT188H1 F	3	1	1	0.50	Calculus II	MAT187H1 S	3	-	1	0.50
						Dynamics	MIE100H1 S	3	-	2	0.50

Approved Course Substitution

1. Students are able to substitute MAT186H1 with the online calculus course APS162H1.
2. Students are able to substitute MAT187H1 with the online calculus course APS163H1.
3. Students are able to substitute APS110H1 with the online course APS164H1.

SECOND YEAR COMPUTER ENGINEERING

Fall Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Electrical and Computer Engineering Seminar	ECE201H1 F	1	-	-	0.15
Circuit Analysis	ECE212H1 F	3	1.50	2	0.50
Digital Systems	ECE241H1 F	3	3	-	0.50
Programming Fundamentals	ECE244H1 F	3	2	1	0.50
Advanced Engineering Mathematics	MAT290H1 F	3	-	2	0.50
Calculus III	MAT291H1 F	3	-	2	0.50

Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Signals and Systems	ECE216H1 S	3	1	2	0.50
Electric and Magnetic Fields	ECE221H1 S	3	1	2	0.50
Introductory Electronics	ECE231H1 S	3	1.50	2	0.50
Computer Organization	ECE243H1 S	3	3	-	0.50
Communication and Design	ECE297H1 S	2	2	2	0.50

THIRD AND FOURTH YEAR COMPUTER ENGINEERING

COURSE SELECTION YEAR 3 or 4

Required Course - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
Engineering Economic Analysis &Entrepreneurship	ECE472H1 F/S	3	-	2	0.50

COURSE SELECTION YEAR 4

Required Course - Year 4		Lect.	Lab.	Tut.	Wgt.
Design Project	ECE496Y1 Y	1	-	1	1.00

AREA 1 - PHOTONICS & SEMICONDUCTOR PHYSICS

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Introduction to Electronic Devices	ECE335H1 F	3	-	2	0.50
TECHNICAL ELECTIVES					
VLSI Technology	ECE437H1 F	3	3	-	0.50
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Semiconductor and Device Physics	ECE330H1 S	3	-	2	0.50
Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Lasers and Detectors	ECE525H1 S	3	-	2	0.50
Introduction to Quantum Mechanics	PHY335H1 S	2	-	1	0.50

AREA 2 - ELECTROMAGNETICS & ENERGY SYSTEMS

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Fundamentals of Electrical Energy Systems	ECE314H1 F	3	1.50	1	0.50
Fields and Waves	ECE320H1 F	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Microwave Circuits	ECE424H1 F	3	1.50	1	0.50
Introduction to Lighting Systems	ECE510H1 F	3	-	2	0.50
Power Electronics: Converter Topologies	ECE514H1 F	3	1.50	1	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
There are no winter term kernel courses offered in this area					0.00
TECHNICAL ELECTIVES					
Medical Imaging	BME595H1 S	2	3	1	0.50
Energy Systems and Distributed Generation	ECE413H1 S	3	1.50	1	0.50
Radio and Microwave Wireless Systems	ECE422H1 S	3	1.50	1	0.50
Electric Drives	ECE463H1 S	3	1.50	1	0.50
Power Electronics: Switch-Mode Power Supplies	ECE533H1 S	3	1	1	0.50

AREA 3 - ANALOG & DIGITAL ELECTRONICS

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Analog Electronics	ECE331H1 F	3	1.50	1	0.50
Digital Electronics	ECE334H1 F	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Microwave Circuits	ECE424H1 F	3	1.50	1	0.50
Analog Integrated Circuits	ECE430H1 F	3	1.50	1	0.50
VLSI Technology	ECE437H1 F	3	3	-	0.50
Sensory Communication	ECE446H1 F	3	1.50	1	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Analog Electronics	ECE331H1 S	3	1.50	1	0.50
Digital Electronics	ECE334H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Analog Signal Processing Circuits	ECE412H1 S	3	-	2	0.50
VLSI Systems and Design	ECE451H1 S	3	3	-	0.50
Digital Systems Design	ECE532H1 S	3	3	-	0.50

AREA 4 - CONTROL, COMMUNICATIONS & SIGNAL PROCESSING

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Dynamic Systems and Control	ECE311H1 F	3	1.50	1	0.50
Communication Systems	ECE316H1 F	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Probability and Applications	ECE302H1 F	3	-	2	0.50
Control Systems	ECE410H1 F	3	1.50	1	0.50
Digital Signal Processing	ECE431H1 F	3	1.50	1	0.50
Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Sensory Communication	ECE446H1 F	3	1.50	1	0.50
Robot Modeling and Control	ECE470H1 F	3	1.50	1	0.50
Random Processes	ECE537H1 F	3	-	2	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Dynamic Systems and Control	ECE311H1 S	3	1.50	1	0.50
Communication Systems	ECE316H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Medical Imaging	BME595H1 S	2	3	1	0.50
Probability and Applications	ECE302H1 S	3	-	2	0.50
Real-Time Computer Control	ECE411H1 S	3	1.50	1	0.50
Digital Communication	ECE417H1 S	3	1.50	1	0.50
Radio and Microwave Wireless Systems	ECE422H1 S	3	1.50	1	0.50
Multimedia Systems	ECE462H1 S	3	2	-	0.50
Wireless Communication	ECE464H1 S	3	1.50	1	0.50
Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Robot Modeling and Control	ECE470H1 S	3	1.50	1	0.50
Intelligent Image Processing	ECE516H1 S	3	3	-	0.50
Inference Algorithms and Machine Learning	ECE521H1 S	3	-	2	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50

AREA 5 - COMPUTER HARDWARE & COMPUTER NETWORKS

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Computer Networks I	ECE361H1 F	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Internetworking	ECE461H1 F	3	1.50	0.50	0.50
Computer Architecture	ECE552H1 F	3	1.50	1	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Computer Hardware	ECE342H1 S	3	3	-	0.50
Computer Networks I	ECE361H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES					
VLSI Systems and Design	ECE451H1 S	3	3	-	0.50
Computer Networks II	ECE466H1 S	3	1.50	1	0.50
Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Digital Systems Design	ECE532H1 S	3	3	-	0.50

AREA 6 - SOFTWARE

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Operating Systems	ECE344H1 F	3	3	-	0.50
Algorithms and Data Structures	ECE345H1 F	3	-	2	0.50
TECHNICAL ELECTIVES					
Programming Languages	CSC326H1 F	3	1.50	1	0.50
Introduction to Databases	CSC343H1 F	2	-	1	0.50
Computer Graphics	CSC418H1 F	2	-	1	0.50
Software Engineering I	CSC444H1 F	3	1.50	1	0.50
Compilers and Interpreters	CSC467H1 F	3	1.50	1	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50
Computer Systems Programming	ECE454H1 F	3	3	-	0.50
Internetworking	ECE461H1 F	3	1.50	0.50	0.50
Computer Security	ECE568H1 F/S	3	3	-	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Operating Systems	ECE344H1 S	3	3	-	0.50
Algorithms and Data Structures	ECE345H1 S	3	-	2	0.50
TECHNICAL ELECTIVES					
Introduction to Databases	CSC343H1 S	2	-	1	0.50
Computer Graphics	CSC418H1 S	2	-	1	0.50
Distributed Systems	ECE419H1 S	3	1.50	1	0.50
Software Engineering II	ECE450H1 S	3	1.50	1	0.50
Optimizing Compilers	ECE540H1 S	3	3	-	0.50
Computer Security	ECE568H1 S	3	3	-	0.50

SCIENCE/MATH ELECTIVES

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Biomedical Engineering Technology and Investigation	BME440H1 F	2	4	-	0.50
Cellular and Molecular Bioengineering II	BME455H1 F	3	1.50	1	0.50
Engineering Biology	CHE353H1 F	2	-	2	0.50
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50
Probability and Applications	ECE302H1 F	3	-	2	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Terrestrial Energy Systems	CIV300H1 S	3	-	2	0.50
Probability and Applications	ECE302H1 S	3	-	2	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50
Introduction to Quantum Mechanics	PHY335H1 S	2	-	1	0.50

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: http://www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/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.

3F	Technical Elective	Other Science/Math	Area Kernel	Area Kernel	Complementary Studies
3S	Engineering Economics	Depth	Area Kernel	Area Kernel	Complementary Studies
4F	Technical Elective	Depth	Depth	4th Year Design Project	Humanities & Social Science
4S	Free Elective	Technical Elective	Depth	4th Year Design Project	Humanities & Social Science

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: https://magellan.ece.toronto.edu.

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. Mary Miceli

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: http://www.ece.utoronto.ca/curriculum-streams. 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: https://magellan.ece.toronto.edu.

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: http://www.ece.utoronto.ca/graduates-home/

FIRST YEAR ELECTRICAL ENGINEERING

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Orientation to Engineering	APS100H1 F	1	-	1	0.25
Engineering Chemistry and Materials Science	APS110H1 F	3	1	1	0.50
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50
Mechanics	CIV100H1 F	3	-	2	0.50
Calculus I	MAT186H1 F	3	-	1	0.50
Linear Algebra	MAT188H1 F	3	1	1	0.50

Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Computer Fundamentals	APS105H1 S	3	2	1	0.50
Engineering Strategies &Practice II	APS112H1 S	2	2	-	0.50
Seminar Course: Introduction to Electrical and Computer Engineering	ECE101H1 S	1	-	-	0.15
Electrical Fundamentals	ECE110H1 S	3	1	2	0.50
Calculus II	MAT187H1 S	3	-	1	0.50
Dynamics	MIE100H1 S	3	-	2	0.50

Approved Course Substitution

1. Students are able to substitute MAT186H1 with the online calculus course APS162H1.
2. Students are able to substitute MAT187H1 with the online calculus course APS163H1.
3. Students are able to substitute APS110H1 with the online course APS164H1.

SECOND YEAR ELECTRICAL ENGINEERING

Fall Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Electrical and Computer Engineering Seminar	ECE201H1 F	1	-	-	0.15
Circuit Analysis	ECE212H1 F	3	1.50	2	0.50
Digital Systems	ECE241H1 F	3	3	-	0.50
Programming Fundamentals	ECE244H1 F	3	2	1	0.50
Advanced Engineering Mathematics	MAT290H1 F	3	-	2	0.50
Calculus III	MAT291H1 F	3	-	2	0.50

Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Signals and Systems	ECE216H1 S	3	1	2	0.50
Electric and Magnetic Fields	ECE221H1 S	3	1	2	0.50
Introductory Electronics	ECE231H1 S	3	1.50	2	0.50
Computer Organization	ECE243H1 S	3	3	-	0.50
Communication and Design	ECE297H1 S	2	2	2	0.50

THIRD AND FOURTH YEAR ELECTRICAL ENGINEERING

COURSE SELECTION YEAR 3 or 4

Required Course - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
Engineering Economic Analysis &Entrepreneurship	ECE472H1 F/S	3	-	2	0.50

COURSE SELECTION YEAR 4

Required Course - Year 4		Lect.	Lab.	Tut.	Wgt.
Design Project	ECE496Y1 Y	1	-	1	1.00

AREA 1 - PHOTONICS & SEMICONDUCTOR PHYSICS

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Introduction to Electronic Devices	ECE335H1 F	3	-	2	0.50
TECHNICAL ELECTIVES					
VLSI Technology	ECE437H1 F	3	3	-	0.50
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Semiconductor and Device Physics	ECE330H1 S	3	-	2	0.50
Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Lasers and Detectors	ECE525H1 S	3	-	2	0.50
Introduction to Quantum Mechanics	PHY335H1 S	2	-	1	0.50

AREA 2 - ELECTROMAGNETICS & ENERGY SYSTEMS

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Fundamentals of Electrical Energy Systems	ECE314H1 F	3	1.50	1	0.50
Fields and Waves	ECE320H1 F	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Microwave Circuits	ECE424H1 F	3	1.50	1	0.50
Introduction to Lighting Systems	ECE510H1 F	3	-	2	0.50
Power Electronics: Converter Topologies	ECE514H1 F	3	1.50	1	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
There are no winter term kernel courses offered in this area.					
TECHNICAL ELECTIVES					
Medical Imaging	BME595H1 S	2	3	1	0.50
Energy Systems and Distributed Generation	ECE413H1 S	3	1.50	1	0.50
Radio and Microwave Wireless Systems	ECE422H1 S	3	1.50	1	0.50
Electric Drives	ECE463H1 S	3	1.50	1	0.50
Power Electronics: Switch-Mode Power Supplies	ECE533H1 S	3	1	1	0.50

AREA 3 - ANALOG & DIGITAL ELECTRONICS

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Analog Electronics	ECE331H1 F	3	1.50	1	0.50
Digital Electronics	ECE334H1 F	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Microwave Circuits	ECE424H1 F	3	1.50	1	0.50
Analog Integrated Circuits	ECE430H1 F	3	1.50	1	0.50
VLSI Technology	ECE437H1 F	3	3	-	0.50
Sensory Communication	ECE446H1 F	3	1.50	1	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Analog Electronics	ECE331H1 S	3	1.50	1	0.50
Digital Electronics	ECE334H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Analog Signal Processing Circuits	ECE412H1 S	3	-	2	0.50
VLSI Systems and Design	ECE451H1 S	3	3	-	0.50
Digital Systems Design	ECE532H1 S	3	3	-	0.50

AREA 4 - CONTROL, COMMUNICATIONS & SIGNAL PROCESSING

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Dynamic Systems and Control	ECE311H1 F	3	1.50	1	0.50
Communication Systems	ECE316H1 F	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Probability and Applications	ECE302H1 F	3	-	2	0.50
Control Systems	ECE410H1 F	3	1.50	1	0.50
Digital Signal Processing	ECE431H1 F	3	1.50	1	0.50
Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Sensory Communication	ECE446H1 F	3	1.50	1	0.50
Robot Modeling and Control	ECE470H1 F	3	1.50	1	0.50
Random Processes	ECE537H1 F	3	-	2	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Dynamic Systems and Control	ECE311H1 S	3	1.50	1	0.50
Communication Systems	ECE316H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Medical Imaging	BME595H1 S	2	3	1	0.50
Probability and Applications	ECE302H1 S	3	-	2	0.50
Real-Time Computer Control	ECE411H1 S	3	1.50	1	0.50
Digital Communication	ECE417H1 S	3	1.50	1	0.50
Radio and Microwave Wireless Systems	ECE422H1 S	3	1.50	1	0.50
Multimedia Systems	ECE462H1 S	3	2	-	0.50
Wireless Communication	ECE464H1 S	3	1.50	1	0.50
Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Robot Modeling and Control	ECE470H1 S	3	1.50	1	0.50
Intelligent Image Processing	ECE516H1 S	3	3	-	0.50
Inference Algorithms and Machine Learning	ECE521H1 S	3	-	2	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50

AREA 5 - COMPUTER HARDWARE & COMPUTER NETWORKS

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Computer Networks I	ECE361H1 F	3	1.50	1	0.50
TECHNICAL ELECTIVES					
Internetworking	ECE461H1 F	3	1.50	0.50	0.50
Computer Architecture	ECE552H1 F	3	1.50	1	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Computer Hardware	ECE342H1 S	3	3	-	0.50
Computer Networks I	ECE361H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES					
VLSI Systems and Design	ECE451H1 S	3	3	-	0.50
Computer Networks II	ECE466H1 S	3	1.50	1	0.50
Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Digital Systems Design	ECE532H1 S	3	3	-	0.50

AREA 6 - SOFTWARE

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Operating Systems	ECE344H1 F	3	3	-	0.50
Algorithms and Data Structures	ECE345H1 F	3	-	2	0.50
TECHNICAL ELECTIVES					
Programming Languages	CSC326H1 F	3	1.50	1	0.50
Introduction to Databases	CSC343H1 F	2	-	1	0.50
Computer Graphics	CSC418H1 F	2	-	1	0.50
Software Engineering I	CSC444H1 F	3	1.50	1	0.50
Compilers and Interpreters	CSC467H1 F	3	1.50	1	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50
Computer Systems Programming	ECE454H1 F	3	3	-	0.50
Internetworking	ECE461H1 F	3	1.50	0.50	0.50
Computer Security	ECE568H1 F/S	3	3	-	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES					
Operating Systems	ECE344H1 S	3	3	-	0.50
Algorithms and Data Structures	ECE345H1 S	3	-	2	0.50
TECHNICAL ELECTIVES					
Introduction to Databases	CSC343H1 S	2	-	1	0.50
Computer Graphics	CSC418H1 S	2	-	1	0.50
Distributed Systems	ECE419H1 S	3	1.50	1	0.50
Software Engineering II	ECE450H1 S	3	1.50	1	0.50
Optimizing Compilers	ECE540H1 S	3	3	-	0.50
Computer Security	ECE568H1 S	3	3	-	0.50

SCIENCE/MATH ELECTIVES

Fall Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Biomedical Engineering Technology and Investigation	BME440H1 F	2	4	-	0.50
Cellular and Molecular Bioengineering II	BME455H1 F	3	1.50	1	0.50
Engineering Biology	CHE353H1 F	2	-	2	0.50
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50
Probability and Applications	ECE302H1 F	3	-	2	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50

Winter Term - Year 3 or 4		Lect.	Lab.	Tut.	Wgt.
Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Terrestrial Energy Systems	CIV300H1 S	3	-	2	0.50
Probability and Applications	ECE302H1 S	3	-	2	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50
Introduction to Quantum Mechanics	PHY335H1 S	2	-	1	0.50

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: http://www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/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.

3F	Technical Elective	Other Science/Math	Area Kernel	Area Kernel	Complementary Studies
3S	Engineering Economics	Depth	Area Kernel	Area Kernel	Complementary Studies
4F	Technical Elective	Depth	Depth	4th Year Design Project	Humanities & Social Science
4S	Free Elective	Technical Elective	Depth	4th Year Design Project	Humanities & Social Science

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: https://magellan.ece.toronto.edu.

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)

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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 prior to Year 4 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 (typically in the first two weeks of the Fall session), 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; 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 required 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
- Electrical and Computer Engineering
- Energy Systems Engineering
- Infrastructure Engineering
- Engineering Mathematics, Statistics & Finance
- Nanoengineering (not available to students entering after Fall 2014)
- Engineering Physics
- Robotics Engineering

The curriculum for the first two years and the curricula for the nine 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. Students may request elective course substitutions, but any such substitutions must be approved in advance by the Division of Engineering Science through the student's 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. Students may change the term in which they take Technical and CS/HSS Electives (for example, switch a CS/HSS elective in Year 3 Fall with a Technical Elective in Year 4 Fall), as long as they meet the elective requirements for their Option.

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.

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 the Professional Experience Year (PEY) will also completely fulfill the Practical Experience Requirement.

YEAR 1 CURRICULUM- ENGINEERING SCIENCE

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Structures and Materials - An Introduction to Engineering Design	CIV102H1 F	3	1	1	0.50
Introduction to Computer Programming	CSC180H1 F	3	3	-	0.50
Praxis I	ESC101H1 F	3	-	2	0.50
Engineering Mathematics and Computation	ESC103H1 F	2	-	2	0.50
Calculus I	MAT194H1 F	3	-	1	0.50
Classical Mechanics	PHY180H1 F	3	1.50	1	0.50

Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Computer Algorithms and Data Structures	CSC190H1 S	3	3	-	0.50
Fundamentals of Electric Circuits	ECE159H1 S	3	1.50	1	0.50
Praxis II	ESC102H1 S	3	-	2	0.50
Linear Algebra	MAT185H1 S	3	-	1	0.50
Calculus II	MAT195H1 S	3	-	1	0.50
Molecules and Materials	MSE160H1 S	3	-	1	0.50

YEAR 2 CURRICULUM - ENGINEERING SCIENCE

Fall Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Vector Calculus &Fluid Mechanics	AER210H1 F	3	0.50	2	0.50
Thermodynamics and Heat Transfer	CHE260H1 F	3	0.50	1	0.50
Digital and Computer Systems	ECE253H1 F	3	3	-	0.50
Engineering and Society	ESC203H1 F	2	-	2	0.50
Ordinary Differential Equations	MAT292H1 F	3	-	2	0.50
Waves and Modern Physics	PHY293H1 F	3	1	1	0.50

Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Engineering Design	AER201H1 S	1	5	-	0.50
Biomolecules and Cells	BME205H1 S	2	1.50	1	0.50
Electromagnetism	ECE259H1 S	3	-	1	0.50
Quantum and Thermal Physics	PHY294H1 S	3	1	1	0.50
Probability and Statistics	STA286H1 S	3	-	1	0.50
Complementary Studies Elective					0.50

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 and test times 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 early in session 2F or 3F: http://engineeringcareers.utoronto.ca/students/undergraduate-internship/pey/. The PEY Office is located in the Fields Institute Building at 222 College Street, Suite 106.

OPTION AEROSPACE ENGINEERING (AEESCBASEA)

YEAR 3 AEROSPACE ENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Dynamics	AER301H1 F	3	-	1	0.50
Aerospace Laboratory I	AER303H1 F	-	1	-	0.15
Aerodynamics	AER307H1 F	3	-	1	0.50
Combustion Processes	AER315H1 F	3	-	1	0.50
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
One of:					
Complex Analysis	MAT389H1 F	3	-	1	0.50
Mathematics for Robotics	ROB310H1 F	3	-	1	0.50

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Aircraft Flight	AER302H1 S	3	-	1	0.50
Aerospace Laboratory II	AER304H1 S	-	1	-	0.15
Gasdynamics	AER310H1 S	3	-	1	0.50
Scientific Computing	AER336H1 S	3	-	1	0.50
Control Systems	AER372H1 S	3	1.50	1	0.50
Mechanics of Solids and Structures	AER373H1 S	3	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25

YEAR 4 AEROSPACE ENGINEERING

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Space Systems Design	AER407H1 F	-	3	-	0.50
Advanced Mechanics of Structures	AER501H1 F	3	-	1	0.50
Complementary Studies Elective					0.50
and two of:					
Thesis	ESC499H1 F	3	2	-	0.50
Thesis	ESC499Y1 Y	3	2	-	1.00
Spacecraft Dynamics and Control	AER506H1 F	3	-	1	0.50
Introduction to Fusion Energy	AER507H1 F	3	-	1	0.50
Robotics	AER525H1 F	3	1.50	1	0.50
Systems Control	ECE557H1 F	3	1.50	1	0.50
Advanced Atmospheric Physics	PHY492H1 F	2	-	-	0.50
Other Technical Elective					0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Aircraft Design	AER406H1 S	-	-	3	0.50
Complementary Studies Elective					0.50
and three of:					
Thesis	ESC499H1 S	3	2	-	0.50
Thesis	ESC499Y1 Y	3	2	-	1.00
Aeroelasticity	AER503H1 S	3	-	1	0.50
Aerospace Propulsion	AER510H1 S	3	-	1	0.50
Mobile Robotics and Perception	AER521H1 S	3	1.50	1	0.50
Applied Nonlinear Equations	APM446H1 S	3	-	-	0.50
Other Technical Elective					0.50

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, AER521H1 or AER525H1.

OPTION BIOMEDICAL SYSTEMS ENGINEERING (AEESCBASET)

YEAR 3 BIOMEDICAL SYSTEMS ENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Modeling, Dynamics, and Control of Biological Systems	BME344H1 F	3	-	1	0.50
Biomedical Systems Engineering I: Organ Systems	BME350H1 F	3	1	2	0.50
Biomedical Systems Engineering II: Cells and Tissues	BME395H1 F	2	1	2	0.50
Organic Chemistry and Biochemistry	CHE391H1 F	3	1.50	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Biomedical Engineering and Omics Technologies	BME346H1 S	2	4	-	0.50
Molecular Biophysics	BME358H1 S	3	-	1	0.50
Biomedical Systems Engineering III: Molecules and Cells	BME396H1 S	3	3	1	0.50
Biomaterials and Biocompatibility	MSE352H1 S	3	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
CS/HSS or Technical Elective					0.50

1. Students may take a CS/HSS or Technical Elective in 3F and take CHE374H1 in 4F.
2. 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.

YEAR 4 BIOMEDICAL SYSTEMS ENGINEERING

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00
Biomedical Systems Engineering IV: Computational Systems Biology	BME428H1 F	3	-	2	0.50
Biomedical Systems Engineering Design	BME489H1 F	1	-	4	0.50
CS/HSS or Technical Elective					0.50
CS/HSS or Technical Elective					0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00
Biomechanics I	MIE439H1 S	3	2	-	0.50
CS/HSS or Technical Elective					0.50
CS/HSS or Technical Elective					0.50
CS/HSS or Technical Elective					0.50

1. Students who completed MIE439H1 in Year 3 are required to take a Technical Elective.
2. Students must complete 2.0 credits of Technical Electives, and 1.0 Credit of Complementary Studies (CS)/Humanities and Social Sciences (HSS) electives in years 3 and 4. All students must fulfill the Faculty graduation requirement of 2.0 CS/HSS credits, at least 1.0 of which must be HSS. ESC203 is 0.5 HSS. Technical and CS/HSS Electives may be taken in any sequence.

TECHNICAL ELECTIVES

Technical Electives		Lect.	Lab.	Tut.	Wgt.
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Systems and Synthetic Biology					
Modelling in Biological and Chemical Systems	CHE471H1 S	3	-	1	0.50
Regulatory Networks and Systems in Molecular Biology	CSB435H1 S	2	-	-	0.50
Proteomics in Systems Biology	CSB450H1 F	2	-	-	0.50
Introduction to Databases	CSC343H1 F/S	2	-	1	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50
Regenerative Medicine and Biomaterials					
Biomaterial and Medical Device Product Development	BME460H1 F	2	-	2	0.50
Regenerative Medicine	BME510H1 S	4	-	-	0.50
Biocomposites: Mechanics and Bioinspiration	CHE475H1 S	3	-	1	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	3	-	-	0.50
* Design of Innovative Products	MIE440H1 F	2	2	1	0.50
Biotransport Phenomena	MIE520H1 F	3	-	1	0.50
Surgical and Dental Implant Design	MSE442H1 S	3	-	1	0.50

Technical Electives		Lect.	Lab.	Tut.	Wgt.
Neuro Sensory and Rehab Engineering					
Human Whole Body Biomechanics	BME430H1 S	3	2	-	0.50
Neurobiology of the Synapse	CSB332H1 S	2	-	-	0.50
The Design of Interactive Computational Media	CSC318H1 F/S	2	-	1	0.50
Human-Computer Interaction	CSC428H1 S	2	-	1	0.50
Communication Systems	ECE363H1 S	3	1.50	1	0.50
Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Sensory Communication	ECE446H1 F	3	1.50	1	0.50
Robot Modeling and Control	ECE470H1 S	3	1.50	1	0.50
Systems Control	ECE557H1 F	3	1.50	1	0.50
Introduction to Neuroscience	HMB200H1 S	2	-	1	0.50
* Design of Innovative Products	MIE440H1 F	2	2	1	0.50
Sensors, Nano/Microsystems and Instrumentation					
Medical Imaging	BME595H1 S	2	3	1	0.50
Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
Signal Analysis and Communication	ECE355H1 F	3	-	2	0.50
Real-Time Computer Control	ECE411H1 S	3	1.50	1	0.50
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50
Digital Signal Processing	ECE455H1 F	3	1.50	1	0.50
* MEMS Design and Microfabrication	MIE506H1 S	3	1.50	1	0.50
Structure and Characterization of Nanostructured Materials	MSE358H1 S	3	1.50	1	0.50

1. Students are required to take a minimum of two technical electives from one focus area (Systems and Synthetic Biology; Regenerative Medicine and Biomaterials; Neuro, Sensory and Rehab Engineering; or Sensors, Nano/Microsystems and Instrumentation).

OPTION ELECTRICAL AND COMPUTER ENGINEERING (AEESCBASER)

YEAR 3 ELECTRICAL AND COMPUTER ENGINEERING

Fall Session-Year 3		Lect.	Lab.	Tut.	Wgt.
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Introduction to Energy Systems	ECE349H1 F	3	1.50	1	0.50
Computer Organization	ECE352H1 F	3	3	-	0.50
Signal Analysis and Communication	ECE355H1 F	3	-	2	0.50
Electronics	ECE360H1 F	3	1.50	1	0.50
Complex Analysis	MAT389H1 F	3	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25

Winter Session-Year 3		Lect.	Lab.	Tut.	Wgt.
Systems Software	ECE353H1 S	3	3	-	0.50
Linear Systems and Control	ECE356H1 S	3	1.50	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
One ECE Elective	. S	-	-	-	0.50
Three Of:					
Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50
Electronic Circuits	ECE354H1 S	3	1.50	0.50	0.50
Electromagnetic Fields	ECE357H1 S	3	1.50	1	0.50
Foundations of Computing	ECE358H1 S	3	-	1	0.50
Communication Systems	ECE363H1 S	3	1.50	1	0.50

1. CHE374H1: It is strongly recommended that students take this course in 3F, but students may choose to take it in 4F.

YEAR 4 ELECTRICAL AND COMPUTER ENGINEERING

Year 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00
Two (2) Complementary Studies Electives					1.00
Three (3) ECE electives and Two (2) ECE or Technical Electives					2.50
and one of:					
Digital Systems Design	ECE532H1 S	3	3	-	0.50
Energy Systems Capstone Design	ESC470H1 S	-	-	5	0.50
Electrical and Computer Capstone Design	ESC472H1 S	-	-	5	0.50
Biomedical Engineering Capstone Design	BME498Y1 Y	2	3	-	1.00

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.
3. Students enrolled in the Electrical and Computer Engineering Option may take a maximum of four (4) 300- or 400-series courses in the Department of Computer Science (CSC).
4. Students who choose to take BME498Y1Y will take only one (1) “ECE or Technical Elective”.

ECE Electives

ECE Electives		Lect.	Lab.	Tut.	Wgt.
Photonics and Semiconductor Physics					
Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50
Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Lasers and Detectors	ECE525H1 S	3	-	2	0.50
Photonic Devices	ECE527H1 F	3	-	2	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		Lect.	Lab.	Tut.	Wgt.
Control, Communications, Signal Processing					
Medical Imaging	BME595H1 S	2	3	1	0.50
Communication Systems	ECE363H1 S	3	1.50	1	0.50
Real-Time Computer Control	ECE411H1 S	3	1.50	1	0.50
Digital Communication	ECE417H1 S	3	1.50	1	0.50
Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Sensory Communication	ECE446H1 F	3	1.50	1	0.50
Digital Signal Processing	ECE455H1 F	3	1.50	1	0.50
Multimedia Systems	ECE462H1 S	3	2	-	0.50
Wireless Communication	ECE464H1 S	3	1.50	1	0.50
Robot Modeling and Control	ECE470H1 S	3	1.50	1	0.50
Intelligent Image Processing	ECE516H1 S	3	3	-	0.50
Inference Algorithms and Machine Learning	ECE521H1 S	3	-	2	0.50
Random Processes	ECE537H1 F	3	-	2	0.50
Systems Control	ECE557H1 F	3	1.50	1	0.50

ECE Electives

ECE Electives		Lect.	Lab.	Tut.	Wgt.
Electromagnetics and Energy Systems					
Electromagnetic Fields	ECE357H1 S	3	1.50	1	0.50
Energy Systems and Distributed Generation	ECE413H1 S	3	1.50	1	0.50
Radio and Microwave Wireless Systems	ECE422H1 S	3	1.50	1	0.50
Microwave Circuits	ECE424H1 F	3	1.50	1	0.50
Electric Drives	ECE463H1 S	3	1.50	1	0.50
Introduction to Lighting Systems	ECE510H1 F	3	-	2	0.50
Power Electronics: Converter Topologies	ECE514H1 F	3	1.50	1	0.50
Power Electronics: Switch-Mode Power Supplies	ECE533H1 S	3	1	1	0.50
Computer Hardware and Computer Networks					
Computer Networks I	ECE361H1 F/S	3	1.50	1	0.50
Internetworking	ECE461H1 F	3	1.50	0.50	0.50
Computer Networks II	ECE466H1 S	3	1.50	1	0.50
Computer Architecture	ECE552H1 F	3	1.50	1	0.50

ECE Electives		Lect.	Lab.	Tut.	Wgt.
Analog and Digital Electronics					
Digital Electronics	ECE334H1 F/S	3	1.50	1	0.50
Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50
Electronic Circuits	ECE354H1 S	3	1.50	0.50	0.50
Analog Signal Processing Circuits	ECE412H1 S	3	-	2	0.50
Analog Integrated Circuits	ECE430H1 F	3	1.50	1	0.50
VLSI Technology	ECE437H1 F	3	3	-	0.50
VLSI Systems and Design	ECE451H1 S	3	3	-	0.50

ECE Electives

ECE Electives		Lect.	Lab.	Tut.	Wgt.
Software					
Programming on the Web	CSC309H1 F/S	2	-	1	0.50
The Design of Interactive Computational Media	CSC318H1 F/S	2	-	1	0.50
Programming Languages	CSC326H1 F	3	1.50	1	0.50
Introduction to Databases	CSC343H1 F/S	2	-	1	0.50
Introduction to Artificial Intelligence	CSC384H1 F/S	2	-	1	0.50
Natural Language Computing	CSC401H1 S	2	-	1	0.50
Machine Learning and Data Mining	CSC411H1 F/S	2	-	1	0.50
Computer Graphics	CSC418H1 F/S	2	-	1	0.50
Human-Computer Interaction	CSC428H1 S	2	-	1	0.50

ECE Electives		Lect.	Lab.	Tut.	Wgt.
Software (continued)					
Database System Technology	CSC443H1 S	2	-	1	0.50
Software Engineering I	CSC444H1 F	3	1.50	1	0.50
Compilers and Interpreters	CSC467H1 F	3	1.50	1	0.50
Foundations of Computing	ECE358H1 S	3	-	1	0.50
Distributed Systems	ECE419H1 S	3	1.50	1	0.50
Software Engineering II	ECE450H1 S	3	1.50	1	0.50
Computer Systems Programming	ECE454H1 F	3	3	-	0.50
Internetworking	ECE461H1 F	3	1.50	0.50	0.50
Inference Algorithms and Machine Learning	ECE521H1 S	3	-	2	0.50
Optimizing Compilers	ECE540H1 S	3	3	-	0.50
Computer Security	ECE568H1 F/S	3	3	-	0.50

Technical Electives

Technical Electives		Lect.	Lab.	Tut.	Wgt.
ECE Electives, or any of the following:					
Scientific Computing	AER336H1 S	3	-	1	0.50
Introduction to Fusion Energy	AER507H1 F	3	-	1	0.50
Mobile Robotics and Perception	AER521H1 S	3	1.50	1	0.50
Robotics	AER525H1 F	3	1.50	1	0.50
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Groups and Symmetries	MAT301H1 F/S	3	-	-	0.50
Elements of Analysis	MAT336H1 S	3	-	-	0.50
Structure and Characterization of Nanostructured Materials	MSE358H1 S	3	1.50	1	0.50
Physics of the Earth (Formerly PHY395H1)	JPE395H1 S	-	-	-	0.50

OPTION ENERGY SYSTEMS ENGINEERING (AEESCBASEJ)

YEAR 3 ENERGY SYSTEMS ENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Energy Systems and Fuels: Global Needs, Challenges, and Technological Opportunities	CHE308H1 F	3	-	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Introduction to Energy Systems	ECE349H1 F	3	1.50	1	0.50
Terrestrial Energy Systems	ENV346H1 F	3	-	3	0.50
Mechanical and Thermal Energy Conversion Processes	MIE303H1 F	3	1.50	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Control Systems	AER372H1 S	3	1.50	1	0.50
Energy Policy	APS305H1 S	3	-	1	0.50
Energy Systems and Distributed Generation	ECE413H1 S	3	1.50	1	0.50
Electric Drives	ECE463H1 S	3	1.50	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
Technical Elective					0.50

YEAR 4 ENERGY SYSTEMS ENGINEERING

Core Courses		Lect.	Lab.	Tut.	Wgt.
Design and Optimization of Hydro and Wind Electric Plants	CIV401H1 F	3	-	2	0.50
Energy Systems Capstone Design	ESC470H1 S	-	-	5	0.50
Thesis	ESC499Y1 Y	3	2	-	1.00
Four (4) Technical Electives					
One (1) HSS/CS Elective					
One (1) Free Elective					

TECHNICAL ELECTIVES

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Introduction to Fusion Energy	AER507H1 F	3	-	1	0.50
Petroleum Processing	CHE451H1 F	3	-	-	0.50
Aqueous Process Engineering	CHE565H1 F	3	-	1	0.50
Elements of Nuclear Engineering	CHE566H1 F	3	-	1	0.50
Studies in Building Science	CIV575H1 F	3	-	2	0.50
Introduction to Lighting Systems	ECE510H1 F	3	-	2	0.50
Power Electronics: Converter Topologies	ECE514H1 F	3	1.50	1	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50
Nuclear Reactor Theory and Design	MIE407H1 F	3	-	2	0.50
Machine Design	MIE442H1 F	3	1.50	3	0.50
Alternative Energy Systems	MIE515H1 F	3	-	1	0.50
Combustion and Fuels	MIE516H1 F	3	-	1	0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Chemical Reaction Engineering	CHE333H1 S	3	-	2	0.50
Advanced Reactor Design	CHE412H1 S	3	-	1	0.50
Fuel Cells and Electrochemical Conversion Devices	CHE469H1 S	3	-	1	0.50
Nuclear Engineering	CHE568H1 S	3	-	1	0.50
Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Sustainable Buildings	CIV576H1 S	3	-	1	0.50
Electromagnetic Fields	ECE357H1 S	3	1.50	1	0.50
Power Electronics: Switch-Mode Power Supplies	ECE533H1 S	3	1	1	0.50
Bioenergy from Sustainable Forest Management	FOR310H1 S	2	-	1	0.50
Bioenergy and Biorefinery Technology	FOR425H1 S	2	-	2	0.50
Physics of the Earth (Formerly PHY395H1)	JPE395H1 S	-	-	-	0.50
Design for the Environment	MIE315H1 S	3	-	1	0.50
* Thermal and Machine Design of Nuclear Power Reactors	MIE408H1 S	3	-	2	0.50
Fuel Cell Systems	MIE517H1 S	3	-	1	0.50
Nanotechnology in Alternate Energy Systems	MSE458H1 S	3	-	2	0.50

1. Students who completed CIV301H1 in Year 3 are required to take a technical elective in place of CIV401H1.

2. APS305H1, a core course within the Energy curriculum, counts towards the Complementary Studies requirement.

3. Students may substitute a CS/HSS or free elective for the technical elective in 3S by taking an additional technical elective in place of the CS/HSS or free elective in the fourth year.

OPTION INFRASTRUCTURE ENGINEERING (AEESCBASEI)

YEAR 3 INFRASTRUCTURE ENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Structural Design 1	CIV352H1 F	3	-	2	0.50
Urban Operations Research	CIV355H1 F	3	-	2	0.50
Transport Planning	CIV531H1 F	3	-	1	0.50
Geotechnical Engineering I	CME321H1 F	3	1	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Mechanics of Solids and Structures	AER373H1 S	3	-	1	0.50
Structural Design 2	CIV357H1 S	3	-	2	0.50
Road Transportation Performance	CIV360H1 S	3	-	1	0.50
Public Transit Operations and Planning	CIV516H1 S	3	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
Complementary Studies Elective					0.50

YEAR 4 INFRASTRUCTURE ENGINEERING

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Collaborative Design Project I	CIV455H1 F	1	3	-	0.50
Engineering Project Finance and Management	CIV460H1 F	3	-	1	0.50
Thesis	ESC499H1 F	3	2	-	0.50
Specialty Elective 1					0.50
Technical Elective					0.50
Take any one from the following:					
Survey CAMP (Civil and Mineral Practicals)	CME358H1 F	-	-	-	0.50
Transportation Specialty					
Technology in Society and the Biosphere I	APS301H1 F	3	-	1	0.50
Management of Construction	CIV280H1 F	3	-	2	0.50
Alternative Energy Systems	MIE515H1 F	3	-	1	0.50
Structures Specialty					
Reinforced Concrete II	CIV416H1 F	3	-	2	0.50
Concrete Technology	CIV514H1 F	3	-	2	0.50
Introduction to Structural Dynamics	CIV515H1 F	3	-	1	0.50
Prestressed Concrete	CIV517H1 F	3	-	-	0.50
Studies in Building Science	CIV575H1 F	3	-	2	0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Collaborative Design Project II	CIV456H1 S	1	3	-	0.50
Specialty Elective 2					0.50
Specialty Elective 3					0.50
Specialty Elective 4					0.50
Complementary Studies Elective					0.50
Take any three from the following:					
Transportation Specialty					
Sustainable Energy Systems	CIV380H1 S	3	-	1	0.50
Infrastructure for Sustainable Cities	CIV577H1 S	3	-	1	0.50
Structures Specialty					
Solid Mechanics II	CIV510H1 S	3	-	2	0.50
Behaviour and Design of Steel Structures	CIV518H1 S	3	-	2	0.50
Geotechnical Design	CIV523H1 S	3	-	1	0.50
Sustainable Buildings	CIV576H1 S	3	-	1	0.50

1. Students who do not wish to specialize may take courses from either the Transportation or Structures List.
2. Students may take a half year thesis in the spring term, if they shift a specialty elective into the fall term. Students may opt for a full-year thesis by replacing 0.5 Specialty Elective credit with the additional 0.5 credit for Thesis.
3. Senior students may take 1000-series (graduate level) courses as Specialty Electives, provided they obtain the approval of the Department of Civil Engineering and the Divison of Engineering Science. In particular, courses on Transportation and Air Quality, Mechanics of Reinforced Concrete, Infrastructure Economics, Simulation, Freight Transportation and ITS Applications, Airport Planning, Transportation and Development, Transportation Demand Analysis, Bridge Engineering, Principles of Earthquake Engineering and Seismic Design, and Finite Element Methods in Structural Mechanics may be of interest to Infrastructure Option students.
4. The Technical Elective may be chosen from any 400 or 500 level technical course offered in Engineering provided students have taken the pre-requisite course(s). Other non-Engineering courses may be taken with the approval of the Division of Engineering Science.
5. CME358H1 is offered during the summer and may be taken to satisfy a Specialty Elective for either the Fall or Winter semester in Year 4. CME358H1 may be taken in the summer following Year 2 or Year 3. Enrolment in the course is limited; priority is given to currently registered Civil and Mineral students, and is available to Engineering Science Infrastructure Majors on a space-available basis. Note: There is an additional fee associated with CME358H1 to cover room and board during the survey camp.

OPTION ENGINEERING MATHEMATICS, STATISTICS & FINANCE (AEESCBASEF)

Year 3 ENGINEERING MATHEMATICS, STATISTICS & FINANCE

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Financial Engineering	MIE375H1 F	3	-	1	0.50
Methods of Data Analysis I	STA302H1 F	3	-	-	0.50
Probability	STA347H1 F	3	-	-	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Financial Principles for Actuarial Science II	ACT370H1 S	3	-	-	0.50
Engineering Finance and Economics	CHE375H1 S	3	-	1	0.50
Elements of Analysis	MAT336H1 S	3	-	-	0.50
Mathematical Programming (Optimization)	MIE376H1 S	3	2	1	0.50
Financial Optimization Models	MIE377H1 S	3	1	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25

Year 4 ENGINEERING MATHEMATICS, STATISTICS & FINANCE

Year 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00
Stochastic Methods for Actuarial Science	ACT460H1 F	3	-	-	0.50
Engineering Mathematics, Statistics and Finance Capstone Design	MIE479H1 F	-	-	5	0.50
Two (2) Complementary Studies Electives					1.00
Four (4) Technical Elective					2.00

1. Students may take a half-year thesis ESC499H1 and an additional 0.5 credit from the electives list instead of a full-year thesis ESC499Y1.

Technical Electives

Electives		Lect.	Lab.	Tut.	Wgt.
Introduction to Databases	CSC343H1 F	2	-	1	0.50
Random Processes	ECE537H1 F	3	-	2	0.50
Systems Modelling and Simulation	MIE360H1 F	3	2	1	0.50
Operations Research III: Advanced OR	MIE365H1 F	3	2	1	0.50
Scheduling	MIE562H1 F	3	-	2	0.50
Decision Analysis	MIE566H1 F	3	-	2	0.50
Fixed Income Securities	RSM430H1 F	2	-	-	0.50
Statistical Computation	STA410H1 F	3	-	-	0.50
Other Technical Elective					0.50

Electives		Lect.	Lab.	Tut.	Wgt.
Scientific Computing	AER336H1 S	3	-	1	0.50
Mathematical Theory of Finance	APM466H1 S	3	-	-	0.50
Modelling in Biological and Chemical Systems	CHE471H1 S	3	-	1	0.50
Data-based Modelling for Prediction and Control	CHE507H1 S	3	-	1	0.50
Data Structures and Analysis	CSC263H1 S	-	-	-	0.50
Introduction to Databases	CSC343H1 S	2	-	1	0.50
Machine Learning and Data Mining	CSC411H1 S	2	-	1	0.50
Foundations of Computing	ECE358H1 S	3	-	1	0.50
Inference Algorithms and Machine Learning	ECE521H1 S	3	-	2	0.50
Cases in Operations Research	MIE367H1 S	3	-	2	0.50
Knowledge Modelling and Management	MIE457H1 S	3	1	1	0.50
Risk Management for Financial Managers	RSM432H1 S	2	-	-	0.50
Financial Trading Strategies (formerly RSM412H1 Financial Trading Strategies)	RSM434H1 S	2	-	-	0.50
Stochastic Processes (formerly STA348H1)	STA447H1 S	3	-	-	0.50
Other Technical Elective					0.50

OPTION NANOENGINEERING (AEESCBASEO)

*Please note: The Engineering Science Major in Nanoengineering is closing. Students who enter Year 1 of the Engineering Science program after Fall 2014 will not be allowed to select this major.

YEAR 3 NANOENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Physical and Inorganic Chemistry	CHE390H1 F	3	-	1	0.50
Organic Chemistry and Biochemistry	CHE391H1 F	3	1.50	1	0.50
Quantum Mechanics I	PHY356H1 F	2	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
and one of:					
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Complex Analysis	MAT389H1 F	3	-	1	0.50

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Introduction to Inorganic and Polymer Materials Chemistry	CHM325H1 S	2	-	-	0.50
Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50
Structure and Characterization of Nanostructured Materials	MSE358H1 S	3	1.50	1	0.50
Advanced Physics Laboratory	PHY327H1 S	-	6	-	0.50
Atoms, Molecules and Solids	PHY358H1 S	2	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25

YEAR 4 NANOENGINEERING

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00
Engineering Science Capstone Design	ESC471H1 F	-	-	5	0.50
Synthesis of Nanostructured Materials	MSE459H1 F	3	2	-	0.50
Complementary Studies Elective					0.50
and one of:					
Biomedical Systems Engineering II: Cells and Tissues	BME395H1 F	2	1	2	0.50
Environmental Engineering	CHE467H1 F	3	-	1	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	3	-	-	0.50
Advanced Materials Chemistry	CHM434H1 F	2	-	-	0.50
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50
Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50
Complex Analysis	MAT389H1 F	3	-	1	0.50
Alternative Energy Systems	MIE515H1 F	3	-	1	0.50
Electronic Materials	MSE430H1 F	2	-	1	0.50
Advanced Physics Laboratory	PHY427H1 F	-	6	-	0.50
Laser Physics	PHY485H1 F	2	-	-	0.50
Condensed Matter Physics	PHY487H1 F	2	-	-	0.50
Other Technical Elective					0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00
Materials Physics II	MSE462H1 S	2	-	1	0.50
Complementary Studies Elective					0.50
and two of:					
Organic Materials Chemistry	CHM446H1 S	2	-	-	0.50
Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
Linear Systems and Control	ECE356H1 S	3	1.50	1	0.50
Lasers and Detectors	ECE525H1 S	3	-	2	0.50
Biomaterials and Biocompatibility	MSE352H1 S	3	-	1	0.50
Forensic Engineering	MSE431H1 S	3	-	1	0.50
Advanced Physical Properties of Structural Nanomaterials	MSE451H1 S	3	2	1	0.50
Nanotechnology in Alternate Energy Systems	MSE458H1 S	3	-	2	0.50
Advanced Physics Laboratory	PHY427H1 S	-	6	-	0.50
Statistical Mechanics	PHY452H1 S	2	-	-	0.50
Other Technical Elective					0.50

OPTION ENGINEERING PHYSICS (AEESCBASEP)

YEAR 3 ENGINEERING PHYSICS

Fall Session Year 3		Lect.	Lab.	Tut.	Wgt.
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Electronics	ECE360H1 F	3	1.50	1	0.50
Advanced Physics Laboratory	PHY327H1 F	-	6	-	0.50
Quantum Mechanics I	PHY356H1 F	2	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
At least one of:					
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Complex Analysis	MAT389H1 F	3	-	1	0.50

Winter Session- Year 3		Lect.	Lab.	Tut.	Wgt.
Electromagnetic Fields	ECE357H1 S	3	1.50	1	0.50
Classical Mechanics	PHY354H1 S	2	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
Four (4) Group A Electives					2.00

1.It is highly recommended that students take one of ECE342H1, ECE350H1, ECE455H1, 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 5.75 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

YEAR 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00
Engineering Science Capstone Design	ESC471H1 F	-	-	5	0.50
Two (2) Complementary Studies electives					1.00

YEAR 4	Lect.	Lab.	Tut.	Wgt.
Three (3) electives from Group B				1.50
Two (2) electives from Groups A or B				1.00

Group A and B Electives

Group A Electives		Lect.	Lab.	Tut.	Wgt.
Introduction to Fusion Energy	AER507H1 F	3	-	1	0.50
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Introduction to Astrophysics	AST320H1 S	2	-	-	0.50
Introduction to Practical Astronomy	AST325H1 F	-	3	-	0.50
Nuclear Engineering	CHE568H1 S	3	-	1	0.50
Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
Computer Hardware	ECE342H1 S	3	3	-	0.50
Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50
Digital Signal Processing	ECE455H1 F	3	1.50	1	0.50
Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Lasers and Detectors	ECE525H1 S	3	-	2	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50
Groups and Symmetries	MAT301H1 F/S	3	-	-	0.50
Elements of Analysis	MAT336H1 S	3	-	-	0.50
Complex Analysis	MAT389H1 F	3	-	1	0.50
Polynomial Equations and Fields	MAT401H1 F	3	-	-	0.50
Classical Geometries	MAT402H1 S	3	-	-	0.50
Structure and Characterization of Nanostructured Materials	MSE358H1 S	3	1.50	1	0.50
Nuclear and Particle Physics	PHY357H1 S	2	-	1	0.50
Atoms, Molecules and Solids	PHY358H1 S	2	-	1	0.50
Physics of Climate	PHY392H1 S	2	-	-	0.50
Physics of the Earth (Formerly PHY395H1)	JPE395H1 S	-	-	-	0.50
Time Series Analysis	PHY408H1 S	1	2	-	0.50
Advanced Physics Laboratory	PHY427H1 F/S	-	6	-	0.50
Advanced Practical Physics II	PHY428H1 F/S	-	6	-	0.50
Advanced Practical Physics III	PHY429H1 F/S	-	6	-	0.50
Relativity Theory II	PHY484H1 S	2	-	-	0.50

Group B Electives		Lect.	Lab.	Tut.	Wgt.
Seismology (Formerly PHY493H1)	JPE493H1 F	-	-	-	0.50
Computational Physics	PHY407H1 F	1	3	-	0.50
Relativistic Electrodynamics	PHY450H1 S	2	-	1	0.50
Statistical Mechanics	PHY452H1 S	2	-	-	0.50
Continuum Mechanics	PHY454H1 S	2	-	1	0.50
Quantum Mechanics II	PHY456H1 F	2	-	1	0.50
Nonlinear Physics	PHY460H1 S	2	-	-	0.50
Relativity Theory I	PHY483H1 F	2	-	-	0.50
Laser Physics	PHY485H1 F	2	-	-	0.50
Condensed Matter Physics	PHY487H1 F	2	-	-	0.50
Introduction to High Energy Physics	PHY489H1 F	2	-	-	0.50
Advanced Atmospheric Physics	PHY492H1 F	2	-	-	0.50
Geophysical Imaging: EM and Potential Fields	PHY494H1 F	2	-	-	0.50
Research Topic in Geophysics	PHY495H1 F	2	-	-	0.50

OPTION ROBOTICS ENGINEERING (AEESCBASEZ)

Year 3 ROBOTICS ENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Dynamics	AER301H1 F	3	-	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50
Data Structures and Analysis	CSC263H1 F	-	-	-	0.50
Circuits with Applications to Mechanical Engineering Systems	MIE342H1 F	3	1.50	1	0.50
Introduction to Robotics	ROB301H1 F	3	1.50	1	0.50
Mathematics for Robotics	ROB310H1 F	3	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Control Systems	AER372H1 S	3	1.50	1	0.50
Introduction to Artificial Intelligence	CSC384H1 S	2	-	1	0.50
Machine Learning and Data Mining	CSC411H1 S	2	-	1	0.50
Analog and Digital Electronics for Mechatronics	MIE346H1 S	3	1.50	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	1	-	-	0.25
CS/HSS or Technical Elective					0.50

Year 4 ROBOTICS ENGINEERING

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00
Robot Modeling and Control	ECE470H1 F	3	1.50	1	0.50
Systems Control	ECE557H1 F	3	1.50	1	0.50
Computer Vision for Robotics	ROB501H1 F	3	-	1	0.50
CS/HSS or Technical Elective					0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00
Mobile Robotics and Perception	AER521H1 S	3	1.50	1	0.50
* Mechatronics Systems: Design and Integration	MIE443H1 S	2	5	-	0.50
CS/HSS or Technical Elective					0.50
CS/HSS or Technical Elective					0.50

1. Robotics Option students must complete 1.0 credit of Technical Electives, and 1.0 credit of Complementary Studies (CS)/Humanities and Social Sciences (HSS) electives in Years 3 and 4. All students must fulfill the Faculty graduation requirement of 2.0 CS/HSS credits, at least 1.0 of which must be HSS. ESC203 is 0.5 HSS. Technical and CS/HSS Electives may be taken in any sequence.

2. Students enrolled in the Robotics Option may take a maximum of four (4) 300- or 400-series courses in the Department of Computer Science (CSC), including the two core courses.

Students are required to select their technical electives from the list of approved courses below. Some courses have limited enrolment. Availability of elective courses for timetabling purposes is not guaranteed. It is the student's responsibility to ensure a conflict-free timetable. Technical Electives outside of the group of courses below must be approved in advance by the Division of Engineering Science.

TECHNICAL ELECTIVES

TECHNICAL ELECTIVES		Lect.	Lab.	Tut.	Wgt.
Functional Courses					
Scientific Computing	AER336H1 S	3	-	1	0.50
Partial Differential Equations	APM384H1 F	3	-	1	0.50
Introduction to Neural Networks and Machine Learning	CSC321H1 S	-	-	-	0.50
Natural Language Computing	CSC401H1 S	2	-	1	0.50
Probabilistic Learning and Reasoning	CSC412H1 S	-	-	-	0.50
Computational Linguistics	CSC485H1 F	-	-	-	0.50
Knowledge Representation and Reasoning	CSC486H1 S	-	-	-	0.50
Systems Software	ECE353H1 S	3	3	-	0.50
Real-Time Computer Control	ECE411H1 S	3	1.50	1	0.50
Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Digital Signal Processing	ECE455H1 F	3	1.50	1	0.50
Intelligent Image Processing	ECE516H1 S	3	3	-	0.50
Inference Algorithms and Machine Learning	ECE521H1 S	3	-	2	0.50
Digital Systems Design	ECE532H1 S	3	3	-	0.50
Geometry of Curves and Surfaces	MAT363H1 S	3	-	-	0.50
Complex Analysis	MAT389H1 F	3	-	1	0.50
Microprocessors and Embedded Microcontrollers	MIE438H1 S	2	3	-	0.50
* Mechatronics Principles	MIE444H1 F	2	3	-	0.50
Other technical elective					0.50

TECHNICAL ELECTIVES		Lect.	Lab.	Tut.	Wgt.
Application Courses					
Aircraft Flight	AER302H1 S	3	-	1	0.50
Aerodynamics	AER307H1 F	3	-	1	0.50
Space Systems Design	AER407H1 F	-	3	-	0.50
Biomedical Systems Engineering I: Organ Systems	BME350H1 F	3	1	2	0.50
Human Whole Body Biomechanics	BME430H1 S	3	2	-	0.50
Automated Manufacturing	MIE422H1 F	2	3	-	0.50
Biomechanics I	MIE439H1 S	3	2	-	0.50
Micro/Nano Robotics	MIE505H1 S	3	3	-	0.50

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.

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FIRST YEAR MATERIALS ENGINEERING

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.	Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Orientation to Engineering	APS100H1 F	1	-	1	0.25	Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Engineering Chemistry and Materials Science	APS110H1 F	3	1	1	0.50	Engineering Strategies &Practice II	APS112H1 S	2	2	-	0.50
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50	Physical Chemistry	CHE112H1 S	3	1	1	0.50
Mechanics	CIV100H1 F	3	-	2	0.50	Electrical Fundamentals	ECE110H1 S	3	1	2	0.50
Calculus I	MAT186H1 F	3	-	1	0.50	Calculus II	MAT187H1 S	3	-	1	0.50
Linear Algebra	MAT188H1 F	3	1	1	0.50	Introduction to Materials Science	MSE101H1 F/S	3	1	1	0.50

Approved Course Substitution

1. Students are able to substitute MAT186H1 with the online calculus course APS162H1.
2. Students are able to substitute MAT187H1 with the online calculus course APS163H1.
3. Students are able to substitute APS110H1 with the online course APS164H1.

SECOND YEAR MATERIALS ENGINEERING

Fall Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Calculus and Differential Equations	MAT294H1 F	3	-	2	0.50
Thermodynamics	MSE202H1 F	3	-	2	0.50
Structure and Characterization of Materials	MSE219H1 F	3	3	1	0.50
Inorganic Materials Chemistry and Processing	MSE244H1 F	3	3	1	0.50
Humanities/Complementary Studies Elective					0.50

Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Mechanics of Solids I	MIE222H1 S	3	1.50	1.50	0.50
Diffusion and Kinetics	MSE217H1 S	3	-	2	0.50
Engineering Statistics and Numerical Methods	MSE238H1 S	3	-	2	0.50
Organic Materials Chemistry and Properties	MSE245H1 S	3	3	1	0.50
Communications I	MSE290H1 S	1	-	1	0.25
Humanities/Complementary Studies Elective					0.50

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 summer vacation periods).

ENGINEERING SUMMER INTERNSHIP PROGRAM (eSIP) PROGRAM

The Engineering Summer Internship Program (eSIP) is a paid summer co-op program offered through the Engineering Career Centre. It is available to eligible engineering students in year 2 or 3 of study, including engineering international students. eSIP is more akin to a traditional co-op placement, where students work for four months and thus serves as an introductory career development program for participants. 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.

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, 222 College Street, Suite 106.

THIRD YEAR MATERIALS ENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Engineering Economics and Accounting	MIE258H1 F	3	-	1	0.50
Phase Transformations	MSE318H1 F	3	3	1	0.50
Heat and Mass Transfer for Materials Processing	MSE332H1 F	3	-	2	0.50
Nanomaterials	MSE342H1 F	2	-	1	0.25
Biomaterials	MSE343H1 F	2	-	1	0.25
Communications II	MSE390H1 F	1	-	1	0.25
Humanities/Complementary Studies					0.50

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Environmental Degradation of Materials	MSE315H1 S	3	-	2	0.50
Mechanical Behaviour of Materials	MSE316H1 S	3	3	1	0.50
Materials Physics	MSE335H1 S	3	-	1	0.50
Design and Simulation of Materials Processes	MSE351H1 S	3	2	1	0.50
Materials in Manufacturing	MSE354H1 S	2	-	1	0.25
Materials Processing and Sustainable Development	MSE355H1 S	2	-	1	0.25
Humanities/Complementary Studies					0.50

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 now provides students with a planning tool, the "AU Tracker", to help students to 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

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Materials Selection in Design II	MSE401H1 F	2	2	1	0.50
Plant Design for Materials Process Industries	MSE450H1 F	2	-	3	0.50
Professional Ethics and Practice	MSE490H1 F	2	-	-	0.25
Design and Research Project	MSE498Y1 Y	3	6	2	1.00
Technical Elective					0.50
Technical Elective					0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Design and Research Project	MSE498Y1 Y	3	6	2	1.00
Technical Elective					0.50
Technical Elective					0.50
Technical Elective					0.50
Free Elective					0.50

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 courses 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:

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Engineering Biology	CHE353H1 F	2	-	2	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	3	-	-	0.50
Introduction to Computational Materials Design	MSE438H1 F	3	2	1	0.50
Biomaterial Processing and Properties	MSE440H1 F	3	-	1	0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Surgical and Dental Implant Design	MSE442H1 S	3	-	1	0.50
Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50

Materials for Manufacturing Theme:

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50
Fracture and Failure Analysis	MSE419H1 F	3	-	1	0.50
Introduction to Computational Materials Design	MSE438H1 F	3	2	1	0.50
Engineered Ceramics	MSE461H1 F	3	-	2	0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Solid State Processing and Surface Treatment	MSE421H1 S	3	-	2	0.50
Forensic Engineering	MSE431H1 S	3	-	1	0.50
Macromolecular Materials Engineering	MSE432H1 S	3	-	-	0.50

Materials Processing for Sustainable Development Theme:

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Aqueous Process Engineering	CHE565H1 F	3	-	1	0.50
Extractive Metallurgy	MSE404H1 F	3	-	2	0.50
Introduction to Computational Materials Design	MSE438H1 F	3	2	1	0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Energy Management in Materials Processing	MSE408H1 S	3	-	1	0.50
Process Simulation and Computer Design	MSE455H1 S	3	-	2	0.50
Innovation and Manufacturing of Sustainable Materials	FOR424H1 S	2	-	1	0.50

Nanomaterials Theme:

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50
Electronic Materials	MSE430H1 F	2	-	1	0.50
Introduction to Computational Materials Design	MSE438H1 F	3	2	1	0.50
Synthesis of Nanostructured Materials	MSE459H1 F	3	2	-	0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Optical and Photonic Materials	MSE435H1 S	3	1	2	0.50
Advanced Physical Properties of Structural Nanomaterials	MSE451H1 S	3	2	1	0.50
Nanotechnology in Alternate Energy Systems	MSE458H1 S	3	-	2	0.50

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.
Industrial Engineering bears close resemblance to: Management Science, Management Engineering, Operations Research, Operations Management, and Systems Engineering.
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

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Orientation to Engineering	APS100H1 F	1	-	1	0.25
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50
Mechanics	CIV100H1 F	3	-	2	0.50
Calculus I	MAT186H1 F	3	-	1	0.50
Linear Algebra	MAT188H1 F	3	1	1	0.50
Introduction to Materials Science	MSE101H1 F	3	1	1	0.50

Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Engineering Strategies &Practice II	APS112H1 S	2	2	-	0.50
Electrical Fundamentals	ECE110H1 S	3	1	2	0.50
Calculus II	MAT187H1 S	3	-	1	0.50
Dynamics	MIE100H1 S	3	-	2	0.50
Seminar Course: Introduction to Mechanical and Industrial Engineering	MIE191H1 S	1	-	-	0.15

Approved Course Substitution

1. Students are able to substitute MAT186H1 with the online calculus course APS162H1.
2. Students are able to substitute MAT187H1 with the online calculus course APS163H1.
3. Students are able to substitute APS110H1 with the online course APS164H1.

SECOND YEAR INDUSTRIAL ENGINEERING

Fall Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Probability	MIE236H1 F	3	-	2	0.50
Psychology For Engineers	MIE242H1 F	3	3	-	0.50
Fundamentals of Object Oriented Programming	MIE250H1 F	2	3	-	0.50
Engineering Economics and Accounting	MIE258H1 F	3	-	1	0.50
Modelling with Differential and Difference Equations	MAT231H1 F	3	-	2	0.50

Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Statistics	MIE237H1 S	3	1	2	0.50
Human Centred Systems Design	MIE240H1 S	3	-	2	0.50
Data Modelling	MIE253H1 S	3	2	-	0.50
Operations Research I: Deterministic OR	MIE262H1 S	3	2	1	0.50
Operations Research II: Stochastic OR	MIE263H1 S	3	-	2	0.50

THIRD YEAR INDUSTRIAL ENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Core Required Course					
Industrial Ergonomics and the Workplace	MIE343H1 F	3	3	-	0.50
Design and Analysis of Information Systems	MIE350H1 F	3	1	1	0.50
Systems Modelling and Simulation	MIE360H1 F	3	2	1	0.50
Natural Science Elective (Choose One):					
Engineering Biology	CHE353H1 F	2	-	2	0.50
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50
Technical Elective (Choose One):					
Ergonomic Design of Information Systems	MIE344H1 F	3	3	-	0.50
Business Process Engineering	MIE354H1 F	3	2	-	0.50
Operations Research III: Advanced OR	MIE365H1 F	3	2	1	0.50
Complementary Studies Elective					
CS Elective					0.50

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Core Required Course					
Algorithms &Numerical Methods	MIE335H1 S	3	1	1	0.50
Resource and Production Modelling	MIE363H1 S	3	-	2	0.50
Quality Control and Improvement	MIE364H1 S	3	1	2	0.50
Technical Elective (Choose One):					
Case Studies in Human Factors and Ergonomics	MIE345H1 S	3	-	2	0.50
Cases in Operations Research	MIE367H1 S	3	-	2	0.50
Analytics in Action	MIE465H1 S	3	2	-	0.50
Reliability and Maintainability Engineering	MIE469H1 S	3	-	2	0.50
Complementary Studies Elective					
CS Elective					0.50

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.
3. Students may choose an alternative Natural Science course to the three listed. A list of approved alternative Natural Science courses offered by the Faculty of Arts & Science is 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, 222 College Street, Suite 106 early in session 2F or 3F.

FOURTH YEAR INDUSTRIAL ENGINEERING

FOURTH YEAR INDUSTRIAL ENGINEERING

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Core Required Courses:					
Integrated System Design	MIE463H1 F	3	-	2	0.50
Capstone Design	MIE490Y1 Y	-	-	4	1.00
Technical Electives (Choose Two):					
Financial Engineering	APS502H1 F	3	-	-	0.50
Ergonomic Design of Information Systems	MIE344H1 F	3	3	-	0.50
Business Process Engineering	MIE354H1 F	3	2	-	0.50
Operations Research III: Advanced OR	MIE365H1 F	3	2	1	0.50
Decision Support Systems	MIE451H1 F	3	1	1	0.50
Research Thesis	MIE498H1 F	-	-	4	0.50
Research Thesis	MIE498Y1 Y	-	-	4	1.00
Engineering Psychology and Human Performance	MIE523H1 F	3	3	-	0.50
Scheduling	MIE562H1 F	3	-	2	0.50
Decision Analysis	MIE566H1 F	3	-	2	0.50
Complementary Studies Elective					
CS Elective					0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Core Required Courses:					
Organization Design	MIE459H1 S	4	-	-	0.50
Capstone Design	MIE490Y1 Y	-	-	4	1.00
Technical Electives (Choose Two):					
Case Studies in Human Factors and Ergonomics	MIE345H1 S	3	-	2	0.50
Cases in Operations Research	MIE367H1 S	3	-	2	0.50
Knowledge Modelling and Management	MIE457H1 S	3	1	1	0.50
Analytics in Action	MIE465H1 S	3	2	-	0.50
Reliability and Maintainability Engineering	MIE469H1 S	3	-	2	0.50
Research Thesis	MIE498H1 S	-	-	4	0.50
Research Thesis	MIE498Y1 Y	-	-	4	1.00
Advanced Manufacturing Technologies	MIE519H1 S	3	-	-	0.50
Human Factors Integration	MIE542H1 S	3	-	2	0.50
Healthcare Systems	MIE561H1 S	3	-	2	0.50
Complementary Studies Elective					
CS Elective					0.50

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, MIE490Y1, 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 Regisrtar's website.
5. Approval to register for the fourth-year thesis course (MIE498H1 or MIE498Y1) must be obtained from the Associate Chair - Undergraduate, and is normally restricted to students with an overall average of at least B in their second and third years.

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 fromt he 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

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Orientation to Engineering	APS100H1 F	1	-	1	0.25
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50
Mechanics	CIV100H1 F	3	-	2	0.50
Calculus I	MAT186H1 F	3	-	1	0.50
Linear Algebra	MAT188H1 F	3	1	1	0.50
Introduction to Materials Science	MSE101H1 F	3	1	1	0.50

Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Engineering Strategies &Practice II	APS112H1 S	2	2	-	0.50
Electrical Fundamentals	ECE110H1 S	3	1	2	0.50
Calculus II	MAT187H1 S	3	-	1	0.50
Dynamics	MIE100H1 S	3	-	2	0.50
Seminar Course: Introduction to Mechanical and Industrial Engineering	MIE191H1 S	1	-	-	0.15

Approved Course Substitution

1. Students are able to substitute MAT186H1 with the online calculus course APS162H1.
2. Students are able to substitute MAT187H1 with the online calculus course APS163H1.
3. Students are able to substitute APS110H1 with the online course APS164H1.

SECOND YEAR MECHANICAL ENGINEERING

Fall Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Engineering Analysis	MIE230H1 F	3	-	2	0.50
Probability and Statistics with Engineering Applications	MIE231H1 F	3	2	2	0.50
Mechanical Engineering Design	MIE243H1 F	3	2	2	0.50
Materials Science	MIE270H1 F	3	0.75	1.50	0.50
Complementary Studies Elective					
CS Elective					0.50

Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Differential Equations	MAT234H1 S	3	-	1.50	0.50
Thermodynamics	MIE210H1 S	3	1.50	1	0.50
Manufacturing Engineering	MIE221H1 S	3	2	1	0.50
Mechanics of Solids I	MIE222H1 S	3	1.50	1.50	0.50
Complementary Studies Elective					
CS Elective					0.50

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, 222 College Street, Suite 106 early in session 2F or 3F.

THIRD YEAR MECHANICAL ENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Kinematics and Dynamics of Machines	MIE301H1 F	3	3	2	0.50
Fluid Mechanics I	MIE312H1 F	3	1	1	0.50
Circuits with Applications to Mechanical Engineering Systems	MIE342H1 F	3	1.50	1	0.50
Engineering Economics and Accounting	MIE358H1 F	3	-	1	0.50
Natural Science Elective (choose one):					
Engineering Biology	CHE353H1 F	2	-	2	0.50
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Core Required Courses					
Design for the Environment	MIE315H1 S	3	-	1	0.50
Heat and Mass Transfer	MIE313H1 S	3	1.50	2	0.50
Numerical Methods I	MIE334H1 S	3	-	1.50	0.50
Stream Options (Choose two streams)					
Manufacturing					
Quality Control and Improvement	MIE364H1 S	3	1	2	0.50
Mechatronics					
Analog and Digital Electronics for Mechatronics	MIE346H1 S	3	1.50	1	0.50
Solid Mechanics &Design					
Mechanics of Solids II	MIE320H1 S	3	1.50	2	0.50
Energy and Environment					
Thermal Energy Conversion	MIE311H1 S	3	3	-	0.50
Bioengineering					
Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50

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 Departments 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.
3. Students may choose an alternative Natural Science course to the three listed. A list of approved alternative Natural Science courses offered by the Faculty of Arts & Science is available on the Engineering Office of the Registrar's website.

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 Undergradaute 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 Mollecular 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

FOURTH YEAR MECHANICAL ENGINEERING

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Core Rquired Course:					
Capstone Design	MIE491Y1 Y	-	-	4	1.00
Stream Courses (two of): Manufacturing					
Automated Manufacturing	MIE422H1 F	2	3	-	0.50
Mechatronics					
Control Systems I	MIE404H1 F	3	3	2	0.50
Solid Mechanics &Design					
Machine Design	MIE442H1 F	3	1.50	3	0.50
Energy &Environment					
Alternative Energy Systems	MIE515H1 F	3	-	1	0.50
Bioengineering					
Biotransport Phenomena	MIE520H1 F	3	-	1	0.50
Technical Electives (one of):					
Aerodynamics	AER307H1 F	3	-	1	0.50
Robotics	AER525H1 F	3	1.50	1	0.50
Operating Systems	ECE344H1 F	3	3	-	0.50
Industrial Ergonomics and the Workplace	MIE343H1 F	3	3	-	0.50
Systems Modelling and Simulation	MIE360H1 F	3	2	1	0.50
Nuclear Reactor Theory and Design	MIE407H1 F	3	-	2	0.50
* Applied Fluid Mechanics	MIE414H1 F	3	3	1	0.50
* Design of Innovative Products	MIE440H1 F	2	2	1	0.50
* Mechatronics Principles	MIE444H1 F	2	3	-	0.50
Research Thesis	MIE498H1 F	-	-	4	0.50
Research Thesis	MIE498Y1 Y	-	-	4	1.00
Combustion and Fuels	MIE516H1 F	3	-	1	0.50
Engineering Psychology and Human Performance	MIE523H1 F	3	3	-	0.50
Engineering Analysis II	MIE563H1 F	3	3	2	0.50
Materials Selection in Design II	MSE401H1 F	2	2	1	0.50
Complementary Studies Elective (one):					
CS Elective					0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Core Required Course:					
Capstone Design	MIE491Y1 Y	-	-	4	1.00
Technical Electives (three of):					
Medical Imaging	BME595H1 S	2	3	1	0.50
Biocomposites: Mechanics and Bioinspiration	CHE475H1 S	3	-	1	0.50
Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Operating Systems	ECE344H1 S	3	3	-	0.50
Innovation and Manufacturing of Sustainable Materials	FOR424H1 S	2	-	1	0.50
Vibrations	MIE402H1 S	3	1	2	0.50
* Thermal and Machine Design of Nuclear Power Reactors	MIE408H1 S	3	-	2	0.50
Waves and their applications in Non-Destructive Testing and Imaging	MIE433H1 S	3	-	-	0.50
Microprocessors and Embedded Microcontrollers	MIE438H1 S	2	3	-	0.50
Biomechanics I	MIE439H1 S	3	2	-	0.50
* Design Optimization	MIE441H1 S	3	2	-	0.50
* Mechatronics Systems: Design and Integration	MIE443H1 S	2	5	-	0.50
Reliability and Maintainability Engineering	MIE469H1 S	3	-	2	0.50
Research Thesis	MIE498H1 S	-	-	4	0.50
Research Thesis	MIE498Y1 Y	-	-	4	1.00
Applied Computational Fluid Dynamics	MIE504H1 S	3	-	-	0.50
Micro/Nano Robotics	MIE505H1 S	3	3	-	0.50
* MEMS Design and Microfabrication	MIE506H1 S	3	1.50	1	0.50
Fuel Cell Systems	MIE517H1 S	3	-	1	0.50
Advanced Manufacturing Technologies	MIE519H1 S	3	-	-	0.50
* Product Design	MIE540H1 S	3	-	1	0.50
Advanced Momentum, Heat and Mass Transfer	MIE550H1 S	3	-	-	0.50
Macromolecular Materials Engineering	MSE432H1 S	3	-	-	0.50
Surgical and Dental Implant Design	MSE442H1 S	3	-	1	0.50
Complementary Studies Elective (one):					
CS Elective					0.50

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.
8. Approval to register for the fourth-year thesis course (MIE498H1 or MIE498Y1) must be obtained from the Associate Chair - Undergraduate, and is normally restricted to students with an overall average of at least B in their second and third years.

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, automotion 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:
Shayni Curtis-Clarke
Room GB105, Galbraith Building, 416-978-5905
E-mail: shayni@ecf.utoronto.ca

UNDERGRADUATE STUDENT ADVISORS:
Professor John Harrison, Associate Chair, Lassonde Mineral Engineering

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 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, 222 College Street, Suite 106 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

Engineering 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

Fall Session - Year 1		Lect.	Lab.	Tut.	Wgt.	Winter Session - Year 1		Lect.	Lab.	Tut.	Wgt.
Orientation to Engineering	APS100H1 F	1	-	1	0.25	Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50	Engineering Strategies &Practice II	APS112H1 S	2	2	-	0.50
Physical Chemistry	CHE112H1 F	3	1	1	0.50	Earth Systems Science	CME185H1 S	3	2	1	0.50
Mechanics	CIV100H1 F	3	-	2	0.50	Calculus II	MAT187H1 S	3	-	1	0.50
Calculus I	MAT186H1 F	3	-	1	0.50	Introduction to Materials Science	MSE101H1 S	3	1	1	0.50
Linear Algebra	MAT188H1 F	3	1	1	0.50						

Approved Course Substitution

1. Students are able to substitute MAT186H1 with the online calculus course APS162H1.
2. Students are able to substitute MAT187H1 with the online calculus course APS163H1.
3. Students are able to substitute APS110H1 with the online course APS164H1.

SECOND YEAR MINERAL ENGINEERING

Fall Session - Year 2		Lect.	Lab.	Tut.	Wgt.	Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Solid Mechanics I	CME210H1 F	3	1.50	1.50	0.50	Probability Theory for Civil and Mineral Engineers	CME263H1 S	3	-	2	0.50
Engineering Mathematics I	CME261H1 F	3	1	1	0.50						
Fluid Mechanics I	CME270H1 F	3	1.50	1	0.50	Engineering Mathematics II	CME362H1 S	3	-	2	0.50
Minerals and Rocks	ESS221H1 F	2	3	-	0.50	Petrology	ESS222H1 S	2	3	-	0.50
Introduction to the Resource Industries	MIN225H1 F	3	2	1	0.50	Surface Mining	MIN250H1 S	3	-	1	0.50
						Complementary Studies Elective (CS) / Humanities and Social Sciences Elective (HSS)					0.50

* In order to graduate, students must obtain credits in the equivalent of at least four half-year Complementary Studies/Humanities and Social Sciences (CS/HSS) Electives. Of these Electives, the equivalent of at least two half-year credits must be Humanities and Social Sciences. Refer to the Registrar's Office website for a list of pre-approved CS/HSS Electives.

THIRD YEAR MINERAL ENGINEERING

Fall Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Geotechnical Engineering I	CME321H1 F	3	1	1	0.50
Survey CAMP (Civil and Mineral Practicals)	CME358H1 F	-	-	-	0.50
Engineering Economics and Decision Making	CME368H1 F	3	-	1	0.50
Geologic Structures and Maps	ESS241H1 F	2	3	-	0.50
Engineering Rock Mechanics	MIN429H1 F	3	1	1	0.50
Thermodynamics	MSE202H1 F	3	-	2	0.50

Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Mineral Reserve and Mineral Resource Estimation	MIN301H1 S	3	-	1	0.50
Explosives and Fragmentation in Mining	MIN320H1 S	3	-	1	0.50
Underground Mining	MIN351H1 S	3	-	1	0.50
Mining Environmental Management	MIN430H1 S	3	-	1	0.50
Mineral Processing	MSE301H1 S	3	1.50	1	0.50
Complementary Studies Elective (CS) / Humanities and Social Sciences Elective (HSS)					0.50

*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.

*In order to graduate, students must obtain credits in the equivalent of at least four half-year Complementary Studies/Humanities and Social Sciences (CS/HSS) Electives. Of these Electives, the equivalent of at least two half-year credits must be Humanities and Social Sciences. Refer to the Registrar's Office website for a list of pre-approved CS/HSS Electives.

FOURTH YEAR MINERAL ENGINEERING

Fall Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Mineral Project Design I	MIN466H1 F	2	2	1	0.50
Mineral Economics	MIN450H1 F	3	-	1	0.50
Complementary Studies Elective (CS) / Humanities and Social Sciences Elective (HSS)					0.50
Field Camp					
Geology Field Camp for Engineers	MIN400H1 F	-	-	-	0.50
Choose two of the following Technical Electives					
Aqueous Process Engineering	CHE565H1 F	3	-	1	0.50
Groundwater Flow and Contamination	CIV549H1 F	3	-	1	0.50
Sedimentation and Stratigraphy	ESS331H1 F	2	3	-	0.50
Mineral Deposits	ESS423H1 F	2	3	-	0.50
Environmental and Archaeological Geophysics	JGA305H1 F	2	1	-	0.50
Integrated Mine Waste Engineering	MIN511H1 F	3	-	1	0.50

Winter Session - Year 4		Lect.	Lab.	Tut.	Wgt.
Mineral Project Design II	MIN467H1 S	1	4	1	0.50
Design and Support of Underground Mine Excavations	MIN565H1 S	3	-	1	0.50
Ventilation and Occupational Health	MIN470H1 S	3	-	1	0.50
Complementary Studies Elective (CS) / Humanities and Social Sciences Elective (HSS)					0.50
Choose one of the following Technical Electives					
Geotechnical Engineering II	CIV324H1 S	3	1	1	0.50
Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Geotechnical Design	CIV523H1 S	3	-	1	0.50
Borehole Geophysics for Engineers and Geoscientists	MIN540H1 S	3	-	1	0.50

*MIN400H1 - This course is taken in the week prior to fall term of 4th year. The results of this are used in computing the student's fourth year fall session average. An extra fee is charged to cover cost of room, board and travel.

*Students must choose 3 half credits of TECH elective from the lists provided below each term. 2 credits are taken in the fall semester, 1 credit is taken in the winter semester.

*In order to graduate, students must obtain credits in the equivalent of at least four half-year Complementary Studies/Humanities and Social Sciences (CS/HSS) Electives. Of these Electives, the equivalent of at least two half-year credits must be Humanities and Social Sciences. Refer to the Registrar's Office website for a list of pre-approved CS/HSS Electives".

COURSE DESCRIPTIONS

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 occuring on alternating weeks

1a: 1 hour of tutorial occuring on alternating week

If a component of the course (ie 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

III-AEESCBASEF

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/MAT257Y1
Exclusion: RSM435H1

ACT460H1 F
Stochastic Methods for Actuarial Science

3/-/-/0.50

IV-AEESCBASEF

Applications of the lognormal distribution, Brownian motion, geometric Brownian motion, martingales, Itos limma, stochastic differential equations, interest rate models, the Black-Scholes model, volatility, value at risk, conditional tail expectation.
Prerequisite: STA347H1 (required)/ ACT370H1 strongly recommended

Aerospace Science and Engineering

AER201H1 S
Engineering Design

1/5/-/0.50

II-AEESCBASE

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.

Recommended Preparation: ESC102H1, CSC190H1 and ECE159H1
NOTE: AER201 includes a total of 33 hours of lecture. While there is 1 regular lecture hour per week, there are an additional 21 hours scheduled into the first 4 weeks of the course.

AER210H1 F
Vector Calculus & Fluid Mechanics

3/0.50/2/0.50

II-AEESCBASE

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.
Prerequisite: MAT195H1
Corequisite: MAT292H1
Exclusion: CHE211H1, CHE221H1, CME261H1, CME270H1, MAT291H1 or MIE312H1
Recommended Preparation: PHY180H1

AER301H1 F
Dynamics

3/-/1/0.50

III-AEESCBASEA, III-AEESCBASEZ, I-AEMINRAM

Reference frames in relative translation and rotation, vector and matrix formulations. Dynamics of a single particle and of systems of particles. Lagrange's equations. D'Alembert's and Hamilton's principle. Orbital dynamics. Rigid body kinematics and dynamics, Lagrangian approach to vibrations of complex systems. Model analysis. Primary Reference: class notes. Reference Books: Greenwood, Principles of Dynamics; Goldstein, Classical Mechanics.
Prerequisite: AER210H1, MAT185H1 and PHY180H1
Exclusion: MIE301H1

AER302H1 S
Aircraft Flight

3/-/1/0.50

III-AEESCBASEA, III-AEESCBASEZ

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); Thurst 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.
Prerequisite: AER307H1 and AER301H1

AER303H1 F
Aerospace Laboratory I

-/1/-/0.15

III-AEESCBASEA

Students will perform a number of experiments in the subject areas associated with the Aerospace Option curriculum, and prepare formal laboratory reports.
Corequisite: AER307H1

AER304H1 S
Aerospace Laboratory II

-/1/-/0.15

III-AEESCBASEA

Students will perform a number of experiments in the subject areas associated with the Aerospace Option curriculum, and prepare formal laboratory reports.
Corequisite: AER373H1

AER307H1 F
Aerodynamics

3/-/1/0.50

III-AEESCBASEA, III-AEESCBASEZ, IV-AEMECBASC

Review of fundamentals of fluid dynamics, potential-flow, Euler, and Navier-Stokes equations; incompressible flow over airfoils, incompressible flow over finite wings; compressibility effects; subsonic compressible flow over airfoils; supersonic flow; viscous flow; laminar

layers and turbulent boundary layers and unsteady aerodynamics. Textbook: Anderson, J.D., Fundamentals of Aerodynamics, 3rd Edition, McGraw Hill, 2001.
Prerequisite: AER210H1 or MIE312H1

AER310H1 S
Gasdynamics

3/-/1/0.50

III-AEESCBASEA

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: AER307H1

AER315H1 F
Combustion Processes

3/-/1/0.50

III-AEESCBASEA

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 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: CHE260H1
Exclusion: MIE516H1

AER336H1 S
Scientific Computing

3/-/1/0.50

III-AEESCBASEA, IV-AEESCBASEF, IV-AEESCBASER, III-AEESCBASEZ

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, 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.
Prerequisite: ESC103H1 and MAT185H1

AER372H1 S
Control Systems

3/1.50/1/0.50

III-AEESCBASEA, III-AEESCBASEJ, III-AEESCBASEZ

An introduction to dynamic systems and control. Models of physical systems. Stability and feedback control theory. Analysis and synthesis of linear feedback systems by "classical" and state space techniques. Introduction to nonlinear and optimal control systems. Digital computer control. Multivariable feedback system design.
Prerequisite: MAT185H1 and MAT292H1
Exclusion: CHE322H1, ECE356H1 or MIE404H1

AER373H1 S
Mechanics of Solids and Structures

3/-/1/0.50

III-AEESCBASEA, III-AEESCBASEI

An Introduction to Solid and Structural Mechanics. Continuum Mechanics: Stress, strain and constitutive relations for continuous systems, Equilibrium equations, Force and Flexibility methods, Introduction to Cartesian Tensors. Variational Principles: Virtual Work, Complementary Virtual Work, Strain Energy and Work, Principle of Stationary Value of the Total Potential Energy, Complementary Potential Energy, Reissner's Principle, Calculus of Variations, Hamilton's Principle. Beam and Plate theory. Dynamics of discrete and continuous systems.
Prerequisite: CIV102H1

AER406H1 S
Aircraft Design

-/-/3/0.50

IV-AEESCBASEA

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.
Prerequisite: AER302H1, AER307H1 and AER373H1

AER407H1 F
Space Systems Design

-/3/-/0.50

IV-AEESCBASEA, III-AEESCBASEZ, I-AEMINRAM

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.

AER501H1 F
Advanced Mechanics of Structures

3/-/1/0.50

IV-AEESCBASEA

Introduction to the Finite Element Method and Structural Optimization. Review of linear elasticity: stress, strain and material constitutive laws, Variational Principles. The Finite Element technique: problem formulation - methods of Ritz and Galerkin, element properties - C0 and C1 formulations, static and dynamic problems: applications to bar, beam, membrane and plate problems. Structural Optimization: Overview of problems, Optimal Design problem formulation, solution strategies - gradient search techniques, Sensitivity analysis for static and dynamic problems, Optimization problems using commercial finite element codes.

Text: Shames & Dym, Energy and Finite Element Methods in Structural Mechanics.
Prerequisite: AER373H1
Recommended Preparation: AER373H1

AER503H1 S
Aeroelasticity

3/-/1/0.50

IV-AEESCBASEA

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.
Prerequisite: AER307H1 and AER501H1

AER506H1 F
Spacecraft Dynamics and Control

3/-/1/0.50

IV-AEESCBASEA

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

3/-/1/0.50

I-AECERNUC, IV-AEESCBASEA,
IV-AEESCBASEJ, IV-AEESCBASEP,
IV-AEESCBASER, I-AEMINENR

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

3/-/1/0.50

IV-AEESCBASEA

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

AER521H1 S
Mobile Robotics and Perception

3/1.50/1/0.50

IV-AEESCBASEA, IV-AEESCBASER,
IV-AEESCBASEZ, I-AEMINRAM

The course addresses fundamentals of mobile robotics and sensor-based perception for applications such as space exploration, search and rescue, mining, self-driving cars, unmanned aerial vehicles, autonomous underwater vehicles, etc. Topics include sensors and their principles, state estimation, computer vision, control architectures, localization, mapping, planning, path tracking, and software frameworks. Laboratories will be conducted using both simulations and hardware kits.

Note: ROB310 will be a required prerequisite for AER521 in 2018-19.
Prerequisite: AER372H1

AER525H1 F
Robotics

3/1.50/1/0.50

IV-AEESCBASEA, IV-AEESCBASER,
IV-AEMECBASC

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.
Prerequisite: AER301H1 and AER372H1
Exclusion: ECE470H1

Anthropology

ANT204H1 F
Anthropology of the Contemporary World (formerly ANT204Y1)

-/-/-/0.50

I-AECERGLOB

A course focused on recent anthropological scholarship that seeks to understand and explain the transformation of contemporary societies and cultures. Topics may include some of the following: new patterns of global inequality, war and neo-colonialism, health and globalization, social justice and indigeneity, religious fundamentalism, gender inequalities, biotechnologies and society etc.
Exclusion: ANT204Y1
Recommended Preparation: ANT100Y1

Applied Mathematics

APM384H1 F
Partial Differential Equations

3/-/1/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC,
III-AEESCBASEA, III-AEESCBASEF,
III-AEESCBASEO, III-AEESCBASEP,
IV-AEESCBASER, IV-AEESCBASET,
III-AEESCBASEZ

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.

APM446H1 S
Applied Nonlinear Equations

3/-/-/0.50

IV-AEESCBASEA

Partial differential equations appearing in physics, material sciences, biology, geometry, and engineering. Nonlinear evolution equations. Existence and long-time behaviour of solutions. Existence of static, traveling wave, self-similar, topological and localized solutions. Stability. Formation of singularities and pattern formation. Fixed point theorems, spectral analysis, bifurcation theory. Equations considered in this course may include: Allen-Cahn equation (material science), Ginzburg-Landau equation (condensed matter physics), Cahn-Hilliard (material science, biology), nonlinear Schroedinger equation (quantum and plasma physics, water waves, etc). mean curvature flow (geometry, material sciences), Fisher-Kolmogorov-Petrovskii-Piskunov (combustion theory, biology), Keller-Segel equations (biology), and Chern-Simmons equations (particle and condensed matter physics).
Prerequisite: APM346H1/MAT351Y1

APM466H1 S
Mathematical Theory of Finance

3/-/-/0.50

IV-AEESCBASEF

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

Applied Science and Engineering (Interdepartmental)

APS100H1 F
Orientation to Engineering

1a/-/1/0.25

I-AECHEBASC, I-AECIVBASC,
I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AELMEBASC, I-AEMECBASC,
I-AEMMSBASC

This course is designed to help students transition into first-year engineering studies and to develop and apply a greater understanding of the academic learning environment, the field of engineering, and how the fundamental mathematics and sciences are used in an engineering context. Topics covered include: study skills, time management, problem solving, successful teamwork, effective communications, exam preparation, stress management and wellness, undergraduate research, extra- and co-curricular involvement, engineering disciplines and career opportunities, and applications of math and science in engineering.

APS105H1 S
Computer Fundamentals

3/2m/1m/0.50

I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC

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 develops essential programming skills.

APS106H1 S
Fundamentals of Computer Programming

3/2/1/0.50

I-AECHEBASC, I-AECIVBASC,
I-AEINDBASC, I-AELMEBASC,
I-AEMECBASC, I-AEMMSBASC

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.

APS110H1 F
Engineering Chemistry and Materials Science

3/1/1/0.50

I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEMMSBASC

This course is structured around the principle of the structure-property relationship. This relationship refers to an understanding of the microstructure of a solid, that is, the nature of the bonds between atoms and the spatial arrangement of atoms, which permits the explanation of observed behaviour. Observed materials behaviour includes mechanical, electrical, magnetic, optical, and corrosive behaviour. Topics covered in this course include: structure of the atom, models of the atom, electronic configuration, the electromagnetic spectrum, band theory, atomic bonding, optical transparency of solids, magnetic properties, molecular bonding, hybridized orbitals, crystal systems, lattices and structures, crystallographic notation, imperfections in solids, reaction rates, activation energy, solid-state diffusion, materials thermodynamics, free energy, and phase equilibrium.

APS111H1 F
Engineering Strategies & Practice I

3/1/1/0.50

I-AECHEBASC, I-AECIVBASC,
I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AELMEBASC, I-AEMECBASC,
I-AEMMSBASC

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

2/2/-/0.50

I-AECHEBASC, I-AECIVBASC,
I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AELMEBASC, I-AEMECBASC,
I-AEMMSBASC

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.

APS160H1 F
Mechanics

-/-/-/0.50

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. Shear 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.
Exclusion: CIV100H1
Available Online: consult Faculty or Graduate Unit for details

APS161H1 F/S
Dynamics

-/-/-/0.50

This course on Newtonian mechanics considers the interactions which influence 2-D, curvilinear motion. These interactions are described in terms of the concepts of force, work, momentum and energy. Initially the focus is on the kinematics and kinetics of particles. Then, the kinematics and kinetics of systems of particles and solid bodies are examined. Finally, simple harmonic motion is discussed. The occurrence of dynamic motion in natural systems, such as planetary motion, is emphasized. Applications to engineered systems are also introduced.
Exclusion: MIE100H1
Available Online: consult Faculty or Graduate Unit for details

APS162H1 F/S
Calculus for Engineers I

-/-/-/0.50

This online-only course focuses on the fundamental tools of calculus and its connections to engineering. The topics include limits, differentiation, graphing, optimization problems, and definite and indefinite integrals. Problems combining calculus with geometry, linear algebra, statics, and mechanics will be examined.
Exclusion: MAT186H1/MAT196H1
Available Online: consult Faculty or Graduate Unit for details

APS163H1 F/S
Calculus for Engineers II

-/-/-/0.50

This online-only course focuses on the fundamental tools of calculus and its connections to engineering. The topics include methods of integration, an introduction to differential equations, series and Taylor series, vector differentiation, and partial differentiation. Problems combining calculus with geometry, linear algebra, statics, and mechanics will be examined.
Prerequisite: APS162H1/MAT186H1
Exclusion: MAT187H1/MAT197H1
Available Online: consult Faculty or Graduate Unit for details

APS164H1 S
Introductory Chemistry from a Materials Perspective

-/-/-/0.50

This online course is structured around the principle of structure-property relationship. This relationship refers to an understanding of the microstructure of a solid, that is, the nature of the bonds between atoms and the spatial arrangement of atoms, which permits the explanation of observed behaviour. Observed materials behaviour includes mechanical, electrical, magnetic, optical, and corrosive behaviour. Topics covered in this course include: structure of the atom, models of the atom, electronic configuration, the electromagnetic spectrum, band theory, atomic bonding, optical transparency of solids, magnetic properties, molecular bonding, hybridized orbitals, crystal systems, lattices and structures, crystallographic notation, imperfections in solids, reaction rates, activation energy, solid-state diffusion, materials thermodynamics, free energy, and phase equilibrium.
Available Online: consult Faculty or Graduate Unit for details

APS191H1 S
Introduction to Engineering

1/-/-/0.15

I-AEENGBASC

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

4/-/1/0.50

I-AECERENTR, I-AEMINBUS

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/MIE488H1/MSE488H1

APS281H1 S
Language and Meaning

2/-/2/0.50

I-AECERCOM

Humanities and Social Science elective

As students study how language is used to make meaning in diverse contexts they will hone their own skills in deploying written and oral professional engineering language. The course explores the nature of language across linguistic, discipline and cultural boundaries and students apply the theoretical knowledge of language and language learning to their own written and oral language performances. In conjunction with this, theories of translation and bilingualism will be introduced to challenge assumptions about the universality of meanings. Weekly lecture and tutorial.

APS299Y0 Y
Summer Research Abroad

-/7/-/1.00

An independent research project conducted in an engineering laboratory at an approved partner institution abroad for 10-16 weeks in the summer term. This course is intended for students who will have completed their 2nd or 3rd year of study by the time they take the course. Students must apply for this program through the Centre for International Experience in the fall term and will be notified by January if they are accepted. Students should inquire with their home department to determine whether the course can count towards their degree requirements. For more information, please contact the Cross-Disciplinary Programs Office at cdp@ecf.utoronto.ca
Prerequisite: Pre-requisite: Students must have a cGPA of at least 3.0 and permission of their department.

APS301H1 F
Technology in Society and the Biosphere I

3/-/1/0.50

II-AECIVBASC, IV-AEESCBASEI, I-AEMINENR, I-AEMINENV

Humanities and Social Science Elective
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.

APS302H1 S
Technology in Society and the Biosphere II

3/-/1/0.50

I-AEMINENV

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

3/-/1/0.50

I-AEMINENV

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

3/-/1/0.50

III-AEESCBASEJ, I-AEMINENR

Complimentary 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

Complimentary Studies Elective

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.

This course is not offered in 2015-16.
Exclusion: APS510H1

APS320H1 F
Representing Science on Stage

2/-/2/0.50

I-AECERCOM

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

I-AECERCOM

Humanities and Social Science elective

Analytical approach to writing and style; representations of current scientific research and developments in technology 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, inlcuding misrepresentations, analogy and metaphor. Focus on the popular media's (mis)representations of climate science, nanotechnology, and bioengineering.
Prerequisite: CHE299H1/CHE397H1/ECE297H1/ECE299H1/ESC201H1 /MSE390H1

APS322H1 S
Language and Power

2/-/2/0.50

I-AECERCOM

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: CHE299H1/CHE397H1/ECE297H1/ECE299H1/ESC201H1 /MSE390H1

APS325H1 F
Engineering and Science in the Arts

2/-/2/0.50

I-AECERCOM

Humanities and Social Science elective

This course examines the connections between engineers, scientists, and artists. Taking examples from architecture, sculpture, painting, and the performing arts, this course will show how these artistic disciplines have grown through their interplay with engineering and science.

Not Offered in 2015/16.

APS343H1 F/S
Engineering Leadership

2/2/-/0.50

I-AECERLEAD, I-AEMINBUS

Complementary Studies elective

This course is a practical approach to being a more productive engineer based on the premise that for technology to become a reality it must be translated through people. A key is to understand that engineers lead in ways that reflect their skills and mind set. The course begins with examining: 1) the meaning of leading (Why do something?); 2) the processes of leading (How do you do you create a vision and motivate others?); and 3) the tools of leading (What steps do you take to lead?). Learning frameworks and personal working styles inventories provide practical tools to assist the student to understand human nature and the logic of learning to become a competent leader of self, teams and organizations. 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 teams. Special attention is given to a number of subjects: transformational change, organizational culture, high performance work systems, and self-leadership. The course material is delivered through lectures, readings, in-class discussion and a team project. The project is based on the team interviewing the CEO of an engineering-intensive company or senior leader in the community. Students will be required to submit written reflections on course content and their personal experience.

APS432H1 S
Entrepreneurship and Business Management

4/-/1/0.50

I-AECERENTR, I-AEMINBUS

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. It is designed to familiarise 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/MIE488H1/MSE488H1

APS420H1 S
Technology, Engineering and Global Development

3/-/-/0.50

I-AECERGLOB, I-AEMINBUS, I-AEMINENV

Humanities and Social Science 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.
Exclusion: APS520H1

APS442H1 S
Cognitive and Psychological Foundations of Effective Leadership

3/-/-/0.50

I-AECERLEAD, I-AEMINBUS

Complementary Studies elective

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.

APS444H1 F
Positive Psychology for Engineers

3/-/-/0.50

I-AECERLEAD, I-AEMINBUS

Humanities and Social Science elective

Many disciplines have explored happiness - philosophy, anthropology, psychology, sociology, neurobiology, film, art and literature - to name a few. Why not engineering? During the first part of the course we will play catch-up, examining the scholarly and creative ways that people have attempted to understand what makes for a happy life. Then we turn our attention to our own domain-expertise, applying engineering concepts like “balance”, “flow”, “amplitude”, “dynamic equilibrium””momentum” and others to explore the ways that your technical knowledge can contribute to a deep understanding of happiness. This course is designed to challenge you academically as we analyze texts from a variety of disciplines, but it is also designed to challenge you personally to explore happiness as it relates to yourself, your own personal development and your success and fulfillment as an engineer.

APS445H1 F
The Power of Story: Discovering Your Leadership Narrative

2/-/1/0.50

I-AECERLEAD, I-AEMINBUS

Humanities and Social Science elective

This course offers an introduction to relational, authentic and transformational leadership theory by focusing on narrative and the power of story telling. Students will practice story-telling techniques by learning about the mechanics of stories, improve their public speaking by engaging in regular storytelling practice, explore their personal history by reflecting on their identities, and develop critical thinking skills regarding the stories (meta-narratives) that surround us, particularly as they relate to engineering problems/ethics. This is a highly experiential course with a focus on reading, discussion, practice and reflection.

APS446H1 S
Leadership in Project Management

3/-/-/0.50

I-AECERLEAD, I-AEMINBUS

Complementary Studies elective

Project management involves both leading people and managing resources to achieve the intended project outcomes and benefits. Leadership is often the difference between project success and failure. The objective of this course is to equip you with the concepts, tools and techniques for effective leadership within a project context. It is also intended to build self-knowledge regarding leadership styles and to provide for opportunities for practice. The course begins with the organizational setting for projects, proceeds through aspects of leading and working with teams, covers the important topic of ethical leadership, and closes with the stakeholder, communication and change management components of leading projects in organizations.

APS447H1 S
The Art of Ethical & Equitable Decision Making in Engineering

3/-/-/0.50

I-AECERLEAD

The primary objective of this course is to help engineering students navigate the ambiguous world of engineering ethics and equity using case studies drawn from the careers of Canadian engineers. In addition to being exposed to a range of ethical theories, the PEO code of ethics and the legal context of engineering ethics, students enrolled in this course will engage in ethical decision-making on a weekly basis.

APS490Y1 Y
Multi-Disciplinary Capstone Design

-/-/3/1.00

An experience in multi-disciplinary engineering practice through a significant, open-ended, client-driven design project in which student teams address stakeholder needs through the use of a creative and iterative design process.
Prerequisite: Permission of student's home department
Exclusion: CHE430Y1/CIV498H1/MIE490Y1/MIE491Y1/ECE496Y1/ESC470H1/ESC471H1/ESC472H1/MSE498Y1

APS502H1 F
Financial Engineering

3/-/-/0.50

IV-AEINDBASC, I-AEMINBUS

This course will focus on capital budgeting, financial optimization, and project evaluation models and their solution techniques. In particular, linear, non-linear, and integer programming models and their solutions techniques will be studied. The course will give engineering students a background in modern capital budgeting and financial techniques that are relevant in practival engineering and commercial settings.
Prerequisite: MAT186H1, MAT187H1, MAT188H1, MIE236H1, MIE237H1, or equivalent.
Exclusion: MIE375H1

APS510H1 F
Innovative Technologies and Organizations in Global Energy Systems

3/-/1/0.50

I-AECERGLOB, I-AEMINBUS, I-AEMINENR

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
Exclusion: APS310H1

APS530H1 S
Appropriate Technology & Design for Global Development

3/-/-/0.50

I-AECERGLOB, I-AEMINENR, I-AEMINENV

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 as healthcare, water & sanitation, land management, energy, infrastructure, and communications in both urban and rural settings.

Astronomy and Astrophysics

AST320H1 S
Introduction to Astrophysics

2m/-/-/0.50

IV-AEESCBASEP

The formation, equilibrium and evolution of structure on all astronomical scales from the largest to the smallest: universe, clusters of galaxies, galaxies, clusters of stars, gas clouds and stars.
Prerequisite: PHY252H1/PHY294H1; AST221H1,AST222H1 (or equivalent AST readings; consult the instructor)

AST325H1 F
Introduction to Practical Astronomy

-/3m/-/0.50

IV-AEESCBASEP

Through experiment and observation, develop the core skills to collect, reduce, and interpret astronomical data. Develop understanding and usage of telescopes, instruments, and detectors; reduction and analysis methods; simulations and model fitting; data and error analysis.
Prerequisite: AST221H1,AST222H1 (or equivalent readings, consult the instructor)
Exclusion: AST326Y1
Recommended Preparation: basic programming/scripting, numerical techniques (e.g., through CSC108H1/CSC148H1, CSC260H1).

Biochemistry

BCB420H1 S
Computational Systems Biology

2/-/2/0.50

I-AEMINBIO

Current approaches to using the computer for analyzing and modeling biology as integrated molecular systems. Lectures plus hands-on practical exercises. The course extends and complements an introductory Bioinformatics course, such as BCH441H1.
Prerequisite: BCH441H1/CSB472H1 or permission of the course coordinator

BCH441H1 F
Bioinformatics

2/-/1/0.50

I-AEMINBIO

This course is an introduction to 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 hands-on competence building with web-based bioinformatics tools and databases, downloadable software including a molecular viewer and a multiple sequence alignment editor, and the statistics workbench and programming language “R”. For syllabus details see: www.biochemistry.utoronto.ca/undergraduates/courses/BCH441H/

Note BCB420H1 extends this syllabus to computational topics of systems biology.
Prerequisite: BCH210H1/BCH242Y1; BCH311H1/MGY311Y1/PSL350H1 or special permission of the course coordinator

Biomaterials and Biomedical Engineering

BME205H1 S
Biomolecules and Cells

2/1.50/1/0.50

II-AEESCBASE, I-AEMINBIO

Introducution to fundamental concepts in cell and molecular biology from a quantitative perspective. Emphasis is placed on the structure and function of biomolecules and cells. Topics include biochemical processes in the cell, modern techniques in cell and molecular biology, and cellular mechanisms as related to tissue engineering and biotechnological applications.
Exclusion: CHE353H1 or BIO130H1

BME225H1 S
Biostatistics for Engineers

3/-/1/0.50

I-AEMINBIO

Students will use the application of statistical methods to design, develop, improve biomedical devices and bioprocesses or to demonstrate the efficacy of medical treatments. Topics that will be covered include statistical distributions, the central limit theorem, linear functions of random variables and error propagation, statistical inference, analysis of variance, empirical model building (multiple regression) and design of experiments (screening designs, blocking, fractional factorial designs) since these are the techniques that are the most commonly used by practicing engineers. The students will also be expected to become proficient in the use of statistical software to analyse experimental data.

BME344H1 F
Modeling, Dynamics, and Control of Biological Systems

3/-/1/0.50

III-AEESCBASET

Introduction to modeling of physiological control systems present in the human body, combining physiology, linear system modeling and linear control theory. Topics include: representation of physical systems using differential equations and linearization of these dynamic models; graphical representation of the control systems/plants; Laplace transforms; transfer functions; performance of dynamic systems; time and frequency analysis; observability and controllability; and close-loop controller design.

BME346H1 S
Biomedical Engineering and Omics Technologies

2/4/-/0.50

III-AEESCBASET, I-AEMINNANO

An introduction to the principles and design of fundamental technologies used in biomedical engineering and “omics” research. Topics may include but are not limited to tissue culture; spectroscopy; electrophoresis; PCR, genomics, sequencing technologies, and gene expression measurement; protein expression assays and tagging strategies; fluorescence labeling tools, microscopy, and high content imaging; DNA manipulation and transfection, RNAi, and other genetic and molecular tools for transformation of organisms. Laboratories will provide hands-on experience with selected technologies. Students will engage in a major design project in which they will design an experimental plan to investigate a specific research question, also of their design, utilizing available laboratory technologies. Exclusion: BME340, BME440

BME350H1 F
Biomedical Systems Engineering I: Organ Systems

3/1/2/0.50

III-AEESCBASET, III-AEESCBASEZ,
I-AEMINBIO, I-AEMINRAM

An introduction to human anatomy and physiology with selected focus on the nervous, cardiovascular, respiratory, renal, and endocrine systems. The structures and mechanisms responsible for proper function of these complex systems will be examined in the healthy and diseased human body. The integration of different organ systems will be stressed, with a specific focus on the structure-function relationship. Application of biomedical engineering technologies in maintaining homeostasis will also be discussed.

BME358H1 S
Molecular Biophysics

3/-/1/0.50

III-AEESCBASET

Topics to be covered will 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

2/1/2/0.50

IV-AEESCBASEO, III-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

3/3/1/0.50

III-AEESCBASET

A quantitative approach to understanding cell and molecular biology. Using engineering tools (especially derived from transport phenomena and chemical kinetics) to model molecular dynamics in living cells and make predictions about cellular behaviour. Specific topics include: receptor-ligand interactions, morphogens, trafficking, signal transduction, cell adhesion and migration, and mechanotransduction. Examples from in vitro tissue culture systems and model organisms in vivo are used.
Prerequisite: BME395H1

BME428H1 F
Biomedical Systems Engineering IV: Computational Systems Biology

3/-/2/0.50

IV-AEESCBASET

Through systematic mathematical analysis of biological networks, this course derives design principles that are cornerstones for the understanding of complex natural biological systems and the engineering of synthetic biological systems. Course material includes: transcriptional networks, autoregulation, feed-forward loops, global network structure,

protein networks, robustness, kinetic proofreading and optimality. After completion of the course, students should be able to use quantitative reasoning to analyze biological systems and construct mathematical models to describe biological systems.

Prerequisite: BME350H1, BME395H1, BME396H1

BME430H1 S
Human Whole Body Biomechanics

3/2/-/0.50

IV-AEESCBASET, III-AEESCBASEZ

An introduction to the principles of human body movement. Specific topics include the dynamics of human motion and the neural motor system, with a focus on the positive/negative adaptability of the motor system. Students will experience basic techniques of capturing and analyzing human motion. Engineering applications and the field of rehabilitation engineering will be emphasized using other experimental materials. This course is designed for senior undergraduate and graduate students.
Prerequisite: CHE353H1 or BME205H1 or MIE100H1

BME440H1 F
Biomedical Engineering Technology and Investigation

2/4/-/0.50

IV-AECHEBASC, III,IV-AECPEBASC,
III,IV-AEELEBASC, I-AEMINBIO,
III-AEMINBME, I-AEMINNANO

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, DNAmanipulation and transfection. Since these technologies enable theinvestigation of a wide range of research questions with importantclinical implications, the main focus of the course is learning thesetechnologies while subsequent application within the lab will allowevidence-based investigation into specific research questions.Scientific literature (both good and bad) pertaining to each technologywill be reviewed as examples of conducting investigations.
Prerequisite: CHE353H1

BME455H1 F
Cellular and Molecular Bioengineering II

3/1.50/1/0.50

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

2/-/2/0.50

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.
Prerequisite: MSE352H1

BME489H1 F
Biomedical Systems Engineering Design

1/-/4/0.50

IV-AEESCBASET

A capstone design project that provides students in the Biomedical Systems Engineering option with an opportunity to intergrate 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.

BME498Y1 Y
Biomedical Engineering Capstone Design

2/3/-/1.00

IV-AEESCBASER, III-AEMINBME

In this project-based design course teams of students from diverse engineering disciplines (enrolled in the biomedical engineering minor) will engage in the bio-medical technology design process to identify, invent and implement a solution to a unmet clinical need. The students will learn about medical technology development and will engage in the process through lectures, guest lectures delivered by medical technology experts, "hands-on" practicums and a student driven design project. Approval to register in the course must be obtained from the Associate Chair, IBBME - Undergraduate.

BME499Y1 Y
Applied Research in Biomedical Engineering

-/7/-/1.00

III-AEMINBME

This course provides the opportunity to gain hands-on exposure and experience in dynamic biomedical research laboratories. Students will be required to perform two modules, one is completed in the Fall semester, and the second is completed in the Winter semester; each module will provide at minimum 90 hours of hands-on activity. Students will select opportunities with faculty in laboratories classified within two (of four) different themes at the Institute of Biomaterials and Biomedical Engineering (IBBME). Activities will provide exposure to experimental design, the use of analytical equipment, and assessment of relevant literature (scientific, patent, and regulatory) related to the research topic

identified by the faculty member.

You may only register in this course after obtaining approval from the Associate Director –Undergraduate IBBME.
Prerequisite: CHE353H1 or equivalent
Corequisite: MIE331H1

BME510H1 S
Regenerative Medicine

4/-/-/0.50

IV-AEESCBASET

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

2/3m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER, IV-AEESCBASET,
IV-AEMECBASC, 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 S
Regulatory Networks and Systems in Molecular Biology

2/-/-/0.50

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

CSB450H1 F
Proteomics in Systems Biology

2/-/-/0.50

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)/BIO255H1, BCH210H1

Chemical Engineering and Applied Chemistry

CHE112H1 F/S
Physical Chemistry

3/1/1/0.50

I-AECHEBASC, I-AECIVBASC,
I-AELMEBASC, I-AEMMSBASC

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

3/1/3/0.50

I-AECHEBASC

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

-/6/-/0.50

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

3/-/2/0.50

II-AECHEBASC

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

3/-/2/0.50

II-AECHEBASC

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

3/-/2/0.50

II-AECHEBASC

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 1low, non-Newtonian fluids and flow in porous systems.

CHE213H1 S
Applied Chemistry II - Organic Chemistry

3/-/1/0.50

II-AECHEBASC

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: CHE204H1

CHE220H1 F
Applied Chemistry I - Inorganic Chemistry

3/-/1/0.50

II-AECHEBASC

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

3/-/2/0.50

II-AECHEBASC

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

3/2/1/0.50

II-AECHEBASC

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

CHE230H1 S
Environmental Chemistry

3/-/2/0.50

II-AECHEBASC, I-AEMINENV

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

3/-/1/0.50

I-AECERBUS, I-AECERENTR,
II-AECHEBASC, I-AEMINBUS

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 financing 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

3/0.50/1/0.50

II-AEESCBASE, I-AEMINENR

Classical thermodynamics and its applications to engineering processes. Concepts of energy, heat, work and entropy. First and second laws of thermodynamics. Properties of pure substances and mixtures. Phase equilibrium, and chemical equilibrium.
Exclusion: CHE210H1, CHE323H1, CHE326H1, CHE119H1, MSE202H1 or MIE210H1
Recommended Preparation: MAT195H1

CHE299H1 Y
Communication

-/-/2/0.25

II-AECHEBASC

Each student will learn to identify the central message they wish to communicate. They will learn to articulate this message through effective argumentation. Students will analyze their audience and purpose to select the most effective mode of communication. Students will summarize and synthesize information from external sources and effectively organize information and prioritize it in each mode of communication. They will apply effective strategies to the design of text, visuals and oral presentations.

CHE308H1 F
Energy Systems and Fuels: Global Needs, Challenges, and Technological Opportunities

3/-/1/0.50

III-AEESCBASEJ

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

3/4/2/0.75

III-AECHEBASC

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

3/-/2/0.50

III-AECHEBASC

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

3/-/2/0.50

III-AECHEBASC, I-AEMINENR

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

3/4m/1/0.75

III-AECHEBASC

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

-/4m/-/0.25

III-AECHEBASC

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 ivestigations of rate constants and Arrhenius behvaiour.

CHE332H1 F
Reaction Kinetics

3/-/2/0.50

III-AECHEBASC

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

3/-/2/0.50

III-AECHEBASC, IV-AEESCBASEJ

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 S
Team Strategies for Engineering Design

1/-/2/0.25

III-AECHEBASC

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

3/-/1/0.50

IV-AECHEBASC

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

2/-/2/0.50

IV-AECHEBASC, IV-AECIVBASC,
III,IV-AECPEBASC, III,IV-AEELEBASC,
III-AEINDBASC, III-AEMECBASC,
I-AEMINBIO, III-AEMINBME,
IV-AEMMSBASC

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

3/1/2/0.50

IV-AECHEBASC, IV-AECIVBASC,
III,IV-AECPEBASC, III,IV-AEELEBASC,
III-AEMECBASC, I-AEMINBIO,
IV-AEMMSBASC

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, hybridomis, cloning, recombinant DNA and biotechnology will also be covered. This course will appeal to students interested in environmental microbiology, biomaterials and tissue engineering, and bioprocesses.
Prerequisite: CHE353H1

CHE374H1 F
Economic Analysis and Decision Making

3/-/1/0.50

I-AECERBUS, I-AECERENTR,
III-AEESCBASEA, III-AEESCBASEF,
III-AEESCBASEI, III-AEESCBASEJ,
III-AEESCBASEO, III-AEESCBASEP,
III-AEESCBASER, III-AEESCBASET,
III-AEESCBASEZ, I-AEMINBUS

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.
Exclusion: CHE249H1, CME368H1 or MIE258H1

CHE375H1 S
Engineering Finance and Economics

3/-/1/0.50

III-AEESCBASEF

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 model, 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

3/-/1/0.50

III-AEESCBASEO

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 complexation 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 multiphase systems will be discussed with emphasis on adsorption and chemistry in water/soil systems.

CHE391H1 F
Organic Chemistry and Biochemistry

3/1.50/1/0.50

III-AEESCBASEO, III-AEESCBASET

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.

CHE403H1 S
Professional Practice

2/-/-/0.00

IV-AECHEBASC

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

3/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEJ

Heterogeneous reactors. Mass and heat transport effects including intraparticle transport effects (Thiele modulus). Stability for various rate laws, transport regimes. Time dependent issues - deactivation/regeneration strategies. Emerging processes.

CHE430Y1 F
Chemical Plant Design

2/-/6/1.00

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)
Exclusion: APS490Y1

CHE450H1 F
Bioprocess Technology and Design

3/0.66/1/0.50

IV-AECHEBASC, I-AEMINBIO

Building upon CHE353 and CHE354, the aim of this course is to learn and apply engineering principles relevant to bioprocess engineering, including energetics and stoichiometry of cell growth, cell and enzyme kinetics, metabolic modeling, bioreactor design, and bioseparation processes. In addition to course lectures, students will complete two laboratory exercises that will provide hands-on learning in bioreactor set-up and use.
Prerequisite: CHE353H1 and CHE354H1

CHE451H1 F
Petroleum Processing

3/-/-/0.50

IV-AECHEBASC, IV-AEESCBASEJ, I-AEMINENR

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.

CHE460H1 S
Environmental Pathways and Impact Assessment

3/-/2/0.50

IV-AECHEBASC, I-AEMINENR, I-AEMINENV

Review of the nature, properties and elementary toxicology of metallic and organic contaminants. Partitioning between environmental media (air, aerosols, water, particulate matter, soils, sediments and biota) including bioaccumulation. Degradation processes, multimedia transport and mass balance models. Regulatory approaches for assessing possible effects on human health and ecosystems.

CHE462H1 S
Food Engineering

3/-/1/0.50

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.

CHE467H1 F
Environmental Engineering

3/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEO, I-AEMINENR, 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

3/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEJ, I-AEMINENR

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 electodics and ionic interaction limitations to mass transfer and heat balance effects,t o the externalities such as economics and system integration challenges. Guest lecturers from the fuel cell industry will be invited to procide an industrial perspective. Participants will complete a paper and in-class presentation.
Exclusion: MIE517H1

CHE470H1 F/S
Special Topics in Chemical Engineering

3/-/1/0.50

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 S
Modelling in Biological and Chemical Systems

3/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEF,
IV-AEESCBASET, I-AEMINBIO,
I-AEMINENV

This course outlines the methodology for the modelling of biological 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 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, chemical and biochemical processes and biomedical systems.

CHE475H1 S
Biocomposites: Mechanics and Bioinspiration

3/-/1/0.50

I-AECERRRE, IV-AECHEBASC,
IV-AEESCBASET, IV-AEMECBASC,
I-AEMINBIO, I-AEMINNANO

An overview on structure, processing and application of natural and biological materials, biomaterials for biomedical applications, and fibre-reinforced eco-composites based on renewable resources will be provided. Fundamental principles related to linear elasticity, linear viscoelasticity, dynamic mechanical response, composite reinforcement mechanics, and time-temperature correspondence will be introduced. Novel concepts in comparative biomechanics, biomimetic and bio-inspired material design, and materials' ecological and environmental impact will be discussed. In addition, key material processing methods and testing and characterization techniques will be presented. Structure-property relationships for materials broadly ranging from natural materials, including wood, bone, cell, and soft tissue, to synthetic composite materials for industrial and biomedical applications will be covered.

Not Offered in 2015-16.

CHE488H1 S
Entrepreneurship and Business for Engineers

3/-/2/0.50

I-AECERBUS, I-AEMINBUS

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, MSE488H1F and CIV488H1S.)

*Complementary Studies Elective
Exclusion: APS234H1, APS432H1

CHE499Y1 Y
Thesis

-/7/-/1.00

IV-AECHEBASC

The course consists of a research project conducted under the supervision of a senior staff member. The project may have an experimental, theoretical or design emphasis. Each thesis will contain a minimum 60% combined Engineering Science and Engineering Design (with a minimum of 10% in each component). This course is open to students with permission of the Department and research project supervisor.

CHE507H1 S
Data-based Modelling for Prediction and Control

3/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEF,
I-AEMINRAM

This course will teach students how to build mathematical models of dynamic systems and how to use these models for prediction and control purposes. The course will deal primarily with a system identification approach to modelling (using observations from the system to build a model). Both continuous time and discrete time representations will be treated along with deterministic and stochastic models. This course will make extensive use of interactive learning by having students use computer based tools available in the Matlab software package (e.g. the System Identification Toolbox and the Model Predictive Control Toolbox).

CHE561H1 S
Risk Based Safety Management

3/-/1/0.50

IV-AECHEBASC

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. Rsik based decision making is introduced, and the course concludes with a discussio of the key management systems required for a successful PSM system.

CHE562H1 F
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering

3/-/-/0.50

IV-AECHEBASC, IV-AEESCBASEO,
IV-AEESCBASET, I-AEMINBIO,
I-AEMINNANO, IV-AEMMSBASC

This course serves as an introduction to concepts in polymer chemistry, polymer science and polymer engineering. This includes a discussion of the mechanisms of step growth, chain growth and ring-opening polymerizations with a focus on industrially relevant polymers and processes. The description of polymers in solution as well as the solid state will be explored. Several modern polymer characterization techniques are introduced including gel permeation chromatography, differential scanning calorimetry, thermal gravimetric analysis and others.
Exclusion: CHM426H1
Recommended Preparation: CHE213H1, CHE220H1 or equivalents.

CHE564H1 S
Pulp and Paper Processes

3/-/1/0.50

IV-AECHEBASC, I-AEMINBIO,
I-AEMINENV

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.

Not offered in 2015-2016.

CHE565H1 F
Aqueous Process Engineering

3/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEJ,
IV-AELMEBASC, I-AEMINENV,
IV-AEMMSBASC

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 streams for environmental protection, and (3) production of high-value-added inorganic materials.

CHE566H1 F
Elements of Nuclear Engineering

3/-/1/0.50

I-AECERNUC, IV-AECHEBASC,
IV-AEESCBASEJ, I-AEMINENR

A first course in nuclear engineering intended to introduce students to all aspects of this interdisciplinary field. Topics covered include nuclear technology, atomic and nuclear physics, thermonuclear fusion, nuclear fission, nuclear reactor theory, nuclear power plants, radiation protection and shielding, environment and nuclear safety, and the nuclear fuel cycle.

CHE568H1 S
Nuclear Engineering

3/-/1/0.50

I-AECERNUC, IV-AECHEBASC,
IV-AEESCBASEJ, IV-AEESCBASEP,
I-AEMINENR

Fundamental and applied aspects of nuclear engineering. The structure of the nucleus; nuclear stability and radioactive decay; the interaction of radiation with matter including radiological health hazards; the interaction of neutrons including cross-sections, flux, moderation, fission, neutron diffusion and criticality. Poison buildup and their effects on criticality. Nuclear engineering of reactors, reactor accidents, and safety issues.
Exclusion: MIE414H1

CHE111H1 F
fdgd

3/-/-/0.50

dfesf

Chemistry

CHM210H1 F
Chemistry of Environmental Change

2m/-/1m/0.50

I-AEMINENV

Examines the fundamental chemical processes of the Earth's natural environment, and changes induced by human activity. Topics relate to the atmosphere: urban air pollution, stratospheric ozone depletion, acid rain; the hydrosphere: water resources and pollution, wastewater analysis; biogeochemistry and inorganic metals in the environment.
Prerequisite: CHM135H1/CHM139H1/CHM151Y1,(MAT135H1,MAT136H1)/MAT137Y1
Exclusion: ENV235Y1

CHM310H1 S
Environmental Chemistry

2m/-/-/0.50

I-AEMINENV

This course considers carbon-containing molecules in the environment from a variety of perspectives: the carbon cycle, climate change and ocean acidification; fossil fuels and alternative energy sources; and the partitioning and degradation pathways of organic chemicals.
Prerequisite: (CHM135H1/CHM139H1,
CHM136H1/CHM138H1)/CHM151Y1, (MAT135H1,
MAT136H1)/MAT137Y1

CHM325H1 S
Introduction to Inorganic and Polymer Materials Chemistry

2/-/-/0.50

III-AEESCBASEO, I-AEMINNANO

Fashioned to illustrate how inorganic and polymer materials chemistry can be rationally used to synthesize superconductors, metals, semiconductors, ceramics, elastomers, thermoplastics, thermosets and polymer liquid crystals, with properties that can be tailored for applications in a range of advanced technologies. Coverage is fairly broad and is organized to crosscut many aspects of the field.
Prerequisite: CHM220H1/CHM222H1/CHM2225Y, CHM238Y1,
CHM247H1/CHM249H1

CHM328H1 S
Modern Physical Chemistry

-/-/-/0.50

I-AEMINNANO

This course explores the microscopic description of macroscopic phenomena in chemistry. Statistical mechanics is introduced as the bridge between the microscopic and macroscopic views, and applied to a variety of chemical problems including reaction dynamics. More advanced topics in thermodynamics are introduced and discussed as required.
Prerequisite: (CHM220H1/CHM222H1,CHM221H1/CHM223H1)/CHM225Y1, MAT235Y1/MAT237Y1
Exclusion: JCP322H5, CHMC20H3

CHM338H1 F
Intermediate Inorganic Chemistry

-/-/-/0.50

I-AEMINNANO

Further study of the structures, physical properties and reactions of compounds and transition metals. Introductions to spectroscopy and structural analysis, reaction mechanisms, d- block organometallic compounds, catalysis, and bioinorganic chemistry. The weekly laboratory demonstrates aspects of transition metal chemistry. (Lab Materials Fee: $25).
Prerequisite: CHM238Y1 with a minimum grade of 63%
Exclusion: CHM331H5
Recommended Preparation: CHM217H1, CHM247H1/CHM249H1

CHM410H1 S
Analytical Environmental Chemistry

2/4/-/0.50

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. (Lab Materials Fee: $25).
Prerequisite: CHM217H1, CHM210H1/CHM310H1
Recommended Preparation: CHM317H1

CHM415H1 S
Topics in Atmospheric Chemistry

2/-/-/0.50

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 organic chemistry, the chemistry of climate including cloud formation and geoengineering, biosphere-atmosphere interactions, the chemistry of remote environments. Reading is from the scientific literature; class discussion is emphasized.
Prerequisite: (CHM220H1/CHM222H1/CHM225Y1),CHM210H1
Recommended Preparation: (PHY131H1, PHY132H1)/(PHY151H1, PHY152H1)

CHM434H1 F
Advanced Materials Chemistry

2/-/-/0.50

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

CHM446H1 S
Organic Materials Chemistry

2/-/-/0.50

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/CHM222H1/CHM225Y1
Recommended Preparation: CHM325H1, CHM342H1/CHM343H1

CIV100H1 F
Mechanics

3/-/2/0.50

I-AECHEBASC, I-AECIVBASC, I-AECPEBASC, I-AEELEBASC, I-AEENGBASC, I-AEINDBASC, I-AELMEBASC, I-AEMECBASC, I-AEMMSBASC

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. Shear 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.
Exclusion: APS160H1

CIV102H1 F
Structures and Materials - An Introduction to Engineering Design

3/1/1/0.50

I-AEESCBASE

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.

Corequisite: PHY180H1
Exclusion: CIV100H1

CIV201H1 F
Introduction to Civil Engineering

-/-/-/0.20

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.

CIV209H1 S
Civil Engineering Materials

3/2/2/0.50

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.
Prerequisite: APS104H1 or MSE101H1

Civil Engineering

CIV214H1 S
Structural Analysis I

3/-/2/0.50

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

3/-/1/0.50

II-AECIVBASC, III,IV-AECPEBASC,
III,IV-AEELEBASC, III-AEINDBASC,
III-AEMECBASC, I-AEMINENV

Core Course in the Environmental Engineering Minor Basic concepts of ecology within the context of urban environments. Response of organisms, populations, dynamic predator-prey and competition processes, and ecosystems to human activities. Thermodynamic basis for food chains, energy flow, biodiversity and ecosystem stability. Biogeochemical cycles, habitat fragmentation and bioaccumulation. Introduction to industrial ecology and life cycle assessment principles. Urban metabolism and material flow analysis of cities. Response of receiving waters to pollution and introduction to waste water treatment. Emphasis is on identifying the environment/engineering interface and minimizing environmental impacts.
Prerequisite: CHE112H1.
Exclusion: EDV220H1

CIV235H1 S
Civil Engineering Graphics

-/6/-/0.50

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 examples demonstrate how graphical skills fit into the overall design process.

CIV250H1 S
Hydraulics and Hydrology

3/1.50/1/0.50

IV-AECHEBASC, II-AECIVBASC,
I-AEMINENV

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 the hydrologic cycle and basics of hydrologic modelling are developed, including precipitation estimation, infiltration and abstraction models, 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 hydraulics are introduced. Energy and momentum principles are studied with application to channel transitions, critical flow, choked flow, and hydraulic jumps.
Prerequisite: CME270H1

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 Development; 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-AECHEBASC, IV-AECIVBASC,
III,IV-AECPEBASC, III,IV-AEELEBASC,
III-AEINDBASC, III-AEMECBASC,
I-AEMINENR, 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: ENV346H1

CIV312H1 F
Steel and Timber Design

3/-/2/0.50

III-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-AECIVBASC

This course provides 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. A major design project, done in teams of two and accounting for 15% of the final mark, requires students to formulate a complete design for a structural system such as a pedestrian bridge or floor system. Project requirements include consideration of alternative designs in terms of structural efficiency and total costs.
Prerequisite: CIV312H1

CIV324H1 S
Geotechnical Engineering II

3/1/1/0.50

III-AECIVBASC, IV-AELMEBASC

Building on CME321, more complex aspects of geotechnical analysis and design are considered. Topics include: mineralogy; soil identification and classification; laboratory- and field-based soil index tests; correlations of index test results to engineering properties; vertical stress distribution; soil-foundation interaction; volume change and consolidation of clay and settlement. Shear strength of soil and slope stability analysis are also discussed. Laboratories are held for soil identification and classification, and confined triaxial compression tests of clay and sand.
Prerequisite: CIV321H1 or CME321H1.
Exclusion: CIV424H1.

CIV331H1 F
Transport I - Introduction to Urban Transportation Systems

3/-/1/0.50

III-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

3/-/1/0.50

III-AECIVBASC

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

3/-/2/0.50

III-AECIVBASC

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

3/1/1/0.50

III-AECIVBASC, I-AEMINBIO

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: CIV540H1

CIV352H1 F
Structural Design 1

3/-/2/0.50

III-AEESCBASEI

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

3/-/2/0.50

III-AEESCBASEI

This course focuses on quantitative methods and techniques for the analysis and modelling of urban transportation and service systems. Major topics include probabilistic modelling, queuing 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

3/-/2/0.50

III-AEESCBASEI

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

CIV360H1 S
Road Transportation Performance

3/-/1/0.50

III-AEESCBASEI

A deep understanding of the behaviour and performance of road systems is fundamental to transportation engineering and planning. This course provides an in-depth exploration of the performance characteristics of highway and street systems that provides the basis for the design of road networks and operating systems, including Intelligent Transportation Systems for real-time control of roadways. Theoretical principles and practical applications concerning roadway performance are discussed, including facility capacity, speed-flow relationships, operational control, measurement of performance and safety. Driver behaviour and route choice and the demand-supply relationship between driver behaviour and system performance are examined in detail. Non-motorized (walking and cycling) system performance is also introduced.

CIV375H1 F
Building Science

3/0.33/2/0.50

IV-AECHEBASC, III-AECIVBASC,
I-AEMINENR, I-AEMINENV

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: CIV575H1.

CIV380H1 S
Sustainable Energy Systems

3/-/1/0.50

III-AECIVBASC, IV-AEESCBASEI

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

-/-/0.25/0.00

III-AECIVBASC

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.

CIV401H1 F
Design and Optimization of Hydro and Wind Electric Plants

3/-/2/0.50

I-AEESCBASEJ

The application of turbo-machinery including the design and operation of typical wind and hydroelectric plants from first principles to the various types of turbo-machines choices. Fundamental fluid mechanics equations, efficiency coefficients, momentum exchanges, characteristic curves, similarity laws, specific speed, vibration, cavitation of hydraulic turbines, pump/turbines; variable speed machines including transients and hydraulic stability. An introduction to overall system configuration and both component and system optimization. Case studies.
Exclusion: EDV301H1, CIV301H1

CIV416H1 F
Reinforced Concrete II

3/-/2/0.50

IV-AECIVBASC, IV-AEESCBASEI

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

CIV420H1 F
Construction Engineering

3/-/2/0.50

IV-AECIVBASC

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

3/-/1/0.50

IV-AECHEBASC, IV-AECIVBASC,
IV-AEESCBASEJ, IV-AELMEBASC,
IV-AEMECBASC, I-AEMINENR,
I-AEMINENV

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

1/3/-/0.50

IV-AEESCBASEI

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

1/3/-/0.50

IV-AEESCBASEI

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

3/-/1/0.50

IV-AEESCBASEI

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.

CIV477H1 F/S
Special Studies in Civil Engineering

3/-/1/0.50

IV-AECIVBASC

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

3/-/2/0.50

I-AECERBUS, I-AEMINBUS

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.)

*Complementary Studies Elective
Exclusion: APS234H1, APS432H1

CIV498H1 S
Group Design Project

-/-/3/0.50

IV-AECIVBASC

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.
Exclusion: APS490Y1

CIV499H1 F/S
Individual Project

-/-/3/0.50

IV-AECIVBASC

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)

CIV510H1 S
Solid Mechanics II

3/-/2/0.50

IV-AECIVBASC, IV-AEESCBASEI

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
3/-/2/0.50

IV-AECIVBASC, IV-AEESCBASEI

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.
Prerequisite: CIV209H1

CIV515H1 F
Introduction to Structural Dynamics
3/-/1/0.50

IV-AECIVBASC, IV-AEESCBASEI

The concept of dynamic equilibrium and corresponding equation of motion will be introduced. The theoretical solution of a songle degree of freedom system will be derived and the effects of verious 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

CIV516H1 S
Public Transit Operations and Planning
3/-/1/0.50

IV-AECIVBASC, III-AEESCBASEI

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
3/-/-/0.50

IV-AECIVBASC, IV-AEESCBASEI

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
3/-/2/0.50

IV-AECIVBASC, IV-AEESCBASEI

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
3/-/2/0.50

IV-AECIVBASC

The general flexibility and stiffness methods of analysis; multispan 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
3/1/-/0.50

IV-AECIVBASC

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

3/-/1/0.50

IV-AECIVBASC, IV-AEESCBASEI, IV-AELMEBASC

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

3/-/1/0.50

IV-AECIVBASC, III-AEESCBASEI, I-AEMINENR, I-AEMINENV

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 F
Environmental Biotechnology

3/-/-/0.50

IV-AECIVBASC, I-AEMINBIO, I-AEMINENV

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-AECIVBASC, IV-AELMEBASC, I-AEMINENV

Mechanics of saturated and unsaturated fluid flow in porous media. Confined and unconfined flow. Flow to wells. Analytical and numerical solutions of groundwater flow equations. Non-reactive and reactive contaminant transport on groundwater systems. Analytical and numerical solutions of contaminant transport equations. Flow and solute transport in fractured porous media. Assessment of environmental impacts of waste disposal operations. Remediation of contaminated groundwater.
Prerequisite: JVM270H1/CIV270H1/CME270H1, CIV250H1/EDV250H1 S or equivalent

CIV550H1 F
Water Resources Engineering

3/-/2/0.50

IV-AECHEBASC, IV-AECIVBASC, I-AEMINENV

Global and national water problems, law and legislation. Hydraulic structures. Reservoir analysis. Urban drainage and runoff control: meteorologic data analysis, deterministic and stochastic modelling techniques. Flood control: structural and nonstructural alternatives. Power generation: hydro and thermal power generation. Low flow augmentation. Economics and decision making.
Prerequisite: CIV250H1/EDV250H1, CIV340H1 S or equivalent

CIV575H1 F
Studies in Building Science

3/-/2/0.50

IV-AEESCBASEI, IV-AEESCBASEJ, I-AEMINENV

This course examines the basic principles governing the control of heat, moisture and air movement in buildings and presents the fundamentals of building enclosure design. 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-AECIVBASC, IV-AEESCBASEI, IV-AEESCBASEJ, I-AEMINENR, 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-AECIVBASC, IV-AEESCBASEI, I-AEMINENR, 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.

Civil and Mineral Engineering

CME185H1 S
Earth Systems Science

3/2/1/0.50

I-AECIVBASC, 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

3/1.50/1.50/0.50

II-AECIVBASC, II-AELMEBASC

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

3/1/1/0.50

II-AECIVBASC, II-AELMEBASC

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

3/-/2/0.50

II-AECIVBASC, II-AELMEBASC

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.
Exclusion: CIV263H1

CME270H1 F
Fluid Mechanics I

3/1.50/1/0.50

II-AECIVBASC, II-AELMEBASC

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 similitude, 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

3/1/1/0.50

III-AECIVBASC, III-AEESCBASEI,
III-AELMEBASC

An introduction to elements of geotechnical analysis and design. Shear strength at constant volume; ultimate limit state design of retaining walls, shored excavations, 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, groundwater flow models, and reinforced earth models.
Prerequisite: CIV270H1/CME270H1, CIV210H1/CME210H1
Exclusion: CIV321H1

CME358H1 F
Survey CAMP (Civil and Mineral Practicals)

-/-/-/0.50

III-AECIVBASC, IV-AEESCBASEI,
III-AELMEBASC

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. Note: This course requires payment of an extra fee for room and board.
Exclusion: CIV358H1

CME362H1 S
Engineering Mathematics II

3/-/2/0.50

II-AECIVBASC, II-AELMEBASC

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.
Exclusion: CIV362H1

CME368H1 F
Engineering Economics and Decision Making

3/-/1/0.50

I-AECERBUS, I-AECERENTR,
III-AECIVBASC, III-AELMEBASC,
I-AEMINBUS

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

RSM430H1 F
Fixed Income Securities

2/-/-/0.50

IV-AEESCBASEF

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. Not eligible for CR/NCR option. Contact Rotman Commerce for details.
Prerequisite: Rotman Commerce: RSM332H1; Actuarial Science: ACT349H1

RSM432H1 S
Risk Management for Financial Managers

2/-/-/0.50

IV-AEESCBASEF

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. Not eligible for CR/NCR option. Contact Rotman Commerce for details.
Prerequisite: RSM333H1

RSM434H1 S
Financial Trading Strategies (formerly RSM412H1 Financial Trading Strategies)

2/-/-/0.50

IV-AEESCBASEF

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. Not eligible for CR/NCR option. Contact Rotman Commerce for details.
Prerequisite: RSM332H1
Exclusion: RSM412H1 Financial Trading Strategies

Computer Science

CSC180H1 F
Introduction to Computer Programming

3/3/-/0.50

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, with specific focus on algorithms, data structures, problem decomposition, and the use of programming paradigms appropriate to the problems being solved. Specifically, this course aims to have students work with and understand profiling and runtime analysis, searching and sorting algorithms, and the use of recursion.
Exclusion: APS105H1, APS106H1 or CSC192H1

CSC190H1 S
Computer Algorithms and Data Structures

3/3/-/0.50

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.
Prerequisite: CSC180H1
Exclusion: APS106H1, CSC192H1, ECE244H1 or MIE250H1

CSC263H1 F/S
Data Structures and Analysis

-/-/-/0.50

IV-AEESCBASEF, III-AEESCBASEZ

Algorithm analysis: worst-case, average-case, and amortized complexity. Expected worst-case complexity, randomized quicksort and selection. Standard abstract data types, such as graphs, dictionaries, priority queues, and disjoint sets. A variety of data structures for implementing these abstract data types, such as balanced search trees, hashing, heaps, and disjoint forests. Design and comparison of data structures. Introduction to lower bounds.
Prerequisite: CSC207H1, CSC236H1/CSC240H1; STA247H1/STA255H1/STA257H1
Exclusion: CSC265H1

CSC309H1 F/S
Programming on the Web

2/-/1/0.50

IV-AEESCBASER

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
Recommended Preparation: CSC343H1

CSC318H1 F/S
The Design of Interactive Computational Media

2/-/1/0.50

IV-AEESCBASER, IV-AEESCBASET

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.

Prerequisite: Any CSC half-course

Recommended Preparation: CSC300H1 provides useful background for work in CSC318H1, so if you plan to take CSC300H1 then you should do it before CSC318H1

CSC321H1 S
Introduction to Neural Networks and Machine Learning

-/-/-/0.50

III-AEESCBASEZ

The first half of the course is about supervised learning for regression and classification problems and will include the perceptron learning procedure, backpropagation, and methods for ensuring good generalisation to new data. The second half of the course is about unsupervised learning methods that discover hidden causes and will include K-means, the EM algorithm, Boltzmann machines, and deep belief nets.

Prerequisite: (MAT136H1 with a minimum mark of 77)/(MAT137Y1 with a minimum mark of 73)/(MAT157Y1 with a minimum mark of 67)/MAT235Y1/MAT237Y1/MAT257Y1, MAT221H1/MAT223H1/MAT240H1; STA247H1/STA255H1/STA257H1

Recommended Preparation: MAT235Y1/MAT237Y1/MAT257Y1

CSC326H1 F
Programming Languages

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, 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

CSC343H1 F/S
Introduction to Databases

2/-/1/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEF, IV-AEESCBASER, IV-AEESCBASET

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/(MAT135H1, MAT136H1)/MAT135Y1/MAT137Y1/MAT157Y1; CSC207H1. Prerequisite for Engineering students only: ECE345H1/CSC190H1/CSC192H1

Exclusion: CSC434H1

CSC384H1 F/S
Introduction to Artificial Intelligence

2/-/1/0.50

IV-AEESCBASER, III-AEESCBASEZ, I-AEMINRAM

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, in both theory and programming, of the core topics.

Prerequisite: CSC263H1/CSC265H1, STA247H1/STA255H1/STA257H1

Recommended Preparation: CSC324H1

CSC401H1 S
Natural Language Computing

2/-/1/0.50

IV-AEESCBASER, III-AEESCBASEZ

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; STA247H1/STA255H1/STA257H1

Recommended Preparation: MAT221H1/MAT223H1/MAT240H1 is strongly recommended

CSC411H1 F/S
Machine Learning and Data Mining

2/-/1/0.50

IV-AEESCBASEF, IV-AEESCBASER, III-AEESCBASEZ, I-AEMINRAM

An introduction to methods for automated learning of relationships on the basis of empirical data. Classification and regression using nearest neighbour methods, decision trees, linear models, and neural networks. Clustering algorithms. Problems of overfitting and of assessing accuracy. Problems with handling large databases. Emphasis on statistical approaches.

Prerequisite: CSC263H1/CSC265H1, MAT(135H1,136H1)/MAT137Y1/MAT137Y1/MAT157Y1, STA247H1/STA255H1/STA257H1

Recommended Preparation: CSC336H1/CSC350H1, STA248H1/STA250H1/STA261H1

CSC412H1 S
Probabilistic Learning and Reasoning

-/-/-/0.50

III-AEESCBASEZ

An introduction to probability as a means of representing and reasoning with uncertain knowledge. Qualitative and quantitative specification of probability distributions using probabilistic graphical models. Algorithms for inference and probabilistic reasoning with graphical models. Statistical approaches and algorithms for learning probability models from empirical data. Applications of these models in artificial intelligence and machine learning.

Prerequisite: CSC411H1

CSC418H1 F/S
Computer Graphics

2/-/1/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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. Students, individually or in teams, implement graphical algorithms or entire graphics systems.
Prerequisite: CSC336H1/CSC350H1/CSC351H1/CSC363H1/CSC365H1/CSC373H1/CSC375H1/CSC463H1, (MAT135H1, MAT136H1)/MAT135Y1/MAT137Y1/MAT157Y1, CSC209H1/proficiency in C or C++; Prerequisite for Engineering students only: ECE345H1 or ECE352H1
Recommended Preparation: MAT237Y1, MAT244H1

CSC428H1 S
Human-Computer Interaction

2/-/1/0.50

IV-AEESCBASER, IV-AEESCBASET, I-AEMINRAM

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 C++ or Java
Recommended Preparation: A course in PSY; CSC209H1

CSC443H1 S
Database System Technology

2/-/1/0.50

IV-AEESCBASER

Implementation of database management systems. Storage management, indexing, query processing, concurrency control, transaction management. Database systems on parallel and distributed architectures. Modern database applications: data mining, data warehousing, OLAP, data on the web. Object-oriented and object-relational databases.
Prerequisite: CSC343H1, CSC369H1, CSC373H1/CSC375H1

CSC444H1 F
Software Engineering I

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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

CSC467H1 F
Compilers and Interpreters

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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: ECE243H1 or ECE352H1

CSC485H1 F
Computational Linguistics

-/-/-/0.50

III-AEESCBASEZ

Computational linguistics and the processing of language by computer. Topics include: context-free grammars; chart parsing, statistical parsing; semantics and semantic interpretation; ambiguity resolution techniques; reference resolution. Emphasis on statistical learning methods for lexical, syntactic, and semantic knowledge.
Prerequisite: STA247H1/STA255H1/STA257H1 or familiarity with basic probability theory, including Bayes's theorem; CSC207H1/CSC209H1 or proficiency in Python and software development.
Recommended Preparation: CSC324H1/CSC384H1

CSC486H1 S
Knowledge Representation and Reasoning

-/-/-/0.50

III-AEESCBASEZ

Representing knowledge symbolically in a form suitable for automated reasoning, and associated reasoning methods. Topics from: first-order logic, entailment, the resolution method, Horn clauses, procedural representations, production systems, description logics, inheritance networks, defaults and probabilities, tractable reasoning, abductive explanation, the representation of action, planning.
Prerequisite: CSC384H1, CSC363H1/CSC365H1/CSC373H1/CSC375H1/CSC463H1
Recommended Preparation: CSC330H1

Earth Science

ESS221H1 F
Minerals and Rocks

2m/3m/-/0.50

II-AELMEBASC

Systematic mineralogy (including: identification, classification and description), Physical and chemical properties of minerals. Crystallography and crystal systems (symmetry, crystal structure, crystal systems) Descriptions of rocks in hand samples. Optical techniques in mineral identification.
Exclusion: GLG206H1, ERS201H5, EESB19H3
Recommended Preparation: (CHM138H1,CHM139H1)/CHM151Y1

ESS222H1 S
Petrology

2m/3m/-/0.50

II-AELMEBASC

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: ESS221H1, ERS203H5, EESC36H3
Exclusion: GLG207H1

ESS241H1 F
Geologic Structures and Maps

2m/3m/-/0.50

III-AELMEBASC

Field observations, description and classification of geological structures: stratigraphic and intrusive contacts, unconformities; relative age determination; folds and fold systems; faults and fault systems; boudinage, foliations and lineations; spherical projections and mechanical principles (stress, strain, rheology). Practical work focuses on reading geological maps, constructing cross-sections, and interpreting both in terms of geological processes and histories.
Exclusion: GLG345H1, EESC37H3
Recommended Preparation: (PHY131H1,PHY132H1)/(PHY151H1,PHY152H1)

ESS331H1 F
Sedimentation and Stratigraphy

2m/3m/-/0.50

IV-AELMEBASC

Formal principles of stratigraphy, types of stratigraphic unit, methods of dating and correlation (biostratigraphic methods, magnetostratigraphy, radiometric dating). Methods of study in surface and subsurface (outcrop measurement, elementary introduction to wireline logs, seismic methods). The principles of facies analysis; sediment transport - sedimentary structures, the flow regime, and sediment gravity flows. The carbonate factory and carbonate rock classification. Trace fossils. Laboratory exercises in understanding facies mapping, isopachs and isolith maps.
Prerequisite: ESS221H1
Exclusion: GLG360H1, ERS313H5
Recommended Preparation: ESS222H1, ESS330H1

ESS423H1 F
Mineral Deposits

2m/3m/-/0.50

IV-AELMEBASC

Geology and geochemistry of ore deposits. Origin and interpretation; systematic ore mineralogy, in hand specimen and reflected light microscopy.
Prerequisite: ESS322H1
Exclusion: GLG442H1

JGA305H1 F
Environmental and Archaeological Geophysics

2m/1m/-/0.50

IV-AELMEBASC

Application of near-surface geophysical methods to investigate environmental and archaeological sites; in particular magnetometry, resistivity, ground-probing radar, and seismic surveys. Course will cover background on the various methods, and allow students to run field surveys and present on case studies.
Prerequisite: ESS241H1 or ANT200Y1 or GGR201H1

JPE395H1 S
Physics of the Earth (Formerly PHY395H1)

-/-/-/0.50

IV-AEESCBASEJ, IV-AEESCBASEP, IV-AEESCBASER, I-AEMINENR

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: PHY132H1/PHY152H1/PHY180H1/MIE100H1, MAT235Y1/MAT237Y1/MAT291H1/AER210H1, PHY254H1/PHY293H1/MAT244H1/MAT290H1/MAT292H1
Exclusion: PHY359H1, PHY395H1

JPE493H1 F
Seismology (Formerly PHY493H1)

-/-/-/0.50

IV-AEESCBASEP

Why do earthquakes occur and how are they related to tectonic motion of the Earth's surface? What is the physics behind the propagation of seismic waves through the Earth, and how can it be used to determine the internal structures of the Earth? This introductory course is aimed at understanding the physics behind seismic wave propagation, as well as asymptotic and numerical solutions to the elastodynamic equation. Travel time and amplitude of seismic waves are discussed based on seismic ray theory, while numerical methods are introduced to obtain accurate solutions to more complex velocity structures. Seismic tomographic methods, including their applications to hydrocarbon reservoir imaging, are also covered.
Prerequisite: JPE395H1, APM346H1/APM351Y1
Exclusion: PHY493H1
Recommended Preparation: ESS345H1

Economics

ECO100Y1 Y
Introduction to Economics

-/-/-/0.50

I-AEMINBUS

An introduction to economic analysis and its applications: price determination; the role of competition; international trade and finance; the theory of production and employment; the role of money and the banking system; monetary and fiscal policy. NOTE graphical and quantitative analysis are used extensively.
Exclusion: ECO105Y1
Recommended Preparation: MCV4U (Calculus & Vectors) and MHF4U (Advanced Functions), or equivalent secondary school mathematics credits

Electrical and Computer Engineering

ECE101H1 S
Seminar Course: Introduction to Electrical and Computer Engineering

1/-/-/0.15

I-AECPEBASC, I-AEELEBASC

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

3/1m/2m/0.50

I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AEMECBASC, I-AEMMSBASC

An overview of the physics of electricity and magnetism: Coulomb's law, Gauss' law, Ampere's law, Faraday's law. Physics of capacitors, resistors and inductors. An introduction to circuit analysis: resistive circuits, nodal and mesh analysis, 1st order RC and RL transient response and sinusoidal steady-state analysis.

ECE159H1 S
Fundamentals of Electric Circuits

3/1.50/1/0.50

I-AEESCBASE

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.

Exclusion: ECE110H1 or ECE212H1
Recommended Preparation: MAT194H1 and ESC103H1

ECE201H1 F
Electrical and Computer Engineering Seminar

1/-/-/0.15

II-AECPEBASC, II-AEELEBASC

This seminar introduces second year students to the various career pathways within the field of Electrical and Computer Engineering. Instructors from various areas will talk about third and fourth year ECE courses in weekly seminars to guide students with the selection of upper year courses. The course also offers talks and advice to aid students transitioning into second year, as well as enhance students' skills such as stress management and time management. 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 3F session. Students who have not received credit for this course at the end of their 3F session will not be permitted to register for their 3S session.

ECE212H1 F
Circuit Analysis

3/1.50m/2m/0.50

II-AECPEBASC, II-AEELEBASC

Nodal and loop analysis and network theorems. Natural and forced response of RL, RC, and RLC circuits. Sinusoidal steady-state analysis. Frequency response; resonance phenomena; poles and zeros; applications of the Laplace transform.

ECE216H1 S
Signals and Systems

3/1/2/0.50

II-AECPEBASC, II-AEELEBASC

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

3/1m/2m/0.50

II-AECPEBASC, II-AEELEBASC

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

3/1.50m/2m/0.50

II-AECPEBASC, II-AEELEBASC

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-AECPEBASC, II-AEELEBASC

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 multiplexors. 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-AECPEBASC, II-AEELEBASC

Basic computer structure. Design of central processing unit. Hardwired control. Input-output and the use of interrupts. Assembly language programming. Main memory organization and caches. Peripherals and interfacing. System design considerations. The laboratory will consist of experiments involving logic systems and microprocessors and a large open project. Design activity constitutes a major portion of laboratory work.

ECE244H1 F
Programming Fundamentals

3/2m/1m/0.50

II-AECPEBASC, II-AEELEBASC

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

3/3/-/0.50

II-AEESCBASE

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: ECE241H1

ECE259H1 S
Electromagnetism

3/-/1/0.50

II-AEESCBASE

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. Vector calculus is applied to determine the relationship between the electric and magnetic fields and their sources (charges and currents). 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.
Prerequisite: ECE159H1 and AER210H1
Exclusion: MAT291H1 or ECE221
Recommended Preparation: MAT292H1 and MAT185H1

ECE297H1 S
Communication and Design

2/2m/2m/0.50

II-AECPEBASC, II-AEELEBASC

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

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC

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 and correlation coefficient. Functions of random variables. Random vectors, joint distributions, transformations. Applications will be chosen from communication theory, estimation and hypothesis testing, predictive analytics and other areas of electrical and computer engineering.
Prerequisite: MAT290H1 and MAT291H1 and ECE216H1
Exclusion: STA286H1

ECE311H1 F/S
Dynamic Systems and Control

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC

An introduction to dynamic systems and their control. Differential equation models of mechanical, electrical, and electromechanical systems. State variable form. Linearization of nonlinear models and transfer functions. Use of Laplace transform to solve ordinary differential equations. Conversion of models from state variable form to transfer function representation and vice versa. Block diagrams and their manipulation. Time response: transient analysis and performance measures. Properties of feedback control systems. Steady state tracking: the notion of system type. The concept of stability of feedback systems, Routh-Hurwitz stability criterion. Frequency response and stability in the frequency domain. Root locus. Bode and Nyquist plots and their use in feedback control design.
Prerequisite: MAT290H1 and MAT291H1 and ECE216H1

ECE314H1 F
Fundamentals of Electrical Energy Systems

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC,
I-AEMINENR

Introduction to 3-phase systems, single line diagrams and complex power flow. Energy conversion via switch-mode power electronic circuits: DC/DC converters, DC/AC converters. Energy conversions via magnetic devices: Faraday's law for time varying fields, characterization of hysteresis and eddy current losses in magnetic materials, modelling of magnetic circuits, transformer and inductor modelling and design. Introduction to electromechanical energy conversion: Lorentz Force, concepts of energy, co-energy, forces between ferromagnetic materials carrying flux, simple magnetic actuators.
Prerequisite: ECE212H1 and ECE221H1 and ECE231H1
Exclusion: ECE315H1

ECE316H1 F/S
Communication Systems

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC,
I-AEMINRAM

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

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASEO, IV-AEESCBASEP,
IV-AEESCBASER, IV-AEESCBASET

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 or ECE259H1

ECE320H1 F
Fields and Waves

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC

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

ECE330H1 S
Semiconductor and Device Physics

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC

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.
Exclusion: MSE235H1

ECE331H1 F/S
Analog Electronics

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC

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

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, I-AEMINNANO

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

3/3m/-/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEP

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

3/3m/-/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEMECBASC

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
Exclusion: ECE353H1

ECE345H1 F/S
Algorithms and Data Structures

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, I-AEMINRAM

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

3/1.50/1/0.50

III-AEESCBASEJ, III-AEESCBASER, I-AEMINENR

Established and emerging sources of electrical energy: hydroelectric, thermal, wind, and solar. Three-phase AC systems and complex power. Mechanisms for electrical-electrical energy conversion: power electronic systems for DC-DC conversion, single-phase DC-AC and three-phase DC-AC conversion, transformers for single-phase and three-phase AC-AC conversion. Electro-mechanical energy conversion via the synchronous machine. Fundamentals of AC electrical energy networks: frequency regulation, voltage regulation, and protection.

ECE350H1 S
Semiconductor Electronic Devices

3/1.50/1/0.50

III-AEESCBASEO, IV-AEESCBASEP, III-AEESCBASER, I-AEMINNANO

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

3/3/-/0.50

III-AEESCBASER

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

3/3/-/0.50

III-AEESCBASER, III-AEESCBASEZ, 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

3/1.50/0.50/0.50

III-AEESCBASER

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

3/-/2/0.50

III-AEESCBASER, IV-AEESCBASET

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

3/1.50/1/0.50

IV-AEESCBASEO, III-AEESCBASER

An introduction to dynamic systems and their control. Differential equation models of physical systems using transfer functions and state space models. Linearization. Initial and input response. Stability theory. Principle of feedback. Internal Model Principle. Frequencey response. Nyquist stability. Loop shaping theory. Computer aided design using MATLAB and Simulink.
Prerequisite: ECE355H1

ECE357H1 S
Electromagnetic Fields

3/1.50/1/0.50

IV-AEESCBASEJ, III-AEESCBASEP, III-AEESCBASER

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

3/-/1/0.50

IV-AEESCBASEF, III-AEESCBASER, I-AEMINRAM

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.

ECE360H1 F
Electronics

3/1.50/1/0.50

III-AEESCBASEP, III-AEESCBASER

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

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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.)

ECE363H1 S
Communication Systems

3/1.50/1/0.50

III-AEESCBASER, IV-AEESCBASET, I-AEMINRAM

An introductory course in analog and digital communication systems. Analog and digital signals. Probability and random processes. 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: MAT389H1 and ECE355H1

ECE410H1 F
Control Systems

3/1.50m/1m/0.50

III,IV-AECPEBASC, 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.
Prerequisite: ECE311H1
Exclusion: ECE557H1

ECE411H1 S
Real-Time Computer Control

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER, IV-AEESCBASET, III-AEESCBASEZ, 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.
Prerequisite: ECE311H1 or ECE356H1

ECE412H1 S
Analog Signal Processing Circuits

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

An overview of analog signal processing in both continuous-time and discrete-time. Analog signal specifications. 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 phase locked loops.
Prerequisite: ECE331H1 or ECE354H1
Exclusion: ECE512H1

ECE413H1 S
Energy Systems and Distributed Generation

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, III-AEESCBASEJ, IV-AEESCBASER, 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.
Prerequisite: ECE314H1 or ECE315H1 or ECE349H1 or ECE359H1

ECE417H1 S
Digital Communication

3/1.50m/1m/0.50

III,IV-AECPEBASC, 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.
Prerequisite: ECE302H1 and ECE316H1, or STA286H1

ECE419H1 S
Distributed Systems

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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 formula and link budget. Propagation phenomena include: diffraction and wave propagation over obstacles; multipath propagation; atmospheric and ionospheric effects. Receiver design aspects include: radio receiver architectures, receiver figures of merit, noise in cascaded systems, noise figure, and noise temperature. System examples are: terrestrial communication systems; satellite communications; radar; radiometric receivers; software-defined radio.
Prerequisite: ECE320H1 or ECE357H1

ECE424H1 F
Microwave Circuits

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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.
Exclusion: ECE524H1

ECE430H1 F
Analog Integrated Circuits

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

Review of MOSFET semiconductor device equations. Noise in electronic devices. Review of single-stage amplifiers and frequency response, including noise analysis. Basic CMOS op amp. Op amp compensation. Advanced op amp circuits: telescopic and folded-cascode op amps. Fully-differential op amps. Common mode feedback.
Prerequisite: ECE331H1 or ECE354H1
Exclusion: ECE530H1

ECE431H1 F
Digital Signal Processing

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, I-AEMINRAM

An introductory course in digital filtering and applications. Introduction to real world signal processing. Review of sampling and quantization of signals. Introduction to the discrete Fourier transform and its properties. The fast Fourier transform. Fourier analysis of signals using the discrete

Fourier transform. Structures for discrete-time systems. Design and realization of digital filters: finite and infinite impulse response filters. DSP applications in areas such as communications, multimedia, video coding, human computer interaction and medicine.

ECE437H1 F
VLSI Technology

3/3/-/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

The introduction to VLSI fabrication techniques, integrated circuit designs and advanced semiconductor devices will give a proper perspective of the past, present and future trends in the VLSI industry. Following the evolution of MOS and bipolar devices, digital and analog CMOS, BiCMOS, deep submicron CMOS, SOI-CMOS, RF-CMOS and HV-CMOS technologies will be studied. Special attention will be given to the physical scaling limits such as short channel effects. In addition, CAD tools and design methodology for the development of advanced semiconductor devices and integrated circuits will be introduced in the laboratory environment. These include the simulation of device fabrication, device characteristics, device modeling, circuit layout, design verification. Finally, advanced technology such as GaN HEMTs, graphene devices, carbon nano-tube devices, power devices, heterojunctions, InP and GaSb HBTs will also be studied.
Prerequisite: (ECE331H1 or ECE334H1 or ECE354H1) and (ECE335H1 or ECE350H1)

ECE442H1 F
Introduction to Micro- and Nano-Fabrication Technologies

3/2m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEO, IV-AEESCBASEP, IV-AEESCBASER, IV-AEESCBASET, IV-AEMMSBASC

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.

This course is not offered in 2016-17.
Prerequisite: ECE335H1 or ECE350H1

ECE445H1 F
Neural Bioelectricity

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEO, IV-AEESCBASER, IV-AEESCBASET, III-AEESCBASEZ, I-AEMINBIO, I-AEMINRAM

Generation, transmission and the significance of bioelectricity in neural networks of the brain. Topics covered include: (i) Basic features of neural systems. (ii) Ionic transport mechanisms in cellular membranes. (iii) Propagation of electricity in neural cables. (iv) Extracellular electric fields. (v) Neural networks, neuroplasticity and biological clocks. (vi) Learning and memory in artificial neural networks. Laboratory experiences include: (a) Biological measurements of body surface potentials (EEG and EMG). (b) Experiments on computer models of generation and propagation of neuronal electrical activities. (c) Investigation of learning in artificial neural networks.

ECE446H1 F
Sensory Communication

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER, IV-AEESCBASET, I-AEMINBIO

Physical acoustics, acoustic measurements, electroacoustic transducers, and physiological acoustics. Speech processing, speech recognition algorithms and signal processing by the auditory system. Engineering aspects of acoustic design. Electrical models of acoustic systems. Noise, noise-induced hearing loss, and noise control. Introduction to vision and other modalities. Musical and psychoacoustics.

ECE448H1 F
Biocomputation

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASET, 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 hierarchal and neural network clustering).

ECE450H1 S
Software Engineering II

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

A continuation of the material introduced in Software Engineering I, focusing on pragmatic structuring principles and design methodologies. Formal specification and validation of software systems. Object-oriented design and design patterns. Testing, metrics and maintenance of software systems. Reverse engineering. Safety-critical and real-time software systems. Emphasis is given to the design and development of large, complex software systems. A session project is normally required.
Prerequisite: CSC444H1

ECE451H1 S
VLSI Systems and Design

3/3m/-/0.50

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.

Not offered in 2015-16.
Prerequisite: ECE241H1

ECE454H1 F
Computer Systems Programming

3/3m/-/0.50

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.

ECE455H1 F
Digital Signal Processing

3/1.50/1/0.50

IV-AEESCBASEP, IV-AEESCBASER, IV-AEESCBASET, III-AEESCBASEZ, I-AEMINRAM

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.
Prerequisite: ECE355H1
Exclusion: ECE362H1, ECE431H1

ECE461H1 F
Internetworking

3/1.50m/0.50m/0.50

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 supernet address extensions; ping program; traceroute program; user datagram protocol; reliable stream transport service (TCP); the socket interface; routing (GGP, 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

ECE462H1 S
Multimedia Systems

3/2m/-/0.50

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

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, III-AEESCBASEJ, IV-AEESCBASER, I-AEMINENR

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

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

The radio medium, radio communication system examples. Link budget: cable losses, propagation loss, antenna gains. Basic concepts of propagation: path loss, multi-path propagation and fading. Raleigh and Rician fading models, Doppler shift, delay spread, coherence time and coherence bandwidth of the channel. Analog modulation schemes and their bandwidths. Digital modulation schemes and their bandwidths and bit rates: BPSK, QPSK, MSK, GMSK. Basic concepts of speech coding. Error correction coding, interleaving, and multiple access frame structure. The physical layer description of the AMPS, IS-54, and GSM cellular systems. The cellular concept: frequency re-use, re-use cluster concept. Channel allocation. Cellular system architecture for AMPS, IS-54, and GSM. Hand-offs and transmitter power control. Cellular traffic, call blocking, concept of Erlangs. Basic ideas in spread spectrum modulation, spreading codes, bit error probability. Orthogonal and non-orthogonal CDMA Basic concepts in CDMA networks.
Prerequisite: ECE302H1 and ECE316H1, or STA286H1

ECE466H1 S
Computer Networks II

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, 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

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEP, 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 F/S
Robot Modeling and Control

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER, IV-AEESCBASET, IV-AEESCBASEZ

Classification of robot manipulators, kinematic modeling, forward and inverse kinematics, velocity kinematics, path planning, point-to-point trajectory planning, dynamic modeling, Euler-Langrange equations, inverse dynamics, joint control, computed torque control, passivity-based control, feedback linearization.

Not offered in Fall for 2015-16.
Prerequisite: ECE311H1 or ECE356H1
Exclusion: AER525H1

ECE472H1 F/S
Engineering Economic Analysis & Entrepreneurship

3/-/2m/0.50

I-AECERBUS, I-AECERENTR, III,IV-AECPEBASC, III,IV-AEELEBASC, I-AEMINBUS

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 in engineering project proposals; measures of economic merit in the public sector; sensitivity and risk analysis. Applications: evaluations of competing engineering project alternatives; replacement analysis; economic life of assets; lease versus buy decisions; break-even and sensitivity analysis. Entrepreneurship and the Canadian business environment will be discussed.

ECE488H1 F
Entrepreneurship and Business for Engineers

3/-/2/0.50

I-AECERBUS, I-AEMINBUS

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: MSE488H1F, MIE488H1F, CHE488H1S and CIV488H1S.)

*Complementary Studies Elective
Exclusion: APS234 and APS432

ECE496Y1 Y
Design Project

1/-/1/1.00

IV-AECPEBASC, 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.
Exclusion: APS490Y1

ECE510H1 F
Introduction to Lighting Systems

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEJ, IV-AEESCBASER, I-AEMINENR

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: ECE221H1 or ECE259H1
Recommended Preparation: ECE320H1 or ECE357H1

ECE514H1 F
Power Electronics: Converter Topologies

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEJ, IV-AEESCBASER, I-AEMINENR

The course focuses on power electronics converters utilized in applications ranging from low-power mobile devices to high-power utility systems. Basic principles of efficient electrical energy processing through switch-mode energy conversion and main converter groups (ac-dc, dc-dc, dc-ac and ac-ac) will be presented and analyzed. Hard switching, resonant and quasi-resonant topologies will be covered. The topics include: converter components, loss mechanisms and converter efficiency, time-domain analysis (volt-second and capacitor charge balance) and converter modeling, frequency domain and state-plane analysis of converters operating in steady state.
Prerequisite: (ECE314H1 or ECE315H1) or ECE349H1 or ECE359H1

ECE516H1 S
Intelligent Image Processing

3/3m/-/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER, III-AEESCBASEZ, 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 and Machine Learning

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEF, IV-AEESCBASER, III-AEESCBASEZ, I-AEMINRAM

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. Matrix 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. Learning graphical models. Applications to image classification, image processing, object tracking, speech recognition, telecommunications and genomics.
Prerequisite: STA286H1 or ECE302H1

ECE525H1 S
Lasers and Detectors

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEO, IV-AEESCBASEP, IV-AEESCBASER, I-AEMINNANO

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.

Not offered in 2015/16.
Prerequisite: One of ECE330H1/ECE350H1 or PHY335H1/PHY355H1, and one of ECE318H1/ECE320H1/ECE357H1. ECE318H1 can also be taken as a co-requisite instead of a pre-requisite.

ECE527H1 F
Photonic Devices

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEJ, IV-AEESCBASEO, IV-AEESCBASEP, IV-AEESCBASER, I-AEMINNANO

Introduction to photonic devices and components useful in a wide range of applications from bio-sensors to optical communications. Fundamentals in the operation and design of the devices will be covered. Topics include: electromagnetic waves; birefringence and polarization; periodic structures and thin films; optical waveguides; interferometers and resonators; couplers and splitters; amplifiers and lasers; photonic intergration; nano-photonics.
Prerequisite: ECE318H1 or ECE320H1 or ECE357H1

ECE532H1 S
Digital Systems Design

3/3m/-/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER, III-AEESCBASEZ, I-AEMINRAM

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 S
Power Electronics: Switch-Mode Power Supplies

3/1m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEJ, IV-AEESCBASER, I-AEMINENR

The course covers the analysis, design and implementation of high-efficiency switched-mode power supplies (SMPS) used in modern electronic equipment. Topics to be covered include: isolated and non-isolated SMPS topologies; steady-state analysis; component datasheets; small-signal modeling and control of non-ideal converters; compensator design; thermal and magnetic circuits; power semiconductor devices; protection and practical implementation issues. The course includes an experimental design project, where teams design, solder and test a closed-loop dc-dc converter.
Prerequisite: (ECE314H1 or ECE315H1) or ECE349H1 or ECE359H1

ECE537H1 F
Random Processes

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASEF, IV-AEESCBASER

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

3/3m/-/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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.

Not offered in 2015-16.

ECE552H1 F
Computer Architecture

3/1.50m/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

Performance analysis and metrics and cost. Instruction set architectures. Instruction-level parallelism: pipelining, superscalar, dynamic scheduling, VLIW processors. Data-level prallelism: vector processors, GPUs. Thread-level parallelism: multiprocessors, multi-core, coherence, simultaneous multi-threading. Memory hierarchies: caches and virtual memory support. Simulation tools and methods. Limited Enrollment. Prerequisite: ECE243H1 or ECE352H1

ECE557H1 F
Systems Control

3/1.50/1/0.50

IV-AEESCBASEA, IV-AEESCBASER, IV-AEESCBASET, IV-AEESCBASEZ, I-AEMINRAM

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.
Exclusion: ECE410H1

ECE568H1 F/S
Computer Security

3/3m/-/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC, IV-AEESCBASER

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.
Prerequisite: ECE344H1 or ECE353H1

Engineering Science

ESC101H1 F
Praxis I

3/-/2/0.50

I-AEESCBASE

Praxis I introduces students to the theory and practice of engineering design and communication. Through an integrated suite of interactive lectures, structured Design Studio activities, and multiple small-team projects, students explore core elements of these disciplines. Emphasis is placed on problem framing, divergent, convergent, and critical thinking, idea generation and selection, modelling and prototyping, efficient and effective teamwork, structuring design activities, constructing credible engineering arguments, and selected additional elements of engineering communication. Praxis I challenges students to explore the theories and principles that underpin engineering design and communication, to develop rigorous, individualized approaches to solving engineering problems, to adopt an outward looking and entrepreneurial engineering perspective, and to take an active role in shaping their future engineering studies.

Exclusion: APS111H1

ESC102H1 S
Praxis II

3/-/2/0.50

I-AEESCBASE

Praxis II 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.
Prerequisite: ESC101H1
Exclusion: APS112H1

ESC103H1 F
Engineering Mathematics and Computation

2/-/2/0.50

I-AEESCBASE

This course is designed to introduce students to mathematics in an engineering context, while exposing students to computational techniques. Topics include: vectors, lines and planes; 3-D visualization; matrices and transformations; matrix inverses, eigenvalues and determinants; solving linear systems; curve fitting and least squares; numerical integration and numerical solutions to differential equations. Course content is complemented with the use of MATLAB computational software.

ESC203H1 F
Engineering and Society

2/-/2/0.50

II-AEESCBASE, I-AEMINENV

Through this course, students will examine the interrelations of science, technology, society and the environment (STSE), emphasizing a humanities and social sciences perspective. Students will consider models of ethical and critical thinking in order to 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 appreciation for the complex interaction between human society and technology, and models for how to analyze and evaluate the social, technological, political, and ethical dimensions of technology.

Humanities and Social Science elective.
Recommended Preparation: ESC102H1

ESC301H1 Y
Engineering Science Option Seminar

1/-/-/0.25

III-AEESCBASEA, III-AEESCBASEF,
III-AEESCBASEI, III-AEESCBASEJ,
III-AEESCBASEO, III-AEESCBASEP,
III-AEESCBASER, III-AEESCBASET,
III-AEESCBASEZ

The Option seminar supports discipline specific discussions of ethics, professionalism, safety and standards and research in a seminar-based setting. Guest speakers, presentations and other activities will highlight various topics of interest, including the present and future research related to the Option. This course will be offered on a credit/no credit basis and the assessment will be through a combination of written assignments, presentations and tests. Concepts in Engineering Communication will be emphasized to support discussion and the development of the course deliverables.

ESC401H1 S
Technology & Society Student Directed Seminar

3/-/1/0.50

Humanities 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

-/-/5/0.50

I-AEESCBASEJ, IV-AEESCBASER

A half-year capstone design course in which students work in 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 context-appropriate energy systems design and simulation, incorporating generation, transmission and storage of energy from across a range of traditional and alternative energy sources. 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.
Exclusion: APS490Y1

ESC471H1 F
Engineering Science Capstone Design

-/-/5/0.50

IV-AEESCBASEO, IV-AEESCBASEP

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 the (re)design and implementation of experiments suitable for the undergraduate classroom or laboratory. 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.
Exclusion: APS490Y1

ESC472H1 S
Electrical and Computer Capstone Design

-/-/5/0.50

IV-AEESCBASER

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.
Exclusion: APS490Y1

ESC490H1 F/S
Engineering Science Independent Study

-/-/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

3/2/-/0.50

IV-AEESCBASEA, IV-AEESCBASEI

Every student in Fourth Year Engineering Science is required to conduct a thesis on an approved subject under the supervision of any faculty member at the University of Toronto. The thesis provides students with an opportunity to conduct, document, and experience engineering related research as an undergraduate student. This course is structured to provide resources to support that process, in particular the documentation of research, through a series of lectures and workshops. While the final thesis document is the main deliverable, students are also required to submit a set of interim deliverables to support ongoing documentation and reflection.
Exclusion: CHE499Y1
Recommended Preparation: Recommended Preparation: ESC301H1

ESC499Y1 Y
Thesis

3/2/-/1.00

IV-AEESCBASEA, IV-AEESCBASEF,
I-AEESCBASEJ, IV-AEESCBASEO,
IV-AEESCBASEP, IV-AEESCBASER,
IV-AEESCBASET, IV-AEESCBASEZ

Every student in Fourth Year Engineering Science is required to conduct a thesis on an approved subject under the supervision of any faculty member at the University of Toronto. The thesis provides students with an opportunity to conduct, document, and experience engineering related research as an undergraduate student. This course is structured to provide resources to support that process, in particular the documentation of research, through a series of lectures and workshops. While the final thesis document is the main deliverable, students are also required to submit a set of interim deliverables to support ongoing documentation and reflection.
Exclusion: CHE499Y1
Recommended Preparation: ESC301H1

Environment

ENV221H1 F
Multidisciplinary Perspectives on Environment (formerly ENV222Y1)

-/-/-/0.50

I-AEMINENV

One of two foundation courses for the School's undergraduate program. Introduces students to ways in which different disciplines contribute to our understanding of environment. Instructors and guest lecturers are drawn from the sciences, social sciences and the humanities and will present subject matter, assumptions, conceptualizations and methodologies of their disciplines.
Exclusion: ENV222Y1/GGR222Y1/JGE221Y1

ENV222H1 S
Interdisciplinary Environmental Studies (formerly ENV222Y1)

-/-/-/0.50

I-AEMINENV

Building upon ENV221H1, shows how environmental studies is working to knit different disciplinary perspectives into one interdisciplinary body of knowledge; interplay of science and values in definition and framing of issues; roles of markets, politics and ethics in developing solutions; local to global scale; historical and current timeframes.
Exclusion: ENV222Y1/GGR222H1/GGR222Y1/JGE221Y1/JIE222Y1
Note: GGR222H1 as an exclusion for ENV222H1 does not apply for the Winter 2011 offering of the ENV222H1/GGR222H1 combined course.

ENV333H1 F
Ecological Worldviews

-/-/-/0.50

I-AECERGLOB

Approaches to environmental concerns are often marked by assumptions that reflect distinct worldviews positing particular understandings of the role of the human with respect to nature. This course explores sundry economic, political, scientific, religious, and moral worldviews pertaining to the environment, including environmental ethics, Gaia, ecofeminism, scientific cosmology, and aboriginal perspectives.
Prerequisite: (ENV221H1,ENV222H1)
Exclusion: INI333H1 (2005-06 academic year and before)

ENV346H1 F
Terrestrial Energy Systems

3/-/3/0.50

III-AEESCBASEJ

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/CHM136H1/CHM138H1/CHM1135H1/CHM139H1/CHM151Y1/PHY131H1/PHY132H1/PHY151H1/PHY152H1

ENV350H1 F
Energy Policy and Environment

-/-/-/0.50

I-AEMINENR, I-AEMINENV

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) or permission of Academic Associate Director

Forestry

FOR308H1 F
Discovering Wood and its Role in Societal Development

3/-/1/0.50

I-AECERRRE, I-AEMINBIO,
I-AEMINBUS, I-AEMINENV

Humanities and Social Science elective

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

2/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEJ,
I-AEMINENR

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.
Exclusion: GGR310H1
Recommended Preparation: Completion of at least 6 Science FCEs

FOR421H1 F
Green Urban Infrastructure: Sustainable City Forests

2/-/-/0.50

I-AECERRRE, I-AEMINBIO,
I-AEMINENV

Complementary Studies elective

With over 80% of the world's population now living in cities, tomorrow's forests will be urban. Increasing global recognition of nature deficit disorder and the values of green infrastructure to mitigate broader human impacts gives a new meaning to the term 'urban forestry', coined here at UofT and now recognized widely. Trees in and around the city are key to providing multiple engineered and ecological services that only recently have been brought into the responsible fiscal planning of every municipality around the globe. If managed properly (a key concept), urban forests mitigate climate change and urban heat island effects, act as carbon sinks, air filters, water purifiers, air conditioners, noise dampeners, wildlife and/or biodiversity refuges, and green spaces for the human spirit. Here, we explore the challenges and opportunities of this exciting new applied field at the cross-roads of ecology, engineering and planning to ensure future global sustainability.
Exclusion: FOR416H1

FOR424H1 S
Innovation and Manufacturing of Sustainable Materials

2/-/1/0.50

I-AECERRRE, IV-AECHEBASC,
IV-AEMECBASC, I-AEMINBIO,
I-AEMINENV, I-AEMINNANO,
IV-AEMMSBASC

Sustainable materials are a mandate for sustainable societies. This course will explore the manufacturing, engineering principles and design fundamentals for creating sustainable materials from renewable resources. Special emphasis will be on bioplastics, biofibre, nanobiofibre, biocomposites and nanobiocomposites. Written communication and design skills will be developed through tutorials and assignments.
Exclusion: FOR423H1
Recommended Preparation: Basic knowledge of materials science.

FOR425H1 S
Bioenergy and Biorefinery Technology

2/-/2/0.50

I-AECERRRE, IV-AECHEBASC,
IV-AEESCBASEJ, I-AEMINBIO,
I-AEMINENR

Technological advances and approaches in deriving biofuels, chemical feedstocks from forest and other biomass resources. 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 explored.
Exclusion: FOR410H1

Geography

GGR216H1 F
Global Cities

-/-/-/0.50

I-AECERGLOB

Most urban courses taught in the English-speaking world implicitly or explicitly focus on large North American, European, or Australian cities. While these places are interesting in their own right, studying them as the sole model of urbanization is misleading. To a great extent, the societies of the westernized, developed world are already highly-urbanized and have been so for decades. Cities outside of this sphere, by contrast, are generally growing much faster, and experiencing greater social and economic upheaval as a result. Understanding non-North American urbanization is a vital part of understanding cities in general. This course is an attempt to introduce students to processes of urbanization that are occurring in places other than North America. There will be a particular focus on comparing the urban form, economies, and social life in cities around the world.

GGR223H1 S
Environment, Society and Resources (formerly GGR222H1)

-/-/-/0.50

I-AEMINENV

Focuses on society-environment relations and different approaches to resource governance and management. This includes exploration of the spatial, social, and political economic origins and implications of humans' changing relations to nature. Drawing on debates from environmental governance and political ecology literatures, the course also investigates the ways that different actors and institutions have framed and sought solutions to environmental and resource challenges.
Exclusion: GGR222H1/GGR222Y1/GGR233Y1/JGE221Y1/ENV222Y1/ ENV222H1 (if ENV222H1 was taken before 2012-13)

GGR251H1 S
Geography of Innovation

-/-/-/0.50

I-AEMINBUS

Explores how new technologies and industries are generated and sustained, or failed to be. Focuses on the dynamics of leading technological sectors such as electronics, automobiles and biotechnology in their geographical and historical contexts. We critically scrutinise the iconic Silicon Valley along with other major innovative regions/nations, and investigate the key role of universities and finance in driving innovation and entrepreneurship.

Exclusion: GGR300H1 (2014-15)

GGR252H1 S
Marketing Geography

2/-/1m/0.50

I-AEMINBUS

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.

GGR347H1 F
Efficient Use of Energy (formerly JGE347H1)

2/-/1a/0.50

I-AEMINENR

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. **Offered alternate years from GGR348H1.**
Prerequisite: Physics SPH3U
Exclusion: GGR333H1, JGE347H1
Recommended Preparation: 8.0 FCE's including first year Math and/or Physics

GGR348H1 S
Carbon-Free Energy (formerly JGE348H1)

2/-/1a/0.50

I-AEMINENR

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. **Offered alternate years from GGR347H1.**
Prerequisite: Physics SPH3U
Exclusion: GGR333H1, JGE348H1
Recommended Preparation: 8.0 FCE's including first year Math and/or Physics

JGI216H1 S
Globalization and Urban Change

-/-/-/0.50

I-AECERGLOB

Focusing on the impacts that global flows of ideas, culture, people, goods, and capital have on cities throughout the globe, this course explores some of the factors that differentiate the experiences of globalization and urban change in cities at different moments in history and in various geographic locations.
Recommended Preparation: GGR124H1

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 available from the IHPST office in Room 316, Old Academic Building, Victoria College 416-978-5397 or www.hps.utoronto.ca. Specific timetable information about Arts and Science courses is 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.

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

HPS210H1 F
Scientific Revolutions I

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

HPS211H1 S
Scientific Revolutions II

2/-/1/0.50

Case studies in the history of science from 1800 to 2000, including Volta, Lyell, Darwin, Mendel, Einstein, Schrdinger, Watson, and Crick. The course is designed to be accessible to science students and non-scientists alike
Exclusion: HPS200Y1

HPS280H1 F/S
History of Science

2/-/1/0.50

Humanities and Social Science elective

This course surveys the development of science from Antiquity to the modern times. We focus on a number of selected topics, ranging from the mechanical worldview to particle physics, from the classification of species to molecular biology, from the introduction of laboratory to the interaction between war and science. Our aim is to explore how and why science came to its current form and status by addressing crucial discoveries and conceptual breakthroughs, conditions and standards indispensable to scientific research, and principal mutual influences between science and society.

HPS281H1 F/S
History of Technology and Engineering Pre-Industrial Revolution

2/-/1/0.50

Humanities and Social Science elective

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).

HPS282H1 F/S
History of Technology and Engineering

2/-/1/0.50

Humanities and Social Science elective

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.)

HPS283H1 S
The Engineer in History

2/-/1/0.50

I-AEMINBUS

Humanities and Social Science elective

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.

HPS321H1 S
Understanding Engineering Practice: From Design to Entrepreneurship

2m/-/-/0.50

I-AEMINBUS

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.
Prerequisite: Three courses with any combination of engineering, natural sciences, medical sciences, or commerce

HPS318H1 F
History of Medicine I

-/-/-/0.50

I-AEMINBIO

This course explores how medicine was practiced, taught and theorized from ancient Greece to the early modern period. It focuses on the historical development of western medicine in relation to societies, politics and culture, and considers topics such as the creation of medical traditions, the tranmission and communication of medical knowledge, the pluralistic world of healers, the role of religion, magic and natural philosophy, the cultural meaning of disease, and the emergence of institutions such as the hospital.
Exclusion: HPS314Y1

HPS319H1 S
History of Medicine II

-/-/-/0.50

I-AEMINBIO

This course examines the development of medicine from the seventeenth to the twentieth century. It focuses on the historical development of western medicine in relation to societies, politics and culture and considers topics such as changing views of the body, the development of medical institutions such as hospitals, asylums and laboratories, the diversifies world of healing and the place of visual and material culture in the production and dissemination of medical knowledge.
Exclusion: HPS314Y1; HPS315H1

Human Biology

HMB200H1 S
Introduction to Neuroscience

2/-/1/0.50

IV-AEESCBASET

An introductory course that explores the development, physiology and continually changing function of the nervous system as it relates to certain types of human behaviour. Critical analysis of scientific evidence is used to enrich learning.
Prerequisite: (BIO120H1, BIO130H1), PSY100H1
Exclusion: HMB220H1
Recommended Preparation: PSL300H1

HMB265H1 F
General & Human Genetics

2/-/1/0.50

I-AEMINBIO

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.

*Please note: requests to waive the pre-requisites or co-requisites for this course are **not** granted. Students must either take BIO230H1 or BIO255H1 before enrolling in HMB265H1 or be concurrently enrolled in BIO230H1/BIO255H1 while enrolled in HMB265H1.*
*If you plan on using transfer credits in lieu of the pre/co-requisites, you must email human.biology@utoronto.ca **before** enrolling in the course to request that your transfer credits be accepted in lieu of the stated pre-/co- requisites.*
Prerequisite: BIO120H1, BIO130H1
Corequisite: BIO230H1/ BIO255H1
Exclusion: BIO260H1/ BIO207H5

Immunology

IMM250H1 F/S
The Immune System and Infectious Disease

-/-/-/0.50

I-AEMINBIO

Students will be introduced to the basic concepts of immunity to infectious disease and how breakdown of the immune response can lead to auto-immunity. We will trace the history of current ideas in immunology and the immune response by examining how bacteria and viruses cause disease and the initial discoveries that led to such developments as vaccination. Current topical and newsworthy infectious diseases (HIV, tuberculosis, SARS, avian flu) will be used as examples of how the immune system copes with microbial infections.
Recommended Preparation: BIO120H1, BIO130H1

Innis College

INI304H1 S
Critical Thinking and Inquiry in Written Communication

-/-/-/0.50

I-AECERCOM

This seminar in critical reading, analysis, and writing focuses on the nature, the evaluation, and the use and abuse of evidence in the process of formulating and supporting an argument. The case study method will be employed to assess the level of authority, credibility, and objectivity evident in public discourse, official sources, and academic inquiry.
Prerequisite: Completion of 4.0 full-course equivalents.

INI305H1 S
Word and Image in Modern Writing

-/-/-/0.50

I-AECERCOM

The rhetorical term Ekphrasis, which refers to writing that is about visual art, is central in the examination of the persuasive power of the conversation or discourse that is produced when the written word attempts the evocation of visual images. Course readings will include ekphrastic texts drawn from several disciplines and genres: journalism, informal essays, poetry, and scholarly writing.
Prerequisite: Completion of 4.0 full-course equivalents.

INI310H1 F
Editing

-/-/-/0.50

I-AECERCOM

A study of professional editorial conventions, focusing on three stages of the editorial process: substantive editing, stylistic editing, and copy editing. As students learn these stages, they enhance their critical thinking, sharpen their language skills, and practise strategies for strengthening their own writing and the writing of others.
Prerequisite: Completion of 4.0 full-course equivalents.

Joint Courses

JRE300H1 F/S
Fundamentals of Accounting and Finance

3/-/1/0.50

I-AECERBUS, I-AEMINBUS

Complementary Studies elective

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.

JRE410H1 F/S
Markets and Competitive Strategy

2/2/-/0.50

I-AECERBUS, I-AEMINBUS

Complementary Studies elective

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.

JRE420H1 F/S
People Management and Organizational Behaviour

3/1/-/0.50

I-AECERBUS, I-AEMINBUS

Complementary Studies elective

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

MAT185H1 S
Linear Algebra

3/-/1/0.50

I-AEESCBASE

Topics include: 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.

Prerequisite: ESC103H1
Exclusion: MAT188H1

MAT186H1 F
Calculus I

3/-/1/0.50

I-AECHEBASC, I-AECIVBASC,
I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AELMEBASC, I-AEMECBASC,
I-AEMMSBASC

Topics include: limits and continuity; differentiation; applications of the derivative –related rates problems, curve sketching, optimization problems, L'Hopital's rule; definite and indefinite integrals; the Fundamental Theorem of Calculus; applications of integration in geometry, mechanics and other engineering problems.

Exclusion: APS162H1

MAT187H1 S
Calculus II

3/-/1/0.50

I-AECHEBASC, I-AECIVBASC,
I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AELMEBASC, I-AEMECBASC,
I-AEMMSBASC

Topics include: techniques of integration, an introduction to mathematical modeling with differential equations, infinite sequences and series, Taylor series, parametric and polar curves, vector-valued functions, partial differentiation, and application to mechanics and other engineering problems.

Prerequisite: APS162H1/MAT186H1
Exclusion: APS163H1/MAT197H1

MAT188H1 F
Linear Algebra

3/1/1/0.50

I-AECHEBASC, I-AECIVBASC,
I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AELMEBASC, I-AEMECBASC,
I-AEMMSBASC

This course covers systems of linear equations and Gaussian elimination, applications; vectors in Rn, independent sets and spanning sets; linear transformations, matrices, inverses; subspaces in Rn, basis and dimension; determinants; eigenvalues and diagonalization; systems of differential equations; dot products and orthogonal sets in Rn; projections and the Gram-Schmidt process; diagonalizing symmetric matrices; least squares approximation. Includes an introduction to numeric computation in a weekly laboratory.

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.
Exclusion: MAT186H1 or APS162H1

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.

Prerequisite: MAT194H1
Exclusion: MAT187H1 or APS163H1

MAT231H1 F
Modelling with Differential and Difference Equations

3/-/2/0.50

II-AEINDBASC

Ordinary differential equations. Equations of first order and first degree. Linear equations of order n. Equations of second order. Systems of simultaneous equations. Difference equations. Linear control. Forecasting. Business dynamics. Throughout the course: formulating and analysing differential or difference equation models for real-world problems.

MAT234H1 S
Differential Equations

3/-/1.50/0.50

II-AEMECBASC

Ordinary differential equations. Classification. Equations of first order and first degree. Linear equations of order n. Equations of second order. Bessel's equation. Legendre's equation. Series solutions. Systems of simultaneous equations. Partial differential equations. Classification of types. The diffusion equation. Laplace's equation. The wave equation. Solution by separation of variables.

MAT290H1 F
Advanced Engineering Mathematics

3/-/2m/0.50

II-AECPEBASC, II-AEELEBASC

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

3/-/2m/0.50

II-AECPEBASC, II-AEELEBASC

The chain rule for functions of several variables; the gradient. Multiple integrals; change of variables, Jacobians. Line integrals, independance 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. Maxima and minima, Lagrange multipliers.

MAT292H1 F
Ordinary Differential Equations

3/-/2/0.50

II-AEESCBASE

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.
Prerequisite: MAT195H1
Exclusion: CHE222H1, CME261H1, CME362H1, MAT290H1, MAT291H1, MAT294H1 or MAT234H1

MAT294H1 F
Calculus and Differential Equations

3/-/2/0.50

II-AEMMSBASC

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

3/-/-/0.50

IV-AEESCBASEP, IV-AEESCBASER

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, Lagrange theorem. Normal subgroups, quotient groups. Classification of finitely generated abelian groups. Emphasis on examples and calculations.
Prerequisite: MAT224H1/MAT247H1, MAT235Y1/MAT237Y1, MAT246H1/CSC236H1/CSC240H1. (These Prerequisites will be waived for students who have MAT257Y1)
Exclusion: MAT347Y1

MAT336H1 S
Elements of Analysis

3/-/-/0.50

III-AEESCBASEF, IV-AEESCBASEP, IV-AEESCBASER

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^n, implicit and inverse function theorems and rigorous integration theory.
Prerequisite: MAT223H1/MAT240H1, MAT235Y1/MAT237Y1
Exclusion: MAT257Y1, MAT337H1

MAT363H1 S
Geometry of Curves and Surfaces

3/-/-/0.50

III-AEESCBASEZ, I-AEMINRAM

Curves and surfaces in 3-spaces. Frenet formulas. Curvature and geodesics. Gauss map. Minimal surfaces. Gauss-Bonnet theorem for surfaces. Surfaces of constant curvature.
Prerequisite: MAT224H1/MAT247H1, MAT237Y1/MAT257Y1 (MAT257Y1 can be taken concurrently)
Exclusion: MAT367H1

MAT367H1 S
Differential Geometry

-/-/-/0.50

Manifolds, partitions of unity, submersions and immersions, vector fields, vector bundles, tangent and cotangent bundles, foliations and Frobenius' theorem, multillinear algebra, differential forms, Stokes' theorem, Poincare-Hopf theorem
Prerequisite: MAT257Y1/(MAT224H1, MAT237Y1,MAT246H1,and permission of instructor)
Recommended Preparation: Multivariable calculus (MAT257Y1), Linear algebra (MAT240H1, MAT247H1)

MAT389H1 F
Complex Analysis

3/-/1/0.50

III-AEESCBASEA, III-AEESCBASEO, III-AEESCBASEP, III-AEESCBASER, III-AEESCBASEZ

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

3/-/-/0.50

IV-AEESCBASEP

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

MAT402H1 S
Classical Geometries

3/-/-/0.50

IV-AEESCBASEP

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

Materials Science and Engineering

MSE101H1 F/S
Introduction to Materials Science

3/1/1/0.50

I-AECHEBASC, 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

MSE160H1 S
Molecules and Materials

3/-/1/0.50

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: MSE101H1 or APS104H1
Recommended Preparation: CIV102H1

MSE202H1 F
Thermodynamics

3/-/2/0.50

III-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

Diffusion mechanisms in solids, liquids and gases. Role of crystal imperfections in solids on diffusion rates. Fick's law, steady state and non-steady state diffusion. Homogeneous and heterogeneous reactions. Orders of reactions. Metastable products and partial equilibrium. Theories on reaction kinetics. Rate limiting step in multi-step processes.

MSE219H1 F
Structure and Characterization of Materials

3/3/1/0.50

II-AEMMSBASC

Introduction to two and three-dimensional crystallography and crystal structures of solids. Topics include: Pearson and Hermann-Mauguin symbols, reciprocal space, point group and space group symmetry analysis, stereographic projections. Introduction to tensor analysis of crystalline material properties, and symmetry breakdown by imperfections in crystals. Experimental techniques used to interpret structure and chemistry of solids and their defects will be covered theoretically and in the laboratory including: X-ray diffractometry, optical, electron and scanning probe microscopy, and surface/bulk spectroscopies based on optical, X-ray, electron and ion-beam analysis methods.

MSE335H1 S
Materials Physics

3/-/1/0.50

III-AEMMSBASC

Application of solid state physics to describe properties of materials. Thermal properties of solids: lattice vibrations (phonons), heat capacity, thermal conductivity. Electrical properties of metals: simple circuits, resistivity of metals (classical and quantum descriptions), Seebeck, Peltier, and Thomson effects. Electrical properties of semiconductors: band structure and occupancy, conductivity, Hall effect, simple devices. Electrical properties of insulators: polarization, capacitance, optical properties, ferroelectric and piezoelectric materials. Magnetic properties: diamagnetism and paramagnetism, ferromagnetic and ferrimagnetic materials, magnetic domains, B-H curves.

This course is not offered 2016-17.

MSE238H1 S
Engineering Statistics and Numerical Methods

3/-/2/0.50

II-AEMMSBASC

This course will teach engineering statistics and numerical methods with MATLAB. Topics on statistics will include probability theory, hypothesis testing, discrete and continuous distribution, analysis of variance, sampling distributions, parameter estimation and regression analysis. The topics on numerical methods will include curve fitting and interpolation, numerical differentiation and integration, solution of ordinary and partial differential equations, initial and boundary value problems, finite difference and finite element methods.

MSE244H1 F
Inorganic Materials Chemistry and Processing

3/3/1/0.50

II-AEMMSBASC

Introduction to atomic and molecular structures, acid-base and redox reactions, transition metal complexes, and detailed chemical properties of the main group elements in the periodic table. Examples of industrial practice in metal processing industry and energy generation/storage technologies. Fundamentals of chemical analysis of inorganic compounds, by both classical "wet" volumetric analysis and instrumental methods.

MSE245H1 S
Organic Materials Chemistry and Properties

3/3/1/0.50

II-AEMMSBASC

Introduction to organic chemistry and organic materials. Naming, bonding and shapes of organic molecules. Properties and reactions of organic compounds. Key mechanisms including electrophilic addition, nucleophilic aliphatic substitution, -elimination reactions and electrophilic aromatic substitution. Syntheses of polymers (step-growth and radical chain growth polymerization) and processing methods. Structure and properties of polymeric materials (amorphous, crystalline, elastomeric). Thermo-transition and visco-elastic properties of polymers. Life-cycle of polymers, mechanisms of degradation and strategies of polymer recycle. Hands-on organic syntheses and separation experiments.

MSE290H1 S
Communications I

1/-/1/0.25

II-AEMMSBASC

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

3/1.50/1/0.50

III-AELMEBASC

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 or MSE244H1

MSE315H1 S
Environmental Degradation of Materials

3/-/2/0.50

I-AEMINENV, III-AEMMSBASC

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

3/3/1/0.50

III-AEMMSBASC

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.

MSE318H1 F
Phase Transformations

3/3/1/0.50

III-AEMMSBASC

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.

MSE332H1 F
Heat and Mass Transfer for Materials Processing

3/-/2/0.50

III-AEMMSBASC

Fundamental concepts of heat and mass transfer as applied in materials engineering. Steady state and transient analysis in slabs, cylinders and spheres through solutions of problems in metallurgy and material processing. Similarity between heat and mass transfer. Concepts of momentum, mass and thermal boundary layers. Coupled problems.

MSE342H1 F
Nanomaterials

2/-/1/0.25

III-AEMMSBASC

An introduction to nanostructured 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).

MSE343H1 F
Biomaterials

2/-/1/0.25

III-AEMMSBASC

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).

MSE351H1 S
Design and Simulation of Materials Processes

3/2/1/0.50

III-AEMMSBASC

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.

MSE352H1 S
Biomaterials and Biocompatibility

3/-/1/0.50

IV-AEESCBASEO, III-AEESCBASET, I-AEMINBIO

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

2/-/1/0.25

III-AEMMSBASC

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.

MSE355H1 S
Materials Processing and Sustainable Development

2/-/1/0.25

I-AEMINENR, III-AEMMSBASC

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

3/1.50/1/0.50

III-AEESCBASEO, IV-AEESCBASEP, IV-AEESCBASER, IV-AEESCBASET

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 microscopy.

Not offered in 2015-16.

MSE390H1 F
Communications II

1/-/1/0.25

III-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

2/2/1/0.50

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.

MSE404H1 F
Extractive Metallurgy

3/-/2/0.50

I-AEMINENR, I-AEMINENV,
IV-AEMMSBASC

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.

MSE408H1 S
Energy Management in Materials Processing

3/-/1/0.50

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

3/-/1/0.50

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

3/-/2/0.50

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.

Not offered in 2016-17.

MSE430H1 F
Electronic Materials

2/-/1/0.50

IV-AEESCBASEO, I-AEMINNANO,
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.

MSE431H1 S
Forensic Engineering

3/-/1/0.50

IV-AEESCBASEO, 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 or MSE160H1

MSE432H1 S
Macromolecular Materials Engineering

3/-/-/0.50

IV-AEMECBASC, I-AEMINNANO,
IV-AEMMSBASC

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 implicaitons of polymers. Several leading edge examples from the

electronics, transportation and medical industries are introduced during the course.
Exclusion: CHE461H1 and MSE330H1

MSE435H1 S
Optical and Photonic Materials

3/1/2/0.50

IV-AEMMSBASC

Optical and photonic materials play a central role in a variety of application fields including telecommunications, metrology, manufacturing, medical surgery, computing, spectroscopy, holography, chemical synthesis, and robotics - to name a few. The properties of light and its interaction with matter lie at the heart of this ever-expanding list of applications. The syllabus comprises the nature of light, wave motion, lasers, interference, coherence, fibre optics, diffraction, polarized light, photonic crystals, metamaterials, plasmonic materials, and practical design applications.

MSE438H1 F
Introduction to Computational Materials Design

3/2/1/0.50

IV-AEMMSBASC

This course will provide a broad overview of the modern computational materials design approaches at various length scales. At the atomic scale, we will cover density functional theory, molecular dynamics, and atomistic kinetic Monte-Carlo. Mesoscale simulations of material behavior will involve dislocation dynamics and phase-field models. At the continuum scale, computational fracture mechanics and plasticity modeling will be covered. Finally, students will be exposed to the concepts and case-studies pertaining to multi-scale modeling. Hands-on training will be provided on software such as LAMMPS and Quantum-ESPRESSO.

MSE440H1 F
Biomaterial Processing and Properties

3/-/1/0.50

IV-AECHEBASC, I-AEMINBIO,
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.

MSE442H1 S
Surgical and Dental Implant Design

3/-/1/0.50

IV-AEESCBASET, 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.

Not offered in 2016-17.
Prerequisite: MSE440H1. For EngSci students, MSE352H1 is recommended.

MSE450H1 F
Plant Design for Materials Process Industries

2/-/3/0.50

IV-AEMMSBASC

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.

MSE451H1 S
Advanced Physical Properties of Structural Nanomaterials

3/2/1/0.50

IV-AEESCBASEO, IV-AEMMSBASC

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.

This course is not offered for 2016-17.

MSE455H1 S
Process Simulation and Computer Design

3/-/2/0.50

IV-AEMMSBASC

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.

MSE458H1 S
Nanotechnology in Alternate Energy Systems

3/-/2/0.50

IV-AEESCBASEJ, IV-AEESCBASEO,
I-AEMINENR, 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.

MSE459H1 F
Synthesis of Nanostructured Materials

3/2/-/0.50

IV-AEESCBASEO, I-AEMINNANO,
IV-AEMMSBASC

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.

MSE461H1 F
Engineered Ceramics

3/-/2/0.50

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.

Not offered in 2016-17.

MSE462H1 S
Materials Physics II

2/-/1/0.50

IV-AEESCBASEO, I-AEMINNANO

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.

MSE488H1 F
Entrepreneurship and Business for Engineers

3/-/2/0.50

I-AECERBUS, I-AEMINBUS

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.)

*Complementary Studies Elective
Exclusion: APS234 and APS432

MSE490H1 F
Professional Ethics and Practice

2/-/-/0.25

IV-AEMMSBASC

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

3/6/2/1.00

IV-AEMMSBASC

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

Mechanical and Industrial Engineering

MIE100H1 S
Dynamics

3/-/2/0.50

I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AEMECBASC

This course on Newtonian mechanics considers the interactions which influence 2-D, curvilinear motion. These interactions are described in terms of the concepts of force, work, momentum and energy. Initially the focus is on the kinematics and kinetics of particles. Then, the kinematics and kinetics of systems of particles and solid bodies are examined. Finally, simple harmonic motion is discussed. The occurrence of dynamic motion in natural systems, such as planetary motion, is emphasized. Applications to engineered systems are also introduced.
Exclusion: APS161H1

MIE191H1 S
Seminar Course: Introduction to Mechanical and Industrial Engineering

1/-/-/0.15

I-AEINDBASC, I-AEMECBASC

This is a seminar series that will preview the core fields in Mechanical and Industrial Engineering. Each seminar will be given by a professional in one of the major areas in MIE. 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 Department to enable them to make educated choices for second year. This course will be offered on a credit/no credit basis. Students who receive no credit for this course must re-take it in their 2S session. Students who have not received credit for this course at the end of their 2S session will not be permitted to register in session 3F.

MIE201H1 S
Essays in Technology and Culture

2/-/1/0.50

Humanities and Social Science elective

This course explores the relationship between changing technologies and cultural representations and teaches a methodology that bridges the world of the artist and the world of the engineer. It enables engineers to explore how the analysis of art has been used in the discussion of the social impacts of technological innovation and to use these methods as they develop new skills in essayistic argument and increase critical vocabulary.

MIE210H1 S
Thermodynamics

3/1.50/1/0.50

II-AEMECBASC

This is a basic course in engineering thermodynamics. Topics covered include: properties and behaviour of pure substances; equation of states for ideal and real gases; compressibility factor; first and second laws of thermodynamics; control mass and control volume analyses; applications of first and second laws of thermodynamics to closed systems, open systems and simple thermal cycles.
Prerequisite: MAT186H1

MIE221H1 S
Manufacturing Engineering

3/2/1/0.50

II-AEMECBASC

Production Fundamentals: Metal casting; metal forming - rolling, forging, extrusion and drawing, and sheet-metal forming; plastic/ceramic/glass forming; metal removal - turning, drilling/ boring/reaming, milling, and grinding; non-traditional machining - ECM, EDM and laser cutting; welding; surface treatment; metrology. Environmental issues in manufacturing processes, recycling of materials. Automation 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.

Instruction and assessment of communication centered around course deliverables that will form part of an ongoing design portfolio.

MIE222H1 S
Mechanics of Solids I

3/1.50/1.50/0.50

II-AEMECBASC, II-AEMMSBASC

Design of mechanical joints. Elasto-plastic torsion of circular sections. Elasto-plastic bending of beams. Residual stresses, shearing stresses in beams, analysis of plane stress and plant strain problems. Pressure vessels, design of members of strength criteria, deflection of beams. Statistically indeterminate problems.

MIE230H1 F
Engineering Analysis

3/-/2/0.50

II-AEMECBASC

Introduction to complex analysis. Multivariate integration with application to calculation of volumes, centroids and moments. Vector calculus. Divergence, curl and gradient operators. Green's theorem. Gauss' theorem. Stokes' theorem. Integral transforms. Laplace transforms and Fourier series, integral and transform.
Prerequisite: MAT186H1, MAT187H1

MIE231H1 F
Probability and Statistics with Engineering Applications

3/2/2/0.50

II-AEMECBASC

Use of data in engineering decision processes. Elements of probability theory. Discrete and continuous random variables. Standard distributions: binomial, Poisson, hypergeometric, exponential, normal etc. Expectation and variance. Random sampling and parameter estimation. Confidence intervals. Hypothesis testing. Goodness-of-fit tests. Regression and correlation. Statistical Process Control and quality assurance. Engineering applications in manufacturing, instrumentation and process control.

MIE236H1 F
Probability

3/-/2/0.50

II-AEINDBASC

Introduction to probability (the role of probability, exploratory data analysis and basic graphical methods). Sample space and events, Venn diagram. Definitions of probability. Axiomatic definition and basic rules. Conditional probability and Bayes' rule. Concept of random variables. Discrete, continuous, and joint distributions. Probability mass functions, density function, cumulative distribution function. Expectation, variance, and covariance. Important discrete and continuous distributions. Multivariate normal distribution. Functions of random variables. Moment Generating functions. Central limit theorem, laws of large numbers, Markov and Chebyshev's inequalities, types of convergence. Fundamental sampling distributions, Chi-square, t, and F distributions. One sample estimation and hypothesis testing.

MIE237H1 S
Statistics

3/1/2/0.50

II-AEINDBASC

Two sample estimation and hypothesis testing. Least squares estimation. Simple linear regression and correlation. Multiple linear regression. Linear models. Model building and model assessment. Design and analysis of single and multi factor experiments. Analysis of variance. Randomization and blocking. Fixed and random effects models. Multiple comparisons. Sample size calculations.
Prerequisite: MIE231H1/MIE236H1 or equivalent

MIE240H1 S
Human Centred Systems Design

3/-/2/0.50

II-AEINDBASC

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

3/3/-/0.50

II-AEINDBASC, I-AEMINBIO

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.

MIE243H1 F
Mechanical Engineering Design

3/2/2/0.50

II-AEMECBASC, I-AEMINRAM

Introduction to basic mechanical parts and mechanisms: gears, cams, bearings, linkages, actuators and motors, chain and belt drives, brakes and clutches, hydraulics and pneumatics. Tutorials on engineering drawing, sketching, and CAD/CAM in SolidWorks: views and drawing types, 2D sketching, 3D modeling and engineering drawing generation, modeling of assembly and motion analysis/animation. Conceptual design examples and mechanical engineering design process, including selection and applications of mechanisms. Dissection and reverse engineering of selected mechanical devices, mechanisms, and subsystems. Competitive group design project including technical report and 3D printing.

Instruction and assessment of communication centered around course deliverables that will form part of an ongoing design portfolio.

MIE250H1 F
Fundamentals of Object Oriented Programming

2/3/-/0.50

II-AEINDBASC

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; design and implementation of programs relevant to industrial engineering needs according to strict specifications.
Prerequisite: APS105H1/APS106H1 or equivalent

MIE253H1 S
Data Modelling

3/2/-/0.50

II-AEINDBASC

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

MIE258H1 F
Engineering Economics and Accounting

3/-/1/0.50

I-AECERBUS, I-AECERENTR,
II-AEINDBASC, I-AEMINBUS,
III-AEMMSBASC

Engineering economic and 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
Exclusion: ECE472H1

MIE262H1 S
Operations Research I: Deterministic OR

3/2/1/0.50

II-AEINDBASC

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

3/-/2/0.50

II-AEINDBASC

Modeling and analysis of systems subject to uncertainty using probabilistic methods. Introduction to decision analysis. Derivation and application of Bernoulli and Poisson processes, Markov chains, and queuing models. Stochastic optimization and extensions. Applications to engineering, games of chance, health care, and management.
Prerequisite: MIE231H1 or MIE236H1

MIE270H1 F
Materials Science

3/0.75/1.50/0.50

II-AEMECBASC

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.

MIE301H1 F
Kinematics and Dynamics of Machines

3/3/2/0.50

III-AEMECBASC, I-AEMINRAM

Classifications of mechanisms, velocity, acceleration and force analysis, graphical and computer-oriented methods, balancing, flywheels, gears, geartrains, cams. Introduction to Lagrangian Dynamics: Lagrange's equations of motion, Hamilton's equations, Hamilton's principle.

Instruction and assessment of communication centered around course deliverables that will form part of an ongoing design portfolio.
Prerequisite: MIE100H1

MIE303H1 F
Mechanical and Thermal Energy Conversion Processes

3/1.50/1/0.50

III-AEESCBASEJ

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

3/1/1/0.50

III-AEMECBASC

Fluid statics, pressure measurement, forces on surfaces. Kinematics of flow, velocity field, streamlines. Conservation of mass. Fluid dynamics, momentum analysis, Euler and Bernoulli equations. Energy and head lines. Laminar flow. Flow at high Reynolds numbers, turbulence, the Moody diagram. External flows. Boundary layers. Lift and drag. Flow separation.
Prerequisite: MIE100H1, MAT234H1, MIE210H1

MIE313H1 S
Heat and Mass Transfer

3/1.50/2/0.50

III-AEMECBASC, I-AEMINENR

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. Analysis of open-ended design problems for improving thermal transport in commercial products.
Prerequisite: MAT234H1, MIE210H1, MIE230H1, MIE312H1 or equivalent

MIE315H1 S
Design for the Environment

3/-/1/0.50

IV-AEESCBASEJ, III-AEMECBASC, I-AEMINENV

Life Cycle Assessment 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 designs. Functional, economic, and societal analysis taught for use in a major team-written project to compare and contrast two product or process alternatives for a client.

Instruction and assessment of communication centered around course deliverables that will form part of an ongoing design portfolio.

MIE320H1 S
Mechanics of Solids II

3/1.50/2/0.50

III-AEMECBASC

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

3/1/1/0.50

IV-AECHEBASC, IV-AECIVBASC, III,IV-AECPEBASC, III,IV-AEELEBASC, III-AEMECBASC, I-AEMINBIO, III-AEMINBME, I-AEMINRAM

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

MIE334H1 S
Numerical Methods I

3/-/1.50/0.50

III-AEMECBASC

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 MATLAB will focus on engineering applications relevant to the background of students taking the course.

MIE335H1 S
Algorithms & Numerical Methods

3/1/1/0.50

III-AEINDBASC

Algorithmic analysis, big-O asymptotic analysis; numerical linear algebra, solution techniques for linear and non-linear systems of equations; matrix factorization, LU and Cholesky factorization, factorization in the revised simplex method; Newton's method, Gale-Shapley method, greedy methods for combinatorial optimization, branch-and-bound search methods; graph theory and graph theoretic algorithms; design and implementation of algorithms to optimize mathematical models.
Prerequisite: MIE262H1

MIE342H1 F
Circuits with Applications to Mechanical Engineering Systems

3/1.50/1/0.50

III-AEESCBASEZ, III-AEMECBASC

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 and MAT187H1
Recommended Preparation: ECE110H1 or ECE159H1

MIE343H1 F
Industrial Ergonomics and the Workplace

3/3/-/0.50

III-AEINDBASC, IV-AEMECBASC,
I-AEMINBIO

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 F
Ergonomic Design of Information Systems

3/3/-/0.50

III-AEINDBASC

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 S
Case Studies in Human Factors and Ergonomics

3/-/2/0.50

III-AEINDBASC

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

MIE346H1 S
Analog and Digital Electronics for Mechatronics

3/1.50/1/0.50

III-AEESCBASEZ, III-AEMECBASC,
I-AEMINRAM

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 instrumentation and mechatronic systems.
Prerequisite: MIE230H1, MAT234H1, MIE342H1

MIE350H1 F
Design and Analysis of Information Systems

3/1/1/0.50

III-AEINDBASC

Provides students with an understanding of the mothods 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

3/2/-/0.50

III-AEINDBASC, I-AEMINBUS

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

MIE358H1 F
Engineering Economics and Accounting

3/-/1/0.50

I-AECERBUS, I-AECERENTR,
III-AEMECBASC

Engineering economic and 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
Exclusion: ECE472H1

MIE360H1 F
Systems Modelling and Simulation

3/2/1/0.50

IV-AEESCBASEF, III-AEINDBASC, IV-AEMECBASC

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

3/-/2/0.50

III-AEINDBASC

This course focuses on features of production/service systems and methods of modelling their operation; the material flow, information flow and control systems. Topics include demand forecasting, inventory management, supply chain management, capacity planning, and lot size planning. Emphasis will be placed on the modelling aspects of operations management, as well as the application of analytical methods in the design of production/service systems. Students will be asked to address open-ended design problems in various activities of the course.
Prerequisite: MIE231H1 / MIE236H1, and MIE262H1 or equivalent

MIE364H1 S
Quality Control and Improvement

3/1/2/0.50

IV-AECHEBASC, III-AEINDBASC, III-AEMECBASC

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, quality certification, six sigma quality, quality improvement using designed experiments and an overview of the Taguchi Methods.
Prerequisite: MIE231H1/MIE236H1 or equivalent

MIE365H1 F
Operations Research III: Advanced OR

3/2/1/0.50

IV-AEESCBASEF, III-AEINDBASC

Design of operations research models to solve a variety of open-ended problems. Linear programming extensions are presented: goal programming, column generation, Dantzig-Wolfe 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

3/-/2/0.50

IV-AEESCBASEF, III-AEINDBASC

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

MIE375H1 F
Financial Engineering

3/-/1/0.50

III-AEESCBASEF

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)

3/2/1/0.50

III-AEESCBASEF

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

3/1/1/0.50

III-AEESCBASEF

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.

MIE402H1 S
Vibrations

3/1/2/0.50

IV-AEMECBASC

Fundamental concepts of vibration of mechanical systems. Free vibration single degree of freedom systems. Various types of damping. Forced vibrations. Vibration measuring instruments. Steady state and transient vibrations. Vibration of multi-degree of freedom systems. Vibration isolation. Modal analysis. Lagrange equations and Hamilton's principle. Vibration of continuous systems. Special topics.
Prerequisite: MAT186H1, MAT187H1, MAT188H1, MIE100H1, MIE222H1

MIE404H1 F
Control Systems I

3/3/2/0.50

IV-AEMECBASC

Analysis of stability, transient and steady state characteristics of dynamic systems. Characteristics of linear feedback systems. Design of control laws using the root locus method, frequency response methods and state space methods. Digital control systems. Application examples.

MIE407H1 F
Nuclear Reactor Theory and Design

3/-/2/0.50

I-AECERNUC, IV-AEESCBASEJ,
IV-AEMECBASC, I-AEMINENR

This course covers the basic principles of the neutronic design and analysis of nuclear fission reactors with a focus on Generation IV nuclear systems. Topics include radioactivity, neutron interactions with matter, neutron diffusion and moderation, the fission chain reaction, the critical reactor equation, reactivity effects and reactor kinetics. Multigroup neutron diffusion calculations are demonstrated using fast-spectrum reactor designs.

Prerequisite: MIE230H1 or equivalent
Recommended Preparation: CHE566H1

MIE408H1 S
*** Thermal and Machine Design of Nuclear Power Reactors**

3/-/2/0.50

I-AECERNUC, IV-AEESCBASEJ,
IV-AEMECBASC, I-AEMINENR

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
Recommended Preparation: CHE566H1

MIE311H1 S
Thermal Energy Conversion

3/3/-/0.50

III-AEMECBASC, I-AEMINENR

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**

3/3/1/0.50

IV-AEMECBASC

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

MIE422H1 F
Automated Manufacturing

2/3/-/0.50

III-AEESCBASEZ, IV-AEMECBASC

Introduction to Computer Integrated Manufactuing. Definitions, terminology. Organization of manufacturing systems. Introduction to NC machines. Introduction to robotics. Types of robot motion. Robot kinematics. Jacobians, singularities. Robot motion trajectories. 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

MIE433H1 S
Waves and their applications in Non-Destructive Testing and Imaging

3/-/-/0.50

IV-AEMECBASC

The course is designed for students who are interested in more advanced studies of applying wave principles to engineering applications in the field of non-destructive testing (NDT) and imaging (NDI). Topics will cover: Review of principles and characteristics of sound and ultrasonic waves; thermal waves; optical (light) waves; photons: light waves behaving as particles; black body radiation, continuous wave and pulsed lasers. The course will focus on NDT and NDI applications in component inspection and medical diagnostics using ultrasonics, laser photothermal radiometry, thermography and dynamic infrared imaging.

MIE438H1 S
Microprocessors and Embedded Microcontrollers

2/3/-/0.50

III-AEESCBASEZ, 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-AEESCBASET, III-AEESCBASEZ,
IV-AEMECBASC, I-AEMINBIO,
III-AEMINBME

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
*** Design of Innovative Products**

2/2/1/0.50

IV-AEESCBASET, IV-AEMECBASC

Recently developed methods applied at different stages of the design process include: Identification of unmet/underserved user needs through a modified definition of lead users (those who experience needs in advance of the mainstream population) including identifying/studying lead users, identifying which lead-user needs are relevant to the general population; Roles of function and affordance in successful products; Obstacles of fixation and cognitive bias to creativity; Concept generation

methods including TRIZ/TIPS (Theory of Inventive Problem Solving, use of unrelated stimuli and analogy (e.g., from biology); Configuration design methods including design for transformation, design for assembly and end-of-life, e.g., reuse, repair and recycling. Hands-on experience of these topics in lectures, tutorials, and labs support successful application of the methods for the course project, as well as future design activities.

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 Manufcaturing, 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 the selection of engineering materials, load determination and failure analysis under static, impact, vibration and cyclic loads. Surface failure and fatigue under contact loads, lubrication and wear. Consideration is given to the characteristics and selection of machine elements such as bearings, shafts, power screws and couplings.
Prerequisite: MIE320H1

MIE443H1 S
*** Mechatronics Systems: Design and Integration**

2/5/-/0.50

IV-AEESCBASEZ, 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.
Prerequisite: MIE346H1

MIE444H1 F
*** Mechatronics Principles**

2/3/-/0.50

III-AEESCBASEZ, IV-AEMECBASC,
I-AEMINRAM

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

MIE451H1 F
Decision Support Systems

3/1/1/0.50

IV-AEINDBASC

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 natural language understanding.
Prerequisite: MIE253H1, MIE350H1

MIE457H1 S
Knowledge Modelling and Management

3/1/1/0.50

IV-AEESCBASEF, IV-AEINDBASC

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

4/-/-/0.50

IV-AEINDBASC

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
Integrated System Design

3/-/2/0.50

IV-AEINDBASC

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

MIE465H1 S
Analytics in Action

3/2/-/0.50

III-AEINDBASC

This course showcases the impact of analytics focusing on real world examples and case studies. Particular focus on decision analytics, where data and models are combined to ultimately improve decision-making. Methods include: linear and logistic regression, classification and regression trees, clustering, linear and integer optimization. Application areas include: healthcare, business, sports, manufacturing, finance, transportation, public sector.

MIE469H1 S
Reliability and Maintainability Engineering

3/-/2/0.50

III-AEINDBASC, IV-AEMECBASC

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

-/-/5/0.50

IV-AEESCBASEF

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

I-AECERBUS, I-AEMINBUS

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, MSE488H1F, CHE488H1S and CIV488H1S.)

*Complementary Studies Elective
Exclusion: APS234 and APS432

MIE490Y1 Y
Capstone Design

-/-/4/1.00

IV-AEINDBASC

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.
Exclusion: APS490Y1

MIE491Y1 Y
Capstone Design

-/-/4/1.00

IV-AEMECBASC

An experience in engineering practice through a significant design project whereby students teams meet specific client needs or the requirements of a recognized design competition 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.

Exclusion: APS490Y1

MIE498H1 F/S
Research Thesis

-/-/4/0.50

IV-AEINDBASC, IV-AEMECBASC

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.
Prerequisite: Approval to register for the fourth-year thesis course must be obtained from the Associate Chair – Undergraduate and is normally restricted to students with an overall average of at least B in their second and third years.

MIE498Y1 Y
Research Thesis

-/-/4/1.00

IV-AEINDBASC, IV-AEMECBASC

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.

Note: Approval to register for the fourth-year thesis course must be obtained from the Associate Chair –Undergraduate and is normally restricted to students with an overall average of at least B in their second and third years.

Prerequisite: Approval to register for the fourth-year thesis course must be obtained from the Associate Chair – Undergraduate and is normally restricted to students with an overall average of at least B in their second and third years.

MIE504H1 S
Applied Computational Fluid Dynamics

3/-/-/0.50

IV-AEMECBASC

The course is designed for Students with no or little Computational Fluid Dynamics (CFD) knowledge who want to learn CFD application to solve engineering problems. The course will provide a general perspective to the CFD and its application to fluid flow and heat transfer and it will teach the use of some of the popular CFD packages and provides them with the necessary tool to use CFD in specific applications. Students will also learn basics of CFD and will use that basic knowledge to learn Fluent Ansys CFD software. Most CFD packages have a variety of modules to deal with a specific type of flow. Students will be introduced to different modules and their specific applications. They will then be able to utilize the CFD package to simulate any particular problem. Ansys software will be the commercial package that will be used in this course. Ansys Fluent is the most common commercial CFD code available and most of the engineering companies use this code for their research & development and product analysis.

Prerequisite: MIE230H1, MAT234H1, MIE334H1

MIE505H1 S
Micro/Nano Robotics

3/3/-/0.50

III-AEESCBASEZ, IV-AEMECBASC,
I-AEMINRAM

This course will cover the design, modeling, fabrication, and control of miniature robot and micro/nano-manipulation systems for graduate and upper level undergraduate students. Micro and Nano robotics is an interdisciplinary field which draws on aspects of microfabrication, robotics, medicine and materials science.

In addition to basic background material, the course includes case studies of current micro/nano-systems, challenges and future trends, and potential applications. The course will focus on a team design project involving novel theoretical and/or experimental concepts for micro/nano-robotic systems with a team of students. Throughout the course, discussions and lab tours will be organized on selected topics.

MIE506H1 S
* MEMS Design and Microfabrication

3/1.50/1/0.50

IV-AEESCBASET, IV-AEMECBASC,
I-AEMINNANO, 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: MIE222H1, MIE342H1

MIE515H1 F
Alternative Energy Systems

3/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEI,
IV-AEESCBASEJ, IV-AEESCBASEO,
IV-AEMECBASC, I-AEMINENR,
I-AEMINENV

This course covers the basic principles, current technologies and applications of selected alternative energy systems. Specific topics include solar thermal systems, solar photovoltaic systems, wind, wave, and tidal energy, energy storage, and grid connections issues. Limited enrolment.

Prerequisite: MIE210H1,MIE312H1 and MIE313H1 (or equivalent courses).

MIE516H1 F
Combustion and Fuels

3/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEJ,
IV-AEMECBASC, I-AEMINENR

Introduction to combustion theory. Chemical equilibrium and the products of combustion. Combustion kinetics and types of combustion. Pollutant formation. Design of combustion systems for gaseous, liquid and solid fuels. The use of alternative fuels (hydrogen, biofuels, etc.) and their effect on combustion systems.

MIE517H1 S
Fuel Cell Systems

3/-/1/0.50

IV-AECHEBASC, IV-AEESCBASEJ,
IV-AEMECBASC, I-AEMINENR,
I-AEMINNANO

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.

MIE519H1 S
Advanced Manufacturing Technologies

3/-/-/0.50

IV-AEINDBASC, IV-AEMECBASC

This course is designed to provide an integrated multidisciplinary approach to Advanced Manufacturing Engineering, and provide a strong foundation including fundamentals and applications of advanced manufacturing AM. Topics include: additive manufacturing, 3D printing, micro and nanomanufacturing, intelligent manufacturing, Advanced Materials, lean manufacturing, AM in machine design and product development, process control technologies. New applications of AM in sectors such as automotive, aerospace, biomedical, electronic, food

processing.

MIE520H1 F
Biotransport Phenomena

3/-/1/0.50

IV-AEESCBASET, IV-AEMECBASC, I-AEMINBIO

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

MIE523H1 F
Engineering Psychology and Human Performance

3/3/-/0.50

IV-AEINDBASC, IV-AEMECBASC, I-AEMINBIO

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

MIE540H1 S
*** Product Design**

3/-/1/0.50

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

3/-/2/0.50

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.

MIE550H1 S
Advanced Momentum, Heat and Mass Transfer

3/-/-/0.50

IV-AEMECBASC

This course observes: conservation of mass, momentum, energy and species; diffusive momentum, heat and mass transfer; dimensionless equations and numbers; laminar boundary layers; drag, heat transfer and mass transfer coefficients; transport analogies; simultaneous heat and mass transfer; as well as evaporative cooling, droplet evaporation and diffusion flames.
Prerequisite: MIE313H1

MIE561H1 S
Healthcare Systems

3/-/2/0.50

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 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

3/-/2/0.50

IV-AEESCBASEF, IV-AEINDBASC

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

MIE563H1 F
Engineering Analysis II

3/3/2/0.50

IV-AEMECBASC

This course explores exact solution techniques for common engineering Partial Differential Equations (PDEs), such as separation of variables, superposition, eigenfunctions, orthogonal functions, complex functions. Other topics include: derivation of common engineering PDEs, introduction to methods of weighted residuals for deriving finite element formulations and limitations of exact solutions relative to approximate solutions.
Prerequisite: MIE230H1, MAT234H1, MIE334H1

MIE566H1 F
Decision Analysis

3/-/2/0.50

IV-AEESCBASEF, IV-AEINDBASC

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

3/2/1/0.50

I-AECERMINR, II-AELMEBASC

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.

MIN250H1 S
Surface Mining

3/-/1/0.50

I-AECERMINR, II-AELMEBASC

Operational aspects of open pit mine design and mine planning. Topics will include: open pit design and pit optimization; long term and short term planning considerations; 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. Pit dewatering, the location and stability of waste dumps and an examination of equipment cost and production statistics are also included.

MIN301H1 S
Mineral Reserve and Mineral Resource Estimation

3/-/1/0.50

III-AELMEBASC

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.

MIN320H1 S
Explosives and Fragmentation in Mining

3/-/1/0.50

III-AELMEBASC

Efficient drilling and blasting is important to successful mining in rock formations. This course studies the planning, design, and economics of rock blasting for a full range of surface and underground, mining and construction projects. Emphasis will be on optimization of fragmentation using blast geometry and those variables available to the field engineer. 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.

MIN351H1 S
Underground Mining

3/-/1/0.50

I-AECERMINR, III-AELMEBASC

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

-/-/-/0.50

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 Fall Session.
Prerequisite: GLG207H1, GLG345H1, MIN429H1

MIN429H1 F
Engineering Rock Mechanics

3/1/1/0.50

IV-AECIVBASC, III-AELMEBASC

This course introduces students to the fundamental concepts of rock mechanics and their application to rock engineering. The following rock mechanics topics are covered: stress and strain; in situ stress; intact rock strength; discontinuity geometry, strength and stiffness; rock mass behavious; anisotropy, heterogeneity and the size effect; rock mass classifcation schemes. Rock engineering topics include: rock excavation; rock stabilisation; instability mechanisms in foundationas and slopes; rock slope design methods; underground openings in discontinuous and continuous rocks; rock-support interaction; synopsis of numerical methods. Associated laboratory sessions involve stress measurement, core logging, compressive strength determination and index testing.

Exclusion: CIV529H1.

MIN430H1 S
Mining Environmental Management

3/-/1/0.50

IV-AECIVBASC, III-AELMEBASC, I-AEMINENV

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

3/-/1/0.50

IV-AELMEBASC

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

2/2/1/0.50

IV-AELMEBASC

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 S cannot be taken without successful completion of MIN 466H1 F)
Prerequisite: MIN429H1, MIN350H1

MIN467H1 S
Mineral Project Design II

1/4/1/0.50

IV-AELMEBASC

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

3/-/1/0.50

IV-AECIVBASC, IV-AELMEBASC

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.
Prerequisite: CIV270H1/CME270H1

MIN511H1 F
Integrated Mine Waste Engineering

3/-/1/0.50

IV-AECIVBASC, IV-AELMEBASC, I-AEMINENV

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 forunderground 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

3/-/1/0.50

IV-AECIVBASC, IV-AELMEBASC

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.

MIN565H1 S
Design and Support of Underground Mine Excavations

3/-/1/0.50

IV-AELMEBASC

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 addresses. 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: MIN429H1/CIV529H1

Molecular Genetics and Microbiology

MGY377H1 F
Microbiology I: Bacteria

3/-/-/0.50

I-AEMINBIO

An in depth study of bacteria including their structure, their biology, their ability to adapt, and their effects on human health. Provides a foundation for advanced studies in bacterial physiology, bacterial genetics, molecular pathogenesis of disease, immunology, and environmental studies.
Prerequisite: BCH210H1/BCH242Y1; BIO120H1, BIO230H1
Exclusion: BIO370Y5 (UTM)

Pharmacology and Toxicology

PCL201H1 S
Introduction to Pharmacology and Pharmacokinetic Principles

3/-/1a/0.50

I-AEMINBIO

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

PCL302H1 F
Pharmacodynamic Principles

3/-/-/0.50

I-AEMINBIO

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

Philosophy

PHL281H1 S
Bioethics (formerly PHL281Y1)

-/-/-/0.50

I-AEMINBIO

An introduction to the study of moral and legal problems in medical practice and in biomedical research; the development of health policy. Topics include: concepts of health and disease, patient rights, informed consent, allocation of scarce resources, euthanasia, abortion, genetic and reproductive technologies, human research, and mental health.
Exclusion: PHL281Y1

PHL295H1 F
Business Ethics

-/-/-/0.50

I-AEMINBUS

Philosophical issues in ethics, social theory, and theories of human nature insofar as they bear on contemporary conduct of business. Issues include: Does business have moral responsibilities? Can social costs and benefits be calculated? Does modern business life determine human nature or the other way around? Do political ideas and institutions such as democracy have a role within business?

PHL342H1 F
Minds and Machines

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/COG250Y1

Physics

PHY180H1 F
Classical Mechanics

3/1.50/1/0.50

I-AEESCBASE

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.
Corequisite: MAT194H1
Exclusion: MIE100H1

PHY293H1 F
Waves and Modern Physics

3/1/1/0.50

II-AEESCBASE

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.
Corequisite: MAT292H1
Exclusion: MIE333H1
Recommended Preparation: MAT195H1

PHY294H1 S
Quantum and Thermal Physics

3/1/1/0.50

II-AEESCBASE

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.
Prerequisite: PHY293H1
Exclusion: MIE333H1
Recommended Preparation: MAT292H1

PHY327H1 F/S
Advanced Physics Laboratory

-/6/-/0.50

III-AEESCBASEO, III-AEESCBASEP

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

2/-/1m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC

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 Schrodiner 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

2/-/1/0.50

III-AEESCBASEP

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

PHY356H1 F
Quantum Mechanics I

2/-/1/0.50

III-AEESCBASEO, III-AEESCBASEP,
IV-AEESCBASER

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/(CHM222H1,CHM223H1)/CHM225Y1, (PHY256H1 recommended)
Corequisite: MAT244H1
Exclusion: CHM326H1, PHY355H1

PHY357H1 S
Nuclear and Particle Physics

2/-/1/0.50

IV-AEESCBASEP

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 PHY400-level course.
Prerequisite: PHY356H1

PHY358H1 S
Atoms, Molecules and Solids

2/-/1/0.50

III-AEESCBASEO, IV-AEESCBASEP,
I-AEMINNANO

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

PHY392H1 S
Physics of Climate

2/-/-/0.50

IV-AEESCBASEP

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/MAT257Y1
Exclusion: PHY315H1

PHY407H1 F
Computational Physics

1/3/-/0.50

IV-AEESCBASEP

This is an introduction to scientific computing in physics. Students will be introduced to computational techniques used in a range of physics research areas. By considering selected physics topics, students will learn computational methods for function analysis, ODEs, PDEs,

eigenvalue problems, non-linear equations and Monte Carlo techniques. A physicist's "computational survival toolkit" will also be developed to introduce students to topics such as command line programming, bash scripting, debugging, solution visualization, computational efficiency and accuracy. The course is based on python and will involve working on a set of computational labs throughout the semester as well as a final project.
Prerequisite: PHY224H1/PHY254H1
Corequisite: Any PHY300-level lecture course in Physics. PHY407H1 may be taken in third or fourth year
Exclusion: PHY307H1

PHY408H1 S
Time Series Analysis

1/2/-/0.50

IV-AEESCBASEP

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. PHY408H1 may be taken in third or fourth year
Corequisite: Any third-year lecture course in Physics
Exclusion: PHY308H1

PHY427H1 F/S
Advanced Physics Laboratory

-/6/-/0.50

IV-AEESCBASEO, IV-AEESCBASEP, I-AEMINNANO

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

-/6/-/0.50

IV-AEESCBASEP

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

PHY429H1 F/S
Advanced Practical Physics III

-/6/-/0.50

IV-AEESCBASEP

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

PHY450H1 S
Relativistic Electrodynamics

2m/-/1m/0.50

IV-AEESCBASEP, I-AEMINNANO

The course illustrates, using classical electromagnetism, how symmetry principles and scaling arguments combine to determine the basic laws of physics. It is shown that the electromagnetic action (from which follow the equations of motion) is uniquely fixed by the principles of special relativity, gauge invariance, and locality. Additional topics include motion of relativistic particles in external electric and magnetic fields, radiation from point charges, and the breakdown of classical electromagnetism.
Prerequisite: PHY350H1
Exclusion: PHY353H1

PHY452H1 S
Statistical Mechanics

2/-/-/0.50

IV-AEESCBASEO, IV-AEESCBASEP, I-AEMINNANO

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: PHY252H1, PHY256H1
Exclusion: PHY480H1

PHY454H1 S
Continuum Mechanics

2/-/1/0.50

IV-AEESCBASEP

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.
Prerequisite: PHY254H1, MAT235Y1/MAT237Y1/MAT257Y1, APM346H1/APM351Y1
Exclusion: PHY459H1

PHY456H1 F
Quantum Mechanics II

2/-/1/0.50

IV-AEESCBASEP, IV-AEESCBASER, I-AEMINNANO

Quantum dynamics in Heisenberg and Schrdinger pictures; WKB approximation; variational method; time-independent perturbation theory; spin; addition of angular momentum; time-dependent perturbation theory; scattering.
Prerequisite: PHY356H1
Exclusion: PHY457H1

PHY460H1 S
Nonlinear Physics

2/-/-/0.50

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

PHY483H1 F
Relativity Theory I

2/-/-/0.50

IV-AEESCBASEP

Basis of Einstein's theory: differential geometry, tensor analysis, gravitational physics leading to General Relativity. Theory starting from solutions of Schwarzschild, Kerr, etc.
Prerequisite: PHY350H1, PHY354H1

PHY484H1 S
Relativity Theory II

2/-/-/0.50

IV-AEESCBASEP

Applications of General Relativity to Astrophysics and Cosmology. Introduction to black holes, large-scale structure of the universe.
Prerequisite: PHY483H1
Recommended Preparation: APM346H1/APM351Y1

PHY485H1 F
Laser Physics

2/-/-/0.50

IV-AEESCBASEO, IV-AEESCBASEP, I-AEMINNANO

This course, which is intended to be an introduction to research in optical sciences, covers the statistics of optical fields and the physics of lasers. Topics include the principles of laser action, laser cavities, properties of laser radiation and its propagation, the diffraction of light, and spatial and temporal coherence.
Prerequisite: PHY350H1, PHY356H1, PHY385H1/ECE318

PHY487H1 F
Condensed Matter Physics

2/-/-/0.50

IV-AEESCBASEO, IV-AEESCBASEP, IV-AEESCBASER, I-AEMINNANO

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.
Prerequisite: PHY356H1, PHY252H1, PHY250H1

PHY489H1 F
Introduction to High Energy Physics

2/-/-/0.50

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.
Prerequisite: PHY354H1, PHY356H1

PHY492H1 F
Advanced Atmospheric Physics

2/-/-/0.50

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

PHY495H1 F
Research Topic in Geophysics

2/-/-/0.50

IV-AEESCBASEP

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. Not eligible for CR/NCR option.
Corequisite: PHY395H1/PHY493H1/PHY494H1

Physiology

PSL300H1 F
Human Physiology I

3/-/1m/0.50

I-AEMINBIO

Principles of neurophysiology, endocrinology and reproductive physiology for students enroled in Life Science programs.
Exclusion: PSL201Y1, PSL302Y1
Recommended Preparation: BIO130H1/BIO150Y1; CHM138H1/CHM151Y1; and 1 FCE from any of the following: MAT135H1, MAT136H1, MAT135Y1, MAT137Y1, MAT157Y1, PHY131H1, PHY132H, PHY151H1, PHY152H1

Political Science

POL201Y1 Y
Politics of Development: Issues and Controversies

2m/-/1m/0.50

I-AECERGLOB

A survey of the developmental challenges facing societies in Latin America, the Caribbean, Asia and Africa, and the efficacy of various development strategies and policies in meeting these challenges.
Prerequisite: 1.0 POL credit/4.0 full course equivalents
Exclusion: POLB90H3/POLB91H3

POL208Y1 Y
Introduction to International Relations

2m/-/1m/0.50

I-AECERGLOB

The course analyzes the impact of the individual, the nation-state, and the international and transnational systems on international conflict and conflict resolution, and examines the major problems the international community confronts in a rapidly changing international environment.
Prerequisite: 1.0 POL credit /4.0 full course equivalents
Exclusion: POLB80H3/POLB81H3
Recommended Preparation: Prior reading or study of modern history

Robotics

ROB301H1 F
Introduction to Robotics

3/1.50/1/0.50

III-AEESCBASEZ

The course is intended to provide an introduction and a very interdisciplinary experience to robotics. The structure of the course is modular and reflects the perception-control-action paradigm of robotics. The course, however, aims for breadth, covering an introduction to the key aspects of general robotic systems, rather than depth, which is available in later more advanced courses. Applications addressed include robotics in space, autonomous terrestrial exploration, biomedical applications such as surgery and assistive robots, and personal robotics. The course culminates in a hardware project centered on robot

integration.
Recommended Preparation: AER201H1

ROB310H1 F
Mathematics for Robotics

3/-/1/0.50

III-AEESCBASEA, III-AEESCBASEZ

The course addresses advanced mathematical concepts particularly relevant for robotics. The mathematical tools covered in this course are fundamental for understanding, analyzing, and designing robotics algorithms that solve tasks such as robot path planning, robot vision, robot control and robot learning. Topics include complex analysis, optimization techniques, signals and filtering, advanced probability theory, and numerical methods. Concepts will be studied in a mathematically rigorous way but will be motivated with robotics examples throughout the course.
Recommended Preparation: ESC103H1, MAT185H1, STA286H1 and MAT292H1

ROB501H1 F
Computer Vision for Robotics

3/-/1/0.50

IV-AEESCBASEZ

An introduction to aspects of computer vision specifically relevant to robotics applications. Topics include the geometry of image formation, basic image processing operations, camera models and calibration methods, image feature detection and matching, stereo vision, structure from motion and 3D reconstruction. Discussion of moving object identification and tracking as time permits.
Exclusion: CSC420H1
Recommended Preparation: CSC263H1

Statistics

STA286H1 S
Probability and Statistics

3/-/1/0.50

II-AEESCBASE

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.
Exclusion: CHE223H1, CME263H1, MSE238H1, MIE236H1, MIE237H1, MIE231H1 or STA257H1

STA302H1 F
Methods of Data Analysis I

3/-/-/0.50

III-AEESCBASEF

Introduction to data analysis with a focus on regression. Initial Examination of data. Correlation. Simple and multiple regression models using least squares. Inference for regression parameters, confidence and prediction intervals. Diagnostics and remedial measures. Interactions and dummy variables. Variable selection. Least squares estimation and inference for non-linear regression.
Prerequisite: STA248H1/STA255H1/STA261H1/ECO227Y1

STA347H1 F
Probability

3/-/-/0.50

III-AEESCBASEF

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/ECO227Y1,MAT223H1/MAT240H1; MAT235Y1/MAT237Y1/MAT257Y1 (Note: STA257H1 and MAT237Y1/MAT257Y1; (MAT223H1, MAT224H1)/MAT240H1 are very strongly recommended)

STA410H1 F
Statistical Computation

3/-/-/0.50

IV-AEESCBASEF

Programming in an interactive statistical environment. Generating random variates and evaluating statistical methods by simulation. Algorithms for linear models, maximum likelihood estimation, and Bayesian inference. Statistical algorithms such as the Kalman filter and the EM algorithm. Graphical display of data.
Prerequisite: STA302H1,
CSC108H1/CSC120H1/CSC121H1/CSC148H1

STA447H1 S
Stochastic Processes (formerly STA348H1)

3/-/-/0.50

IV-AEESCBASEF

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

Course ECE534H1 State Changed

Course ECE534H1 was modified in section Electrical and Computer Engineering on Feb 22, 2016

REPLACED BY ECE437H1

Course ECE535H1 State Changed

Course ECE535H1 was modified in section Electrical and Computer Engineering on Feb 22, 2016

REPLACED BY ECE437H1

Program AEESCBASER State Changed

Program AEESCBASER was modified in section Engineering Science on Feb 22, 2016

REMOVED ECE534H1 AND ECE535H1. ADDED ECE437H1 TO TE LIST

Program AECHEBASC State Changed

Program AECHEBASC was modified in section Chemical Engineering and Applied Chemistry on Feb 3, 2016

Course MSE435H1 State Changed

Course MSE435H1 was moved to the S term on Feb 4, 2016

Program AEMMSBASC State Changed

Program AEMMSBASC was modified in section Materials Science and Engineering on Feb 4, 2016

Course APS321H1 State Changed

Course APS321H1 was modified in section Applied Science and Engineering (Interdepartmental) on Feb 19, 2016

ADDED PREREQ OF CHE299H1

Course APS322H1 State Changed

Course APS322H1 was modified in section Applied Science and Engineering (Interdepartmental) on Feb 19, 2016

ADDED PREREQ OF CHE299H1

Course MSE431H1 State Changed

Course MSE431H1 was modified in section Materials Science and Engineering on Mar 15, 2016

Added MSE160H1 as prereq (equivalent to MSE260H1)

Course BME430H1 State Changed

Course BME430H1 was modified in section Biomaterials and Biomedical Engineering on Mar 16, 2016

NEW COURSE BME430H1 - Human Whole Body Biomechanics added.

Course BME430H1 State Changed

Course BME430H1 was modified in section Biomaterials and Biomedical Engineering on Mar 16, 2016

Prerequisites added: CHE353H1 or BME205H1 or MIE100H1

Course CHE451H1 State Changed

Course CHE451H1 was modified in section Chemical Engineering and Applied Chemistry on Mar 16, 2016

Delivery changed to 3/0/0

Course CHE353H1 State Changed

Course CHE353H1 was modified in section Chemical Engineering and Applied Chemistry on Mar 16, 2016

Delivery changed to 2/0/2

Program AEENGBASC State Changed

Program AEENGBASC was modified in section First Year on Mar 29, 2016

Errata

Program AECHEBASC State Changed

Program AECHEBASC was modified in section Chemical Engineering and Applied Chemistry on Mar 29, 2016

Program AECIVBASC State Changed

Program AECIVBASC was modified in section Civil Engineering on Mar 29, 2016

Program AECPEBASC State Changed

Program AECPEBASC was modified in section Electrical and Computer Engineering on Mar 29, 2016

Program AEELEBASC State Changed

Program AEELEBASC was modified in section Electrical and Computer Engineering on Mar 29, 2016

Program AEMMSBASC State Changed

Program AEMMSBASC was modified in section Materials Science and Engineering on Mar 29, 2016

Program AEINDBASC State Changed

Program AEINDBASC was modified in section Mechanical and Industrial Engineering on Mar 29, 2016

Program AEMECBASC State Changed

Program AEMECBASC was modified in section Mechanical and Industrial Engineering on Mar 29, 2016

Program AELMEBASC State Changed

Program AELMEBASC was modified in section Mineral Engineering on Mar 29, 2016

Program AEINDBASC State Changed

Program AEINDBASC was modified in section Mechanical and Industrial Engineering on Mar 30, 2016

Program AEINDBASC State Changed

Program AEINDBASC was modified in section Mechanical and Industrial Engineering on Mar 30, 2016

MIE465H1 added to year 3W TE list.

MIE519H1 removed form year 3W TE list; added to year 4W TE list.

Course MIE563H1 State Changed

Course MIE563H1 was modified in section Mechanical and Industrial Engineering on Mar 30, 2016

MIE563H1 moved to the F term

Program AEMECBASC State Changed

Program AEMECBASC was modified in section Mechanical and Industrial Engineering on Mar 30, 2016

Program AEESCBASET State Changed

Program AEESCBASET was modified in section Engineering Science on Apr 7, 2016

Added BME430H1 to ESC-T option Tech Electives list.

Program AEESCBASEZ State Changed

Program AEESCBASEZ was modified in section Engineering Science on Apr 7, 2016

Added BME430H1 to Tech Electives

Course APS447H1 State Changed

Course APS447H1 was modified in section Applied Science and Engineering (Interdepartmental) on Apr 11, 2016

This course is being offered in the S term.

Program AECERLEAD State Changed

Program AECERLEAD was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Apr 11, 2016

APS447H1 offered in S term.

Course CHE111H1 State Changed

Course CHE111H1 was modified in section Chemical Engineering and Applied Chemistry on Apr 22, 2016

Course MSE442H1 State Changed

Course MSE442H1 was modified in section Materials Science and Engineering on Aug 17, 2016

Course is not offered for 2016-17.

Course MSE461H1 State Changed

Course MSE461H1 was modified in section Materials Science and Engineering on Aug 17, 2016

Course MSE421H1 State Changed

Course MSE421H1 was modified in section Materials Science and Engineering on Aug 17, 2016

Course MSE451H1 State Changed

Course MSE451H1 was modified in section Materials Science and Engineering on Aug 17, 2016

Course ECE442H1 State Changed

Course ECE442H1 was modified in section Electrical and Computer Engineering on Aug 17, 2016

Course MSE335H1 State Changed

Course MSE335H1 was modified in section Materials Science and Engineering on Aug 17, 2016

Program AEMMSBASC State Changed

Program AEMMSBASC was modified in section Materials Science and Engineering on Aug 17, 2016