



Faculty of Applied Science and Engineering

2014-2015 Calendar

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MESSAGE FROM THE DEAN

Welcome to the 2014-15 academic year!

As a student at U of T Engineering, you benefit directly from the expertise and devotion of our faculty as they prepare you to stand out, and stand apart, as a global engineering leader, innovator and entrepreneur. We are so glad that you have chosen to join our vibrant community.

As the premier engineering school in Canada (according to all international rankings) and 12th globally (as determined by the 2013 Academic Ranking of World Universities), we continually seek opportunities to build on our strengths, collaborate across fields and create innovative learning environments to inspire the next generation of engineers.

Our graduate attributes, co- and extra-curricular activities, certificates and minors are all mechanisms designed to ensure you graduate with the skills and competencies necessary to begin your thriving careers. As we move into the latter half of our Academic Plan, we continue to make significant progress towards achieving our goals to educate future engineers and enhance the student experience.

I encourage you to take advantage of the substantial opportunities and resources available to you. The advice, guidance, counselling and other services provided by our First Year, departmental undergraduate (for upper-year students) and Registrar's Offices are there when you need them.

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.

In addition, we seek to keep you informed through our e-newsletters, Town Halls, information sessions, the Engineering Society's website, and digital signage displays. Your feedback is important to us and we look forward to hearing from you.

I wish you a very rewarding year 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. The University is also 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. 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) 2014

Engineering Courses

April 9	Wednesday	First day students can enrol in Engineering Minor courses on ROSI (6 a.m.)
April 30	Wednesday	Last day to pay/defer fees
May 5	Monday	First Year T-Program classes begin. F Session Engineering Minor courses begin (including APS/CHE/JRE courses). LIEP Program courses begin
May 14	Wednesday	Courses removed for non-registered students
May 16	Friday	Last day for waitlists for F Engineering Minor courses
May 19	Monday	Deadline for students to enrol in F/Y/S Engineering Minor or LIEP courses on SWS; Deadline for students to be enrolled in T-Program courses
May 19	Monday	Victoria Day Holiday: University closed
June 9	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 20	Friday	First Year T-Program/F Session Engineering Minor classes end
June 23 to June 27	Monday to Friday	Final examinations for First Year T-Program courses/F Session Minor courses *For LIEP courses, study break may vary by course.
July 1	Tuesday	Canada Day Holiday: University closed
July 2	Wednesday	S Session Engineering Minor courses begin/LIEP courses resume
July 6	Sunday	Last day for waitlists for S Engineering Minor courses
July 8	Tuesday	Deadline to enrol in S Session courses in SWS
July 20	Sunday	Last day to drop Y Session courses without academic penalty*
July 29	Tuesday	Last day to drop S Session courses without academic penalty*
August 4	Monday	Civic Holiday: University closed
August 15	Friday	S Session Engineering Minor/LIEP courses end
August 18 to August 22	Monday to Friday	Final examination period for S Session Engineering Minor/LIEP 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 21	Monday	First day for Engineering students to enrol in Arts & Science summer courses (6 a.m.)
April 30	Wednesday	Last day to pay/defer fees
May 12	Monday	Classes begin in F and Y courses
May 14	Wednesday	Courses removed for non-registered students
May 19	Monday	Deadline to enrol in F and Y courses on SWS
May 19	Monday	Victoria Day: University closed
June 9	Monday	Last day to drop F courses without academic penalty*
June 20	Friday	Classes end in F Session courses
June 23 to June 27	Monday to Friday	Final examinations for F courses

June 23 to June 30	Monday to Monday	Y Section Code Courses Break
July 1	Tuesday	Canada Day Holiday: University closed
July 2	Wednesday	Classes begin for S Session courses; Y courses resume
July 8	Tuesday	Deadline to enrol in S Session courses on SWS
July 20	Sunday	Last day to drop Y Session courses without academic penalty*
July 29	Tuesday	Last day to drop S Session courses without academic penalty*
August 4	Monday	Civic Holiday: University closed
August 12	Tuesday	Classes end S and Y Session courses
August 13 to August 19	Wednesday Tuesday	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. Check the refund schedules for refund dates, which are available at www.fees.utoronto.ca.

FALL SESSION (F) 2014

July 22	Tuesday	First day for Engineering students to make changes to their personal timetable on SWS
July 22	Tuesday	First day for Engineering students to add Arts and Science (A&S) courses with reserved seating (6:00am)
August 13	Wednesday	First day for Engineering students to enrol in all Arts and Science (A&S) courses
August 7 August 12 August 14 & September 5	Thursday Tuesday Thursday Friday	No Course Enrolment dates (A&S)
August 22	Friday	Last day to pay/defer fees
September 1	Monday	Labour Day: University closed
September 2	Tuesday	Orientation programs for First Year students begin
September 4	Thursday	Engineering lectures in F and Y Session courses begin
September 4	Thursday	Last day for Engineering students to enrol in A&S courses with reserved seating
September 4	Thursday	Courses removed for non-registered students
September 8	Monday	Arts & Science lectures in F and Y Session courses begin
September 11	Thursday	eSIP & PEY Registration Begins (www.engineeringcareers.utoronto.ca)
September 14	Sunday	Last day waitlists operational
September 21	Sunday	Last day for students to add or substitute any Fall Session (F) or Full Year (Y) courses on the SWS
September 22 to September 26	Monday Friday	Late enrolment for Y Section code courses only (Registrar's Office only)
October 1	Wednesday	Last day for students to apply to re-enrol for 2015 Winter Session
October 13	Monday	Thanksgiving Day: University closed
November 1	Saturday	Examination timetable for F Session courses posted (tentative)

Sessional Dates

November 3	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 2	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 3	Wednesday	Last day of lectures in F Session; All session work should be submitted by this date.
December 4	Thursday	Engineering Study Day
December 5 to December 19	Friday Friday	F Session Engineering examinations; Note: Examinations in courses offered by other Faculties may be held during other periods Engineering may hold exams on Saturdays and evenings during this period
December 8 to December 19	Monday Friday	F Session Arts & Science examinations
December 22 to January 2	Monday Friday	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) 2015

January 5	Monday	Lectures begin in S courses and resume in Y Session courses for Arts & Science
January 5	Monday	Lectures begin in S courses and resume in Y Session courses for Engineering
January 11	Sunday	Last day waitlist is operational for S courses
January 12	Monday	Lectures begin for T-Program courses
January 18	Sunday	Last day for students to add or substitute S Session courses
February 16	Monday	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 16	Monday	Family Day: University closed
February 17 to February 20	Tuesday Friday	Reading Week: No lectures, tutorials, or practicals
February 28	Saturday	Examination timetable for S and Y Session courses posted (tentative)
March 8	Sunday	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 2015 Fall Session
April 2	Thursday	(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 3	Friday	Good Friday: University closed
April 10	Friday	Last day for lectures in S Session; All session work should be submitted by this date

April 13	Monday	Engineering Study Day
April 14 to April 29	Tuesday Wednesday	S and Y Session examinations (April 30 is reserved for examinations postponed by general emergency) Note: Examinations in courses offered by other faculties may be held outside of this period
April 8 to April 30	Wednesday Thursday	S and Y session examination period for Arts & Science courses
May 15	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. Check the refund schedules for refund dates, which are available at www.fees.utoronto.ca.

SUMMER SESSION 2015 (TENTATIVE)

First Year Engineering Courses

May 4	Monday	First Year Engineering classes begin
May 18	Monday	Victoria Day: University Closed
June 19	Friday	First Year Engineering classes end
June 22 to June 26	Monday Friday	Final examinations for First Year Engineering courses

Overview of the Faculty

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: Susan McCahan, B.S., M.S., Ph.D., FAAAS, P.Eng.

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, B.A.(Hon), M.L.I.S.

Assistant Dean, Academic HR & Diversity: Lisa Simpson-Camilleri, B.A.

OFFICE OF THE REGISTRAR

Faculty Registrar: Barbara McCann, M.Ed.

Associate Registrar, Student Services and Records: Khuong Doan, B.Sc.

Associate Registrar, Director of Administrative Information Systems: Dan Pettigrew, B.A.Sc.

Associate Registrar, Director of Admissions and Academic Scheduling: Thomas Nault, B.Sc., M.Ed.

Assistant Registrar, Scholarships and Financial Aid: Pierina Filippone

ENGINEERING COMPUTING FACILITIES

Director: Phil Poulos, B.Sc., M.Sc.

ENGINEERING CAREER CENTRE

Director: Jose Pereira

ADVANCEMENT OFFICE

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

AN OVERVIEW

Founded in 1873, the Faculty of Applied Science and Engineering community includes more than 5,000 undergraduate and more than 1,900 graduate students, about 230 professors, 290 staff and has more than 44,000 alumni. Our graduates have pursued careers in all engineering fields throughout Canada and the world. They contribute towards resource industries, manufacturing, transportation, communications, as well as law, finance and health care systems. Skule™ alumni are employed by governments, in private enterprise, and throughout our educational system. Many have become leaders in major corporations, businesses and develop new companies as technological entrepreneurs.

PROGRAMS OF STUDY

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

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

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

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

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

FACULTY STRUCTURE

Most of Engineering's undergraduate students' teaching is provided by 230 professors across the Faculty's five Departments and two Institutes: the departments of Chemical Engineering and Applied Chemistry, Civil Engineering, Electrical and Computer Engineering, Mechanical and Industrial Engineering, Materials Science and Engineering, the University of Toronto Institute for Aerospace Studies and the Institute of Biomaterials and Biomedical Engineering.

The Faculty is fortunate to be part of a great University that provides access to a vast range of resources. The departments of Computer Science,

English, Geology, Mathematics, Philosophy and Physics, all in the Faculty of Arts and Science, make important contributions to the Engineering curriculum.

The Engineering Alumni Association to which all graduates belong, supports the ongoing work of the Faculty, and, through representative membership on the Faculty Council, participates in governance. The buildings of the Faculty are located primarily at the southern end of the University's St. George Campus. The Faculty's decaan 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 student in the Faculty is entitled to an ECF account. The intention is to have the computing system used as often as the student requires it in his or her studies, just as one might use a library or other communal resource. Normally, students access their ECF accounts through terminals on campus. While students are not required to have their own computers, it is recognized that many do, and facilities are provided to transfer data to and from the ECF systems so that personal and University computers can complement each other. This data transfer can be via any network. There are also ECF (UNIX & WINDOWS) stations available which can transfer data to and from a user's USB memory stick so that those without remote access can carry data to and from home. There are two major components to ECF: general UNIX and WINDOWS environments. The general purpose UNIX machines consist of 172 PCs that run LINUX. All of these systems are interconnected with Ethernet and share files (using NFS). They are also connected to the campus backbone network, and thereby, to the Internet. This provides students with electronic mail and electronic file transfer capabilities, as well as access to remote sites such as supercomputer facilities. The ECF WINDOWS environment is composed of 183 PCs for CAD and general applications that run 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 BASc 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 BASc 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 MASc or MEng degrees and obtain approval from his or her thesis topic from the BASc Thesis Coordinator. The Thesis Coordinator will require assurance that the BASc thesis project provides a suitable preparation for the proposed MASc thesis or MEng project and that satisfactory arrangements have been made for supervision of both the coordinated program thesis and the proposed Master's program.

GRADUATE STUDY AND RESEARCH

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

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

Master of Engineering (M.Eng.): professional degree in engineering with certificate options in ELITE (Entrepreneurship, Leadership, Innovation, and Technology in Engineering), EPP (Engineering and Public Policy) Robotics and Mechatronics, and Globalization

Master of Applied Science (M.A.Sc.): traditional, full-time, research-intensive master's degree

Master of Health Science in Clinical Engineering (M.H.Sc.): combines the fields of engineering, life sciences, medicine and clinical application

Doctor of Philosophy (Ph.D.): highest degree in engineering

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

Overview of the Faculty

SPECIAL STUDENTS

Persons wishing to enrol as Special Students (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 first day of classes. Failure to pay by this date will result in the cancellation of registration.

UNDERGRADUATE ENROLMENT AS OF NOVEMBER 1, 2013

Program	Year 1	Year 2	Year 3	Year 4	Total
Full-Time Enrolment					
Chemical Engineering	113	152	101	92	458
Civil Engineering	97	139	114	135	485
Computer Engineering	85	137	97	87	406
Electrical Engineering	143	225	217	158	743
Engineering Science	264	208	204	168	844
Industrial Engineering	54	108	93	85	340
Lassonde Mineral Engineering	34	34	42	16	126
Materials Engineering	70	41	51	41	203
Mechanical Engineering	106	212	207	168	693
Track One - General Engineering	198	0	0	0	198
Total Full Time	1,164	1,256	1,126	950	4,496
Part-Time Enrolment					
Chemical Engineering	3	13	1	4	21
Civil Engineering	1	0	2	6	9
Computer Engineering	3	5	4	8	20
Electrical Engineering	4	9	3	11	27
Engineering Science	1	0	1	5	7
Industrial Engineering	1	7	2	3	13
Lassonde Mineral Engineering	1	0	1	1	3
Materials Engineering	3	0	0	0	3
Mechanical Engineering	2	3	9	10	24
Track One - General Engineering	3	0	0	0	3
Total Part-time	22	37	23	48	130

Program	Year 1	Year 2	Year 3	Year 4	Total
Special Students					6
International Foundation Program					31
Professional Experience Year					693
Total Undergraduates	1,186	1,293	1,149	998	5,319

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 PROFESSOR AND ASSOCIATE DIRECTOR

H.H.T. Liu, B.Eng. (SHANGHAI), M.Eng. (BEIJING), Ph.D., A.F.A.I.A.A., P.Eng.

SENIOR LECTURER AND UNDERGRADUATE COORDINATOR

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

UNIVERSITY PROFESSOR EMERITUS

B. Etkin, B.A.Sc., M.A.Sc., D.Eng. (CARLETON), F.R.S.C., F.C.A.S.I., F.A.I.A.A., P.Eng., Member of Order of Canada

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.
 J.P. Sislian, M.Sc. (YEREVAN), CAND. PHYS & MATH. SCI. (MOSCOW), Ph.D.
 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

C.J. Damaren, B.A.Sc., M.A.Sc., Ph.D., F.C.A.S.I., A.F.A.I.A.A., P.Eng.
 G.M.T. D'Eleuterio, B.A.Sc., M.A.Sc., Ph.D.
 C.P.T. Groth, B.A.Sc. (UBC), M.A.Sc., Ph.D.

ASSOCIATE PROFESSOR

P.R. Grant, B.A.Sc. (MANITOBA), M.A.Sc., Ph.D., P.Eng.

ASSOCIATE PROFESSOR AND MANAGER, SPACE FLIGHT LABORATORY

R. Zee, B.A.Sc., M.A.Sc., Ph.D.

ASSISTANT PROFESSORS

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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

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

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)

CENTRES AND INSTITUTES

BIOZONE

Director: Elizabeth Edwards

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 of 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 recently completed; 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. and leading universities in Canada, United States, Japan, France, Italy and Germany.

Coatings Technology

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

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

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

CENTER FOR ADVANCED DIFFUSION-WAVE TECHNOLOGIES (CADIFT)

Director: Professor Andreas Mandelis, Canada Research Chair (Tier 1) in Diffusion-Wave Sciences and Technologies

Website: <http://cadift.mie.utoronto.ca>

Diffusion Waves: They go where no light has gone before!

At the core of the Center for Advanced Diffusion-Wave Technologies (CADIFT) are the unique diagnostic capabilities of diffusion waves, which include a wide range of physical fields and phenomena: thermal, electronic, photonic and atmospheric to name a few.

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 and health sector applications. For a full description of current CADIFT research visit our website.

CENTRE FOR ADVANCED NANOTECHNOLOGY

Director: Harry E. Ruda

Website: www.utoronto.ca/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>

The Centre for Global Engineering (CGEN) was created to identify the role of engineering in addressing some of the world’s most complex problems. In particular, CGEN is working to enhance the Faculty’s global impact by working with undergraduate and graduate students; non-profit, non-governmental and for-profit organizations; academic institutions and other partners to research appropriate and sustainable solutions for challenging problems in international development and globalization.

The Centre’s primary areas of focus are in the design of appropriate technologies to meet global needs, sustainable development, innovation diffusion and knowledge translation. Creating innovations in the engineering curriculum to incorporate issues related to globalization is also a major component of CGEN’s work.

CENTRE FOR MANAGEMENT OF TECHNOLOGY AND ENTREPRENEURSHIP

Director: Joseph C. Paradi

Associate Director: Yuri Lawryshyn

Website: www.cmte.utoronto.ca

Interdisciplinary and collaborative in nature, the Centre for Management of Technology and Entrepreneurship’s researchers work to measure and improve service industries 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 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 eight 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 220 completed projects at all levels of complexity and intellectual challenge (BASc, MASc and PhD). The entrepreneurial development of students—both at undergraduate and graduate levels—is a priority.

All of the Centre’s research projects involve industrial sponsors; the work has a significant practical component and could 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: David Sinton

Website: www.energy.utoronto.ca

The 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 the tremendous amount of research already underway throughout the University in a wide variety of energy-related fields.

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.

Overview of the Faculty

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

Director: Andrew K S Jardine

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, a growing global phenomenon, combines a broad range of diverse technologies which are applied to transportation to save lives, money and time. The range of technologies involved includes micro-electronics, communications and computer informatics. Additionally, ITS cuts across disciplines such as transportation engineering, telecommunications, computer science, financing, electronic and automobile manufacturing. The new face of the transportation industry as shaped by ITS is no longer restricted to civil engineers nor is it restricted to a single department or agency. Instead, the ITS field is multi-departmental, multi-agency and even multi-jurisdictional. Furthermore, the ITS market is rapidly expanding worldwide. Access to this market is vital to the transportation and related technology sectors. In addition to direct transport benefits, a healthy ITS industry would also have other non-traffic-related fringe societal benefits which 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, but rather 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 center equipped with state of the art capabilities for designing traffic analysis and decision-support tools, and real-time communication links to sensors and control devices all over the physical Toronto transportation network via the two major traffic operation centres in the 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: Paul Santerre

Website: <http://ibbme.utoronto.ca/>

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

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

TORONTO NANOFABRICATION CENTRE (TNFC)

Director: Wai Tung Ng

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 within the University of Toronto. At the forefront of mining research, the Institute focuses on a wide range of issues, which include, but are not limited to, mineral resource identification through mine planning and excavation, extraction and processing.

The Institute is an international center of excellence in mining engineering that brings together mining, civil, materials and chemical engineers, geophysicists, geologists, geochemists, materials scientists and environmental scientists. Each undertakes research that crosses disciplines and traditional boundaries.

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.

The Lassonde Institute of Mining is housed in the newly renovated Goldcorp Mining Innovation Suite in the Lassonde Mining Building (170 College St.).

INSTITUTE FOR LEADERSHIP EDUCATION IN ENGINEERING (ILead)

Director: Doug Reeve

Website: ilead.engineering.utoronto.ca

ILead offers transformative learning opportunities so engineering students can enhance their leadership capabilities. We empower the whole engineer to maximize their potential and contribution. ILead recognizes that complex human relationships are critical to effective engineering practice. Through a suite of academic courses and workshops, we engage students on four levels of leadership learning: self, relational, organizational and societal leadership. Beginning in September 2014 for the first time in Canada, undergraduate students will be able to earn a Certificate in Engineering Leadership. Our vision is for 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 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-caliber training programs focused on robotics and mechatronics at both the graduate and undergraduate levels.

PULP & PAPER CENTRE

Director: Hong Yi N. 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. The Pulp & Paper Centre is an opportunity for the creation of new science and technology to benefit the Canadian economy and to win the hearts and minds of students and faculty to—in collaboration with industry and government—do the job.

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.

Overview of the Faculty

Since it was founded in 1987, the Centre has experienced exceptional expansion in student and faculty involvement and research support. In 2008-2009, there were 60 graduate students, 16 undergraduate students, 27 faculty and 28 associated staff from several departments within and outside U of T, and three operating industrial research consortia. Thirty-two companies from eight countries provided financial support to research projects in pulp and paper processing, energy recovery systems and environmental research. The Centre has extensive student involvement at the graduate and undergraduate levels and continues to enrich students' educational experience through interesting and relevant research projects, seminar programs, professional development programs and international exchanges and tours.

SOUTHERN ONTARIO CENTRE FOR ATMOSPHERIC AEROSOL RESEARCH (SOCAAR)

Director: Greg Evans

Website: www.socaar.utoronto.ca

The Southern Ontario Centre for Atmospheric Aerosol Research (SOCAAR) is an interdisciplinary research centre—hosted in the Faculty of Applied Science and Engineering—dedicated to the study of air quality, with a focus on the effects of aerosol on human health, the environment and climate. SOCAAR promotes collaborative research through access to state-of-the-art facilities and partnerships with government and industry. In addition, the Centre offers opportunity for student involvement at the graduate and undergraduate levels.

Recent research projects 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 new initiative that formally unites the collective expertise of leading Canadian aerosol researchers from the University of Toronto, Dalhousie University and the University of British Columbia.

DIVISION OF ENVIRONMENTAL ENGINEERING AND ENERGY SYSTEMS (DEEES)

Director: Bryan Karney

Website: www.energy.engineering.utoronto.ca

The Division of Environmental Engineering and Energy Systems administers and coordinates the Graduate Collaborative Program in Environmental Engineering in conjunction with the Departments of Civil Engineering, Chemical Engineering, Mechanical and Industrial Engineering, Materials Science and Engineering and the School of the Environment.

The Collaborative Program is an interdisciplinary, collaborative program designed for students who are interested in taking a concentration of courses and conducting research in environmental engineering. It is open to MASc, MEng and PhD students in the graduate programs listed above. Approximately 30 full-time faculty members carry out advanced research and teach postgraduate courses in a wide range of environmental engineering specialties.

URBAN TRANSPORTATION RESEARCH & ADVANCEMENT CENTRE

Chair: Amer Shalaby

Website: www.utrac.utoronto.ca

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

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

The new EDU:D is called the University of Toronto Institute for Multi-Disciplinary Design and Innovation (UT-IMDI). It 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 Student Profile Form. Possession of the minimum entrance requirements does not guarantee admission. Applicants who have been out of studies for more than five years will generally not be considered for admission. Detailed admission requirements can be found online at the Admissions and Awards website www.adm.utoronto.ca. Information can also be found on the Faculty website: 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, 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, physics and chemistry.

Transfer Students

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

Non-matriculants (Mature Students)

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

Non-degree (Special) Students

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

Scholarships and Financial Aid

INDEX

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

National Scholarship Program
University of Toronto Scholars Program
President's Scholars of Excellence Program
President's Entrance Scholarship Program The University's Commitment
University of Toronto Advance Planning for Students (UTAPS)
Government Financial Aid
University of Toronto Work-Study Program
Bursary for Students with Disabilities
Part-Time Studies
International Students
Dean's Honour List
General Terms and Conditions of Awards
Ontario Student Opportunity Trust Fund (OSOTF) Awards

OSOTF ADMISSION SCHOLARSHIPS/AWARDS

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

NON-OSOTF ADMISSION SCHOLARSHIPS

Betz Entrance Scholarship in Electrical & Computer Engineering
The **Bi-cultural** Admission Scholarship
Calgary SkuleTM Admission Scholarship
Chemical Engineering and Applied Chemistry Alumni Entrance Scholarships
Civil Engineering Admission Scholarships
Sydney and Florence **Cooper** Admission

Faculty of Applied Science and Engineering Admission Scholarships
J. Colin **Finlayson** Admission Scholarship
U of T **FIRST** Engineering Scholarship
Robert M. **Friedland** Scholarships
James A. **Gow** Admission Scholarship
The **Grabill** Admission Scholarship
Greater Toronto Sewer and Watermain Contractors Association Admission Scholarship
George A. **Guess** Admission Scholarships
Frank Howard **Guest** Admission Bursary
Walter Scott **Guest** Memorial Scholarships
Reginald and Galer **Hagarty** Scholarship
Horace **Hally** Admission Scholarship
Jane Elizabeth **Ham** Memorial Scholarship
William **Harland** Leadership Award
Hatch Engineering Aboriginal Scholarship
Hatch Engineering Entrance Scholarship
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
Helmut **Krueger** Undergraduate Admission Scholarship in Engineering
Lassonde Scholarships
John C.H. **Lee** Memorial Scholarship
Donald C. **Leigh** Memorial Scholarship
James Turner **MacBain** Scholarship
Salim **Majdalany** Scholarship
The Hal **Major** Memorial Admission Award
J. Edgar **McAllister** Foundation Admission Awards
The John Wolfe **McColl** Memorial Awards
Lachlan Dales **McKellar** Admission Scholarships
Mechanical & Industrial Engineering Admission Scholarship(s)
Metallurgy & Materials Science Alumni Admission Scholarships
George R. **Mickle** Admission Bursaries
Michael M. **Mortson** Industrial Engineering Admission Scholarship
Professional Engineers Ontario Foundation for Education: Entrance Scholarships
Norman **Ramm** Scholarship
Edward S. **Rogers** Admission Scholarship
Edward A. **Rolph** Scholarships
Leslie and Lois **Shaw** Admission Scholarship The **Shaw** Admission Scholarship
Julius D. **Solomon** Scholarship
Joey and Toby **Tanenbaum** Admission

The Sydney C. **Cooper** Scholarships
George B. **Craig** Scholarship
C. William **Daniel** Leadership Awards
Duncan R. **Derry** Scholarships
Dharma Master Chuk Mor Memorial Scholarship
R.A. **Downing** Scholarship in Civil Engineering
ECE Alumni Scholarship
Engineering Society Award
Ford Electronics Scholarship
Andrew **Frow** Memorial Award
General Motors Environmental Engineering Awards
General Motors Women in Electrical and Mechanical Engineering Awards
Herbert **Gladish** Memorial Scholarship
Jack **Gorrie** Memorial Undergraduate Scholarship
J. Frank **Guenther** Scholarship
Anthony A. **Haasz** Scholarship
Halsall Scholarships in Building Engineering
Lisa Anne **Hamann** Memorial Award
Chester B. **Hamilton** Scholarship
John Karl **Hergovich** Memorial Scholarship
Dr. John G. **Hogeboom** Scholarship
Johannes Michael **Holmboe** Undergraduate Summer Research Fellowship
Philip H. **Jones** Scholarship
Andrew Alexander **Kinghorn** Scholarships
Dietmar **Koslowski** Memorial Bursary in Electrical Engineering
Frankie **Kwok** Memorial Scholarship
Ronald Paul **Manning** Scholarships
Eric **Miglin** Scholarship
Marshall Macklin **Monaghan** Scholarship
Samer **Mutlak** Memorial Award
Barry James **O'Sullivan** Grant
The Dr. John Hamilton **Parkin** Scholarship
James A. **Peers** Scholarship in Industrial Engineering
Ryn **Pudden** Memorial Award
The Peter **Sands** Award in Engineering Science
Kenneth A. **Selby** Scholarship in Construction Engineering in the Department of Civil Engineering
Douglas Scott **Shaw** Memorial Scholarship
Shell Canada Limited Engineering Scholarships Program

Scholarship

Edward L. **Donegan** Scholarship in Engineering
John Pearson **Duncan** Admission Award (Brant
County)

Engineering Alumni Association Admission
Scholarships

Engineering Science Alumni Admission
Scholarships

Enwave Leadership Awards

The **ERCO** Worldwide Leadership Scholarships

Scholarships

The FCCP - John Hin Chung **Tsang** Memorial
Admission Scholarship

OSOTF IN-COURSE

SCHOLARSHIPS/AWARDS

APSC Award

T. Christie **Arnold** Scholarship

Anthony A. **Brait** Memorial Scholarship

Paul **Cadario** Scholarship

John Dixon **Campbell** Memorial Scholarship

Canadian Imperial Bank of Commerce

BASc/MBA Scholarships

Chachra Family Scholarship in Engineering
Science

Chemical Engineering Alumni In-Course Awards

Class of 3T7 Scholarships

Class of 5T0 Engineering Leadership Award

Class of 8T3 Vince Volpe Memorial Award

Class of 9T7 Award

Scholarships and Financial Aid

William Bernard **Silverston** Scholarship
Christopher **Skrok** Memorial Scholarships
Gordon R. **Slemon** Scholarship
Kenneth Carless **Smith** Award in Engineering Science
Kenneth Ward **Smith** Scholarships
Robert M. **Smith** Scholarships
SNC-Lavalin Scholarship
The **St. George's** Society of Toronto Endowment Fund
Peter K. **Strangway** Scholarship
The Maurice **Stren** Memorial Scholarship
Sullivan Memorial Scholarship
James M. **Toguri** Memorial Scholarship
The **Trenwith and Galipeau** Aerospace Science Award
William Ian MacKenzie **Turner** Scholarship in Industrial Engineering
University of Toronto Women's Association Scholarship
Lloyd George **Webber** Memorial Scholarship
Julie **Wilkinson** Memorial Scholarship
Yolles-Bergmann Scholarship

NON-OSOTF IN-COURSE SCHOLARSHIPS AND GRANTS

Henry G. **Acres** Medal
Harvey **Aggett** Memorial Scholarship
Aloha Innovation Fund
AMD Electrical and Computer Engineering Scholarship
American Concrete Institute, Ontario Chapter Scholarship
Anchor Shoring & Caissons Ltd. Scholarship
Ardagh Scholarship
Wellington Thomas **Ashbridge** Memorial Bursaries
The **Babb** Bursary Fund
Steven **Ballan** Scholarship in Civil Engineering
Baptie Scholarship
Jack and Barbara **Baron** Scholarship
Ben **Bernholtz** Memorial Prize in Operational Research
APWA Ontario Chapter Bruce **Brunton** Award
The Edith Grace **Buchan** Summer Research Fellowship
The **Burge-Connell** Bursary
Carman **Burton** Bursary
Norman E. **Byrne** Award
John Dixon **Campbell** Memorial Prize
#2 **Canadian** Army University Course Award

Canadian Society of Industrial Engineering Scholarship
Canadian Society for Chemical Engineering Medal
Centennial Senior Project Awards
The Wallace G. **Chalmers** Engineering Design Scholarship
Chemical Institute of Canada Book Prize (Toronto Section)
CISC/Walters Inc. Scholarship
5T6 **Civils** Scholarship
Ross L. **Clark** Memorial Scholarship
Class of 2004 Grant
Class of 4T3 Engineering James Ham Award
Class of 4T7 Bursaries
Class of 5T5 Civil Engineering Scholarship
Class of 5T9 Chemical Engineering Leaders of Tomorrow Award
Consulting Engineers of Ontario(CEO) Scholarship
Dan **Cornacchia**/Ernst & Young Scholarship
Crocker Foundation Bursaries
The Alfredo **DaCunha** Memorial Foundation
Gavin **Dass** Memorial Scholarship
Davis + Henderson Hatchery Award
Hanna Wejtko **De Angelis** CIV6T0 Scholarship
Roger E. **Deane** Memorial Scholarship
Delcan Scholarship in Civil Engineering
Joseph A. **Devine** Bursary
Satinder Kaur **Dhillon** Memorial Scholarship
G.W. Ross **Dowkes** Memorial Prize
William J. **Dowkes** Undergraduate Summer Research Grant
Earl H. **Dudgeon** Bursary
Duhamel Helsing Environmental Engineering Award
Stuart **Ellam** Grant
The John M. **Empey** Scholarships
Enbridge Scholarship in Engineering
Engineering Alumni Centennial Bursaries
5T3 **Engineering** Award
Engineering 8T4 Leadership Award
Engineering Class of 5T6 Award of Merit
Engineering Science Chairs' Scholarship
Engineering Science Foundation Scholarship
Enwave Design Awards
Enwave Graduating Awards of Distinction

ERCO Worldwide Leaders of Tomorrow Award
Etkin Medal for Excellence
Faculty of Applied Science and Engineering Leadership Award(s)
Manual A. **Fine** Scholarship
J.A. **Findlay** Scholarships
The Denis **Flynn** Memorial Scholarship
Andrew **Forde** Polymath Award
The James **Franceschini** Foundation Scholarship
Laura Chizuko **Fujino** Scholarship in Engineering Science
Hugh **Gall** Award
Vern **Gomes** Memorial Award
The Blake H. **Goodings** Memorial Award in Mechanical Engineering
Greater Toronto Sewer and Watermain Contractors Association Award in Civil Engineering
H.J. **Greeniaus** ESROP Fellowship
The George A. **Guess** Scholarships
Frank Howard **Guest** Admission Bursary
Frank Howard **Guest** In-Course Bursary
B. Conrad **Hansen** Memorial Award Fund
Sydney George **Harris** Bursary
Glenn P. **Hauck** Memorial Scholarship
Dr. Arthur **Herrmann** Memorial Award
Mackay **Hewer** Memorial Prize
Hill & Schumacher Entrepreneur Award
General D.M. **Hogarth** Bursary
Otto **Holden** Scholarship
William V. **Hull** Scholarship
Husky Injection Molding Systems Ltd. Award(s)
Neil B. **Hutcheon** Building Science Scholarship
IEEE Canada-Toronto Section Scholarship
IEEE Canada-Toronto Section
Bruno N. Di Stefano Scholarship
IEEE Canadian Foundation Scholarship
Inspec-Sol Scholarship
Sue **Joel** CIV6T5 Scholarship
The L.E. (Ted) **Jones** Award in Distinction
Margaret **Kende** CIV6T0 Scholarship
KGHM International Ltd. Scholarship
Konrad Group Scholarship
Lacavera Prize for Entrepreneurship
Lassonde Scholarships
Lassonde Bursaries
Stavros **Leventis** Award
Charles A. **Lowry** Prize
The Earl Charles **Lyons** Memorial Award
James Turner **MacBain** Scholarship
The Elsie Gregory **MacGill** Memorial Scholarship
The Alexander **MacLean** Scholarship
MacLennan-MacLeod Memorial Prize
Salim **Majdalany** Scholarship
Steven **Mann** Award in Wearable Computing

The Garnet W. **McKee-Lachlan** Gilchrist Scholarship in Engineering Science
 The Garnet W. **McKee-Lachlan** Gilchrist Geophysics Scholarships
 The First Garnet W. **McKee-Lachlan** Gilchrist Geophysics Scholarships
 The Second Garnet W. **McKee-Lachlan** Gilchrist Geophysics Scholarships
 Marlene **Metzger** CIV6T0 Scholarship
 Hugh **Middleton** Bursary
 R.W. **Missen** Memorial Prize in Thermodynamics
 Kiyoharu and Kiyooki **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
PACE Project Design Award
 Gary L. **Palmer** Memorial Scholarship
 Dr. John Hamilton **Parkin**
Paulin Memorial Scholarship
 A.B. **Platt** Award, Toronto Section of the Society of Tribologists and Lubrication Engineers

Frank H.R. **Pounsett** Memorial Scholarship
 Florence Evelyn and William Leonard **Prideaux** Award
Professional Engineers Ontario Foundation for Education In-course Scholarships
Professional Engineers Ontario Foundation for Education Gold Medal for Academic Achievement
 Ewing **Rae** Undergraduate Scholarship
Ransom Scholarship in Chemical Engineering
 Reginald J. **Redrupp** Award
 J.E. **Reid** Memorial Prize
 Russell **Reynolds** Scholarship in Engineering Science
 Dagmar **Rinne** Scholarship
 The Bertrand G.W. **Robinson** Award
 The Richard **Rowland** Memorial Scholarship
 Mary and Mario **Ruggiero** Scholarship
 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

Charles Gordon **Manning** Prize
 Oscar J. **Marshall** Scholarship
 J. Edgar **McAllister** Foundation Bursaries
 J. Edgar **McAllister** Summer Research Fellowships
 John B. **McGeachie** Grant
 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
 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, which have been established through the University, its alumni associations, governments, commercial organizations and other benefactors to encourage and honour outstanding achievement.

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

THE NATIONAL SCHOLARSHIP PROGRAM

The University of Toronto National Scholarships is awarded to students who demonstrate superior academic performance, original and creative thought and exceptional achievement in a broad context. The National Scholars will be those who not only excel in academic pursuits but also have an enthusiasm for intellectual exploration and an involvement in the life of their school and community. Each secondary school is invited to nominate one student on the basis of these criteria to receive a University of Toronto National Book Award. These students, and others who identify themselves as

Scholarships and Financial Aid

meeting the National Scholarship criteria, are invited to enter the National Scholarship Competition. Information is sent to secondary schools in the early fall; the applications are available online and the deadline is in mid-November of the student's graduating year.

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

UNIVERSITY OF TORONTO SCHOLARS PROGRAM

The University of Toronto Scholars Program provides recognition to the University's outstanding students at admission and on an ongoing basis. There are 350 admission awards, which have a value of \$5,000, and may be held in conjunction with any admission award that students may receive from their college/faculty. Outstanding students are considered automatically for these awards.

Awards under the University of Toronto Scholars Program are not renewable. Outstanding students, however, may be eligible for consideration for University of Toronto (in-course) Scholarships at the end of the first, second and third year of their programs. There are approximately 100 scholarships at each level. These in-course awards are worth \$1,500 and are tenable with other in-course scholarships.

PRESIDENT'S SCHOLARS OF EXCELLENCE PROGRAM

Approximately 50 of the most highly-qualified students applying to first year of direct entry undergraduate studies will be distinguished as President's Scholars of Excellence. This distinction includes a \$5,000 entrance scholarship in first year; guaranteed access to part-time, meaningful, 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; these will be communicated explicitly in the letter of admission. Outstanding students are considered automatically 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 who meet the following criteria will receive admission scholarship(s) (totalling at least \$2,000) from the University, its faculties or colleges they enroll in first year at U of T in the fall. No application is required. Eligibility criteria:

- Canadian citizens or permanent residents
- Studying at a secondary school or CEGEP in Canada
- Have completed each of the courses required for admissions, including prerequisites, with "A" standing
- Admission average is 92% or better

THE UNIVERSITY'S COMMITMENT

The University's Policy on Student Financial Support states that students should have access to the resources required to meet their financial needs as calculated by the Ontario Student Assistance Program (OSAP). The commitment is based on the assumption that Canadian citizens/permanent residents/protected persons (recognized convention refugees) will first access the government aid for which they are eligible. University of Toronto Advance Planning for Students (UTAPS) funding is assessed based on the Ontario Student Assistance Program, as OSAP provides a uniform, verified method of assessing student need. For students, who are full-time in both terms of an academic year and who are assessed by OSAP as requiring maximum assistance, and whose assessed needs are not fully covered by government aid, the University will ensure that the unmet needs are met. 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 a UTAPS application at <http://www.adm.utoronto.ca/>. First year applicants should submit their online UTAPS applications by the end of February so they can be considered for need-based admission awards.

GOVERNMENT FINANCIAL AID

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

UNIVERSITY OF TORONTO WORK-STUDY PROGRAM

This program is funded by the University and the Ministry of Training, Colleges and Universities and provides on-campus part-time employment to eligible students. Information and applications are available from the Career Centre. Further information can be found at www.careers.utoronto.ca/jobsearch/workstudy.aspx.

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 or Accessibility Services.

PART-TIME STUDIES

The Federal Government has established a loan and grant program for part-time students enrolled in course loads of less than sixty percent. Unlike OSAP loans, the interest on part-time Canada Student Loans becomes repayable thirty days after the loan is received. Federal grants for educational expenses are also available for high-need part-time students.

The Ontario Special Bursary Plan provides assistance to part-time students in receipt of social assistance. The bursary assists with direct educational expenses such as tuition, books, transportation and babysitting.

Further information and application forms may be obtained from 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 their studies.

ADMISSION SCHOLARSHIPS

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

IN-COURSE SCHOLARSHIPS AND BURSARIES

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

DEAN'S HONOUR LIST

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

GENERAL TERMS AND CONDITIONS OF AWARDS

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

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

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

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

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

Scholarships and Financial Aid

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 on the basis of financial need. Academic merit is also considered. Additional preference is given to a student who has extra-curricular involvement/service in the East Indian community.

Kenneth Au-Yeung Memorial Scholarship

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

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 their first year of studies in Industrial Engineering on the basis of financial need and academic merit.

The Robert L. Bullen Admission Scholarship

This scholarship, derived from the income of a capital fund, was established in 1982 in memory of the late Robert L. Bullen, B.A.Sc., Metallurgical Engineering, 1929, by his wife, Mrs. Robert L. Bullen. The scholarship is awarded annually on the basis of financial need to one or more students entering 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.

Colantonio Family Leadership Award

This award was established in 2004 through the generosity of John Colantonio in memory of his father, the late Mr. Frank Colantonio. This award is granted on the basis of financial need and high academic achievement to a student entering the first year of Electrical Engineering. Preference 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.

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% in each year. If in any given year, the renewal portion is not granted, it shall be awarded, by reversion, to the next qualifying candidate in that year.

The Sydney C. Cooper Scholarships

Through the generosity of the family educational and charitable foundation of Sydney C. Cooper (B.A.Sc., Civil Engineering, 1945) two awards are established in the Department of Civil Engineering. One award 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 the First year of the Electrical Engineering or Computer Engineering programs (alternated annually between the two programs) who has demonstrated financial need. Academic merit will also be considered.

The Lau Family Scholarships

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

Motorola Foundation Scholarships

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

Vera Catherine Noakes Scholarship

Established in 2001, this Scholarship is to be awarded to a student entering first year of any undergraduate program in Engineering on the basis of financial need. Preference will be 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 has demonstrated financial need and has excelled academically. Preference will be given to students with a disability.

Robert John Richardson Memorial Scholarship

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

Donald Ross Leadership Award

Through a generous gift of Mr. Donald Ross in 1997 this award was established in the Department of Chemical Engineering and Applied Chemistry. The award is granted to a student entering the first year of the program on the basis of financial need academic achievement and demonstrated leadership skills in high school through participation in team sports and/or student affairs and community involvement will also be considered.

The award may be renewed for second year providing at least 75% standing is maintained and that the awardee is still deserving.

Leon Rubin Scholarships

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

Robert Sangster Memorial Admission Award

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

Fred Schaeffer Scholarship in Civil Engineering

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

Edward and Helen Swanston Scholarships

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

Christopher Skrok Memorial Scholarships

(See listing later in this Chapter)

The Jean Wallace Memorial Scholarship

This award was established in 1999 by William L. Wallace, B.A.Sc., (5T6 Metallurgical Engineering) in memory of his mother, the late Jean Wallace. The

Scholarships and Financial Aid

award will be granted to one or two students entering first year of Materials Engineering on the basis of financial need. Academic achievement and demonstrated leadership qualities through both school and community involvement will also be considered. If no suitable candidate is found at the admissions level, the award may be granted to a student completing year one of the Materials Engineering program based on the same criteria. By 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

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

Chemical Engineering and Applied Chemistry Alumni Entrance Scholarships

Established in 1995, these scholarships, provided through the generosity of alumni and friends of the Department of Chemical Engineering and Applied Chemistry, are open to students entering the first year of the program on the basis of academic standing in the subjects required for admission.

Civil Engineering Admission Scholarships

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

Sydney and Florence Cooper Admission Scholarship

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

Edward L. Donegan Scholarship in Engineering

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

John Pearson Duncan Admission Award (Brant County)

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

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

The first award was made in 1982.

Engineering Alumni Association Admission Scholarships

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

There are two types of scholarships:

- (a) The William Ian MacKenzie Turner 2T5 Scholarship, named after a "Schoolman of Distinction", with a full value of \$1,500.
- (b) Four Centennial Scholarships with a value of \$1,000 each when entering First year.

Engineering Science Alumni Admission Scholarships

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

Enwave Leadership Awards

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

The ERCO Worldwide Leadership Scholarships

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

Faculty of Applied Science and Engineering Admission Scholarship(s)

These awards, derived from the annual income of a capital donation, are granted to students entering First year of any Engineering program on the basis of outstanding academic achievement in the prerequisite courses.

J. Colin Finlayson Admission Scholarship

Established in 2007 through a generous donation by J. Colin Finlayson, this award is given to a student (or students) entering First year of Mechanical or Industrial Engineering on the basis of academic merit. Preference is given to students who have demonstrated leadership in the community and through extra-curricular activities.

U of T First Engineering Scholarship

Established in 2007, up to five awards, each valued at \$2,000, will be awarded to students admitted to the first year of any program in the Faculty. Recipients must have a minimum 90% in pre-requisite courses and have substantial (well above average) involvement in a school robotics team.

Robert M. Friedland Scholarships

These scholarships were established in 1996 through a generous donation from Robert M. Friedland, Chairman of Indochina Goldfields Ltd. and Bakyrchik Gold PLC. The awards 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 in the Division of Mineral Engineering. If there are no suitable candidates in the Lassonde Mineral Engineering Program, the award can be granted to international students entering the first year of any undergraduate program in the Faculty. If there are no suitable candidates in the Faculty 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, University of Toronto, 4T6, on his retirement, and to recognize his many contributions to the Faculty. Jim Gow served the Faculty for 35 years, the last 20 as Secretary and Assistant Dean. Over those years he was friend and counsellor to staff and to countless students who remember him as one dedicated to their well-being. The Scholarship is awarded annually to a student who achieves high standing in an Ontario secondary school. The award is tenable in any program.

The Grabill Admission Scholarship

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

Greater Toronto Sewer and Watermain Contractors Association Admission Scholarship

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

George A. Guess Admission Scholarships

(see listing later in this Chapter)

Frank Howard Guest Admission Bursary

(see listing later in this Chapter)

Walter Scott Guest Memorial Scholarships

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

Reginald and Galer Hagarty Scholarship

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

Scholarships and Financial Aid

Horace Hally Admission Scholarship

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

Jane Elizabeth Ham Memorial Scholarship

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

William Harland Leadership Award

This Award, established in 2000 by Dr. Carlton Smith in memory of the donor's late wife, Marguerite Smith, and in honour of the donor's father-in-law, William Harland, is awarded to a student entering the first year of the Civil Engineering Program. To be 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 on the basis of 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% 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 graduate of this Faculty in 1905. 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% 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 was made in the Session 1962 - 63.

Roy Jarvis Henry Admission Scholarships

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

John Hirschorn Memorial Scholarship

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

Arthur B. Johns Award

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

Albert and Rose Jong Entrance Scholarship

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

Kenneth Raffles Kilburn Scholarship(s)

Established in 2006 from the estate of the late Kenneth R. Kilburn, these scholarships are 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, B.A.Sc. (Engineering and Business 1959),

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

Helmut Krueger Undergraduate Admission Scholarship in Engineering

Established in 2013 through a generous donation by Helmut Krueger, this scholarship is awarded based on academic merit to one or more students entering the first year of any undergraduate program in the Faculty.

Lassonde Scholarships

(see listing later 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. Applications are required along with a reference letter from either a high school teacher or a past employer. 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 entering first year, Engineering Science, full-time, on the basis of academic excellence. Recipients must be Canadian citizens or permanent residents.

James Turner MacBain Scholarship

(see listing later in this Chapter)

Salim Majdalany Scholarship

(see listing later in this Chapter)

The Hal Major Memorial Admission Award

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

J. Edgar McAllister Foundation Admission Awards

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

The John Wolfe McColl Memorial Awards

The income of this fund is divided equally among the Faculty of Applied Science and Engineering, the Faculty of Arts and Science and the Faculty of 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 offered to students who have achieved high standing on the prerequisite courses for admission to the Faculty.

Mechanical & Industrial Engineering Admission Scholarship(s)

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

Metallurgy & Materials Science Alumni Admission Scholarships

Established in 1995 by friends and alumni of the Department of Materials Science and Engineering, this scholarship is awarded to students entering the first year of the Materials Engineering program on the basis of outstanding academic performance in the subjects required for admission and involvement in school and community activities. The award is renewable in the second year of the program provided a minimum of 75% is obtained at the end of year one.

George R. Mickle Admission Bursaries

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

Michael M. Mortson Industrial Engineering Admission Scholarship

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

Scholarships and Financial Aid

Professional Engineers Ontario Foundation for Education Entrance Scholarships

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

Norman Ramm Scholarship

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

Edward S. Rogers Sr. Admission Scholarships

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

The scholarships are awarded to students entering, full-time, the Edward S. Rogers Sr. Department of Electrical and Computer Engineering on the basis of academic achievement and extra-curricular activities. Some awards may be renewable.

Edward A. Rolph Scholarships

Established in 1994 from the estate of Edward A. Rolph and Kathryn S. Rolph, these Scholarships will be granted to one or more students entering the First year of any program in the Faculty on the basis of academic 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 first year of 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 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% overall average and continues in Engineering Science.

Julius D. Solomon Scholarship

This award was established in 2013 from a bequest through the estate of the late Julius Dennison Solomon. This scholarship is awarded on the basis of academic merit to one or more students entering the first or second year of Civil Engineering as recommended by the Chair (or designate) of the Department of Civil Engineering.

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 FCCP - John Hin Chung Tsang Memorial Admission Scholarship

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

Toronto & Area Road Builders Association Scholarship

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

Wallberg Admission Scholarship

A number of admission scholarships, each of a value of \$1,000, are awarded annually from the income from the Wallberg bequest on the recommendation of the Council of the Faculty to the six candidates with the highest average percentage in subjects prescribed for admission to the Faculty.

To qualify for the scholarship a candidate must achieve an average of at least 75% in the subjects prescribed for admission and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than five years in an Ontario Secondary school or its equivalent unless evidence can be provided satisfactory to Council that this extended attendance was for reasons beyond the student's control.

W. J. T. Wright Admission Scholarship

The W.J.T. Wright Admission Scholarship was established in honour of Professor W.J.T. Wright, a highly regarded emeritus member of the Faculty. The capital donation is provided by the 67th University of Toronto Battery of the Canadian Army. The scholarship is awarded annually to a student entering

the first year of 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 a student in the Faculty on the basis of financial need. Academic standing will also be considered.

T. Christie Arnold Scholarship

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

Anthony A. Brait Memorial Scholarship

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

Paul Cadario Scholarship

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

John Dixon Campbell Memorial Scholarship

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

Canadian Imperial Bank of Commerce BASc/MBA Scholarships

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

Chachra Family Scholarship in Engineering Science

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

Chemical Engineering Alumni In-Course Awards

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

Class of 3T7 Scholarships

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

Class of 5T0 Engineering Leadership Award

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

Class of 8T3 Vince Volpe Memorial Award

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

Class of 9T7 Award

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

Scholarships and Financial Aid

The Sidney C. Cooper Scholarships

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

George B. Craig Scholarship

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

C. William Daniel Leadership Awards

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

Duncan R. Derry Scholarships

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

Dharma Master Chuk Mor Memorial Scholarship

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

R.A. Downing Scholarship in Civil Engineering

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

ECE Alumni Scholarship

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

Engineering Society Award

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

Ford Electronics Scholarship

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

Andrew Frow Memorial Award

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

General Motors Environmental Engineering Awards

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

General Motors Women in Electrical and Mechanical Engineering Awards

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

Jack Gorrie Memorial Undergraduate Scholarship

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

Herbert Gladish Memorial Scholarship

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

J. Frank Guenther Scholarship

The J. Frank Guenther scholarship was established in 1997 in the Division of Engineering Science through the generosity of BVA Systems Limited. The 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 is made to a student completing second year and one to a student completing third year on the basis of financial need. The recipients should also exhibit a high level of interest and academic achievement in Civil Engineering applied to buildings, as well as significant contribution to community and/or student activities. The relevant course content would include structures, materials and building science.

Lisa Anne Hamann Memorial Award

This award was established by family and friends in memory of Lisa Ann Hamann (nee Anzil) P.Eng., a graduate of the Class of 8T6 Mechanical Engineering, who passed away in 1995 in her 31st year. Lisa was a successful Nuclear Engineer with Ontario Hydro, whose career path evolved from nuclear design, through project management and lastly as an Account Executive in International Sales. The consummate professional, committed to excellence in all her ventures, she was gifted with intelligence, talent and strength.

Lisa's 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 graduate of the Faculty in 1906, established an annual scholarship in his memory. The first award was made in 1958 - 1959.

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 of Chemical Engineering on the basis of financial need, academic ability and having faced challenges 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 is 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 will also be 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, who was a 1950 graduate of the Faculty in Chemical Engineering. One or more fellowship(s) are available to student(s) completing years one,

Scholarships and Financial Aid

two or three on the basis of financial need. Additionally, academic ability and the responsibility of the applicant in the research project will also be considered. The fellowship(s) will be awarded to student(s) to work on research project(s) under the supervision of staff and/or graduate students during the summer.

Philip H. Jones Scholarship

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

Andrew Alexander Kinghorn Scholarships

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

Dietmar Koslowski Memorial Bursary in Electrical Engineering

This award was established in 1987 in memory of the late Dietmar Koslowski, P.Eng, (6T7) by his parents and family. The bursary, derived from the annual interest of the capital fund, will be granted on the recommendation of the Chair to a student completing their third year Electrical and Computer Engineering. In addition to financial need, good academic standing will also be considered. The first award was made in the 1987 - 1988 session.

Frankie Kwok Memorial Scholarship

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

Ronald Paul Manning Scholarships

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

Eric Miglin Scholarship

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

Marshall Macklin Monaghan Scholarship

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

Barry James O'Sullivan Grant

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

James A. Peers Scholarship in Industrial Engineering

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

Ryn Pudden Memorial Award

This award was established in 1999 in memory of Ryn Pudden through the generosity of her family. The award is granted to a female student in Engineering Science who demonstrates financial need. Preference is given to students entering the third year of the Aerospace Option and is involved in extra-curricular activities (e.g. music, student council, athletics).

The Peter Sands Award in Engineering Science

This award was established by family and friends in memory of the late Peter Sands, B.A.Sc. (1962), M.A.Sc. (1966). The award is made on the recommendation of the Chair to a student completing the second year of Engineering Science on the basis of 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 on the basis of financial need. Academic achievement in the program and particular ability and creativity in the field of construction engineering, specifically second and third-year construction engineering-related courses will also be considered.

Douglas Scott Shaw Memorial Scholarship

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

Shell Canada Limited Engineering Scholarships Program

Established in 1997 through the generosity of Shell Canada Limited, these scholarships are granted to two students entering third year and two students entering fourth year in each of the following three departments: Mineral Engineering, Chemical Engineering and Applied Chemistry and Mechanical and Industrial Engineering. The awards are granted on the basis of 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 on the basis of 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 Stanislaw Skrok, in honour of her husband Christopher Skrok (Civil 6T0). The awards will be granted to three students entering first year and three students entering fourth year of 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 on the basis of financial need to a student entering the Third year of the Lassonde Mineral Engineering Program. Academic standing will also be considered. The Scholarship is renewable in the Fourth year on the basis of continued financial need and academic standing. Should the candidate not qualify for the renewal, the award can be granted by reversion to the next qualifying candidate in the Fourth year of the Program.

SNC-Lavalin Scholarship

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

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.

Scholarships and Financial Aid

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 1995-96 Session.

Sullivan Memorial Scholarship

The Sullivan Memorial Scholarship commemorates May and Philip Sullivan, of Sydney, Australia. Being denied the benefits of an advanced education, they fostered their three children's ambitions. All became University faculty, one in Australia, one in New Zealand, and one in Canada. The award is derived from the annual income and is awarded to a student entering the second year of the Engineering Science Program on the basis of financial need. Academic standing will also be considered. The selection is made by the Chair of the Division. The first award was granted in the 1998 -1999 Session.

James M. Toguri Memorial Scholarship

This scholarship was established in 2004 by friends and family in memory of Professor James M. Toguri. The award is to be granted to a full-time student proceeding to third or fourth year of Materials Engineering on the basis of financial need and academic achievement. 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 will be given to students with demonstrated qualities of leadership. Recommendation of the Chair or his/her designate.

The Trenwith and Galipeau Aerospace Science Award

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

William Ian MacKenzie Turner Scholarship in Industrial Engineering

This award was established in recognition of the professional achievements of William Ian MacKenzie Turner (B.A.Sc., Electrical Engineering, 1925), and of his dedication to the interests of the undergraduates and graduates of the Faculty of Applied Science and Engineering.

The scholarship, derived from the annual income, is awarded to the student on the basis of financial need who, having obtained Honours standing, ranks in first place on the results of the annual examinations in the third year of the Industrial Engineering Program. Should the candidate hold an award of greater value, the award may be made to the next ranking candidate. The first award, under these terms, was made in the 1998 - 1999 Session.

University of Toronto Women's Association Scholarship

In 1995 the University of Toronto Women's Association donated a capital sum to the University, a portion of which provides an award in the Faculty of Applied Science & Engineering. This scholarship is awarded to a male or female student in any year of any program in the Faculty on the basis of 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 (3T6, Chemical Engineering). The award will be granted to a student completing third year of Chemical Engineering and Applied Chemistry on the basis of financial need. Academic standing will also be considered.

Julie Wilkinson Memorial Scholarship

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

In honour of her memory, the scholarship is awarded to a student registered in any year of Industrial Engineering on the basis of 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 Engineering Society president.

Yolles-Bergmann Scholarship

This scholarship was established in 1997 in Civil Engineering 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 award is made to a student proceeding to the fourth year of the program who achieves a high academic standing and who has successfully completed a structural design project in their third year that demonstrates 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., a graduate of the School of Practical Science in the class of 1903. From 1981 onward, continuation of the award has been possible through the generosity of Acres International Limited who also provide an honorarium of \$500 to the recipient of the medal.

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

Harvey Aggett Memorial Scholarship

This scholarship was donated by the late Mr. J.T. Aggett of Toronto as a perpetual memorial to his son, the late Lieutenant Harvey Aggett, who enlisted in 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 student of the second year in this Faculty who, obtaining honours and being ranked one of the first three in the annual examinations, has been adjudged highest of the three in general student activities and service in the University during first year. The annual value of the scholarship is the income from the fund.

When regulations do not permit the winner to hold this scholarship, the students 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 will be made on the basis of outstanding academic achievement and demonstrated leadership. Successful candidates must demonstrate an obvious commitment to, and interest in, CPU, GPU as well as semi-conductors.

American Concrete Institute, Ontario Chapter Scholarship

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

Anchor Shoring & 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 specializing in structures and/or geotechnical. Academic achievement and extra-curricular activities will also be considered.

APWA Ontario Chapter Bruce Brunton Award

Established in 2000 by the Ontario Chapter of the American Public Works. It is awarded to a student in any year in Civil Engineering on the basis of financial need and academic achievement sufficient enough to proceed to the next year of the program. The value of the award is \$500.

Ardagh Scholarship

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

Wellington Thomas Ashbridge Memorial Bursaries

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

Scholarships and Financial Aid

The Babb Bursary Fund

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

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 on the basis of their aggregate performance on assignments in both Introduction to Civil Engineering and Construction Management courses, as recommended by the Chair of the Department.

Baptie Scholarship

The Baptie Scholarship is derived from a bequest under the will of the late Mrs. Margaret W. Baptie of Ottawa. The Governing Council has directed that a Scholarship of one half the annual income shall be awarded annually to an engineering student on the record of his or her first year. The Board of Governors also authorizes a remission of fees in the case of the holder of the scholarship, up to \$75.

The conditions of the award are that the scholarship be awarded to the student who, in the annual examinations of first year, enrolled in any of the programs of Civil Engineering, Mechanical Engineering, Chemical Engineering, Electrical Engineering, Computer Engineering or Materials Engineering, obtains the highest aggregate percentage of marks in those subjects which are common to the first year curricula of those courses. The first award was made in the 1925 - 1926 Session.

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 achieves the highest aggregate mark in the two courses Operational Research I and II.

The prize was established in 1980 by colleagues and friends of the late Dr. Ben Bernholtz, twice Chair of the Department of Industrial Engineering and a founder of the Canadian Operational Research Society. Should the candidate be qualified for another award of higher value, the award may be reverted to the student with the next highest aggregate mark in the specified courses.

The Edith Grace Buchan Summer Research Fellowship

A summer research fellowship is provided by a bequest of the late Edith Grace Buchan. The fellowship is open to students who have completed the first, second or third year in any program in the Faculty. Interested students should apply by application to the Chair of their department early in the Winter Session. The selection will be made on the basis of the applicant's academic background and interests.

The Burge-Connell Bursary

Provided through the generosity of the Women's Association of the Mining Industry of Canada, this bursary is open to students in second year 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 (2T0, Electrical Engineering) by his wife, Mrs. C.E. Burton. The annual income from a capital donation will provide bursaries to students registered in the Faculty in any undergraduate program on the basis of good academic standing and financial need. Application should be made on the Undergraduate Grant Application Form.

Norman E. Byrne Award

This award is made annually by the University Masonic Lodge in honour of one of their members, a Past Grand Master of the Grand Lodge of Canada in Ontario, Mr. Norman E. Byrne, a graduate of Mechanical Engineering, Toronto. The award is made on the recommendation of the Chair on the basis of financial need, academic excellence and qualities of character as demonstrated by University and Community activities to a student who has completed the first, second or third year of the Mechanical Engineering Program. The value of the Award is \$1,000.

John Dixon Campbell Memorial Prize

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

#2 Canadian Army University Course Award

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

Canadian Society of Industrial Engineering Scholarship

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

of 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 the written and laboratory work of the third year. The first award was made on the results of the final examinations of 1947. From 1985 onwards, the cash portion of the prize is provided through the generosity of the Local Toronto Chapter of the Canadian Society for Chemical Engineering.

Centennial Senior Project Awards

The Centennial Thesis Awards were established in 1972 - 73 in honour of the Centennial of the founding of the Faculty in 1873. To recognize excellence in fourth year thesis 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.

Wallace Chalmers graduated in 1950 from the Department of Mechanical Engineering at the University of Toronto. Throughout his career, Mr. Chalmers demonstrated a keen interest in design and perceived the need to place greater emphasis on the design aspect of engineering education.

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 will also be considered.

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 achieves 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 the second year of the Civil Engineering Program and are registered in the third year of the program. Application is not required. The award will be based on a recommendation by a selection committee composed of the Civil Engineering Undergraduate Student Counsellor and two other members of the teaching staff who are acquainted with the students in third year of Civil Engineering. The selection of the recipient is based on qualities of scholarship, leadership and character. In addition to high academic marks, the recipient will also be involved in extra-curricular activities to demonstrate the qualities of leadership and character. The award is presented at the annual reunion of the Class of 5T6 Civils and is not tenable with any other scholarship of greater value. The first award was made in 1964.

Ross L. Clark Memorial Scholarship

The friends of Ross L. Clark, 3T7 Civil graduate, have set up a scholarship to honour his substantial contributions to municipal and environmental engineering, practiced so well by him as Commissioner of Works for Metropolitan Toronto for many years. The value of the scholarship is the annual income. It will be awarded to a student entering the fourth year of 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.

Scholarships and Financial Aid

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% 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 a student in the Faculty on the basis of financial need. Applications should be made on the Undergraduate Grant Application Form.

Class of 5T5 Civil Engineering Scholarship

Established in 2004 through the generosity of the Class of 5T5 Civil Engineering, this award is granted to a student entering fourth year of Civil Engineering on the basis of financial need. Preference is given to students who 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.

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.

Delcan Scholarship in Civil Engineering

Valued at \$750, this scholarship is offered in memory of the late Jack Spiegelman (B.A.Sc., Civil Engineering, 1951) by De 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 the Fourth year of the Civil Engineering Program who has achieved high standing, with Honours, on the examinations of the third year, and who has demonstrated qualities of character and leadership indicative of becoming a worthy member of the profession. The scholarship is not tenable with other awards of greater value. Application is not required.

Joseph A. Devine Bursary

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

Satinder Kaur Dhillon Memorial Scholarship

Established in 2011 from the Estate of the late Satinder Kaur Dhillon, this award is given to a student completing first or second year of Engineering 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 on 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.

Stuart Ellam Grant

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

The John M. Empey Scholarships

This fund was established under a bequest of \$10,000 in the will of the late John Morgan Empey, B.A.Sc., 1903. Three scholarships of equal value are provided from the income from the fund. A scholarship is awarded to a student in the first, second and third years on the annual examinations who, obtaining Honours, achieves the highest average percentage of marks in the written and laboratory subjects of the year. The scholarships are open to any students registered in the Faculty. In case the winner does not attend the Faculty during the session following the award, the right to the scholarship 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 a student who demonstrates significant community involvement and volunteerism. Additional preference is given to a student who exhibits leadership qualities as demonstrated through involvement in extra-curricular activities, athletics and student council.

Engineering Alumni Centennial Bursaries

Through the generosity of the Engineering Alumni Association, several bursaries have been established in the Faculty of Applied Science and Engineering. The bursaries are awarded on the basis of academic achievement and financial need with preference given to students in third and fourth year. Application should be made on the Undergraduate Grant Application Form.

5T3 Engineering Award

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

Engineering 8T4 Leadership Award

Established in 2009 by the Engineering Class of 8T4, this award is given to a full-time student entering second, third or fourth year in any program in the Faculty on the basis of high 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

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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 on the basis of 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 the fourth year and the following:

*for Chemical Engineering: preference given to students who demonstrate a particular aptitude for studies related to alternative energy technologies

*for Electrical Engineering: preference given to students who demonstrate an aptitude for studies related to power generation and distribution

*for Environmental Engineering (Minor): preference given to students who demonstrate an aptitude for studies related to environmental sustainability and sustainable development

*for 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). It 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 student in Engineering Science. 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 their first year of Civil Engineering on the basis of good academic standing and qualities of character and leadership. In order to enjoy the award the recipient must register in the second year of the Program.

Andrew Forde Polymath Award

Established in 2012 through annual donations made by Andrew Forde, this award is given to a full-time student proceeding to second, third, or fourth year in the Faculty 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 of the Civil Engineering Program who achieve 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 third or fourth year of the Electrical and Computer Engineering Option in the Division of Engineering Science on the basis of academic achievement. Extra-curricular activities may also be considered.

Hugh Gall Award

The Hugh Gall Award was established in 1946 by the graduate class of 1910 "to commemorate a deceased classmate who was a splendid type of student, a loyal friend and nationally outstanding in athletic achievement during his undergraduate career." Upon expiration of the original gift in 1951, the award was supported by Mrs. Hugh Gall until her death in 1970; under the terms of her will a sum of \$5,000 was provided to support the award in perpetuity, the annual value of the award being the income from the bequest.

The award is made to a student who, having completed first year with a general average of at least 66% without conditions, has entered the second year and needs financial assistance to continue. It is desirable, but not necessary, that the recipient not 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 on the In-course Bursary Form.

Vern Gomes Memorial Award

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

The Blake H. Goodings Memorial Award in Mechanical Engineering

The Blake H. Goodings Memorial Award was established in 1987 by his wife, Mrs. Gloria Goodings, in memory of her husband, a graduate of this Faculty in 1949. 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 of Mechanical Engineering who has attained a 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 the fourth year of Civil Engineering who has demonstrated academic excellence and who has shown 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 will be considered.

H.J. Greeniaus ESROP Fellowship

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

The George A. Guess Scholarships

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

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

The Guess Admission Scholarship is awarded to student(s) with high standing in the subjects needed for admission to the first year of the Materials Engineering Program. The Guess In-Course Scholarships are awarded to students completing first, second or third year of Materials Engineering and are made on the basis of achieving a minimum average of 75%. Extra-curricular/leadership qualities may also be considered.

Frank Howard Guest Admission Bursary

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

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Frank Howard Guest In-Course Bursary

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

B. Conrad Hansen Memorial Award Fund

The fund was established in 1979 in memory of the late B. Conrad Hansen, B.A.Sc., Electrical Engineering, 1962. The income from the fund is used to provide one or more bursaries for students in need of financial assistance, preference being given to students in 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 either third or fourth year in any program. In addition to mental capacity, the student must show leadership ability and give promise, through activities, of becoming a worthwhile influence in the affairs of the profession and community. While attention is given to scholastic ability, as evidenced by academic standing, it is not the governing factor. The recipient must, however, stand in the top quarter of the class. Special consideration is given to financial need. The annual value is approximately \$1,000.

Glenn P. Hauck Memorial Scholarship

Established in 2010, through a generous donation by Stephen and Linda Hauck, this scholarship 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.

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. It is awarded to the student completing their fourth year of Chemical Engineering who achieves the highest standing in fourth-year courses related to environmental studies. The first award was made in 1980-81.

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 on the basis of financial need. Applicants must complete the regular Undergraduate Grant Application form.

Otto Holden Scholarship

Otto Holden, B.A.Sc., 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 in the 1967-68 session.

William V. Hull Scholarship

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

Husky Injection Molding Systems Ltd. Award(s)

Established in 2010 through a generous donation by Husky Injection Molding Systems Ltd. Four awards are provided annually to students entering their second year of Mechanical Engineering after successful completion of their first year in any program in the Faculty. The awards are made on the basis of strong academic achievement and financial need.

Neil B. Hutcheon Building Science Scholarship

Two awards available for students with the highest and second highest marks in CIV575H1.

IEEE Canada-Toronto Section Scholarship

This scholarship, 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 has the highest academic standing in the examinations of the year. In order to enjoy the scholarship, the student must register in the fourth year of the Program. The first award was made in 1982.

IEEE Canada-Toronto Section Bruno N. Di Stefano Scholarship

This scholarship, 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% 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 is 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, 1936-44; Mechanical Engineering, 1944-75) and Engineering Archivist (from 1970) to students, alumni and the Faculty over his long and distinguished career, as well as his continuing support and dedication to the Engineering Society and the Engineering Alumni Association of the University of Toronto. The award endorses Ted's great appreciation of the arts and, in particular, his love of music. The Award is presented annually to a graduating student in the Faculty of Applied Science and Engineering who has achieved distinction in his or her academic program while making a significant contribution in the musical field during the year at University.

Sponsored by the Engineering Alumni Association, the award consists of a certificate of recognition presented annually at the Grad Ball and subsequently at Spring Reunion. Nominations for the award may be submitted to the Engineering Alumni Office by undergraduate students, members of the Faculty, or alumni by January 31 of the year in which the award is to be given. Nominations should include sufficient information for the Committee to determine the merits of the nominee. The Committee reserves the right to suspend presentation of the award if suitable candidates are not identified in any year. The selection Committee will comprise the Director of Alumni Relations, a member of the Faculty, the President and first Vice-President of the Engineering Alumni Association, the President and the fourth-year Chair of the Engineering Society. The first award was presented in the spring of 1997.

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 is one. The award, valued at \$500, is given to a student entering second year of Civil Engineering, having completed first year of any program in the Faculty, with the most improvement between first and second term of First year as measured by the full-time term averages. The award is not tenable with other merit-based scholarships of greater value.

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 of the Faculty, in the Environmental Engineering Minor, on the basis of strong academic achievement. Preference is given to students who demonstrate an interest in the mining industry based on course selection, extra-curricular activities and/or work term(s).

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 on the basis of 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.

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.

Scholarships and Financial Aid

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 on the basis of financial need to students in any year of the Lassonde Mineral Engineering Program. Applicants must complete the regular Undergraduate Grant Application form.

Stavros Leventis Award

Provided by Mrs. 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, contributes to the University and community at large through volunteer participation. The student must possess qualities of leadership and integrity and demonstrate a keen interest in computers.

Charles A. Lowry Prize

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

The Earl Charles Lyons Memorial Award

The Earl Charles Lyons Memorial Award was established in 1983 by his wife, Mrs. Earl C. Lyons, in memory of her husband, a graduate of this Faculty in 1933. The award, which is set up in perpetuity, is of the value of the annual income of a capital donation. It is made on the recommendation of the Chair of the Department of Mechanical & Industrial Engineering to a student completing the third year of the Mechanical Engineering Program with honours. In addition to academic standing, consideration will be given to character and leadership capabilities through involvement in student and professional activities. This award is not tenable with other awards. The first award was made in the 1983 - 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 in the 1991 - 1992 academic 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 on the basis of academic standing and demonstrated commitment to women's issues within the Faculty and the community at large. In addition to academic standing, qualities of character and leadership abilities are also considered. The award will alternate with the Faculty of Arts & Science.

The Alexander MacLean Scholarship

The scholarship was established by graduates of the University of Toronto and other friends in honour of Professor Alexander MacLean, B.A.(1908) who retired in 1954. The scholarship is awarded to an outstanding student in GLG 318H and/or GLG319H in the Department of Geology, Faculty of Arts and Science or completing third year of Lassonde Mineral Engineering, Faculty of Applied Science and Engineering. The first award was made in 1955.

MacLennan-MacLeod Memorial Prize

The Graduating Class of 1910 donated an annual prize in memory of their first Class President, George MacLennan, who was killed in action in France in 1917, and of Doug MacLeod, their first Secretary, who died in France in 1916 from wounds received in action.

The prize, of the value of approximately \$25, is awarded to the first-year student in the Faculty of Applied Science and Engineering who ranks highest in Calculus among those who obtain standing without condition at the annual examinations; or, in the event of more than one student obtaining equally high rank in Calculus, to the one of these who also has the highest standing in some other subject common to the competitors, such as Algebra, such subject to be determined by the Council of the Faculty.

An award will not be made in any year in which, in the opinion of the Council, no student obtains a sufficiently high standing in Calculus to merit the award. If in any year no award is made, a second award will be available in the subsequent year.

Salim Majdalany Scholarship

The scholarship was established by 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, Jordan, Iraq or any other member state of the Arab League, who is entering or is enrolled in the Faculty of Applied Science and Engineering or the Faculty of Law. The award is open to students in both Faculties; 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 of any program on the basis of financial need. Application should be made on the Undergraduate Grant Application Form.

The Garnet W. McKee-Lachlan Gilchrist Scholarship in Engineering Science

Mrs. Garnet W. McKee and Professor Lachlan Gilchrist each contributed \$1,000 to provide for a scholarship in the first year of the course in Engineering Science. The value of the scholarship is the annual income from the capital fund and is awarded to the student who ranks first in honours at the annual 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 student ranking second in honours in the course. To receive payment the winner must register in the second year of the course in Engineering Science. The scholarship was awarded for the first time on the results of the annual examinations in 1947.

The Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships

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

The First Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship

This scholarship is awarded to the student in the second year of Engineering Science who has the highest aggregate standing at the examinations of the first and second years in the course provided that the student obtains honours standing in the examinations of the second year.

The Second Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship

This scholarship is awarded to the student who ranks second in second year of Engineering Science and who achieves the highest aggregate standing 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 of 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 on the basis of financial need. Application should be made on the Undergraduate Grant Application form.

R.W. Missen Memorial Prize in Thermodynamics

This award was created in 2008 through a generous donation by family and friends of the late Professor Ronald W. Missen, a faculty member of the Department of Chemical Engineering and Applied Chemistry for 35 years, in memory of his professional and scholarly achievements. The award is given

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to the student who receives the highest mark in CHE323H1: Engineering Thermodynamics, which was taught by Professor Missen for many years.

Kiyoharu and Kiyooki Momose Memorial Scholarship

This Scholarship in the amount of approximately \$300 was bequeathed by Yoshiko Momose. The award will be made to a student entering the 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

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

James L. Morris Memorial Prize

The James L. Morris Memorial Prize is the gift of Mrs. J.H. Craig and Mr. J.R. Morris, K.C., in memory of their father, James L. Morris, C.E., O.L.S., D.Eng., the first graduate of the School of Practical Science, who died in 1946 after a distinguished career.

Graduating in Civil Engineering in 1881 as the sole member of his class, Dr. Morris engaged in railway work for some time, first as an engineer and then as a contractor. For forty-three years he conducted a successful civil engineering practice in Pembroke, Ontario, involving important undertakings in the field of municipal power and bridge work.

The prize, of the value of the annual income from \$3,000, is awarded annually to the student in the Second year of the Civil Engineering Program who achieves the highest aggregate percentage at the annual examinations of the First and Second years of the course, provided always that the student achieve Honours standing at the examinations of the Second year.

Joseph G. Monkhouse Memorial Bursary in Engineering

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

Peter L. Munro Memorial Scholarship

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

Henry and Mary Nahrgang Bursaries

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

NACE International, Toronto Section, Prize

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

Nortel Institute Undergraduate Scholarship(s)

This Scholarship is made possible through a donation from Nortel Networks Limited. It is award to students in Second or Third year of Applied Science and Engineering and Arts and Science on the basis of financial need and academic merit and an essay. Candidates must submit an essay on "The Future of Communications" (maximum 500 words) along with two references. 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, Computer, Mechanical, Chemical, or Environmental Engineering. Students must be a member of employment equity target group (women, aboriginal, disabled, visible minority). In addition to academic standing (minimum B average) the following will also be considered: demonstrated leadership skills, possess strong oral and written communication skills, and are involved in extra-curricular activities. Candidates must be legally eligible to work in Canada upon graduation. Will not be receiving more than one award of equal or greater value in Second year.

PACE Project Design Award

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

Gary L. Palmer Memorial Scholarship

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

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

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

The Dr. John Hamilton Parkin Scholarship

Established by family friends and colleagues in 1983, this award honours the late Dr. John Hamilton Parkin, 1T1, 1T2 Mechanical and Electrical Engineering.

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

Paulin Memorial Scholarship

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

A. B. Platt Award, Toronto Section of the Society of Tribologists and Lubrication Engineers

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

Frank H.R. Pounsett Memorial Scholarship

This award, established in 2010 by the estate of Margaret Catharine Pounsett in memory of her late husband, is given to the top student completing second year of Electrical Engineering.

Florence Evelyn and William Leonard Prideaux Award

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

Professional Engineers Ontario Foundation for Education In-Course Scholarships

The Professional Engineers Foundation for Education offers a total of eight scholarships to students in first, second and third years in the Faculty of Applied Science and Engineering in any program. The awards are granted on the basis of strong academic performance and leadership or role model qualities as demonstrated through involvement in professional affairs and extra-curricular activities.

Professional Engineers Ontario Foundation for Education Gold Medal for Academic Achievement

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

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 in 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

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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 achieves the highest aggregate percentage of marks in the examinations of the first year. The scholarship will be paid to the winner only if the recipient proceeds to the second year of the program at the University of Toronto.

Reginald J. Redrupp Award

This award was established in 1987 by 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 in granting the award.

J.E. Reid Memorial Prize

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

The Russell Reynolds Scholarship in Engineering Science

This award, established in 2001, is to be awarded to a student entering the third year of 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 Industrial Engineering studies and 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 retirement, he returned to the University of Toronto and in November, 1979 graduated with his Master of Engineering. Application should be made on the Undergraduate Grant Application Form.

The Richard Rowland Memorial Scholarship

This Scholarship was established by family, friends and colleagues in memory of Richard Rowland, an active member of Phi Delta Theta and a 1989 graduate of Mechanical Engineering. Richard passed away in 1996 as a result of an automobile accident. While Richard was successful in his work as an engineer, he found time to explore the outdoors when canoeing and skiing. He was also active in amateur theatricals. His circle of friends reflected these varied activities. 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.

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 on the basis of having demonstrated a 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% 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 each year since 1945. The name is based on the biblical text "Whosoever shall compel thee to go one mile, go with him twain". The second mile is the voluntary mile. Convinced that a successful engineer must be not only professionally competent but also constantly aware of his or her broader responsibilities, the donors encourage undergraduates to participate fully in extra-curricular activities of all kinds. The award is comprised of a monetary prize and illuminated scroll that is presented to a student in the 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 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 department recommendation.

The Joseph Seidner Bursary Fund

The Joseph Seidner Bursary Fund was established in 1987 by Mr. Joseph Seidner, a principal in the firm of Brady & Seidner Associates Ltd., a large mechanical contractor in Ontario. 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 on the basis of suitability for the fellowship.

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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 in Chemical Engineering and Applied Chemistry who achieves the highest weighted average over the four years.

Murray F. Southcote Scholarship

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

C.H.E. Stewart Bursaries

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

The Kenneth H. Sullivan / Pratt & Whitney Canada Scholarship

This scholarship was established in 2003, through a generous donation by both Pratt & Whitney Canada Corp. and the family of Kenneth H. Sullivan. This award, valued at \$5,000, is 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 Session.

Gordon F. Tracy Scholarship

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

Charles Edwin Trim Scholarship

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

Troost Family Leaders of Tomorrow Award

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

Marjorie Hilda Merrick Turner Award

The President of the Engineering Society receives the Marjorie Hilda Merrick Turner Award, which is derived from the income of a capital fund, established in 1985 by the sons of Mrs. Marjorie H.M. Turner. As a granddaughter, daughter, wife, mother and grandmother of 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.

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 (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 second year of Materials Engineering on the basis of academic achievement. Recipients must be Canadian citizens or permanent residents and must have achieved honours.

The Stewart Wilson Award

This Award, first made in 1965-66, is available through the generosity of the Engineering Alumni Association. Its value fluctuates to cover the residence fee of New College. It is open to students who, proceeding to the second or third year of any course in the Faculty of Applied Science and Engineering, were resident or non-resident members of New College during their first or second year. The award is based upon academic ability, leadership qualities, contribution to New College activities and financial need. The 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, achieves the highest standing in the final year of the course. The first awards were made in the Session 1962-63.

William R. Worthington Memorial Scholarship

The William R. Worthington Memorial Scholarship, the gift of Ida R. Worthington in memory of her brother, William R. Worthington, DIPL.(1904), B.A.Sc.(1905), of the value of the income from the fund, is awarded annually to a student in second year of the Civil Engineering Program who ranks highest at the annual examinations of that year. The first award was made in the 1954 - 1955 Session.

Barbara Zdasiuk Memorial Scholarship

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

LOAN FUNDS

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

Fees and Expenses

TUITION FEES

Method of Payment

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

Invoice Payment

An invoice detailing the fees payable will be posted to the student's account on the Student Web Service (SWS) (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 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 (65% of the total fee) 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 at 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).

Verify Your Registration Status

Check to see if you are registered on ROSI 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% (19.56% per annum). For more information, please refer to www.fees.utoronto.ca. Please note that when you make your tuition/fees payment at a bank, it takes at least 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 2014 - 2015 session will be available on the Student Accounts website at www.fees.utoronto.ca in July 2014. Check www.fees.utoronto.ca for the finalized session fees once these are available. For reference, below are the amounts from the 2013 - 2014 academic year.

FULL-TIME STUDENTS, 2013-2014

DOMESTIC STUDENTS

Academic Year	I	II	III	IV
Academic Fee	\$12,363.00	\$12,246.00	\$11,792.00	\$11,354.00
Incidental Fees*	\$1,473.56	\$1,473.56	\$1,473.56	\$1,473.56

Total Fee (If paid in one installment)	\$13,836.56	\$13,719.56	\$13,265.56	\$12,827.56
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Minimum First Installment	\$8,993.76	\$8,917.71	\$8,622.61	\$8,337.91
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INTERNATIONAL STUDENTS

Academic Year	I	II	III	IV
Academic Fee	\$35,982.00	\$33,634.00	\$32,033.00	\$30,578.00
Incidental Fees*	\$1,473.56	\$1,473.56	\$1,473.56	\$1,473.56
University Health Insurance Plan (UHIP) Fees	\$684.00	\$684.00	\$684.00	\$684.00
Total Fee (If paid in one installment)	\$38,139.56	\$35,791.56	\$34,190.56	\$32,735.56
Minimum First Installment	\$24,790.71	\$23,264.51	\$22,223.86	\$21,278.11

PART-TIME AND SPECIAL STUDENTS, 2013-2014

DOMESTIC STUDENTS

Academic Year	I	II	III	IV
Academic Fee	\$12,363.00	\$12,246.00	\$11,792.00	\$11,354.00
For each Engineering course	\$1,236.30	\$1,224.60	\$1,179.20	\$1,135.40
Incidental Fee (once annually)	\$431.98	\$431.98	\$431.98	\$431.98

INTERNATIONAL STUDENTS

Academic Year	I	II	III	IV
For each Engineering course	\$3,598.20	\$3,363.40	\$3,203.30	\$3,057.80
Incidental Fee (once annually)	\$431.98	\$431.98	\$431.98	\$431.98

*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 www.engineeringcareers.utoronto.ca for details)	\$900
eSIP Placement Fee (subject to annual approval - see www.engineeringcareers.utoronto.ca for details)	\$250
Copy of documents in student information file (other than transcript)	\$15

Fees and Expenses

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.	\$13
Letter of Permission	\$35
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	\$24
Registration Letter	\$ 7
- 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:

1. Books and instruments per year: \$1,500
2. Fees (see fees schedule above)
3. Room and board (meal plan included): approximately \$7,840 - \$12,200 per year, or \$980 - \$1,525 per month.

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

REFUND SCHEDULE

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

PENALTIES

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 \$235 in respect of academic fees.

Further information about the minimum charge is listed on the Student Accounts website at 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 concerning all matters related to Engineering students. Within the Office of the Registrar are the First Year Office (located in GB170), which offers academic counselling to First Year students, and the Engineering Undergraduate Admissions Office (located in GB153) which manages the admissions process, transfer credits, financial aid and OSAP distribution. Some of the services offered include:

- Academic and personal counselling
- Academic scheduling
- Course listings building and classroom locations
- Final Exam Copy and Final Course Mark Re-Check
- Final 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
- Transcripts

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

OFFICE OF THE FACULTY REGISTRAR

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

FIRST YEAR OFFICE

Assistant Registrar, First Year, Leslie Grife
Assistant Registrar, First Year (Acting) Stephanie Rose
Student Success Specialist, Curtis Norman
First Year Counsellor, 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 a.m. to 4:30 p.m.

UNDERGRADUATE PROGRAM COUNSELLOR OFFICES

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

CHEMICAL ENGINEERING

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

Professor S. Valaee
Room B600, Sandford Fleming Building
or
Linda Espeut
(416) 978-8570
Room B600, Sandford Fleming Building
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

Hana Lee (first- & second-year students)
Room 2110, Bahen Centre, (416) 946-7351
nsci1_2@ecf.utoronto.ca

Anne Marie Kwan (third- & fourth-year students)
Room 2110, Bahen Centre, (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) 978-3012
mse@ecf.utoronto.ca

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

www.rosi.utoronto.ca

ROSI, the Repository of Student Information, contains data relating to a student's admission to and academic performance at the University of Toronto.

Student Web Service (SWS)

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

Responsible Use of SWS

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

First Time Log in Instructions/PIN Reset Instructions

To log in to ROSI, you need your U of T student number and six-digit personal identification number (PIN). The first time you log in to ROSI, your PIN represents your birth date in the form YYMMDD. (e.g. If you were born July 31, 1992, then your initial PIN would be 920731). Once you successfully log in to ROSI for the first time, for security purposes, you will be prompted to change your PIN to a new six digit PIN. This new PIN will be what you use to access ROSI in the future. Please note, your PIN must be six digits and must be comprised of numbers only.

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

Student Services and Resources

If you cannot come to the Registrar's Office in person, then you must fax a request for ROSI PIN reset form to the Office in order to verify that you are the one requesting a PIN reset. This allows the Registrar's Office to verify that you are the one requesting a PIN reset. The PIN reset form can be found at: uoft.me/rosipin. The fax number for the Registrar's Office is 416-978-1866. PIN reset requests cannot be made by telephone.

UNIVERSITY OF TORONTO PORTAL

www.portalinfo.utoronto.ca

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

T-CARD/LIBRARY CARD

www.utoronto.ca/tcard

The student photo identification card is a wallet-sized card bearing the student's photograph and signature; 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 of \$12.00 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 \$7.00 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

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

OTHER RESOURCES FOR STUDENTS IN THE FACULTY

ENGINEERING COMPUTING FACILITY

www.undergrad.engineering.utoronto.ca/Student_Life/Engineering_Computing_Facility.htm

ENGINEERING COMMUNICATION PROGRAM AND ENGINEERING COMMUNICATION CENTRE

www.engineering.utoronto.ca/Directory/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 PROGRAMS AND SERVICES

Student Life Programs and Services

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

The Division of Student Life Programs and Services includes:

Academic Success Centre

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

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

Academic Success Centre

The Academic Success Centre is dedicated to 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
www.asc.utoronto.ca

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 a 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
130 St. George Street, First Floor
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

Counselling and Psychological Services

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

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

Counselling and Psychological Services
Koffler Student Services Centre

Student Services and Resources

214 College Street
416-978-8070
www.caps.utoronto.ca

Centre for Community Partnerships

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

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

First Nations House

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

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

Hart House

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

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

Health Service

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

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

Centre for International Experience

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

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

Multi-Faith Centre

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

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

Student Housing Service

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

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

UNIVERSITY OF TORONTO STUDENT SERVICES AND RESOURCES

A-Z Of Student Services

www.life.utoronto.ca/get-info/a-z-list.htm

ULIFE-What are you doing after classes?

www.ulife.utoronto.ca

Other Resources:

Academic Integrity, Resources for Students
Antiracism and Cultural Diversity Office
Campus Community Police
Centre for International Experience
Equity Offices
Family Care Office
Freedom of Information & Protection of Privacy Office
Information Commons
Online Harassment
Report Homophobia
Sexual & Gender Diversity Office
Sexual Harassment Office
Summer Abroad Programs
University Ombudsperson
Walk Safer

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:

Student Services and Resources

- 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.).

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
Tel: (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."

ONLINE HARASSMENT

www.enough.utoronto.ca

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

REPORT HOMOPHOBIA

www.sgdo.utoronto.ca/Report_Bullying.htm

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

SEXUAL & GENDER DIVERSITY OFFICE

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

Student Services and Resources

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 Office 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

All part-time undergraduate students on all three campuses of the University of Toronto are members of the Association of Part-time Undergraduate Students. The mission of the Association of Part-time Undergraduate Students (APUS) is to ensure that part-time undergraduate students have access to the full range of programs, services and resources at the University of Toronto in order to improve the quality of the part-time undergraduate educational experience. APUS works to ensure that a variety of post-secondary educational opportunities are available for students who, for any reason, choose to study part-time. APUS believes that education can be combined with work, family and other activities and that part-time study represents a viable option for students who 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.

Academic Regulations

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.

Academic Regulations

- 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

Academic Regulations

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.

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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:

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

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

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%,

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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%

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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
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*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:

- Remain in Engineering Science and proceed to 1W subject to Engineering Science promotion rules
- Voluntarily transfer to another Engineering program with space and be unconditionally accepted
- 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
- 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	
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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

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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) Cases, purses, file folders, etc. are not permitted on candidates' desks except during a Type X examination. If taken into the examination room, they must be left at the front or back of the room, as directed by the presiding examiner or the Assistants. Valuable items may be placed in a bag (paper, transparent plastic or non-transparent plastic) under the candidate's desk. No electronic devices, storage media and accessories are permitted unless explicitly authorized in writing. For the purposes of this section, electronic devices, storage media and accessories are described as but not limited to:

i) computers, including all hardware and software

ii) PDAs or any other handheld personal organizers (e.g. Palm Pilot, etc.)

iii) Cell phones, radios, pagers of any kind (voice, numeric or alpha-numeric; e.g. BlackBerry, etc.) wireless adapters, or any other telecommunication devices

iv) Electronic storage media or accessories of any kind (e.g. computer floppy discs, hard drives, CDs, DVDs, USB storage devices, memory cards etc.)

v) Any other electronic device, storage medium, accessories not explicitly authorized and examined.

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 on the standard form will be provided by each examiner using the type C examination. Students must 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.

Academic Regulations

- 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, such aid sheet being on a standard form supplied to the examiner by the Registrar of the Faculty. Students may enter on both sides of the aid sheet any information they desire, without restriction, except that nothing may be affixed or appended to it.

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 at any time during the session, and consequently misses any graded work, should discuss the matter with the appropriate instructor and, if necessary, submit a Petition for Consideration in Course Work. Such a petition must be accompanied by appropriate documentation (e.g., medical certificate) and must be submitted to the instructor within one week of the student's return to classes.

ii) Petition for Consideration in Final Examinations

A student who believes that their academic performance has been adversely affected by illness, mishap or other circumstance during the examination period should submit a Petition for Consideration in Final Examinations. Such petitions must be submitted online through the Engineering Portal within one week of the date of the student's last examination.

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

Curriculum

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 Engineering Undergraduate Admissions Office, located within the Galbraith building at 35 St. George Street (room 153). This form must be submitted with a copy of the official course description from the host institution's academic calendar. A non-refundable processing fee of \$30 per letter of permission will be charged.

Please note that a Letter of Permission does not apply to courses taken while participating in an official International Exchange.

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. Over 800 students are in placements at over 300 companies for the current PEY 2013-2014 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 \$45,000.

ENGINEERING COMMUNICATION PROGRAM

Director: Peter Weiss

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 a one-to-one (or one-to-team) tutoring service to help develop ideas and improve communication skills.

THE JEFFREY SKOLL BASc/MBA PROGRAM (SKOLL PROGRAM)

The Jeffrey Skoll Combined BASc/MBA Program allows qualified and selected students of the Faculty of Applied Science and Engineering (APSC) to complete both a BASc and an MBA degree nearly simultaneously and in a reduced time.

The program genesis dates back to the mid-1990s and clearly followed from the wide recognition that engineering and management provide an important combination of skills and understanding. The method to address this recognized need — having a combined program between the two cognizant faculties (the Faculty of Applied Science and Engineering and the Rotman School of Management) — is a well understood strategic goal, in particular given the highly competitive employment environment that pervades the market.

Following an extensive review of the Skoll Program, a number of enhancements have been implemented to improve the overall student experience, provide stronger student services, and allow students to maintain a connection to each faculty as they complete their studies.

The Skoll Program application process remains unchanged:

- Students will apply to and be accepted into the program while in engineering with the admission process as outlined on the Skoll website. Students will have to complete an application form, write the GMAT exam (acceptable performance on the exam to be gauged by Rotman), provide three satisfactory reference letters and complete a final brief interview with both Rotman and Engineering representatives. Students will be admitted into the program during their fourth year of studies in the BASc program.

The following are the current elements of the program:

- Once accepted into the program, students continue in their engineering studies, and complete the four-year BASc program. Students in the Skoll program will graduate from Engineering and receive their iron rings with their classmates.
- Students in the Skoll program will be required to complete a 12 to 16 month "PEY" (Professional Experience Year) component using the existing APSC machinery (PEY office) to secure the placement. To ensure uniformity, and further, to allow Skoll engineering students to graduate as a cohort, all Skoll students will complete the "PEY" between their 3rd and 4th years of engineering studies
- Beginning the September following graduation from engineering, Skoll students will enter the Rotman School of Management, and complete their MBA with regular Rotman MBA students. After completing their MBA studies, Skoll students will graduate with their MBA class.

These program elements allow students to:

- Maintain a connection, both physically and philosophically, with each faculty independent of the other.
- Better use the services offered by each faculty, without the requirement of a dedicated "bridging" administrative service.
- Have far greater flexibility to select electives in each program by avoiding scheduling conflicts.

PART-TIME STUDIES

Curriculum

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:

Curriculum

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 Republic

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 (Clermont-Ferrand)
Lumiere University (Lyons II)
Lyons III Université Jean Moulin
Paris I - Université Pantheon Sorbonne
Paris II - Université Pantheon Assas
Paris III - Université 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)
		Engineering Science (Infrastructure Engineering)
AEESCBASEI	BASc in Eng.Sci	Engineering Science (Energy Systems Option)
AEESCBASEJ	BASc in Eng.Sci	Engineering Science (Nanoengineering)
AEESCBASEO	BASc in Eng.Sci	Engineering Science (Physics)
AEESCBASEP	BASc in Eng.Sci	Engineering Science (Electrical and Computer)
AEESCBASER	BASc in Eng.Sci	Engineering Science (Biomedical Systems Option)
AEESCBASET	BASc in Eng.Sci	
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
AEMINRAM		Minor in Robotics and Mechatronics
AECERBUS		Certificate in Engineering Business
AECERENTR		Certificate in Entrepreneurship
AECERGLOB		Certificate in Global Engineering
AECERMINR		Certificate in Mineral Resources
AECERNUC		Certificate in Nuclear Engineering
AECERPESD		Certificate in Preventive Engineering & Social Development

Minors in the Faculty of Applied Science and Engineering

Manager and Student Counsellor

Sharon Brown

Cross-Disciplinary Programs Office

44 St. George St.

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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) courses towards the 6 required courses IF the Thesis or Design course is strongly related to bioengineering. This requires approval by the Bioengineering Minor Director.
 - d. Some Departments may require students to select their electives from a pre-approved subset. Please contact your Departmental Advisor for details.
 - e. Arts and Science Courses listed below may be considered eligible electives for students taking the Bioengineering Minor (to be counted at a weight of 0.50 only), subject to the student meeting any prerequisite requirements. Students must also seek the approval of their home program to ensure that they meet their degree requirements. In situations where these courses don't meet those of their home program, students can elect to take these as extra courses.

Minor in Bioengineering

Courses Offered in the Fall				Lect.	Lab.	Tut.	Wgt.	Courses Offered in the Winter				Lect.	Lab.	Tut.	Wgt.
Core Requirement Courses								Core Requirement Courses							
Biomedical Systems	BME350H1	F	3		1	2	0.50	Biomolecules and Cells	BME205H1	S	2		1.75	1	0.50
Engineering I: Organ Systems								Physiological Control Systems	MIE331H1	S	3		1	1	0.50
Engineering Biology	CHE353H1	F	3		-	1	0.50	Introductory Courses							
Biomedical Design in Society	BME221H1	F	3		3	2	0.50	Biostatistics	BME225H1	S	3		-	3	0.50
Biomedical Systems	BME350H1	F	3		1	2	0.50	Biomedical Engineering Technology and Investigation	BME440H1	S	2		4	-	0.50
Engineering I: Organ Systems								Introduction to Genes, Genetics & Biotechnology	HMB201H1	S	2		-	1	0.50
Organic Chemistry and Biochemistry	CHE391H1	F	3		1.50	1	0.50	Physiological Control Systems	MIE331H1	S	3		1	1	0.50
Water and Wastewater Treatment Processes	CIV342H1	F	3		1	-	0.50	Biomechanics I	MIE439H1	S	3		2	-	0.50
General & Human Genetics	HMB265H1	F	2		-	1	0.50	Introduction to Pharmacology and Pharmacokinetic Principles	PCL201H1	S	3		-	1	0.50
Psychology For Engineers	MIE242H1	F	3		3	-	0.50								
Industrial Ergonomics and the Workplace	MIE343H1	F	3		3	-	0.50								
	MSE440H1		-		-	-	0.00								
	F/S/Y														
Discovering Wood and its Role in Societal Development	FOR308H1	F	3		-	1	0.50								
Human Physiology I	PSL300H1	F	3		-	1	0.50								

Minor in Bioengineering (continued)

Minor in Bioengineering (continued)				Lect.	Lab.	Tut.	Wgt.	Minor in Bioengineering (continued)				Lect.	Lab.	Tut.	Wgt.
Advanced Courses								Advanced Courses							
Bioinformatics	BCH441H1	F	2		-	1	0.50	Computational Systems Biology	BCB420H1	S	2		-	2	0.50
Biomedical Systems	BME395H1	F	3		-	2	0.50	Medical Imaging	BME595H1	S	2		3	1	0.50
Engineering II: Cells and Tissues								Cellular and Molecular Biology	CHE354H1	S	3		1	2	0.50
Cellular and Molecular Bioengineering II	BME455H1	F	3		1.50	1	0.50	Food Engineering	CHE462H1	S	3		-	1	0.50
Bioprocess Engineering	CHE466H1	F	3		0.66	1	0.50	Pulp and Paper Processes	CHE564H1	S	3		-	1	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1	F	2		-	1	0.50	Biocomposites: Mechanics and Bioinspiration	CHE475H1	S	3		-	1	0.50
Neural Bioelectricity	ECE445H1	F	3		1.50	1	0.50	Organic Materials Chemistry	CHM446H1	S	2		-	-	0.50
Sensory Communication	ECE446H1	F	3		1.50	1	0.50	Environmental Biotechnology	CIV541H1	S	3		-	-	0.50
Biocomputation	ECE448H1	F	3		-	2	0.50	Bioenergy and Biorefinery Technology	FOR425H1	S	2		-	2	0.50
Green Urban Infrastructure: Sustainable City Forests	FOR421H1	F	2		-	-	0.50	Innovation and Manufacturing of Sustainable Materials	FOR424H1	S	3		-	-	0.50
Introductory Immunology	IMM334Y1	Y	2		-	-	0.50	Introductory Immunology	IMM334Y1	Y	2		-	-	0.50
Microbiology I: Bacteria	MGY377H1	F	3		-	-	0.50	Healthcare Systems	MIE561H1	S	3		-	2	0.50
Engineering Psychology and Human Performance	MIE448H1	F	3		3	-	0.50	Biomaterials and Biocompatibility	MSE352H1	S	3		-	1	0.50
Biotransport Phenomena	MIE520H1	F	3		-	1	0.50	Surgical and Dental Implant Design	MSE442H1	S	3		-	1	0.50
Pharmacodynamic Principles	PCL302H1	F	3		-	-	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, BME396H1, CHE391H1 and CHE393H1 are only open to Engineering Science Students.

Engineering Programs

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 pharmaceutical and therapeutic technologies, medical devices, medical diagnostics, health care delivery, 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 technologies. 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. 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.

Students in the Biomedical Engineering minor must successfully complete the following 5 mandatory courses:

1. CHE353H1 - Engineering Biology
2. MIE331H1 - Physiological Control Systems
3. BME440H1 - Bio-Instrumentation
4. MIE439H1 - Biomechanics
5. BME499Y1 - Innovation and Applied R&D in Biomedical Engineering

Notes:

- For those Engineering Science student who transferred into another program, BME205H1 can replace CHE353H1 and is an eligible pre-requisite for MIE331H1.

MINOR IN ENGINEERING BUSINESS (AEMINBUS)

This minor is for students interested in learning more about the business dimension of engineering, from finance and economics to management and leadership. Courses reach to areas of wealth production and creation, accounting, research and development, management, economics and entrepreneurship, all within a global context. Students in the Engineering Science Mathematics, Statistics and Finance Option are not eligible to take this minor.

Course Requirements for the Minor in Engineering Business

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

1. Required Departmental Engineering Economics Course (CHE249H1, CHE374H1, CME368H1, ECE472H1, MIE258H1)
2. JRE300H1 - (CS Elective)
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							Courses offered in the Winter						
			Lect.	Lab.	Tut.	Wgt.				Lect.	Lab.	Tut.	Wgt.
Engineering Economics Course							Engineering Economics Course						
Engineering Economic Analysis	CHE249H1	F	3	-	1	0.50	Engineering Economic Analysis & Entrepreneurship	ECE472H1	S	3	-	2	0.50
Economic Analysis and Decision Making	CHE374H1	F	3	-	1	0.50							
Engineering Economics and Decision Making	CME368H1	F	3	-	1	0.50	Required Courses						
Engineering Economic Analysis & Entrepreneurship	ECE472H1	F	3	-	2	0.50	Fundamentals of Accounting and Finance	JRE300H1	F/S	3	-	1	0.50
Engineering Economics and Accounting	MIE258H1	F	3	-	1	0.50	Markets and Competitive Strategy	JRE410H1	F/S	2	2	-	0.50
Required Courses							People Management and Organizational Behaviour	JRE420H1	F/S	3	1	-	0.50
Fundamentals of Accounting and Finance	JRE300H1	F/S	3	-	1	0.50	Elective Courses						
Markets and Competitive Strategy	JRE410H1	F/S	2	2	-	0.50	Foundations of Engineering Leadership	APS343H1	S	2	-	2	0.50
People Management and Organizational Behaviour	JRE420H1	F/S	3	1	-	0.50	Entrepreneurship and Business Management	APS432H1	S	4	-	1	0.50
Elective Courses							Cognitive and Psychological Foundations of Effective Leadership	APS442H1	S	3	-	-	0.50
Entrepreneurship and Small Business	APS234H1	F	4	-	1	0.50	Technology, Engineering and Global Development	APS520H1	S	3	-	-	0.50
Foundations of Engineering Leadership	APS343H1	F	2	-	2	0.50	Entrepreneurship and Business for Engineers	CHE488H1	S	3	-	2	0.50
Positive Psychology for Engineers	APS444H1	F	3	-	-	0.50	Entrepreneurship and Business for Engineers	CIV488H1	S	3	-	2	0.50
The Power of Story: Discovering Your Leadership Narrative	APS445H1	F	2	-	1	0.50	The Spatial Organization of Economic Activity	GGR220H1	S	2	-	1	0.50
Innovative Technologies and Organizations in Global Energy Systems	APS510H1	F	3	-	1	0.50	Marketing Geography	GGR252H1	S	2	-	1	0.50
Entrepreneurship and Business for Engineers	ECE488H1	F	3	-	2	0.50	The Engineer in History	HPS283H1	S	2	-	1	0.50
Discovering Wood and its Role in Societal Development	FOR308H1	F	3	-	1	0.50	Understanding Engineering Practice: From Design to Entrepreneurship	HPS321H1	S	2	-	-	0.50
Technology and Prosperity	HPS308H1	F	2	-	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							

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:

Engineering Programs

- 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.
- Of the 4 elective courses, at least 2 must be from the Advanced category.
- Either a Thesis or Design course can count for up to two (half year) courses towards the 6 required courses IF the Thesis or Design course is strongly related to sustainable energy. This requires approval by the Sustainable Energy Minor Director.
- Some Departments may require students to select their electives from a pre-approved subset. Please contact your Departmental Advisor for details.
- 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							Courses Offered in the Winter						
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.		
Core Requirement Courses							Core Requirement Courses						
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50		Terrestrial Energy Systems	CIV300H1 S	3	-	2	0.50	
Energy Policy and Environment	ENV350H1 F	-	-	-	0.50		Energy Policy	APS305H1 S	3	-	1	0.50	
Introductory Courses							Introductory Courses						
Technology in Society and the Biosphere I	APS301H1 F	3	-	1	0.50		Environmental Pathways and Impact Assessment	CHE460H1 S	3	-	2	0.50	
Defining Energy Futures in India and Canada	APS310H0 F	3	1	-	0.50		Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50	
Innovative Technologies and Organizations in Global Energy Systems	APS510H1 F	3	-	1	0.50		Bioenergy from Sustainable Forest Management	FOR310H1 S	2	-	1	0.50	
Thermodynamics and Heat Transfer	CHE260H1 F	3	0.50	1	0.50		Carbon-Free Energy (formerly JGE348H1)	GGR348H1 S	2	-	1	0.50	
Engineering Thermodynamics	CHE323H1 F	3	-	2	0.50		Thermodynamics	MIE210H1 S	3	1.50	1	0.50	
Environmental Engineering Building Science	CHE467H1 F	3	-	1	0.50		Heat and Mass Transfer	MIE313H1 S	3	1.50	2	0.50	
Fundamentals of Electrical Energy Systems	CIV375H1 F	3	0.33	2	0.50		Materials Processing and Sustainable Development	MSE355H1 S	2	-	1	0.25	
Introduction to Energy Systems	ECE314H1 F	3	1.50	1	0.50		Advanced Courses						
Efficient Use of Energy (formerly JGE347H1)	ECE349H1 F	3	1.50	1	0.50		Appropriate Technology & Design for Global Development	APS530H1 S	3	-	-	0.50	
Physics of the Earth	GGR347H1 F	2	-	1	0.50		Fuel Cells and Electrochemical Conversion Devices	CHE469H1 S	3	-	1	0.50	
Advanced Courses							Nuclear Engineering	CHE568H1 S	3	-	1	0.50	
Introduction to Fusion Energy	PHY395H1 F	2	-	1	0.50		Sustainable Buildings Infrastructure for Sustainable Cities	CIV576H1 S	3	-	1	0.50	
Petroleum Processing	AER507H1 F	3	-	1	0.50		Energy Systems and Distributed Generation	CIV577H1 S	3	-	1	0.50	
Introduction to Nuclear Engineering	ECE413H1 S	3	-	1	0.50		Power Electronics: Switch-Mode Power Supplies	ECE533H1 S	3	1	1	0.50	
Transport Planning	CHE451H1 F	3	-	1	0.50		Bioenergy and Biorefinery Technology	FOR425H1 S	2	-	2	0.50	
Introduction to Lighting Systems	CHE566H1 F	3	-	1	0.50		* Thermal and Machine Design of Nuclear Power Reactors	MIE408H1 S	3	-	2	0.50	
Power Electronics: Converter Topologies	ECE510H1 F	3	-	2	0.50		Alternative Energy Systems	MIE515H1 S	3	-	1	0.50	
Nuclear Reactor Theory and Design	ECE514H1 F	3	1.50	1	0.50		Fuel Cell Systems	MIE517H1 S	3	-	1	0.50	
Thermal Energy Conversion	MIE407H1 F	3	-	2	0.50		Energy Management in Materials Processing	MSE408H1 S	3	-	1	0.50	
Combustion and Fuels	MIE411H1 F	3	3	-	0.50		Nanotechnology in Alternate Energy Systems	MSE558H1 S	3	0.50	1	0.50	
Extractive Metallurgy	MIE516H1 F	3	-	1	0.50								
	MSE504H1 F	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.

- Two (2) courses from the following:

(If you take more than 2, the extra course may be able to count as an elective below)

- APS301H1
- CIV220H1
- CIV440H1
- CHE460H1
- CHE467H1

- Four (4) other electives from the list of Environmental Engineering designated courses or departmental thesis and design courses subject to the following constraints:

a. Of the 6 (half year) environmental engineering courses required, one (half year) course can also be a core course in a student's Program, if applicable.

b. Of the 4 elective courses, at least 2 must be from the Advanced category.

c. Either a Thesis or Design course can count for up to two (half year) courses towards the 6 required courses IF the Thesis or Design course is strongly related to environmental engineering. This requires approval by the Environmental Engineering Minor Director.

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.	Courses Offered in the Winter				Lect.	Lab.	Tut.	Wgt.
Core Requirement Courses								Core Requirement Courses							
Technology in Society and the Biosphere I	APS301H1	F	3	-	1	0.50		Environmental Pathways and Impact Assessment	CHE460H1	S	3	-	2	0.50	
Environmental Engineering	CHE467H1	F	3	-	1	0.50		Environmental Impact and Risk Assessment	CIV440H1	S	3	-	1	0.50	
Urban Engineering Ecology	CIV220H1	F	3	-	1	0.50									
Introductory Courses								Introductory Courses							
Chemistry of Environmental Change	CHM210H1	F	2	-	1	0.50		Environmental Chemistry	CHE230H1	S	3	-	2	0.50	
Terrestrial Energy Systems	CIV300H1	F	3	-	2	0.50		Environmental Chemistry	CHM310H1	S	2	-	-	0.50	
Building Science	CIV375H1	F	3	0.33	2	0.50		Hydraulics and Hydrology	CIV250H1	S	3	1.50	1	0.50	
Energy Policy and Environment	ENV350H1	F	-	-	-	0.50		Terrestrial Energy Systems	CIV300H1	S	3	-	2	0.50	
Discovering Wood and its Role in Societal Development	FOR308H1	F	3	-	1	0.50		Design for the Environment	MIE315H1	S	3	-	1	0.50	
Advanced Courses								Environmental Degradation of Materials	MSE315H1	S	3	-	2	0.50	
Bioprocess Engineering	CHE466H1	F	3	0.66	1	0.50		Advanced Courses							
Aqueous Process Engineering	CHE565H1	F	3	-	1	0.50		Technology in Society and the Biosphere II	APS302H1	S	3	-	1	0.50	
Analytical Environmental Chemistry	CHM410H1	F	2	4	-	0.50		Preventive Engineering and Social Development	APS304H1	S	3	-	1	0.50	
Transport Planning	CIV531H1	F	3	-	1	0.50		Appropriate Technology & Design for Global Development	APS530H1	S	3	-	-	0.50	
Groundwater Flow and Contamination	CIV549H1	F	3	-	1	0.50		Pulp and Paper Processes	CHE564H1	S	3	-	1	0.50	
Water Resources Engineering	CIV550H1	F	3	-	2	0.50		Topics in Atmospheric Chemistry	CHM415H1	S	2	-	-	0.50	
Green Urban Infrastructure: Sustainable City Forests	FOR421H1	F	2	-	-	0.50		Environmental Biotechnology	CIV541H1	S	3	-	-	0.50	
Extractive Metallurgy	MSE504H1	F	3	-	2	0.50		Sustainable Buildings Infrastructure for Sustainable Cities	CIV576H1	S	3	-	1	0.50	
									CIV577H1	S	3	-	1	0.50	
								Innovation and Manufacturing of Sustainable Materials	FOR424H1	S	3	-	-	0.50	
								Alternative Energy Systems	MIE515H1	S	3	-	1	0.50	
								Mining Environmental Management	MIN430H1	S	3	-	1	0.50	

Engineering Programs

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 constraints:

- a. Of the 6 (half year) courses required, one (half year) course can also be a core course in a student's Program, if applicable.
- b. Of the four elective courses, at least two must be from the Advanced category.
- c. A thesis course can count for up to two electives (2 HCEs) toward the six required Minor courses if the thesis is strongly related to robotics or mechatronics. This requires approval by the Director of the Minor.
- d. Of the six Minor courses required, not all can have the same course prefix.

Introductory Courses

Fall Courses						Winter Courses							
			Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.	
Dynamics	AER301H1	F	3	-	1	0.50	Communication Systems	ECE316H1	S	3	1.50	1	0.50
Biomedical Systems	BME350H1	F	3	1	2	0.50	Algorithms and Data Structures	ECE345H1	S	3	-	2	0.50
Engineering I: Organ Systems							Systems Software	ECE353H1	S	3	3	-	0.50
Communication Systems	ECE316H1	F	3	1.50	1	0.50	Foundations of Computing	ECE358H1	S	3	-	1	0.50
Algorithms and Data Structures	ECE345H1	F	3	-	2	0.50	Physiological Control Systems	MIE331H1	S	3	1	1	0.50
Kinematics and Dynamics of Machines	MIE301H1	F	3	3	2	0.50	Mechanical Engineering Design	MIE341H1	S	3	3	1	0.50
							Analog and Digital Electronics for Mechatronics	MIE346H1	S	3	1.50	1	0.50

Advanced Courses

Fall Courses						Winter Courses					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Space Systems Design	AER407H1 F	-	3	-	0.50	Mobile Robotics and Perception	AER521H1 S	3	1.50	1	0.50
Introduction to Artificial Intelligence	CSC384H1 F	2	-	1	0.50	Data-based Modelling for Prediction and Control	CHE507H1 S	3	-	1	0.50
Machine Learning and Data Mining	CSC411H1 F	2	-	1	0.50	Introduction to Artificial Intelligence	CSC384H1 S	2	-	1	0.50
Control Systems	ECE410H1 F	3	1.50	1	0.50	Human-Computer Interaction	CSC428H1 S	2	-	1	0.50
Digital Signal Processing	ECE431H1 F	3	1.50	1	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	ECE431H1 S	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
Systems Control	ECE557H1 F	3	1.50	1	0.50	Digital Systems Design	ECE532H1 S	3	3	-	0.50
Machine Design	MIE442H1 F	3	1.50	3	0.50	Geometry of Curves and Surfaces	MAT363H1 S	3	-	-	0.50
* Mechatronics Principles	MIE444H1 F	2	3	-	0.50	Microprocessors and Embedded Microcontrollers	MIE438H1 S	2	3	-	0.50
Minds and Machines	PHL342H1 F	3	-	-	0.50	* Mechatronics Systems: Design and Integration	MIE443H1 S	2	5	-	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 consult the department concerned regarding the availability of courses.

Engineering Programs

Certificate Programs in the Faculty of Applied Science and Engineering

CERTIFICATE IN ENGINEERING BUSINESS (AECERBUS)

Successful completion of an Engineering Certificate will be included on transcripts beginning in the 2012 - 2013 academic year. 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.

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						Electives					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Choose one of:						Choose two of :					
Engineering Economic Analysis	CHE249H1 F	3	-	1	0.50	Fundamentals of Accounting and Finance	JRE300H1 F/S	3	-	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50	Markets and Competitive Strategy	JRE410H1 F/S	2	2	-	0.50
Engineering Economics and Decision Making	CME368H1 F	3	-	1	0.50	People Management and Organizational Behaviour	JRE420H1 F/S	3	1	-	0.50
Engineering Economic Analysis & Entrepreneurship	ECE472H1 F/S	3	-	2	0.50	One choice above can be replaced by one of the following:					
Engineering Economics and Accounting	MIE258H1 F	3	-	1	0.50	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 thier transcript for one of the Engineering Business Certificate or the Entrepreneurship Certificate, or the Engineering Business Minor.

CERTIFICATE IN ENGINEERING LEADERSHIP (AECERLEAD)

Successful completion of an Engineering Certificate will be included on transcripts beginning in the 2012 - 2013 academic year. 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:					
Foundations of 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

**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 will be included on transcripts beginning in the 2012 - 2013 academic year. 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.	Economics Elective		Lect.	Lab.	Tut.	Wgt.
Entrepreneurship and Small Business	APS234H1 F	4	-	1	0.50	Choose one of:					
Entrepreneurship and Business Management	APS432H1 S	4	-	1	0.50	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

**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.

Engineering Programs

CERTIFICATE IN GLOBAL ENGINEERING (AECERGLOB)

Successful completion of an Engineering Certificate will be included on transcripts beginning in the 2012 - 2013 academic year. 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.	Courses		Lect.	Lab.	Tut.	Wgt.
Choose two of:						Choose one of:					
Innovative Technologies and Organizations in Global Energy Systems	APS510H1 F	3	-	1	0.50	Anthropology of the Contemporary World (formerly ANT204Y1)	ANT204H1	-	-	-	0.50
Technology, Engineering and Global Development	APS520H1 S	3	-	-	0.50	Ecological Worldviews	ENV333H1	-	-	-	0.50
Appropriate Technology & Design for Global Development	APS530H1 S	3	-	-	0.50	Global Cities	GGR216H1	-	-	-	0.50
						Globalization and Urban Change	JGI216H1	-	-	-	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 will be included on transcripts beginning in the 2012 - 2013 academic year. 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 will be included on transcripts beginning in the 2012 - 2013 academic year. 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.
Introduction to 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 PREVENTIVE ENGINEERING AND SOCIAL DEVELOPMENT (AECERPESD)

Successful completion of an Engineering Certificate will be included on transcripts beginning in the 2012 - 2013 academic year. Note that no course counted for degree credit, can be counted for more than one minor or certificate.

The Certificate in Preventive Engineering and Social Development is designed to help future engineers become as socially and environmentally literate as they are technically competent by enabling them to anticipate the consequences of their design and decision-making and to apply this knowledge in a negative-feedback mode to prevent or greatly reduce undesired and harmful effects on human life, society and the biosphere. The results of such a preventive orientation are, almost always, much more cost-effective than their conventional counterparts. Studies of the career paths of engineers show that they quickly move into administrative and managerial functions for which a broader perspective is required. An understanding of how technology interacts with human life, society and the biosphere (the ecology of technology) is essential to complement their understanding of how the inputs of materials, labour, knowledge and capital are converted to desired outputs (the economy of technology).

The requirements for the elective sequence are:

Engineering Programs

CERTIFICATE COURSES

Required		Lect.	Lab.	Tut.	Wgt.
Technology in Society and the Biosphere I	APS301H1 F	3	-	1	0.50
Technology in Society and the Biosphere II	APS302H1 S	3	-	1	0.50
Preventive Engineering and Social Development	APS304H1 S	3	-	1	0.50

**NOTE

Students who successfully complete these three courses are eligible for the Certificate. For further information, please refer to the description of the Centre for Technology and Social Development in this Calendar. Students should register for this elective sequence when they begin the third course.

CERTIFICATE IN RENEWABLE RESOURCES ENGINEERING (AECERRRE)

Successful completion of an Engineering Certificate will be included on transcripts beginning in the 2012 - 2013 academic year. 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	3	-	-	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

Senior Lecturer Micah Stickel, B.A.Sc., M.A.Sc., Ph.D.

ASSISTANT REGISTRAR, FIRST YEAR

Leslie Grife, B.A. (Hons)
Stephanie Rose (Interim)

STUDENT SUCCESS SPECIALIST

Curtis Norman, B.A. (Hons), M.Ed.

FIRST YEAR ADVISOR

Jennifer Fabro

FIRST YEAR ASSISTANT

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						Winter Session - Year 1					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Computer Fundamentals	APS105H1 F	3	2	1	0.50	Introduction to Materials and	APS104H1 S	3	0.50	1	0.50
Engineering Strategies & Practice I	APS111H1 F	3	1	1	0.50	Chemistry					
Ethics in Engineering	APS150H1 F	-	-	1	0.05	Engineering Strategies & Practice II	APS112H1 S	3	2	-	0.50
Mechanics	CIV100H1 F	3	-	2	0.50	Introduction to Engineering	APS191H1 S	1	-	-	0.15
Calculus I	MAT186H1 F	3	-	1	0.50	Electrical Fundamentals	ECE110H1 S	3	1	2	0.50
Linear Algebra	MAT188H1 F	3	-	1	0.50	Calculus II	MAT187H1 S	3	-	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.

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.

APS105H1 Computer Fundamentals	MAT186H1 Calculus I
APS111H1 Engineering Strategies & Practice 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.

Engineering Programs

The courses offered in the Summer Session are:

APS106H1 Fundamentals of Computer Programming	MAT187H1 Calculus II
APS112H1 Engineering Strategies & Practice II	MIE100H1 Dynamics
ECE110H1 Electrical Fundamentals	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

Director: Christopher Yip

Biomedical engineering applies to an interdisciplinary field that integrates the principles of biology with those of engineering. It applies methods, principles, and tools of engineering, physical sciences, and mathematics to the solution of problems in the medical and life sciences.

Through its faculty, staff and students, and through close collaboration with the faculty of related departments, hospitals and other institutions, the Institute serves as the centre for the direct entry and collaborative Graduate Program in Biomedical Engineering at the University of Toronto. The Institute educates graduate-level engineering, dentistry, and medical sciences personnel to meet societal needs. The Institute also educates undergraduate-level engineering science students in the biomedical engineering option as well as undergraduate students with interests in biomedical engineering through other collaborative departments and programs, such as the bioengineering minor.

The Institute's faculty researchers have strong backgrounds in one or more of engineering, dentistry, medical and biological sciences disciplines. Augmenting this faculty are part-time members, many of whom act as supervisors of students at the Institute. Graduate students registered in the Institute, or in collaborating graduate departments, proceed towards M.Eng., M.A.Sc., M.Sc., M.H.Sc., or Ph.D. degrees in engineering dentistry, medicine, or the physical or life sciences.

The Faculty offers a two-year professional degree program for specialized training in Clinical Engineering. These graduates normally find employment in health-care institutions or in the medical devices industry both in Canada and internationally.

An active summer student program offers both employment and a structured educational experience, within the Institute's research laboratories, for approximately twenty undergraduate students each year. The graduates from this program often find employment in various engineering industries, as well as some to the healthcare industry. Some will proceed to graduate studies.

The Institute's laboratories are principally located in the Rosebrugh Building, the Mining Building, the Banting Building, and the Donnelly Centre for Cellular and Biomolecular Research on the St. George Campus. These laboratories serve as centres for development of experimental and clinical techniques and instrumentation; real-time and interactive computer applications; innovative biomaterials; functional replacements for biological tissues; and simulations for electrochemical and physiological models. Since many members of the Institute hold appointments in the nearby teaching hospitals and medical research centres, a significant amount of research is also carried out in these hospitals and centres.

Chemical Engineering and Applied Chemistry

UNDERGRADUATE PROGRAM IN CHEMICAL ENGINEERING (AECHEBASC)

Undergraduate Student Counsellor
Ms Jane Chung
Room 216A, Wallberg Building, 416-978-5336
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 either the design of a chemical plant. 4th year students may undertake an individual full year research project. This project, the culmination of which is a thesis, serves in many cases as an introduction to research, and provides an opportunity to apply the principles developed during the first three years of the program to problems of engineering interest. A thesis project may, for example, concern an experimental laboratory investigation, the design of a process, or a computer study of a complex chemical system.

The Technical Elective subjects available in the Third and Fourth Years cover a wide range of fundamental and application areas of Chemical Engineering and Applied Chemistry. By choosing electives from a restricted list, it is possible for students to complete the requirements for an Engineering Minor. A minor signifies that a student has gained an enhanced understanding of a specific field of study. For more information on the various Minors, please see the sections of the Calendar relating to these programs

First Year Chemical Engineering

Fall Session - Year 1						Winter Session - Year 1					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Engineering Strategies & Practice I	APS111H1 F	3	1	1	0.50	Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Ethics in Engineering	APS150H1 F	-	-	1	0.05	Engineering Strategies & Practice II	APS112H1 S	3	2	-	0.50
Physical Chemistry	CHE112H1 F	3	1	1	0.50	Concepts in Chemical Engineering	CHE113H1 S	3	1	3	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	3	1	0.50
Linear Algebra	MAT188H1 F	3	-	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.

Second Year Chemical Engineering

Fall Session - Year 2						Winter Session - Year 2					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Applied Chemistry III - Laboratory	CHE204H1 Y	-	6	-	0.50	Applied Chemistry III - Laboratory	CHE204H1 Y	-	6	-	0.50
Process Engineering	CHE208H1 F	3	-	2	0.50	Heat and Mass Transfer	CHE210H1 S	3	-	2	0.50
Fluid Mechanics	CHE211H1 F	3	-	2	0.50	Applied Chemistry II - Organic Chemistry	CHE213H1 S	3	-	1	0.50
Applied Chemistry I - Inorganic Chemistry	CHE220H1 F	3	-	1	0.50	Applied Differential Equations	CHE222H1 S	3	-	2	0.50
Calculus and Numerical Methods	CHE221H1 F	3	2	2	0.50	Statistics	CHE223H1 S	3	-	1	0.50
Engineering Economic Analysis	CHE249H1 F	3	-	1	0.50	Environmental Chemistry	CHE230H1 S	3	-	2	0.50
Seminar Course: Communications Portfolio I	CHE297Y1 Y	-	-	0.25	0.00	Seminar Course: Communications Portfolio I	CHE297Y1 Y	-	-	0.25	0.00
Communication	CHE299H1 Y	-	-	2	0.50	Communication	CHE299H1 Y	-	-	2	0.50

Practical Experience Requirement

- For information on CHE297Y, see course description in Chapter 8.
- As described in the beginning of this chapter, students are required to have completed a total of 600 hours of acceptable practical experience before graduation (normally during their summer vacation periods).

PROFESSIONAL EXPERIENCE YEAR

Students registered within this program, and all other undergraduate programs within the Faculty of Applied Science and Engineering, may elect to enroll and participate in the Professional Experience Year (PEY) program. The PEY program requires that qualified students undertake a paid, full-time 12-16 month continuous work period with a cooperating industry. Details are described in the beginning of this chapter. For more information, consult the Professional Experience Year Office, 45 Willcocks Street 2nd Floor early in session 2F or 3F.

Third Year Chemical Engineering

Fall Session - Year 3							Winter Session - Year 3						
			Lect.	Lab.	Tut.	Wgt.				Lect.	Lab.	Tut.	Wgt.
Engineering Thermodynamics	CHE323H1	F	3	-	2	0.50	Separation Processes	CHE311H1	S	3	4	2	0.75
Process Design	CHE324H1	F	3	4	2	0.75	Process Dynamics and Control	CHE322H1	S	3	0.25	2	0.50
Thermodynamics and Kinetics Laboratory	CHE326H1	F	-	4	-	0.25	Chemical Reaction Engineering	CHE333H1	S	3	-	2	0.50
Reaction Kinetics	CHE332H1	F	3	-	2	0.50	Team Strategies for Engineering Design	CHE334H1	S	1	-	2	0.25
Technical Elective						0.50	and one of:						
Complementary Studies/Humanities and Social Sciences Elective						0.50	Technical Elective						0.50
							Complementary Studies/Humanities and Social Sciences Elective						0.50

¹ In years 3 and 4, two of the four Complementary Studies/Humanities and Social Sciences elective courses must be from the Humanities and Social Sciences category. Students may take their Complementary Studies/Humanities and Social Sciences electives in any order in years 3 and 4.

Fourth Year Chemical Engineering

Fall Session - Year 4						Winter Session - Year 4							
			Lect.	Lab.	Tut.	Wgt.				Lect.	Lab.	Tut.	Wgt.
Engineering Materials	CHE341H1	F	3	-	1	0.50	Professional Practice	CHE403H1	S	2	-	-	0.00
Chemical Plant Design	CHE430Y1	F	2	-	6	1.00	Technical Elective ¹						0.50
Complementary						0.50	Technical Elective ¹						0.50
Studies/Humanities and							Free Elective						0.50
Social Sciences Elective ²							Complementary						0.50
and one of:							Studies/Humanities and						
Thesis	CHE499Y1	Y	-	7	-	1.00	Social Sciences Elective ²						
Technical Elective ¹						0.50	and one of:						
							Thesis	CHE499Y1	Y	-	7	-	1.00
							Technical Elective ¹						0.50

¹ See below for the list of eligible technical electives.

² In years 3 and 4, two of the four Complementary Studies/Humanities and Social Sciences elective courses must be from the Humanities and Social Sciences category. Students may take their Complementary Studies/Humanities and Social Sciences electives in any order in years 3 and 4.

³ In years 3 and 4, students must complete a total of 5 Technical Electives (or 3 Technical Electives plus CHE499Y1), one free elective and 4 HSS/CS electives

⁴ Some programs require students to take a Free Elective. A Free Elective has few restrictions: any degree credit course listed in the current calendars of the Faculty of Applied Science and Engineering, the Faculty of Arts and Science, and the School of Graduate Studies is acceptable as a Free Elective provided it does not duplicate material covered in courses taken or to be taken.

THESIS

CHE499Y1Y Thesis

Full-year (Fall and Winter Sessions) thesis requires approval of the department and research project supervisor.

TECHNICAL ELECTIVES

Students are required to select their technical electives from the list of approved courses below. Technical Electives outside the group of courses below must first be approved by the Chemical Engineering UG Coordinator.

Students wishing to pursue an Engineering Minor should take their core courses as technical electives in terms 3F and 3S. The organization of the minors and the sets of eligible electives are presented below.

Technical Electives

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Cellular and Molecular Bioengineering II	BME455H1 F	3	1.50	1	0.50	Biomedical Engineering Technology and Investigation	BME440H1 S	2	4	-	0.50
Engineering Biology	CHE353H1 F	3	-	1	0.50	Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Petroleum Processing	CHE451H1 F	3	-	1	0.50	Advanced Reactor Design	CHE412H1 S	3	-	1	0.50
Bioprocess Engineering	CHE466H1 F	3	0.66	1	0.50	Environmental Pathways and Impact Assessment	CHE460H1 S	3	-	2	0.50
Environmental Engineering	CHE467H1 F	3	-	1	0.50	Food Engineering	CHE462H1 S	3	-	1	0.50
Special Topics in Chemical Engineering	CHE470H1 F	3	-	1	0.50	Fuel Cells and Electrochemical Conversion Devices	CHE469H1 S	3	-	1	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	2	-	1	0.50	Special Topics in Chemical Engineering	CHE470H1 S	3	-	1	0.50
Aqueous Process Engineering	CHE565H1 F	3	-	1	0.50	Modelling in Biological and Chemical Systems	CHE471H1 S	3	-	1	0.50
Introduction to Nuclear Engineering	CHE566H1 F	3	-	1	0.50	Biocomposites: Mechanics and Bioinspiration	CHE475H1 S	3	-	1	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50	Data-based Modelling for Prediction and Control	CHE507H1 S	3	-	1	0.50
Water and Wastewater Treatment Processes	CIV342H1 F	3	1	-	0.50	Risk Based Safety Management	CHE561H1 S	3	-	1	0.50
Building Science	CIV375H1 F	3	0.33	2	0.50	Pulp and Paper Processes	CHE564H1 S	3	-	1	0.50
Groundwater Flow and Contamination	CIV549H1 F	3	-	1	0.50	Nuclear Engineering	CHE568H1 S	3	-	1	0.50
Water Resources Engineering	CIV550H1 F	3	-	2	0.50	Topics in Atmospheric Chemistry	CHM415H1 S	2	-	-	0.50
Combustion and Fuels	MIE516H1 F	3	-	1	0.50	Hydraulics and Hydrology	CIV250H1 S	3	1.50	1	0.50
Biomaterial Processing and Properties	MSE440H1 F	3	-	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	3	-	-	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
						Alternative Energy Systems	MIE515H1 S	3	-	1	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.

Engineering Programs

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
Ms. Nelly Pietropaolo
Room GB105, Galbraith Building

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						Winter Session - Year 1					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Engineering Strategies & Practice I	APS111H1 F	3	1	1	0.50	Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Ethics in Engineering	APS150H1 F	-	-	1	0.05	Engineering Strategies & Practice II	APS112H1 S	3	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	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.

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.	Winter Session - Year 2		Lect.	Lab.	Tut.	Wgt.
Technology in Society and the Biosphere I	APS301H1 F	3	-	1	0.50	Civil Engineering Materials	CIV209H1 S	3	2	2	0.50
						Structural Analysis I	CIV214H1 S	3	-	2	0.50
Introduction to Civil Engineering	CIV201H1 F	-	-	-	0.20	Civil Engineering Graphics	CIV235H1 S	-	6	-	0.50
						Hydraulics and Hydrology	CIV250H1 S	3	1.50	1	0.50
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50	Probability Theory for Civil and Mineral Engineers	CME263H1 S	3	-	2	0.50
Management of Construction	CIV280H1 F	3	-	2	0.50						
Engineering Communications I	CIV282H1 F	1	-	1	0.20	Complementary Studies					0.50
Solid Mechanics I	CME210H1 F	3	1.50	1.50	0.50	Elective (CS)/ Humanities					
Engineering Mathematics I	CME261H1 F	3	1	1	0.50	And Social Sciences					
Fluid Mechanics I	CME270H1 F	3	1.50	1	0.50	Elective (HSS)					

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.	Winter Session - Year 3		Lect.	Lab.	Tut.	Wgt.
Steel and Timber Design	CIV312H1 F	3	-	2	0.50	Reinforced Concrete I	CIV313H1 S	3	-	2	0.50
Transport I - Introduction to Urban Transportation Systems	CIV331H1 F	3	-	1	0.50	Geotechnical Engineering II	CIV324H1 S	3	1	1	0.50
Water and Wastewater Treatment Processes	CIV342H1 F	3	1	-	0.50	Transport II - Performance	CIV332H1 S	3	-	1	0.50
						Municipal Engineering	CIV340H1 S	3	-	2	0.50
Building Science	CIV375H1 F	3	0.33	2	0.50	Sustainable Energy Systems	CIV380H1 S	3	-	1	0.50
Civil Engineering	CIV382Y1 Y	-	-	0.25	0.00	Civil Engineering	CIV382Y1 Y	-	-	0.25	0.00
Communication Portfolio						Communication Portfolio					
Geotechnical Engineering I	CME321H1 F	3	1	1	0.50	Engineering Mathematics II	CME362H1 S	3	-	2	0.50
Survey CAMP (Civil and Mineral Practicals)	CME358H1 F	-	-	-	0.50						
Engineering Economics and Decision Making	CME368H1 F	3	-	1	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

Engineering Programs

of completed minor or certificate program requirements.

FOURTH YEAR CIVIL ENGINEERING

Fall Session - Year 4					Lect.	Lab.	Tut.	Wgt.	Winter Session - Year 4					Lect.	Lab.	Tut.	Wgt.
Free Elective								0.50	Group Design Project		CIV498H1 S	-	-	3	0.50		
Free Elective								0.50	Free Elective						0.50		
Complementary Studies								0.50	Complementary Studies						0.50		
Elective (CS) / Humanities and Social Sciences									Elective (CS) / Humanities and Social Sciences								
Elective (HSS)									Elective (HSS)								
Choose two technical electives from the following list:									Choose two technical electives from the following list:								
Engineering Biology	CHE353H1 F	3	-	1	0.50	Cellular and Molecular Biology		CHE354H1 S	3	1	2	0.50					
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50	Terrestrial Energy Systems		CIV300H1 S	3	-	2	0.50					
Reinforced Concrete II	CIV416H1 F	3	-	2	0.50	Environmental Impact and		CIV440H1 S	3	-	1	0.50					
Construction Engineering	CIV420H1 F	3	-	2	0.50	Risk Assessment											
Special Studies in Civil Engineering	CIV477H1 F	3	-	1	0.50	Special Studies in Civil Engineering		CIV477H1 S	3	-	1	0.50					
Individual Project	CIV499H1 F	-	-	3	0.50	Individual Project		CIV499H1 S	-	-	3	0.50					
Concrete Technology	CIV514H1 F	3	-	2	0.50	Solid Mechanics II		CIV510H1 S	3	-	2	0.50					
Introduction to Structural Dynamics	CIV515H1 F	3	-	1	0.50	Public Transit Operations and Planning		CIV516H1 S	3	-	1	0.50					
Prestressed Concrete	CIV517H1 F	3	-	-	0.50	Behaviour and Design of Steel Structures		CIV518H1 S	3	-	2	0.50					
Structural Analysis II	CIV519H1 F	3	-	2	0.50	Geotechnical Design		CIV523H1 S	3	-	1	0.50					
Rock Mechanics	CIV521H1 F	3	1	-	0.50	Environmental Biotechnology		CIV541H1 S	3	-	-	0.50					
Transport Planning	CIV531H1 F	3	-	1	0.50	Sustainable Buildings		CIV576H1 S	3	-	1	0.50					
Groundwater Flow and Contamination	CIV549H1 F	3	-	1	0.50	Infrastructure for Sustainable Cities		CIV577H1 S	3	-	1	0.50					
Water Resources Engineering	CIV550H1 F	3	-	2	0.50	Physiological Control Systems		MIE331H1 S	3	1	1	0.50					
Engineering Rock Mechanics	MIN429H1 F	3	1	1	0.50	Mining Environmental Management		MIN430H1 S	3	-	1	0.50					
Integrated Mine Waste Engineering	MIN511H1 F	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, MSc and PhD Programs. The MEng program is course-based (although a 1 or 2 course-equivalent project may be taken), whereas the MSc 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						Winter Session - Year 1					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Computer Fundamentals	APS105H1 F	3	2	1	0.50	Introduction to Materials and Chemistry	APS104H1 S	3	0.50	1	0.50
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50	Engineering Strategies &Practice II	APS112H1 S	3	2	-	0.50
Ethics in Engineering	APS150H1 F	-	-	1	0.05	Electrical Fundamentals	ECE110H1 S	3	1	2	0.50
Mechanics	CIV100H1 F	3	-	2	0.50	Calculus II	MAT187H1 S	3	-	1	0.50
Seminar Course: Introduction to Electrical and Computer Engineering	ECE101H1 F	1	-	-	0.15	Dynamics	MIE100H1 S	3	-	2	0.50
Calculus I	MAT186H1 F	3	-	1	0.50						
Linear Algebra	MAT188H1 F	3	-	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.

Engineering Programs

SECOND YEAR COMPUTER ENGINEERING

Fall Session - Year 2						Winter Session - Year 2					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Electrical and Computer Engineering Seminar	ECE201H1 F	1	-	-	0.15	Signals and Systems	ECE216H1 S	3	1	2	0.50
Circuit Analysis	ECE212H1 F	3	1.50	2	0.50	Electric and Magnetic Fields	ECE221H1 S	3	1	2	0.50
Digital Systems	ECE241H1 F	3	3	-	0.50	Introductory Electronics	ECE231H1 S	3	1.50	2	0.50
Programming Fundamentals	ECE244H1 F	3	2	1	0.50	Computer Organization	ECE243H1 S	3	3	-	0.50
Advanced Engineering Mathematics	MAT290H1 F	3	-	2	0.50	Communication and Design	ECE297H1 S	2	2	2	0.50
Calculus III	MAT291H1 F	3	-	2	0.50						

THIRD AND FOURTH YEAR COMPUTER ENGINEERING

COURSE SELECTION

Required Course - Year 3 or 4						Required Course - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Engineering Economic Analysis & Entrepreneurship	ECE472H1 F/S	3	-	2	0.50	Design Project	ECE496Y1 Y	1	-	1	1.00

AREA 1 - PHOTONICS & SEMICONDUCTOR PHYSICS

Fall Term - Year 3 or 4						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES						KERNEL COURSES					
Introduction to Electronic Devices	ECE335H1 F	3	-	2	0.50	Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES						TECHNICAL ELECTIVES					
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50	Semiconductor and Device Physics	ECE330H1 S	3	-	2	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50	Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Advanced Electronic Devices	ECE535H1 F	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						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES						KERNEL COURSES					
Fundamentals of Electrical Energy Systems	ECE314H1 F	3	1.50	1	0.50	There are no winter term kernel courses offered in this area					
Fields and Waves	ECE320H1 F	3	1.50	1	0.50						
TECHNICAL ELECTIVES						TECHNICAL ELECTIVES					
Introduction to Lighting Systems	ECE510H1 F	3	-	2	0.50	Medical Imaging	BME595H1 S	2	3	1	0.50
Power Electronics: Converter Topologies	ECE514H1 F	3	1.50	1	0.50	Energy Systems and Distributed Generation	ECE413H1 S	3	1.50	1	0.50
Microwave Circuits	ECE524H1 F	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						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES						KERNEL COURSES					
Analog Electronics	ECE331H1 F	3	1.50	1	0.50	Analog Electronics	ECE331H1 S	3	1.50	1	0.50
Digital Electronics	ECE334H1 F	3	1.50	1	0.50	Digital Electronics	ECE334H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES						TECHNICAL ELECTIVES					
Sensory Communication	ECE446H1 F	3	1.50	1	0.50	VLSI Systems and Design	ECE451H1 S	3	3	-	0.50
Analog Integrated Circuits	ECE530H1 F	3	1.50	1	0.50	Analog Integrated Systems	ECE512H1 S	3	-	2	0.50
Integrated Circuit Engineering	ECE534H1 F	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						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES						KERNEL COURSES					
Dynamic Systems and Control	ECE311H1 F	3	1.50	1	0.50	Dynamic Systems and Control	ECE311H1 S	3	1.50	1	0.50
Communication Systems	ECE316H1 F	3	1.50	1	0.50	Communication Systems	ECE316H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES						TECHNICAL ELECTIVES					
Probability and Applications	ECE302H1 F	3	-	2	0.50	Medical Imaging	BME595H1 S	2	3	1	0.50
Control Systems	ECE410H1 F	3	1.50	1	0.50	Probability and Applications	ECE302H1 S	3	-	2	0.50
Digital Signal Processing	ECE431H1 F	3	1.50	1	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 Communication	ECE417H1 S	3	1.50	1	0.50
Sensory Communication	ECE446H1 F	3	1.50	1	0.50	Digital Signal Processing	ECE431H1 S	3	1.50	1	0.50
Random Processes	ECE537H1 F	3	-	2	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	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						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES						KERNEL COURSES					
Computer Networks I	ECE361H1 F	3	1.50	1	0.50	Computer Hardware	ECE342H1 S	3	3	-	0.50
TECHNICAL ELECTIVES						Computer Networks I	ECE361H1 S	3	1.50	1	0.50
Internetworking	ECE461H1 F	3	1.50	0.50	0.50	TECHNICAL ELECTIVES					
Computer Architecture	ECE552H1 F	3	1.50	1	0.50	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						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES						KERNEL COURSES					
Operating Systems	ECE344H1 F	3	3	-	0.50	Operating Systems	ECE344H1 S	3	3	-	0.50
Algorithms and Data Structures	ECE345H1 F	3	-	2	0.50	Algorithms and Data Structures	ECE345H1 S	3	-	2	0.50
TECHNICAL ELECTIVES						TECHNICAL ELECTIVES					
Programming Languages	CSC326H1 F	3	1.50	1	0.50	Introduction to Databases	CSC343H1 S	2	-	1	0.50
Introduction to Databases	CSC343H1 F	2	-	1	0.50	Computer Graphics	CSC418H1 S	2	-	1	0.50
Computer Graphics	CSC418H1 F	2	-	1	0.50	Distributed Systems	ECE419H1 S	3	1.50	1	0.50
Software Engineering I	CSC444H1 F	3	1.50	1	0.50	Software Engineering II	ECE450H1 S	3	1.50	1	0.50
Compilers and Interpreters	CSC467H1 F	3	1.50	1	0.50	Optimizing Compilers	ECE540H1 S	3	3	-	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50	Computer Security	ECE568H1 S	3	3	-	0.50
Computer Systems Programming	ECE454H1 F	3	3	-	0.50						
Internetworking	ECE461H1 F	3	1.50	0.50	0.50						

Engineering Programs

SCIENCE/MATH ELECTIVES

Fall Term - Year 3 or 4						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Partial Differential Equations	APM384H1 F	3	-	1	0.50	Biomedical Engineering	BME440H1 S	2	4	-	0.50
Cellular and Molecular Bioengineering II	BME455H1 F	3	1.50	1	0.50	Technology and Investigation					
Engineering Biology	CHE353H1 F	3	-	1	0.50	Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50	Terrestrial Energy Systems	CIV300H1 S	3	-	2	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50	Probability and Applications	ECE302H1 S	3	-	2	0.50
Probability and Applications	ECE302H1 F	3	-	2	0.50	Evolution and Adaptation	EEB214H1 S	2	-	1	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50	Physiological Control Systems	MIE331H1 S	3	1	1	0.50
						Materials Physics	MSE235H1 S	3	-	1	0.50
						Introduction to Quantum Mechanics	PHY335H1 S	2	-	1	0.50
						Physics of the Earth	PHY395H1 S	2	-	1	0.50

ECE Program Requirements

There are nine requirements:

- BREADTH REQUIREMENT:** A minimum of four kernel courses, each in a different area, must be chosen.
- 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.
- ENGINEERING ECONOMICS REQUIREMENTS:** ECE472H1 must be chosen. Course can be taken in either third or fourth year.
- 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.
- MATH/SCIENCE REQUIREMENT:** At least one course from the Math/Science area must be chosen.
- 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.
- FREE ELECTIVE REQUIREMENT:** One is required, and may be a technical or a non-technical course.
- 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
- 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/>

Engineering Programs

FIRST YEAR ELECTRICAL ENGINEERING

Fall Session - Year 1						Winter Session - Year 1					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Computer Fundamentals	APS105H1 F	3	2	1	0.50	Introduction to Materials and Chemistry	APS104H1 S	3	0.50	1	0.50
Engineering Strategies & Practice I	APS111H1 F	3	1	1	0.50	Engineering Strategies & Practice II	APS112H1 S	3	2	-	0.50
Ethics in Engineering	APS150H1 F	-	-	1	0.05	Electrical Fundamentals	ECE110H1 S	3	1	2	0.50
Mechanics	CIV100H1 F	3	-	2	0.50	Calculus II	MAT187H1 S	3	-	1	0.50
Seminar Course: Introduction to Electrical and Computer Engineering	ECE101H1 F	1	-	-	0.15	Dynamics	MIE100H1 S	3	-	2	0.50
Calculus I	MAT186H1 F	3	-	1	0.50						
Linear Algebra	MAT188H1 F	3	-	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.

SECOND YEAR ELECTRICAL ENGINEERING

Fall Session - Year 2						Winter Session - Year 2					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Electrical and Computer Engineering Seminar	ECE201H1 F	1	-	-	0.15	Signals and Systems	ECE216H1 S	3	1	2	0.50
Circuit Analysis	ECE212H1 F	3	1.50	2	0.50	Electric and Magnetic Fields	ECE221H1 S	3	1	2	0.50
Digital Systems	ECE241H1 F	3	3	-	0.50	Introductory Electronics	ECE231H1 S	3	1.50	2	0.50
Programming Fundamentals	ECE244H1 F	3	2	1	0.50	Computer Organization	ECE243H1 S	3	3	-	0.50
Advanced Engineering Mathematics	MAT290H1 F	3	-	2	0.50	Communication and Design	ECE297H1 S	2	2	2	0.50
Calculus III	MAT291H1 F	3	-	2	0.50						

THIRD AND FOURTH YEAR ELECTRICAL ENGINEERING

COURSE SELECTION

Required Course - Year 3 or 4						Required Course - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Engineering Economic Analysis & Entrepreneurship	ECE472H1 F/S	3	-	2	0.50	Design Project	ECE496Y1 Y	1	-	1	1.00

AREA 1 - PHOTONICS & SEMICONDUCTOR PHYSICS

Fall Term - Year 3 or 4						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES						KERNEL COURSES					
Introduction to Electronic Devices	ECE335H1 F	3	-	2	0.50	Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
TECHNICAL ELECTIVES						TECHNICAL ELECTIVES					
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50	Semiconductor and Device Physics	ECE330H1 S	3	-	2	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50	Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50
Advanced Electronic Devices	ECE535H1 F	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					
Introduction to Lighting Systems	ECE510H1 F	3	-	2	0.50
Power Electronics: Converter Topologies	ECE514H1 F	3	1.50	1	0.50
Microwave Circuits	ECE524H1 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					
Sensory Communication	ECE446H1 F	3	1.50	1	0.50
Analog Integrated Circuits	ECE530H1 F	3	1.50	1	0.50
Integrated Circuit Engineering	ECE534H1 F	3	3	-	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					
VLSI Systems and Design	ECE451H1 S	3	3	-	0.50
Analog Integrated Systems	ECE512H1 S	3	-	2	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
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
Digital Signal Processing	ECE431H1 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	ECE521H1 S	3	-	2	0.50
Physiological Control Systems	MIE331H1 S	3	1	1	0.50

Engineering Programs

AREA 5 - COMPUTER HARDWARE & COMPUTER NETWORKS

Fall Term - Year 3 or 4						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES						KERNEL COURSES					
Computer Networks I	ECE361H1 F	3	1.50	1	0.50	Computer Hardware	ECE342H1 S	3	3	-	0.50
TECHNICAL ELECTIVES						Computer Networks I	ECE361H1 S	3	1.50	1	0.50
Internetworking	ECE461H1 F	3	1.50	0.50	0.50	TECHNICAL ELECTIVES					
Computer Architecture	ECE552H1 F	3	1.50	1	0.50	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						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
KERNEL COURSES						KERNEL COURSES					
Operating Systems	ECE344H1 F	3	3	-	0.50	Operating Systems	ECE344H1 S	3	3	-	0.50
Algorithms and Data Structures	ECE345H1 F	3	-	2	0.50	Algorithms and Data Structures	ECE345H1 S	3	-	2	0.50
TECHNICAL ELECTIVES						TECHNICAL ELECTIVES					
Programming Languages	CSC326H1 F	3	1.50	1	0.50	Introduction to Databases	CSC343H1 S	2	-	1	0.50
Introduction to Databases	CSC343H1 F	2	-	1	0.50	Computer Graphics	CSC418H1 S	2	-	1	0.50
Computer Graphics	CSC418H1 F	2	-	1	0.50	Distributed Systems	ECE419H1 S	3	1.50	1	0.50
Software Engineering I	CSC444H1 F	3	1.50	1	0.50	Software Engineering II	ECE450H1 S	3	1.50	1	0.50
Compilers and Interpreters	CSC467H1 F	3	1.50	1	0.50	Optimizing Compilers	ECE540H1 S	3	3	-	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50	Computer Security	ECE568H1 S	3	3	-	0.50
Computer Systems Programming	ECE454H1 F	3	3	-	0.50						
Internetworking	ECE461H1 F	3	1.50	0.50	0.50						

SCIENCE/MATH ELECTIVES

Fall Term - Year 3 or 4						Winter Term - Year 3 or 4					
		Lect.	Lab.	Tut.	Wgt.			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	Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Engineering Biology	CHE353H1 F	3	-	1	0.50	Terrestrial Energy Systems	CIV300H1 S	3	-	2	0.50
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50	Probability and Applications	ECE302H1 S	3	-	2	0.50
Terrestrial Energy Systems	CIV300H1 F	3	-	2	0.50	Evolution and Adaptation	EEB214H1 S	2	-	1	0.50
Probability and Applications	ECE302H1 F	3	-	2	0.50	Physiological Control Systems	MIE331H1 S	3	1	1	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50	Materials Physics	MSE235H1 S	3	-	1	0.50
						Introduction to Quantum Mechanics	PHY335H1 S	2	-	1	0.50
						Physics of the Earth	PHY395H1 S	2	-	1	0.50

ECE Program Requirements

There are nine requirements:

- BREADTH REQUIREMENT:** A minimum of four kernel courses, each in a different area, must be chosen.
- 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.
- ENGINEERING ECONOMICS REQUIREMENTS:** ECE472H1 must be chosen. Course can be taken in either third or fourth year.
- 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.
- MATH/SCIENCE REQUIREMENT:** At least one course from the Math/Science area must be chosen.
- 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.
- FREE ELECTIVE REQUIREMENT:** One is required, and may be a technical or a non-technical course.
- 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)

CHAIR:

Professor Mark Kortschot, Ph.D., P.Eng.
Room 2110, Bahen Centre, 416-978-2903
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UNDERGRADUATE STUDENT COUNSELLORS:

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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 (towards the end of September), at the end of the Fall Session, and at the end of the Winter Session. Continuation into the Winter Session of Year 1 requires a minimum average of 55% in the Fall Session and continuation into Year 2 requires a minimum average of 65% in the Winter Session of Year 1. Students who do not meet these requirements are 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
- Engineering Mathematics, Statistics & Finance
- Infrastructure Engineering
- Nanoengineering
- Engineering Physics

The curriculum for the first two years and the curricula for the eight Options are presented on the pages that follow.

Degree Designation

Engineering Science students graduate with the degree "Bachelor of Applied Science in Engineering Science". On their official transcript, their chosen Option is indicated as their Major, e.g. Major in Aerospace Engineering.

Degree Requirements

In order to graduate, students must meet all of the degree requirements outlined in the section on Academic Regulations in this Calendar. In addition to these requirements, students must also successfully complete their chosen Program of Study in Engineering Science as described on the following pages of this Calendar, as well as the curriculum requirements of the Canadian Engineering Accreditation Board (CEAB).

To complete their chosen Program of Study, students are responsible for ensuring that they have taken all of the required courses and the correct number of technical electives for their Option. 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.

To satisfy the CEAB requirements, students must accumulate during their program of study a minimum total number of accreditation units (AU) as well as a minimum number of AU in six categories: complementary studies, mathematics, natural science, engineering science, engineering design, and combined engineering science and design. The Division of Engineering Science provides students with a planning tool called the AU Tracker to help students ensure that they satisfy these requirements. The AU Tracker, which lists all successfully completed courses as well as all of the courses they are enrolled in for the current academic year, confirms whether students are on track to meet or exceed the CEAB requirements.

If a student is deficient in terms of the Program of Study or falls short in any of the CEAB categories, the student must adjust their course selection accordingly in order to graduate.

YEAR 1 CURRICULUM- ENGINEERING SCIENCE

Fall Session - Year 1						Winter Session - Year 1					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Structures and Materials - An Introduction to Engineering Design	CIV102H1 F	3	1	1	0.50	Computer Algorithms and Data Structures	CSC190H1 S	3	3	-	0.50
Introduction to Computer Programming	CSC180H1 F	3	3	-	0.50	Fundamentals of Electric Circuits	ECE159H1 S	3	1.50	1	0.50
Praxis I	ESC101H1 F	3	-	2	0.50	Praxis II	ESC102H1 S	3	-	2	0.50
Engineering Mathematics and Computation	ESC103H1 F	2	-	2	0.50	Linear Algebra	MAT185H1 S	3	-	1	0.50
Calculus I	MAT194H1 F	3	-	1	0.50	Calculus II	MAT195H1 S	3	-	1	0.50
Classical Mechanics	PHY180H1 F	3	1.50	1	0.50	Molecules and Materials	MSE160H1 S	3	-	1	0.50

YEAR 2 CURRICULUM - ENGINEERING SCIENCE

Fall Session - Year 2						Winter Session - Year 2					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Vector Calculus & Fluid Mechanics	AER210H1 F	3	0.50	2	0.50	Engineering Design	AER201H1 S	1	5	-	0.50
Thermodynamics and Heat Transfer	CHE260H1 F	3	0.50	1	0.50	Biomolecules and Cells	BME205H1 S	2	1.75	1	0.50
Digital and Computer Systems	ECE253H1 F	3	3	-	0.50	Electromagnetism	ECE259H1 S	3	-	1	0.50
Engineering, Society & Critical Thinking	ESC203H1 F	3	-	1	0.50	Quantum and Thermal Physics	PHY294H1 S	3	1	1	0.50
Calculus III	MAT292H1 F	3	-	2	0.50	Probability and Statistics	STA286H1 S	3	-	1	0.50
Waves and Modern Physics	PHY293H1 F	3	1	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)

Engineering Programs

YEAR 3 AEROSPACE ENGINEERING

Fall Session - Year 3						Winter Session - Year 3					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Dynamics	AER301H1 F	3	-	1	0.50	Aircraft Flight	AER302H1 S	3	-	1	0.50
Aerospace Laboratory I	AER303H1 F	-	1	-	0.15	Aerospace Laboratory II	AER304H1 S	-	1	-	0.15
Aerodynamics	AER307H1 F	3	-	1	0.50	Gasdynamics	AER310H1 S	3	-	1	0.50
Combustion Processes	AER315H1 F	3	-	1	0.50	Scientific Computing	AER336H1 S	3	-	1	0.50
Partial Differential Equations	APM384H1 F	3	-	1	0.50	Control Systems	AER372H1 S	3	1.50	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50	Mechanics of Solids and Structures	AER373H1 S	3	-	1	0.50
Complex Analysis	MAT389H1 F	3	-	1	0.50	Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25
Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25						

YEAR 4 AEROSPACE ENGINEERING

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Space Systems Design	AER407H1 F	-	3	-	0.50	Aircraft Design	AER406H1 S	-	-	3	0.50
Advanced Mechanics of Structures	AER501H1 F	3	-	1	0.50	Complementary Studies Elective					0.50
Complementary Studies Elective					0.50	and three of:					
and two of:						Thesis	ESC499H1 S	3	2	-	0.50
Thesis	ESC499H1 F	3	2	-	0.50	Thesis	ESC499Y1 Y	3	2	-	1.00
Thesis	ESC499Y1 Y	3	2	-	1.00	Aeroelasticity	AER503H1 S	3	-	1	0.50
Spacecraft Dynamics and Control	AER506H1 F	3	-	1	0.50	Aerospace Propulsion	AER510H1 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	Other Technical Elective					0.50
Applied Nonlinear Equations	APM446H1 F	3	-	-	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						

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						Winter Session - Year 3					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Partial Differential Equations	APM384H1 F	3	-	1	0.50	Biomedical Engineering and Omics Technologies	BME346H1 S	2	4	-	0.50
Modeling, Dynamics, and Control of Biological Systems	BME344H1 F	3	-	1	0.50	Molecular Biophysics	BME358H1 S	3	-	1	0.50
Biomedical Systems Engineering I: Organ Systems	BME350H1 F	3	1	2	0.50	Biomedical Systems Engineering III: Molecules and Cells	BME396H1 S	3	3	1	0.50
Biomedical Systems Engineering II: Cells and Tissues	BME395H1 F	3	-	2	0.50	Biomechanics I	MIE439H1 S	3	2	-	0.50
Organic Chemistry and Biochemistry	CHE391H1 F	3	1.50	1	0.50	Biomaterials and Biocompatibility	MSE352H1 S	3	-	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25	Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25

YEAR 4 BIOMEDICAL SYSTEMS ENGINEERING

Fall Session - Year 4					Winter Session - Year 4						
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00	Thesis	ESC499Y1 Y	3	2	-	1.00
Biomedical Systems Engineering IV: Computational Systems Biology	BME428H1 F	3	-	2	0.50	Biomedical Systems Engineering Design Complementary Studies elective	BME489H1 S	-	-	5	0.50
Introduction to Biomedical Systems Engineering Design Concepts	BME479H1 F	-	-	1	0.10	Technical elective					0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50	Technical elective					0.50
Complementary Studies elective					0.50						
Technical elective					0.50						

TECHNICAL ELECTIVES

Technical Electives						Technical Electives					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Systems and Synthetic Biology						Neuro Sensory and Rehab Engineering					
Regulatory Networks and Systems in Molecular Biology	CSB435H1 F	2	-	-	0.50	Communication Systems	ECE363H1 S	3	1.50	1	0.50
Proteomics in Systems Biology	CSB450H1 F	2	-	-	0.50	Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Biocomputation	ECE448H1 F	3	-	2	0.50	Sensory Communication	ECE446H1 F	3	1.50	1	0.50
Modelling in Biological and Chemical Systems	CHE471H1 S	3	-	1	0.50	Robot Modeling and Control	ECE470H1 S	3	1.50	1	0.50
Regenerative Medicine and Biomaterials						Sensors, Nano/Microsystems and Instrumentation					
Biomaterial and Medical Device Product Development	BME460H1 F	2	-	2	0.50	Medical Imaging	BME595H1 S	2	3	1	0.50
Regenerative Medicine	BME510H1 S	4	-	-	0.50	Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
Biocomposites: Mechanics and Bioinspiration	CHE475H1 S	3	-	1	0.50	Real-Time Computer Control	ECE411H1 S	3	1.50	1	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	2	-	1	0.50	Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50
* Design of Innovative Products	MIE440H1 F	2	2	1	0.50	Digital Signal Processing	ECE455H1 F	3	1.50	1	0.50
Biotransport Phenomena	MIE520H1 F	3	-	1	0.50	* MEMS Design and Microfabrication	MIE506H1 S	3	1.50	1	0.50
Surgical and Dental Implant Design	MSE442H1 S	3	-	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)

Engineering Programs

YEAR 3 ELECTRICAL AND COMPUTER ENGINEERING

Fall Session-Year 3		Lect.	Lab.	Tut.	Wgt.	Winter Session-Year 3		Lect.	Lab.	Tut.	Wgt.
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50	Systems Software	ECE353H1 S	3	3	-	0.50
Introduction to Energy Systems	ECE349H1 F	3	1.50	1	0.50	Linear Systems and Control	ECE356H1 S	3	1.50	1	0.50
Computer Organization	ECE352H1 F	3	3	-	0.50	Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25
Signal Analysis and Communication	ECE355H1 F	3	-	2	0.50	One ECE Elective	. S	-	-	-	0.50
Electronics	ECE360H1 F	3	1.50	1	0.50	Three Of:					
Complex Analysis	MAT389H1 F	3	-	1	0.50	Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25	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. Students cannot take ECE350H1 and ECE358H1 in the same semester.
2. 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

1. While a full-year thesis is recommended, students may substitute with a half-year thesis and an ECE or Technical elective.
2. ECE electives or Technical electives can be taken in Year 3 or Year 4 provided that course pre-requisites have been met. Contact the Division of Engineering Science for clarification of course pre-requisites.

ECE Electives

ECE Electives		Lect.	Lab.	Tut.	Wgt.	ECE Electives		Lect.	Lab.	Tut.	Wgt.
Photonics and Semiconductor Physics						Control, Communications, Signal Processing					
Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50	Medical Imaging	BME595H1 S	2	3	1	0.50
Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50	Communication Systems	ECE363H1 S	3	1.50	1	0.50
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50	Real-Time Computer Control	ECE411H1 S	3	1.50	1	0.50
Optical Communications and Networks	ECE469H1 S	3	1.50	1	0.50	Digital Communication	ECE417H1 S	3	1.50	1	0.50
Lasers and Detectors	ECE525H1 S	3	-	2	0.50	Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50	Sensory Communication	ECE446H1 F	3	1.50	1	0.50
Quantum Mechanics I	PHY356H1 F	2	-	1	0.50	Digital Signal Processing	ECE455H1 F	3	1.50	1	0.50
Quantum Mechanics II	PHY456H1 F	2	-	1	0.50	Multimedia Systems	ECE462H1 S	3	2	-	0.50
Condensed Matter Physics	PHY487H1 F	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	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
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
Microwave Circuits	ECE524H1 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

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	2	-	1	0.50
Computer Graphics	CSC418H1 F/S	2	-	1	0.50
Human-Computer Interaction	CSC428H1 S	2	-	1	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	PHY395H1 S	2	-	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
VLSI Systems and Design	ECE451H1 S	3	3	-	0.50
Analog Integrated Systems	ECE512H1 S	3	-	2	0.50
Analog Integrated Circuits	ECE530H1 F	3	1.50	1	0.50
Integrated Circuit Engineering	ECE534H1 F	3	3	-	0.50
Advanced Electronic Devices	ECE535H1 F	3	1.50	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	ECE521H1 S	3	-	2	0.50
Optimizing Compilers	ECE540H1 S	3	3	-	0.50
Computer Security	ECE568H1 S	3	3	-	0.50

Engineering Programs

OPTION ENERGY SYSTEMS ENGINEERING (AEESCBASEJ)

YEAR 3 ENERGY SYSTEMS ENGINEERING

Fall Session - Year 3						Winter Session - Year 3					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Chemical Processes for Energy Generation and Storage	CHE308H1 F	3	-	1	0.50	Control Systems	AER372H1 S	3	1.50	1	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50	Energy Policy	APS305H1 S	3	-	1	0.50
Introduction to Energy Systems	ECE349H1 F	3	1.50	1	0.50	Design of Hydro and Wind Electric Plants	CIV301H1 S	3	-	2	0.50
Terrestrial Energy Systems	ENV346H1 F	3	-	3	0.50	Energy Systems and Distributed Generation	ECE413H1 S	3	1.50	1	0.50
Mechanical and Thermal Energy Conversion Processes	MIE303H1 F	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	Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25

YEAR 4 ENERGY SYSTEMS ENGINEERING

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00	Thesis	ESC499Y1 Y	3	2	-	1.00
Free Elective					0.50	Energy Systems Capstone Design	ESC470H1 S	-	-	5	0.50
one of two:						Complementary Studies Elective					0.50
Introduction to Lighting Systems	ECE510H1 F	3	-	2	0.50	and two of:					
Power Electronics: Converter Topologies	ECE514H1 F	3	1.50	1	0.50	Advanced Reactor Design	CHE412H1 S	3	-	1	0.50
and two of:						Fuel Cells and Electrochemical Conversion Devices	CHE469H1 S	3	-	1	0.50
Introduction to Fusion Energy	AER507H1 F	3	-	1	0.50	Nuclear Engineering	CHE568H1 S	3	-	1	0.50
Petroleum Processing	CHE451H1 F	3	-	1	0.50	Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Aqueous Process Engineering	CHE565H1 F	3	-	1	0.50	Sustainable Buildings	CIV576H1 S	3	-	1	0.50
Introduction to Nuclear Engineering	CHE566H1 F	3	-	1	0.50	Power Electronics: Switch-Mode Power Supplies	ECE533H1 S	3	1	1	0.50
Studies in Building Science	CIV575H1 F	3	-	2	0.50	Bioenergy from Sustainable Forest Management	FOR310H1 S	2	-	1	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50	Bioenergy and Biorefinery Technology	FOR425H1 S	2	-	2	0.50
Nuclear Reactor Theory and Design	MIE407H1 F	3	-	2	0.50	Design for the Environment	MIE315H1 S	3	-	1	0.50
Machine Design	MIE442H1 F	3	1.50	3	0.50	* Thermal and Machine Design of Nuclear Power Reactors	MIE408H1 S	3	-	2	0.50
Combustion and Fuels	MIE516H1 F	3	-	1	0.50	Alternative Energy Systems	MIE515H1 S	3	-	1	0.50
						Fuel Cell Systems	MIE517H1 S	3	-	1	0.50
						Nanotechnology in Alternate Energy Systems	MSE558H1 S	3	0.50	1	0.50
						Physics of the Earth	PHY395H1 S	2	-	1	0.50

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

OPTION ENGINEERING MATHEMATICS, STATISTICS & FINANCE (AEESCBASEF)

Year 3 ENGINEERING MATHEMATICS, STATISTICS & FINANCE

Fall Session - Year 3						Winter Session - Year 3					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Partial Differential Equations	APM384H1 F	3	-	1	0.50	Financial Principles for	ACT370H1 S	3	-	-	0.50
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50	Actuarial Science II					
Financial Engineering	MIE375H1 F	3	-	1	0.50	Engineering Finance and Economics	CHE375H1 S	3	-	1	0.50
Methods of Data Analysis I	STA302H1 F	3	-	-	0.50	Elements of Analysis	MAT336H1 S	3	-	-	0.50
Probability	STA347H1 F	3	-	-	0.50	Mathematical Programming	MIE376H1 S	3	2	1	0.50
Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25	(Optimization)					
						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	ACT460H1 F	3	-	-	0.50
Actuarial Science					
Engineering Mathematics,	MIE479H1 F	-	-	5	0.50
Statistics and Finance					
Capstone Design					
Two (2) Complementary					1.00
Studies Electives					
Four (4) Technical Elective					2.00
(Methodologies & Tools or					
Domain Courses)					

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.

Methodologies and Tools

Electives		Lect.	Lab.	Tut.	Wgt.	Electives		Lect.	Lab.	Tut.	Wgt.
Random Processes	ECE537H1 F	3	-	2	0.50	Scientific Computing	AER336H1 S	3	-	1	0.50
Systems Modelling and Simulation	MIE360H1 F	3	2	1	0.50	Mathematical Theory of Finance	APM466H1 S	3	-	-	0.50
Operations Research III: Advanced OR	MIE365H1 F	3	2	1	0.50	Modelling in Biological and Chemical Systems	CHE471H1 S	3	-	1	0.50
Scheduling	MIE562H1 F	3	-	2	0.50	Data-based Modelling for Prediction and Control	CHE507H1 S	3	-	1	0.50
Decision Analysis	MIE566H1 F	3	-	2	0.50	Foundations of Computing	ECE358H1 S	3	-	1	0.50
Fixed Income Securities	RSM430H1 F	2	-	-	0.50	Inference Algorithms	ECE521H1 S	3	-	2	0.50
Financial Trading Strategies (formerly RSM412H1 Financial Trading Strategies)	RSM434H1 F	2	-	-	0.50	Cases in Operations Research	MIE367H1 S	3	-	2	0.50
Statistical Computation	STA410H1 F	3	-	-	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

Engineering Programs

Domain Courses

Electives		Lect.	Lab.	Tut.	Wgt.
Aerospace					
Dynamics	AER301H1 F	3	-	1	0.50
Aerodynamics	AER307H1 F	3	-	1	0.50
Mechanics of Solids and Structures	AER373H1 S	3	-	1	0.50
Biomedical					
Biomedical Systems Engineering I: Organ Systems	BME350H1 F	3	1	2	0.50
Biomedical Systems Engineering II: Cells and Tissues	BME395H1 F	3	-	2	0.50
Electrical and Computer					
Introduction to Energy Systems	ECE349H1 F	3	1.50	1	0.50
Computer Organization	ECE352H1 F	3	3	-	0.50
Systems Software	ECE353H1 S	3	3	-	0.50
Signal Analysis and Communication	ECE355H1 F	3	-	2	0.50
Electronics	ECE360H1 F	3	1.50	1	0.50

Domain Courses

Electives		Lect.	Lab.	Tut.	Wgt.
Infrastructure					
Structural Design 1	CIV352H1 F	3	-	2	0.50
Structural Design 2	CIV357H1 S	3	-	2	0.50
Road Transportation Performance	CIV360H1 S	3	-	1	0.50
Engineering Project Finance and Management	CIV460H1 F	3	-	1	0.50
Public Transit Operations and Planning	CIV516H1 S	3	-	1	0.50
Transport Planning	CIV531H1 F	3	-	1	0.50
Mining					
Geotechnical Engineering I	CME321H1 F	3	1	1	0.50
Mineral Reserve and Mineral Resource Estimation	MIN401H1 S	3	-	1	0.50
Mining Environmental Management	MIN430H1 S	3	-	1	0.50

Electives		Lect.	Lab.	Tut.	Wgt.
Energy and the Environment					
Innovative Technologies and Organizations in Global Energy Systems	APS510H1 F	3	-	1	0.50
Chemical Processes for Energy Generation and Storage	CHE308H1 F	3	-	1	0.50
Terrestrial Energy Systems	CIV300H1 F/S	3	-	2	0.50
Design of Hydro and Wind Electric Plants	CIV301H1 S	3	-	2	0.50
Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Mechanical and Thermal Energy Conversion Processes	MIE303H1 F	3	1.50	1	0.50
Design for the Environment	MIE315H1 S	3	-	1	0.50
Alternative Energy Systems	MIE515H1 S	3	-	1	0.50

Electives		Lect.	Lab.	Tut.	Wgt.
Manufacturing					
Robotics	AER525H1 F	3	1.50	1	0.50
Risk Based Safety Management	CHE561H1 S	3	-	1	0.50
Manufacturing Engineering	MIE221H1 S	3	2	1	0.50
Automated Manufacturing	MIE422H1 F	2	3	-	0.50
* Design of Innovative Products	MIE440H1 F	2	2	1	0.50
Reliability and Maintainability Engineering	MIE469H1 S	3	-	2	0.50
* Product Design	MIE540H1 S	3	-	1	0.50

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						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Collaborative Design Project I	CIV455H1 F	1	3	-	0.50	Collaborative Design Project II	CIV456H1 S	1	3	-	0.50
Engineering Project Finance and Management	CIV460H1 F	3	-	1	0.50	Specialty Elective 2					0.50
Thesis	ESC499H1 F	3	2	-	0.50	Specialty Elective 3					0.50
Specialty Elective 1					0.50	Specialty Elective 4					0.50
Technical Elective					0.50	Complementary Studies Elective					0.50
Take any one from the following:						Take any three from the following:					
Transportation Specialty						Transportation Specialty					
Technology in Society and the Biosphere I	APS301H1 F	3	-	1	0.50	Sustainable Energy Systems	CIV380H1 S	3	-	1	0.50
Management of Construction	CIV280H1 F	3	-	2	0.50	Infrastructure for Sustainable Cities	CIV577H1 S	3	-	1	0.50
Structures Specialty						Alternative Energy Systems	MIE515H1 S	3	-	1	0.50
Reinforced Concrete II	CIV416H1 F	3	-	2	0.50	Structures Specialty					
Concrete Technology	CIV514H1 F	3	-	2	0.50	Solid Mechanics II	CIV510H1 S	3	-	2	0.50
Introduction to Structural Dynamics	CIV515H1 F	3	-	1	0.50	Behaviour and Design of Steel Structures	CIV518H1 S	3	-	2	0.50
Prestressed Concrete	CIV517H1 F	3	-	-	0.50	Geotechnical Design	CIV523H1 S	3	-	1	0.50
Studies in Building Science	CIV575H1 F	3	-	2	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.
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 Division of Engineering Science. In particular, courses on Travel Survey Methods, 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.

OPTION NANOENGINEERING (AEESCBASEO)

YEAR 3 NANOENGINEERING

Fall Session - Year 3						Winter Session - Year 3					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50	Introduction to Inorganic and Polymer Materials Chemistry	CHM325H1 S	2	-	-	0.50
Physical and Inorganic Chemistry	CHE390H1 F	3	-	1	0.50	Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50
Organic Chemistry and Biochemistry	CHE391H1 F	3	1.50	1	0.50	Structure and Characterization of Nanostructured Materials	MSE358H1 S	3	1.50	1	0.50
Quantum Mechanics I	PHY356H1 F	2	-	1	0.50	Advanced Physics Laboratory	PHY327H1 S	-	6	-	0.50
Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25	Atoms, Molecules and Solids	PHY358H1 S	2	-	1	0.50
and one of:						Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25
Partial Differential Equations	APM384H1 F	3	-	1	0.50						
Complex Analysis	MAT389H1 F	3	-	1	0.50						

Engineering Programs

YEAR 4 NANOENGINEERING

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00	Thesis	ESC499Y1 Y	3	2	-	1.00
Engineering Science Capstone Design	ESC471H1 F	-	-	5	0.50	Materials Physics II	MSE462H1 S	2	-	1	0.50
Synthesis of Nanostructured Materials	MSE459H1 F	3	2	-	0.50	Complementary Studies Elective					0.50
Complementary Studies Elective					0.50	and two of:					
and one of:						Organic Materials Chemistry	CHM446H1 S	2	-	-	0.50
Biomedical Systems	BME395H1 F	3	-	2	0.50	Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50
Engineering II: Cells and Tissues						Linear Systems and Control	ECE356H1 S	3	1.50	1	0.50
Environmental Engineering	CHE467H1 F	3	-	1	0.50	Lasers and Detectors	ECE525H1 S	3	-	2	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	2	-	1	0.50	Alternative Energy Systems	MIE515H1 S	3	-	1	0.50
Advanced Materials Chemistry	CHM434H1 F	2	-	-	0.50	Biomaterials and Biocompatibility	MSE352H1 S	3	-	1	0.50
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50	Advanced Physical Properties of Structural Nanomaterials	MSE550H1 S	3	2	1	0.50
Neural Bioelectricity	ECE445H1 F	3	1.50	1	0.50	Nanotechnology in Alternate Energy Systems	MSE558H1 S	3	0.50	1	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50	Advanced Physics Laboratory	PHY427H1 S	-	6	-	0.50
Complex Analysis	MAT389H1 F	3	-	1	0.50	Statistical Mechanics	PHY452H1 S	2	-	-	0.50
Electronic Materials	MSE430H1 F	2	-	1	0.50	Other Technical Elective					0.50
Forensic Engineering	MSE431H1 F	3	-	1	0.50						
Advanced Physics Laboratory	PHY427H1 F	-	6	-	0.50						
Advanced Classical Optics	PHY485H1 F	2	-	-	0.50						
Condensed Matter Physics	PHY487H1 F	2	-	-	0.50						
Other Technical Elective					0.50						

OPTION ENGINEERING PHYSICS (AEESCBASEP)

YEAR 3 ENGINEERING PHYSICS

Fall Session Year 3		Lect.	Lab.	Tut.	Wgt.	Winter Session- Year 3		Lect.	Lab.	Tut.	Wgt.
Economic Analysis and Decision Making	CHE374H1 F	3	-	1	0.50	Electromagnetic Fields	ECE357H1 S	3	1.50	1	0.50
Electronics	ECE360H1 F	3	1.50	1	0.50	Classical Mechanics	PHY354H1 S	2	-	1	0.50
Advanced Physics Laboratory	PHY327H1 F	-	6	-	0.50	Engineering Science Option Seminar	ESC301H1 Y	-	-	1	0.25
Quantum Mechanics I	PHY356H1 F	2	-	1	0.50	Four (4) Group A Electives					2.00
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						

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.	YEAR 4		Lect.	Lab.	Tut.	Wgt.
Thesis	ESC499Y1 Y	3	2	-	1.00	Three (3) electives from Group B					1.50
Engineering Science Capstone Design	ESC471H1 F	-	-	5	0.50	Two (2) electives from Groups A or B					1.00
Two (2) Complementary Studies electives					1.00						

Group A and B Electives

Group A Electives		Lect.	Lab.	Tut.	Wgt.	Group B Electives		Lect.	Lab.	Tut.	Wgt.
Introduction to Fusion Energy	AER507H1 F	3	-	1	0.50	Computational Physics	PHY407H1 F	1	3	-	0.50
Partial Differential Equations	APM384H1 F	3	-	1	0.50	Relativistic Electrodynamics	PHY450H1 S	2	-	1	0.50
Introduction to Astrophysics	AST320H1 S	2	-	-	0.50	Statistical Mechanics	PHY452H1 S	2	-	-	0.50
Introduction to Practical Astronomy	AST325H1 F	-	3	-	0.50	Continuum Mechanics	PHY454H1 S	2	-	1	0.50
Nuclear Engineering	CHE568H1 S	3	-	1	0.50	Quantum Mechanics II	PHY456H1 F	2	-	1	0.50
Fundamentals of Optics	ECE318H1 S	3	1.50	1	0.50	Nonlinear Physics	PHY460H1 S	2	-	-	0.50
Computer Hardware	ECE342H1 S	3	3	-	0.50	Relativity Theory I	PHY483H1 F	2	-	-	0.50
Semiconductor Electronic Devices	ECE350H1 S	3	1.50	1	0.50	Advanced Classical Optics	PHY485H1 F	2	-	-	0.50
Digital Signal Processing	ECE455H1 F	3	1.50	1	0.50	Condensed Matter Physics	PHY487H1 F	2	-	-	0.50
Lasers and Detectors	ECE525H1 S	3	-	2	0.50	Introduction to High Energy Physics	PHY489H1 F	2	-	-	0.50
Photonic Devices	ECE527H1 F	3	-	2	0.50	Advanced Atmospheric Physics	PHY492H1 F	2	-	-	0.50
Groups and Symmetries	MAT301H1 F/S	3	-	-	0.50	Seismology	PHY493H1 F	2	-	-	0.50
Elements of Analysis	MAT336H1 S	3	-	-	0.50	Geophysical Imaging: EM and Potential Fields	PHY494H1 F	2	-	-	0.50
Complex Analysis	MAT389H1 F	3	-	1	0.50	Research Topic in Geophysics	PHY495H1 F	2	-	-	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	PHY395H1 S	2	-	1	0.50						
Times 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						

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 BSc/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						Winter Session - Year 1					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50	Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Ethics in Engineering	APS150H1 F	-	-	1	0.05	Engineering Strategies &Practice II	APS112H1 S	3	2	-	0.50
Mechanics	CIV100H1 F	3	-	2	0.50	Physical Chemistry	CHE112H1 S	3	1	1	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	0.50	Calculus II	MAT187H1 S	3	-	1	0.50
Introduction to Materials Science	MSE101H1 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.

SECOND YEAR MATERIALS ENGINEERING

Fall Session - Year 2						Winter Session - Year 2					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Calculus and Differential Equations	MAT294H1 F	3	-	2	0.50	Diffusion and Kinetics	MSE217H1 S	3	-	2	0.50
Thermodynamics	MSE202H1 F	3	-	2	0.50	Materials Physics	MSE235H1 S	3	-	1	0.50
Structure and Characterization of Materials	MSE219H1 F	3	3	1	0.50	Engineering Statistics and Numerical Methods	MSE238H1 S	3	-	2	0.50
Inorganic Materials Chemistry and Processing	MSE244H1 F	3	2	1	0.50	Organic Materials Chemistry and Properties	MSE245H1 S	3	2	1	0.50
Humanities/Complementary Studies Elective					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						Winter Session - Year 3					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Engineering Economics and Accounting	MIE258H1 F	3	-	1	0.50	Environmental Degradation of Materials	MSE315H1 S	3	-	2	0.50
Phase Transformations	MSE318H1 F	3	3	1	0.50	Mechanical Behaviour of Materials	MSE316H1 S	3	3	1	0.50
Heat and Mass Transfer for Materials Processing	MSE332H1 F	3	-	2	0.50	Design and Simulation of Materials Processes	MSE351H1 S	3	2	1	0.50
Nanomaterials	MSE342H1 F	2	-	1	0.25	Materials in Manufacturing	MSE354H1 S	2	-	1	0.25
Biomaterials	MSE343H1 F	2	-	1	0.25	Materials Processing and Sustainable Development	MSE355H1 S	2	-	1	0.25
Communications II	MSE390H1 F	1	-	1	0.25	Humanities/Complementary Studies					0.50
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.

Engineering Programs

FOURTH YEAR MATERIALS ENGINEERING

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Materials Selection in Design II	MSE401H1 F	2	2	1	0.50	Design and Research Project	MSE498Y1 Y	3	6	2	1.00
Plant Design for Materials Process Industries	MSE450H1 F	2	-	3	0.50	Technical Elective					0.50
Professional Ethics and Practice	MSE490H1 F	2	-	-	0.25	Technical Elective					0.50
Design and Research Project	MSE498Y1 Y	3	6	2	1.00	Technical Elective					0.50
Technical Elective					0.50	Free Elective					0.50
Technical 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						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Biomaterial Processing and Properties	MSE440H1 F	3	-	1	0.50	Surgical and Dental Implant Design	MSE442H1 S	3	-	1	0.50
Engineering Biology	CHE353H1 F	3	-	1	0.50	Cellular and Molecular Biology	CHE354H1 S	3	1	2	0.50
Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering	CHE562H1 F	2	-	1	0.50						

Materials for Manufacturing Theme:

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50	Solid State Processing and Surface Treatment	MSE421H1 S	3	-	2	0.50
Fracture and Failure Analysis	MSE419H1 F	3	-	1	0.50	Macromolecular Materials Engineering	MSE432H1 S	3	-	1	0.50
Forensic Engineering	MSE431H1 F	3	-	1	0.50						
Engineered Ceramics	MSE561H1 F	3	-	2	0.50						

Materials Processing for Sustainable Development Theme:

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Extractive Metallurgy	MSE504H1 F	3	-	2	0.50	Energy Management in Materials Processing	MSE408H1 S	3	-	1	0.50
Aqueous Process Engineering	CHE565H1 F	3	-	1	0.50	Process Simulation and Computer Design	MSE455H1 S	3	-	2	0.50
						Innovation and Manufacturing of Sustainable Materials	FOR424H1 S	3	-	-	0.50

Nanomaterials Theme:

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Introduction to Micro- and Nano-Fabrication Technologies	ECE442H1 F	3	2	1	0.50	Advanced Physical Properties of Structural Nanomaterials	MSE550H1 S	3	2	1	0.50
Electronic Materials	MSE430H1 F	2	-	1	0.50	Nanotechnology in Alternate Energy Systems	MSE558H1 S	3	0.50	1	0.50
Synthesis of Nanostructured Materials	MSE459H1 F	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				Winter Session - Year 1			
		Lect.	Lab.	Tut.	Wgt.		
Core Required Courses				Core Required Courses			
Engineering Strategies &Practice I	APS111H1 F	3	1	1	0.50	Fundamentals of Computer Programming	APS106H1 S
Ethics in Engineering	APS150H1 F	-	-	1	0.05	Engineering Strategies &Practice II	APS112H1 S
Mechanics	CIV100H1 F	3	-	2	0.50	Electrical Fundamentals	ECE110H1 S
Calculus I	MAT186H1 F	3	-	1	0.50	Calculus II	MAT187H1 S
Linear Algebra	MAT188H1 F	3	-	1	0.50	Dynamics	MIE100H1 S
Introduction to Materials Science	MSE101H1 F	3	1	1	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.

SECOND YEAR INDUSTRIAL ENGINEERING

Fall Session - Year 2						Winter Session - Year 2					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Core Required Courses						Core Required Courses					
Probability	MIE236H1 F	3	-	2	0.50	Differential Equations	MAT234H1 S	3	-	1.50	0.50
Psychology For Engineers	MIE242H1 F	3	3	-	0.50	Statistics	MIE237H1 S	3	1	2	0.50
Fundamentals of Object Oriented Programming	MIE250H1 F	2	3	-	0.50	Human Centred Systems Design	MIE240H1 S	3	-	2	0.50
Engineering Economics and Accounting	MIE258H1 F	3	-	1	0.50	Data Modelling	MIE253H1 S	3	2	-	0.50
Operations Research I: Deterministic OR	MIE262H1 F	3	2	1	0.50	Operations Research II: Stochastic OR	MIE263H1 S	3	-	2	0.50

THIRD YEAR INDUSTRIAL ENGINEERING

Fall Session - Year 3						Winter Session - Year 3					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Core Required Course						Core Required Course					
Industrial Ergonomics and the Workplace	MIE343H1 F	3	3	-	0.50	Algorithms & Numerical Methods	MIE335H1 S	3	1	1	0.50
Design and Analysis of Information Systems	MIE350H1 F	3	1	1	0.50	Resource and Production Modelling	MIE363H1 S	3	-	2	0.50
Systems Modelling and Simulation	MIE360H1 F	3	2	1	0.50	Quality Control and Improvement	MIE364H1 S	3	1	2	0.50
Natural Science Elective (Choose One):						Technical Elective (Choose One):					
Engineering Biology	CHE353H1 F	3	-	1	0.50	Case Studies in Human Factors and Ergonomics	MIE345H1 S	3	-	2	0.50
Urban Engineering Ecology	CIV220H1 F	3	-	1	0.50	Cases in Operations Research	MIE367H1 S	3	-	2	0.50
Terrestrial Energy Systems	CIV300H1 F/S	3	-	2	0.50	Facility Planning	MIE468H1 S	3	-	2	0.50
Technical Elective (Choose One):						Reliability and Maintainability Engineering	MIE469H1 S	3	-	2	0.50
Ergonomic Design of Information Systems	MIE344H1 F	3	3	-	0.50	Complementary Studies Elective					
Business Process Engineering	MIE354H1 F	3	2	-	0.50	CS Elective					0.50
Operations Research III: Advanced OR	MIE365H1 F	3	2	1	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

Engineering Programs

FOURTH YEAR INDUSTRIAL ENGINEERING

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Core Required Courses:						Core Required Courses:					
Integrated System Design	MIE463H1 F	3	-	2	0.50	Organization Design	MIE459H1 S	4	-	-	0.50
Capstone Design	MIE490Y1 Y	-	-	4	1.00	Capstone Design	MIE490Y1 Y	-	-	4	1.00
Technical Electives (Choose Two):						Technical Electives (Choose Two):					
Financial Engineering	APS502H1 F	3	-	-	0.50	Case Studies in Human Factors and Ergonomics	MIE345H1 S	3	-	2	0.50
Ergonomic Design of Information Systems	MIE344H1 F	3	3	-	0.50	Cases in Operations Research	MIE367H1 S	3	-	2	0.50
Business Process Engineering	MIE354H1 F	3	2	-	0.50	Knowledge Modelling and Management	MIE457H1 S	3	1	1	0.50
Operations Research III: Advanced OR	MIE365H1 F	3	2	1	0.50	Facility Planning	MIE468H1 S	3	-	2	0.50
Engineering Psychology and Human Performance	MIE448H1 F	3	3	-	0.50	Reliability and Maintainability Engineering	MIE469H1 S	3	-	2	0.50
Decision Support Systems	MIE451H1 F	3	1	1	0.50	Research Thesis	MIE498H1 S	-	-	4	0.50
Research Thesis	MIE498H1 F	-	-	4	0.50	Research Thesis	MIE498Y1 Y	-	-	4	1.00
Research Thesis	MIE498Y1 Y	-	-	4	1.00	Human Factors Integration	MIE542H1 S	3	-	2	0.50
Scheduling	MIE562H1 F	3	-	2	0.50	Healthcare Systems	MIE561H1 S	3	-	2	0.50
Decision Analysis	MIE566H1 F	3	-	2	0.50						
Complementary Studies Elective						Complementary Studies Elective					
CS Elective					0.50	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 Registrar'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 from the Mechanical and Industrial Engineering Graduate Studies Office online at www.mie.utoronto.ca/graduate.

MECHANICAL ENGINEERING (AEMECBASC)

UNDERGRADUATE STUDENT COUNSELLOR:

Ms Carla Baptista
Room MC109, Mechanical Engineering Building
416-978-6420

The Mechanical Engineering profession faces unprecedented challenges and exciting opportunities in its efforts to serve the needs of society. The broad disciplinary base and design orientation of the field will continue to make the skills of the mechanical engineer crucial to the success of virtually all technical systems that involve energy, motion, materials, design, automation and manufacturing. The explosive growth in the availability of lower-cost, compact and high speed computing hardware and software is already revolutionizing the analysis, design, manufacture and operation of many mechanical engineering systems. Mechanical engineering systems are part of automotive engineering, robotics, fuel utilization, nuclear and thermal power generation, materials behaviour in design applications, transportation, biomechanical engineering, environmental control and many others.

To prepare Mechanical Engineers for the challenges of such a broad discipline, the program is designed to:

- (i) Provide fundamental knowledge of the various subdisciplines;
- (ii) Teach methodology and systems analysis techniques for integrating this knowledge into useful design concepts, and
- (iii) Make graduates fully conversant with modern facilities, such as CAD/CAM and microprocessor control, by which design concepts can be produced and competitively manufactured.

The knowledge component includes the key subdisciplines of mechanics, thermodynamics, fluid mechanics, control theory, dynamics, material science

and design. All are based on adequate preparation in mathematics and in such fundamental subjects as physics and chemistry.

Integration of this knowledge is accomplished in third and fourth year courses. Students select many upper-year courses from a list of electives, permitting them to choose subjects compatible with their individual interests. Most technical elective courses from one of five streams or subject areas: Manufacturing, Mechatronics, Solid Mechanics and Machine Design, Energy and Environment or Bioengineering. Students are encouraged to select a sequence of courses from two of the five streams, acquiring greater depth of knowledge in those areas. The fourth year Capstone Design course encompasses all aspects of the program as students complete a two-term design project for an industrial partner or client. Students also have the option of doing a one or two term thesis in the fourth year, allowing independent study and research with a university faculty member.

With this diverse background, virtually all industries seek the services of the practicing mechanical engineer as an employee or a consultant. Mechanical engineers are involved in the primary power production industry where hydraulic, thermal and nuclear energy is converted to electricity; in integrated manufacturing of automobiles and other equipment; in aircraft and other transportation systems; in the heating and air conditioning industry; in the design and manufacture of electronic hardware; in materials processing plants and many others industries.

For the modern mechanical engineer, the undergraduate program is only the first step in this educational process. An increasing number of graduates pursue advanced degrees in particular areas of specialization. Graduates entering industry can continue their education by participating in the graduate program. For further details please see the information following the program outline.

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FIRST YEAR MECHANICAL ENGINEERING

Fall Session - Year 1						Winter Session - Year 1					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Core Required Courses						Core Required Courses					
Engineering Strategies & Practice I	APS111H1 F	3	1	1	0.50	Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Ethics in Engineering	APS150H1 F	-	-	1	0.05	Engineering Strategies & Practice II	APS112H1 S	3	2	-	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	0.50	Dynamics	MIE100H1 S	3	-	2	0.50
Introduction to Materials Science	MSE101H1 F	3	1	1	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.

SECOND YEAR MECHANICAL ENGINEERING

Fall Session - Year 2						Winter Session - Year 2					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Core Required Courses						Core Required Courses					
Engineering Analysis	MIE230H1 F	3	-	2	0.50	Differential Equations	MAT234H1 S	3	-	1.50	0.50
Probability and Statistics with Engineering Applications	MIE231H1 F	3	2	2	0.50	Thermodynamics	MIE210H1 S	3	1.50	1	0.50
Mechanical Engineering Design	MIE243H1 F	3	2	2	0.50	Manufacturing Engineering	MIE221H1 S	3	2	1	0.50
Materials Science	MIE270H1 F	3	0.75	1.50	0.50	Mechanics of Solids I	MIE222H1 S	3	1.50	1.50	0.50
Complementary Studies Elective						Foundations of Design Portfolio	MIE297H1 S	-	-	-	0.00
CS Elective					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.

Engineering Programs

THIRD YEAR MECHANICAL ENGINEERING

Fall Session - Year 3							Winter Session - Year 3						
			Lect.	Lab.	Tut.	Wgt.				Lect.	Lab.	Tut.	Wgt.
Core Required Courses							Core Required Courses						
Kinematics and Dynamics of Machines	MIE301H1	F	3	3	2	0.50	Design for the Environment	MIE315H1	S	3	-	1	0.50
Fluid Mechanics I	MIE312H1	F	3	1	1	0.50	Engineering Physics	MIE333H1	S	3	-	1.50	0.50
Numerical Methods I	MIE334H1	F	3	-	1.50	0.50	Mechanical Engineering Design	MIE341H1	S	3	3	1	0.50
Circuits with Applications to Mechanical Engineering Systems	MIE342H1	F	3	1.50	1	0.50	Design Portfolio	MIE397Y1	Y	-	-	-	0.00
Design Portfolio	MIE397Y1	Y	-	-	-	0.00	Stream Options (Choose two streams)						
Natural Science Elective (choose one):							Manufacturing						
Engineering Biology	CHE353H1	F	3	-	1	0.50	Quality Control and Improvement	MIE364H1	S	3	1	2	0.50
Urban Engineering Ecology	CIV220H1	F	3	-	1	0.50	Mechatronics						
Terrestrial Energy Systems	CIV300H1	F	3	-	2	0.50	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						
							Heat and Mass Transfer	MIE313H1	S	3	1.50	2	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 Undergraduate Student Counsellor. Students may complete this minor by the end of the fourth-year, Mechanical program by taking the following courses, however other combinations are possible:

- CHE353H1, Engineering Biology
- MIE331H1, Physiological Control Systems, and/or CHE354H1, Cellular and Molecular Biology
- ECE445H1, Neural Bioelectricity or ECE446H1, Sensory Communication or MIE343H1, Industrial Ergonomics & the Workplace or MIE439H1, Biomechanics I or MIE448H1, Engineering Psychology & Human Performance or MSE440H1, Biomaterial Processing and Properties
- MSE442H1, Surgical and Dental Implant Design

FOURTH YEAR MECHANICAL ENGINEERING

Engineering Programs

Fall Session - Year 4							Winter Session - Year 4						
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.		
Core Required Course:							Core Required Course:						
Capstone Design	MIE491Y1 Y	-	-	4	1.00		Capstone Design	MIE491Y1 Y	-	-	4	1.00	
Stream Courses (two of):							Technical Electives (three of):						
Manufacturing							Biocomposites: Mechanics and Bioinspiration	CHE475H1 S	3	-	1	0.50	
Automated Manufacturing	MIE422H1 F	2	3	-	0.50		Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50	
Mechatronics							Operating Systems	ECE344H1 S	3	3	-	0.50	
Control Systems I	MIE404H1 F	3	3	2	0.50		Innovation and Manufacturing of Sustainable Materials	FOR424H1 S	3	-	-	0.50	
Solid Mechanics & Design							Vibrations	MIE402H1 S	3	1	2	0.50	
Machine Design	MIE442H1 F	3	1.50	3	0.50		* Thermal and Machine Design of Nuclear Power Reactors	MIE408H1 S	3	-	2	0.50	
Energy & Environment							Microprocessors and Embedded Microcontrollers	MIE438H1 S	2	3	-	0.50	
Thermal Energy Conversion	MIE411H1 F	3	3	-	0.50		Biomechanics I	MIE439H1 S	3	2	-	0.50	
Bioengineering							* Design Optimization	MIE441H1 S	3	2	-	0.50	
Biotransport Phenomena	MIE520H1 F	3	-	1	0.50		* Mechatronics Systems: Design and Integration	MIE443H1 S	2	5	-	0.50	
Technical Electives (one of):							Reliability and Maintainability Engineering	MIE469H1 S	3	-	2	0.50	
Aerodynamics	AER307H1 F	3	-	1	0.50		Research Thesis	MIE498H1 S	-	-	4	0.50	
Robotics	AER525H1 F	3	1.50	1	0.50		Research Thesis	MIE498Y1 Y	-	-	4	1.00	
Operating Systems	ECE344H1 F	3	3	-	0.50		Applied Computational Fluid Dynamics	MIE504H1 S	3	-	-	0.50	
Industrial Ergonomics and the Workplace	MIE343H1 F	3	3	-	0.50		* MEMS Design and Microfabrication	MIE506H1 S	3	1.50	1	0.50	
Systems Modelling and Simulation	MIE360H1 F	3	2	1	0.50		Alternative Energy Systems	MIE515H1 S	3	-	1	0.50	
Nuclear Reactor Theory and Design	MIE407H1 F	3	-	2	0.50		Fuel Cell Systems	MIE517H1 S	3	-	1	0.50	
* Applied Fluid Mechanics	MIE414H1 F	3	3	1	0.50		* Product Design	MIE540H1 S	3	-	1	0.50	
* Design of Innovative Products	MIE440H1 F	2	2	1	0.50		Advanced Momentum, Heat and Mass Transfer	MIE550H1 S	3	-	-	0.50	
* Mechatronics Principles	MIE444H1 F	2	3	-	0.50		Engineering Analysis II	MIE563H1 S	3	3	2	0.50	
Engineering Psychology and Human Performance	MIE448H1 F	3	3	-	0.50		Macromolecular Materials Engineering	MSE432H1 S	3	-	1	0.50	
Research Thesis	MIE498H1 F	-	-	4	0.50		Surgical and Dental Implant Design	MSE442H1 S	3	-	1	0.50	
Research Thesis	MIE498Y1 Y	-	-	4	1.00		Complementary Studies						
Combustion and Fuels	MIE516H1 F	3	-	1	0.50		Elective (one):						
Materials Selection in Design II	MSE401H1 F	2	2	1	0.50		CS Elective					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 be 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,

Engineering Programs

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 Hadjigeorgiou, Director, Lassonde Mineral Engineering Program

Nelly Pietropaolo
Room GB105, Galbraith Building

Mineral engineering encompasses those activities necessary to extract and process natural mineral resources. The Lassonde Mineral Engineering Program is comprehensive, covering topics from the entire scope of minerals engineering: from geology and mineral exploration, through analysis and design of surface and underground excavations, mechanical and explosive excavation of geological materials, planning and management of mines and quarries, processing of metallic, nonmetallic and industrial minerals, safety and environmental protection, and on to financial aspects of minerals operations. This wide range of topics means that the program is truly interdisciplinary, using concepts and techniques from mathematics, physics, chemistry, geology and economics; in the setting of the University of Toronto it is thus both interdepartmental and interfaculty, with the Departments of Civil Engineering, Geology and Materials Science and Engineering contributing to the program. As Toronto is a world centre for mining and mining finance, the program is able to maintain close links with the minerals industry, and thus invites recognised experts from various branches of the industry to deliver state-of-the-art treatment of specialised topics within the curriculum.

The first year of the four-year curriculum is similar to that of other engineering programs at the University. All subsequent years are unique to the Lassonde Mineral Engineering Program, with transfer into Year 2 of Mineral Engineering being permitted from both the General Engineering first year and other engineering programs. Year 2 concentrates on minerals engineering fundamentals, and years 3 and 4 comprise a minerals engineering core supplemented by technical electives. A wide range of technical electives are available, thereby allowing students to specialise should they so wish in one particular branch of minerals engineering. Students also study humanities and complementary studies electives in the final two years. Practical aspects of the program are presented through laboratory sessions, and students attend one survey and one geology field camp, each of two weeks duration. Students are encouraged and helped to obtain industrial experience during summer vacations, and have the opportunity to take a Professional Experience Year between years 3 and 4. Attractive entrance and in-course scholarships and bursaries are available, including the prestigious, competitively awarded Lassonde Scholarships.

Graduates obtain a comprehensive training in minerals engineering, and are well prepared for future challenges in the planning and financing of mineral and related engineering projects as well as for graduate study in mining, geological, or civil engineering. The program is accredited with the Canadian Engineering Accreditation Board.

PERSONAL PROTECTIVE EQUIPMENT

There will be many occasions where students are required to use Personal Protective Equipment (PPE) including safety footwear bearing the CSA Green Patch, hard hats, protective eyewear with side shields, tear away safety vests and ear protection. Students are required to purchase their own PPE. All field trips, laboratories, and other events require advance briefing on the nature of potential hazards and students are required to attend these briefings and to follow the provided instructions.

PRACTICAL EXPERIENCE REQUIREMENT

Students are required to have completed at least 600 hours of acceptable practical experience before graduation. This is normally acquired during the summer vacation periods or during a Professional Experience Year (PEY) internship.

PROFESSIONAL EXPERIENCE YEAR

Students registered 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.

Engineering Programs

MINORS AND CERTIFICATE PROGRAMS

Several Engineering Minors and Certificate Programs are available and generally require the student to successfully complete a carefully selected slate of electives in their Fourth Year. Late in the Third Year Winter Session, students use an on-line pre-registration tool to indicate their preferred fourth-year electives. Students should review the various minor and certificate program requirements and attend the department's information sessions in Third Year to ensure that the appropriate electives are taken in Fourth Year. Students should note that they can also complete the requirements of a minor or certificate program even after they have graduated, as long as the additional requirements are met within nine years of their initial registration in the BASc program. If completed after graduation, additional fees will be assessed, and a transcript will be issued with the amended courses and indication of completed minor or certificate program requirements.

JEFFREY SKOLL BASC/MBA PROGRAM

The Jeffrey Skoll Combined BASc/MBA Program allows qualified and selected students in the Faculty of Applied Science and Engineering to complete both a BASc and an MBA in a reduced time. Students will be admitted to the program prior to entering their fourth year of studies in the BASc program. Interested students should contact the Registrar's Office early in the Third Year to obtain important information including application deadlines.

GRADUATE TRAINING IN MINERAL ENGINEERING

Students with the necessary qualifications (generally at least a B+ average in the final year of the undergraduate program) who wish to proceed to graduate studies may do so through the Lassonde Institute, an interdisciplinary research institute for engineering geoscience. The Department of Civil Engineering, the Department of Mechanical Engineering, the Department of Materials Science and Engineering, the Department of Geology, and the Collaborative Program in Geophysics are all collaborators in the Lassonde Institute.

The Engineering Departments offer programs leading to the MASc, MEng, and PhD degrees. Other Departments offer MSc and PhD degree programs. Additional information may be obtained at www.lassondeinstitute.utoronto.ca or the websites of the collaborating Departments.

FIRST YEAR MINERAL ENGINEERING

Fall Session - Year 1						Winter Session - Year 1					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Engineering Strategies & Practice I	APS111H1 F	3	1	1	0.50	Fundamentals of Computer Programming	APS106H1 S	3	2	1	0.50
Ethics in Engineering	APS150H1 F	-	-	1	0.05	Engineering Strategies & Practice II	APS112H1 S	3	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	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.

SECOND YEAR MINERAL ENGINEERING

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

Students must acquire two half or one full-year course equivalent of both CS and HSS credits by the end of Fourth Year.

THIRD YEAR MINERAL ENGINEERING

Fall Session - Year 3						Winter Session - Year 3					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Geotechnical Engineering I	CME321H1 F	3	1	1	0.50	Mineral Reserve and Mineral	MIN301H1 S	3	-	1	0.50
Survey CAMP (Civil and Mineral Practicals)	CME358H1 F	-	-	-	0.50	Resource Estimation					
Engineering Economics and Decision Making	CME368H1 F	3	-	1	0.50	Explosives and Fragmentation in Mining	MIN320H1 S	3	-	1	0.50
Geologic Structures and Maps	ESS241H1 F	2	3	-	0.50	Underground Mining	MIN351H1 S	3	-	1	0.50
Engineering Rock Mechanics	MIN429H1 F	3	1	1	0.50	Mining Environmental Management	MIN430H1 S	3	-	1	0.50
Thermodynamics	MSE202H1 F	3	-	2	0.50	Mineral Processing	MSE301H1 S	3	1.50	1	0.50
						Complementary Studies					0.50
						Elective (CS) / Humanities and Social Sciences					
						Elective (HSS)					

CME358H1 - Survey CAMP (Civil and Mineral Practicals), is a two-week field-based course taken in the month prior to starting Third Year. The results of this course are used in computing the student's Third Year Fall Session Average. An extra fee is charged to cover part of the costs of food and accommodation.

Technical Electives must be chosen from the list shown under the Fourth Year curriculum table.

Students must acquire two half or one full-year course equivalent of both CS and HSS credits by the end of Fourth Year.

FOURTH YEAR MINERAL ENGINEERING

Fall Session - Year 4						Winter Session - Year 4					
		Lect.	Lab.	Tut.	Wgt.			Lect.	Lab.	Tut.	Wgt.
Mineral Project Design I	MIN466H1 F	2	2	1	0.50	Mineral Project Design II	MIN467H1 S	1	4	1	0.50
Mineral Economics	MIN450H1 F	3	-	1	0.50	Design and Support of	MIN565H1 S	3	-	1	0.50
Complementary Studies					0.50	Underground Mine Excavations					
Elective (CS) / Humanities and Social Sciences						Mineral Reserve and Mineral Resource Estimation	MIN401H1 S	3	-	1	0.50
Elective (HSS)						Ventilation and Occupational Health	MIN470H1 S	3	-	1	0.50
Field Camp						Complementary Studies					0.50
Geology Field Camp for Engineers	MIN400H1 F	-	-	-	0.50	Elective (CS) / Humanities and Social Sciences					
Choose two of the following						Elective (HSS)					
Technical Electives						Technical Electives					
Aqueous Process Engineering	CHE565H1 F	3	-	1	0.50	Geotechnical Engineering II	CIV324H1 S	3	1	1	0.50
Groundwater Flow and Contamination	CIV549H1 F	3	-	1	0.50	Environmental Impact and Risk Assessment	CIV440H1 S	3	-	1	0.50
Sedimentation and Stratigraphy	ESS331H1 F	2	3	-	0.50	Geotechnical Design	CIV523H1 S	3	-	1	0.50
Mineral Deposits	ESS423H1 F	2	3	-	0.50	Borehole Geophysics for Engineers and Geoscientists	MIN540H1 S	3	-	1	0.50
Environmental and Archaeological Geophysics	JGA305H1 F	2	1	-	0.50						
Integrated Mine Waste Engineering	MIN511H1 F	3	-	1	0.50						

Course Descriptions

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 occurring on alternating weeks

1a: 1 hour of tutorial occurring 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

III-AEESCBASEF

3/-/0.50

Mathematical theory of financial derivatives, discrete and continuous option pricing models, hedging strategies and exotic option valuation.

Prerequisite: ACT240H1 (minimum grade C); ACT245H1 (minimum grade C); ACT247H1 (minimum grade C); (STA257H1, STA261H1); MAT237Y1

Exclusion: MGT438H1

ACT460H1 F Stochastic Methods for Actuarial Science

IV-AEESCBASEF

3/-/0.50

Applications of the lognormal distribution, Brownian motion, geometric Brownian motion, martingales, Itos lemma, 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

II-AEESCBASE

1/5/-/0.50

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.

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

II-AEESCBASE

3/0.50/2/0.50

The first part of this course covers multiple integrals and vector calculus. Topics covered include: double and triple integrals, derivatives of definite integrals, surface area, cylindrical and spherical coordinates, general coordinate transformations (Jacobians), Taylor series in two variables, line and surface integrals, parametric surfaces, Green's theorem, the divergence and gradient theorems, Stokes's theorem. The second part of the course provides a general introduction to the principles of continuum fluid mechanics. The basic conservation laws are derived in both differential and integral form, and the link between the two is demonstrated. Applications covered include hydrostatics, incompressible

and compressible frictionless flow, the speed of sound, the momentum theorem, viscous flows, and selected examples of real fluid flows.

AER301H1 F Dynamics

III-AEESCBASEA, IV-AEESCBASEF, I-AEMINRAM

3/-/1/0.50

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.

Recommended Preparation: PHY180, MAT185, AER210

AER302H1 S Aircraft Flight

III-AEESCBASEA

3/-/1/0.50

Basics of aircraft performance with an introduction to static stability and control. Topics covered include: Equations of Motion; Characteristics of the Atmosphere; Airspeed Measurement; Drag (induced drag, total airplane drag); Thrust and Power (piston engine characteristics, gas turbine performance); Climb (range payload); Turns; 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.

Recommended Preparation: AER307, AER301

AER303H1 F Aerospace Laboratory I

III-AEESCBASEA

-/1/-/0.15

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

AER304H1 S Aerospace Laboratory II

III-AEESCBASEA

-/1/-/0.15

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

AER307H1 F Aerodynamics

III-AEESCBASEA, IV-AEESCBASEF, IV-AEMEBCASC

3/-/1/0.50

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.

Recommended Preparation: AER210

Course Descriptions

AER310H1 S Gasdynamics

III-AEESCBASEA

3-/1/0.50

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.

Recommended Preparation: AER307H1

AER315H1 F Combustion Processes

III-AEESCBASEA

3-/1/0.50

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.

Recommended Preparation: CHE260H1

AER336H1 S Scientific Computing

III-AEESCBASEA, IV-AEESCBASEF,
IV-AEESCBASER

3-/1/0.50

An introduction is provided to numerical methods for scientific computation which are relevant to the solution of a wide range of engineering problems. Topics addressed include interpolation, integration, linear systems, least-squares fitting, 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.

Recommended Preparation: ESC103H1, MAT185H1

AER372H1 S Control Systems

III-AEESCBASEA, III-AEESCBASEJ

3/1.50/1/0.50

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.

Recommended Preparation: MAT185H1, MAT292H1

AER373H1 S Mechanics of Solids and Structures

III-AEESCBASEA, IV-AEESCBASEF,
III-AEESCBASEI

3-/1/0.50

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. Text: Shames & Dym, Energy and Finite Element Methods in Structural Mechanics.

Recommended Preparation: CIV102, PHY180

AER406H1 S Aircraft Design

IV-AEESCBASEA

-/-/3/0.50

This course involves the detailed preliminary design of an airplane. Performance and mission specifications are given, as well as the engine's characteristics. The class is divided into teams of three to four students who are guided to develop an airplane that can meet these specifications. Individual team members will specialize in areas such as "performance", "structure", "systems", etc., although all team members should be conversant with each other's results and methodology. Each week, a representative of each team presents a progress lecture on that team's efforts, which is discussed and critiqued by the class. Also, the teams meet one-on-one with the professor and tutors to discuss specific design questions. At the end of the course each team will present a verbal and written report of sufficient detail to provide a compelling case for the feasibility of their proposed airplane. Text: Raymer, Daniel P., Aircraft Design: A Conceptual Approach, published by the AIAA.

Recommended Preparation: AER302H1, AER307H1, AER373H1

AER407H1 F Space Systems Design

IV-AEESCBASEA, I-AEMINRAM

-/3-/0.50

Introduction to the conceptual and preliminary design phases for a space system currently of interest in the Aerospace industry. A team of visiting engineers provide material on typical space systems design methodology and share their experiences working on current space initiatives through workshops and mock design reviews. Aspects of operations, systems, electrical, mechanical, software, and controls are covered. The class is divided into project teams to design a space system in response to a Request for Proposals (RFP) formulated by the industrial team. Emphasis is placed on standard top-down design practices and the tradeoffs which occur during the design process. Past projects include satellites such as Radarsat, interplanetary probes such as a solar sailer to Mars, a Mars surface rover and dextrous space robotic systems.

Recommended Preparation: No specific courses appropriate.

AER501H1 F Advanced Mechanics of Structures

IV-AEESCBASEA

3-/1/0.50

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.

Recommended Preparation: AER373H1

AER503H1 S Aeroelasticity

IV-AEESCBASEA

3/-/1/0.50

Static aeroelastic phenomena are studied, including divergence of slender wings and control reversal. Various methods of solution are considered such as closed form, matrix format iteration and the Rayleigh-Ritz approach. A Study of vibration and flutter of wings and control surfaces is presented with particular emphasis on those parameters which affect flutter speed.

Recommended Preparation: AER307H1, AER501H1

AER506H1 F Spacecraft Dynamics and Control

IV-AEESCBASEA

3/-/1/0.50

Planar "central force" motion; elliptical orbits; energy and the major diameter; speed in terms of position; angular momentum and the conic parameter; Kepler's laws. Applications to the solar system; applications to Earth satellites. Launch sequence; attaining orbit; plane changes; reaching final orbit; simple theory of satellite lifetime. Simple (planar) theory of atmospheric entry. Geostationary satellite; adjustment of perigee and apogee; east-west stationkeeping. Attitude motion equations for a torque-free rigid body; simple spins and their stability; effect of internal energy dissipation; axisymmetric spinning bodies. Spin-stabilized satellites; long-term effects; sample flight data. Dual-spin satellites; basic stability criteria; example-CTS. "active" attitude control; reaction wheels; momentum wheels; controlmoment gyros; simple attitude control systems.

Recommended Preparation: AER301H1 and AER372H1

AER507H1 F Introduction to Fusion Energy

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

3/-/1/0.50

Nuclear reactions between light elements provide the energy source for the sun and stars. On earth, such reactions could form the basis of an essentially inexhaustible energy resource. In order for the fusion reactions to proceed at a rate suitable for the generation of electricity, the fuels (usually hydrogen) must be heated to temperatures near 100 million Kelvin. At these temperatures, the fuel will exist in the plasma state. This course will cover: (i) the basic physics of fusion, including reaction cross-sections, particle energy distributions, Lawson criterion and radiation balance, (ii) plasma properties including plasma waves, plasma transport, heating and stability, and (iii) fusion plasma confinement methods (magnetic and inertial). Topics will be related to current experimental research in the field.

AER510H1 S Aerospace Propulsion

IV-AEESCBASEA

3/-/1/0.50

Scope and history of jet and rocket propulsion; fundamentals of air-breathing and rocket propulsion; fluid mechanics and thermodynamics of propulsion including boundary layer mechanics and combustion; principles of aircraft jet engines, engine components and performance; principles of rocket propulsion, rocket performance, and chemical rockets; environmental impact of aircraft jet engines.

Recommended Preparation: AER310H1

AER521H1 S Mobile Robotics and Perception

IV-AEESCBASEA, IV-AEESCBASER,
I-AEMINRAM

3/1.50/1/0.50

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. Recommended Preparation: AER372H1

AER525H1 F Robotics

IV-AEESCBASEA, IV-AEESCBASEF,
IV-AEESCBASER, IV-AEMECCBASC

3/1.50/1/0.50

The course addresses fundamentals of analytical robotics as well as design and control of industrial robots and their instrumentation. Topics include forward, inverse, and differential kinematics, screw representation, statics, inverse and forward dynamics, motion and force control of robot manipulators, actuation schemes, task-based and workspace design, mobile manipulation, and sensors and instrumentation in robotic systems. A series of experiments in the Robotics Laboratory will illustrate the course subjects.

Exclusion: ECE470H1

Recommended Preparation: AER301H1, AER372H1

Applied Mathematics

APM384H1 F Partial Differential Equations

III,IV-AECPBASC, III,IV-AEELEBASC,
III-AEESCBASEA, III-AEESCBASEF,
III-AEESCBASEO, III-AEESCBASEP,
IV-AEESCBASER, III-AEESCBASET

3/-/1/0.50

Boundary value problems and Sturm-Liouville theory for ordinary differential equations. Partial differential equations of first order, characteristics, Hamilton-Jacobi theory. Diffusion equations; Laplace transform methods. Harmonic functions, Green's functions for Laplace's equation, surface and volume distributions; Fourier transforms. Wave equation, characteristics; Green's functions for the wave equation; Huygens principle.

APM446H1 F Applied Nonlinear Equations

IV-AEESCBASEA

3/-/0.50

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).

Course Descriptions

Prerequisite: APM346H1/APM351Y1

APM466H1 S **Mathematical Theory of Finance**

IV-AEESCBASEF

3/-/0.50

Introduction to the basic mathematical techniques in pricing theory and risk management: Stochastic calculus, single-period finance, financial derivatives (tree-approximation and Black-Scholes model for equity derivatives, American derivatives, numerical methods, lattice models for interest-rate derivatives), value at risk, credit risk, portfolio theory.

Prerequisite: APM346H1, STA347H1

Corequisite: STA457H1

Applied Science and Engineering **(Interdepartmental)**

APS104H1 S **Introduction to Materials and Chemistry**

I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC

3/0.50/1/0.50

This is an introductory course in materials science and physical chemistry. Topics include: fundamentals of atomic, structure, the nature of bonding, crystal structure and defects, the laws of chemical thermodynamics (including a discussion of enthalpy and entropy), reaction equilibrium, and phase equilibria. These basic principles provide the foundation for an exploration of structure-property relationships in metals, ceramics, and polymers, with emphasis on mechanical properties.

APS105H1 F **Computer Fundamentals**

I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC

3/2m/1m/0.50

An introduction to computer systems and problem solving using computers. Topics include: the representation of information, programming techniques, programming style, basic loop structures, functions, arrays, strings, pointer-based data structures and searching and sorting algorithms. The laboratories reinforce the lecture topics and develops essential programming skills.

APS106H1 S **Fundamentals of Computer Programming**

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

3/2/1/0.50

An introduction to computer systems and software. Topics include the representation of information, algorithms, programming languages, operating systems and software engineering. Emphasis is on the design of algorithms and their implementation in software. Students will develop a competency in the C programming language. Laboratory exercises will explore the concepts of both Structure-based and Object-Oriented programming using examples drawn from mathematics and engineering applications.

APS111H1 F **Engineering Strategies & Practice I**

3/1/1/0.50

I-AECHEBASC, I-AECIVBASC,
I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AELMEBASC, I-AEMEGBASC,
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**

3/2/-/0.50

I-AECHEBASC, I-AECIVBASC,
I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AELMEBASC, I-AEMEGBASC,
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.

APS150H1 F **Ethics in Engineering**

-/-/1/0.50

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

An introduction to professional ethics and the Academic Code of Conduct. Topics include: the theory of ethics, professional code of ethics, ethics in the profession, proper use of intellectual property in the professional and in academic settings, plagiarism, the Academic Code of Conduct, and application of ethics in practice.

APS160H1 F/S **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.

Not offered in 2013-2014.

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.

Not offered in 2013-2014.

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

APS191H1 S Introduction to Engineering

I-AEENGBASC

1/-/0.15

This is a seminar series that will preview the core fields in Engineering. Each seminar will highlight one of the major areas of Engineering. The format will vary and may include application examples, challenges, case studies, career opportunities, etc. The purpose of the seminar series is to provide first year students with some understanding of the various options within the Faculty to enable them to make educated choices for second year. This course will be offered on a credit/no credit basis.

APS234H1 F Entrepreneurship and Small Business

I-AECERENTR, I-AEMINBUS

4/-/1/0.50

Complementary Studies elective

Part 1 of the 2 Part Entrepreneurship Program

The age of enterprise has arrived. Strategic use of technology in all sorts of businesses makes the difference between success and failure for these firms. Wealth creation is a real option for many and the business atmosphere is ready for you! Increasingly, people are seeing the advantages of doing their own thing, in their own way, in their own time. Entrepreneurs can control their own lives, structure their own progress

and be accountable for their own success - they can fail, but they can not be fired! After all, engineers are the most capable people to be in the forefront of this drive to the business life of the next century. This course is the first of a series of two dealing with entrepreneurship and management of a small company. It is intended that the student would continue to take the follow up course APS432 as s/he progresses toward the engineering degree. Therefore, it is advisable that the descriptions of both courses be studied prior to deciding to take this one. This is a limited enrolment course. If the number of students electing to take the course exceeds the class size limit, selection of the final group will be made on the basis of the "Entrepreneur's Test". There will be a certificate awarded upon the successful completion of both courses attesting to the fact that the student has passed this Entrepreneurial Course Series at the University of Toronto. The course is based on real life issues, not theoretical developments or untried options. Topics covered include: Who is an entrepreneur; Canadian business environment; Acquisitions; Different business types (retail, wholesale, manufacturing, and services); Franchising; Human resources, Leadership, Business law; and many others. Several visitors are invited to provide the student with the opportunity to meet real entrepreneurs. There will be several assignments and a session project. It should be noted that the 5 hours per week would all be used for whatever is needed at the time, so tutorials will not normally happen as the calendar indicates them.

Exclusion: CHE488H1/CIV488H1/ECE488H1/MIE488H1/MSE488H1

APS281H1 S Language and Meaning

2/-/2/0.50

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. Registration is by permission of the Department.

APS301H1 F Technology in Society and the Biosphere I

3/-/1/0.50

I-AECERPESD, 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-AECERPESD, 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

Course Descriptions

transformation; other “post-industrial” phenomena; the transition from experience to information; technique as social force, life-milieu and system; and living with complex socio-technical systems.
Prerequisite: APS301H1/APS203H1/APS103H1

APS304H1 S Preventive Engineering and Social Development

I-AECERPESD, I-AEMINENV

3/-/1/0.50

Humanities and Social Science Elective

The present intellectual and professional division of labour makes it next to impossible for specialists to deal with the consequences of their decisions that fall beyond their domains of expertise, thus institutionalizing an end-of-pipe approach to the many problems created by contemporary civilization. To turn this situation around, preventive approaches have been developed that use the understanding of how technology interacts with human life, society and the biosphere to adjust decision-making in order to achieve the desired results while at the same time preventing or reducing undesired effects. These preventive approaches can transform our materials and production systems, energy systems, workplaces and urban habitats to make contemporary ways of life more economically sound, socially viable and environmentally sustainable.

Prerequisite: APS301H1/APS203H1/APS103H1, APS302H1

APS305H1 S Energy Policy

III-AEESCBASEJ, I-AEMINENV

3/-/1/0.50

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

I-AEMINENR

3/1/-/0.50

The future of energy systems in India and Canada. A spectrum of current and emerging technologies used in providing energy and in its end use, including but not limited to electricity generation and transportation systems, are compared and contrasted re their applicability and barriers. Energy issues and challenges across the two countries; the role of energy in economic growth and in reducing poverty. Multi-variable analytic approach: technical aspects of the energy systems at an intermediate level of depth, but also economic analysis, environmental and sustainability issues, and social benefits. Case study examples of organizations bringing these technologies into use. India and Canada respectively in a global energy context relative to China, the U.S. and the Middle Eastern countries. Developing a framework for broader assessment of the context of engineering work –how engineering solutions and practices vary depending on the setting where the solutions are used. Possible collaborations between India and Canada, and between universities in the two countries, are explored.

Offered through Summer Abroad Program. Duration of the course will be

two to three calendar weeks, comprising approximately 42 hours of classroom instruction (up to 7 hours per day) and at least 3 field trips totaling 10 hours of instruction time. Total of 52 hours of instruction scheduled over 2-3 weeks.

Exclusion: APS510H1

APS320H1 F Representing Science on Stage

2/-/2/0.50

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

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, including misrepresentations, analogy and metaphor. Focus on the popular media's (mis)representations of climate science, nanotechnology, and bioengineering.

Prerequisite: CHE397H1/ECE297H1/ECE299H1/ESC201H1/MSE390H1

APS322H1 S Language and Power

2/-/2/0.50

Analytical approach to writing and style. Study of persuasion in political, scientific and ethical contexts. Development of critical thinking skills. History of rhetoric viewing major contributors in context: Aristotle, Cicero, Medieval rhetoric, modern rhetoricians. Analysis of major scientific and political writing and speech.

Prerequisite: CHE397H1/ECE297H1/ECE299H1/ESC201H1/MSE390H1

APS325H1 F Engineering and Science in the Arts

2/-/2/0.50

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.

APS343H1 F/S Foundations of Engineering Leadership

2/-/2/0.50

I-AECERLEAD, I-AEMINBUS

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

I-AECERENTR, I-AEMINBUS

4/-/1/0.50

Complementary Studies elective

Part 2 of the 2 Part Entrepreneurship Program

This is part two of the Entrepreneurship course series. The student considering taking this course would typically plan to pursue a career in small business started by him/herself, or in a family enterprise. The skills acquired, however, are very useful in any business where a graduate might end up in his/her career, without the need for actually being an entrepreneur. Our approach to teaching is based on real-life business experiences and many years of successful practice of "what we preach". The course contains very little theoretical work or academic approaches. 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

APS442H1 S Cognitive and Psychological Foundations of Effective Leadership

I-AECERLEAD, I-AEMINBUS

3/-/1/0.50

This course investigates the cognitive and psychological foundations of effective leadership. Students will explore current theories driving effective leadership practice including models of leadership, neurophysiological correlates of leadership and psychodynamic approaches to leadership. Students will learn and apply skills including mental modeling, decision-making, teamwork and self-evaluation techniques. This course is aimed at helping Engineering students to gain practical skills that will enhance their impact as leaders throughout their careers.

APS444H1 F Positive Psychology for Engineers

3/-/1/0.50

I-AECERLEAD, I-AEMINBUS

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

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.

APS490Y1 Y Multi-Disciplinary Capstone Design

-/1/3/1.00

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/-/1/0.50

IV-AEINDBASC

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 practical engineering and commercial settings.

Prerequisite: MAT186H1, MAT187H1, MAT188H1, MIE236H1,
MIE237H1, or equivalent.

Exclusion: MIE375H1

Course Descriptions

APS510H1 F Innovative Technologies and Organizations in Global Energy Systems

I-AECERGLOB, IV-AEESCBASEF,
I-AEMINBUS, I-AEMINENR

3/-/1/0.50

Complementary Studies elective

A broad range of global energy systems are presented including electricity generation, electricity end use, transportation and infrastructure. Discussions are based on two key trends: (a) the increasing ability to deploy technologies and engineering systems globally, and (b) innovative organizations, many driven by entrepreneurship (for profit and social) and entrepreneurial finance techniques. The course considers these types of innovations in the context of developed economies, rapidly developing economies such as India and China, and the developing world. The course will interweave a mix of industry examples and more in-depth case studies. The examples and cases are examined with various engineering, business and environmental sustainability analysis perspectives.

Prerequisite: Undergraduate economics course

Exclusion: APS310H1

APS520H1 S Technology, Engineering and Global Development

I-AECERGLOB, I-AEMINBUS

3/-/1/0.50

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.

APS530H1 S Appropriate Technology & Design for Global Development

I-AECERGLOB, I-AEMINENR,
I-AEMINENV

3/-/1/0.50

Engineering design within the context of global society, emphasizing the needs of users in order to support appropriate, sustainable technology. A design project will comprise the major component of the course work. The course will take the approach of "design for X". Students are expected to be familiar with design for functionality, safety, robustness, etc. This course will extend the students' understanding of design methodologies to design for "appropriateness in developing regions". Readings and discussions will explore the social, cultural, economic, educational, environmental and political contexts in which third world end users relate to technology. Students will then incorporate their deepened understanding of this context in their design project. The projects will be analyzed for functionality as well as appropriateness and sustainability in the third world context. Upon completion of the course, students should have a deeper appreciation of the meaning of appropriate technology in various international development sectors such 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

BCB410H1 F Applied Bioinformatics

2/-/1/0.50

Practical introduction to concepts, standards and tools for the implementation of strategies in bioinformatics and computational biology. Student led discussions plus a strong component of hands-on exercises.

Prerequisite: BCH311H1/MGY311Y1;

(CSC324H1/CSC373H1/CSC375H1) or permission of the course coordinator

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

BCH210H1 F Biochemistry I: Proteins, Lipids and Metabolism

3/-/2/0.50

Proteins, enzymes, membranes and the metabolism of carbohydrates and lipids. This course is intended for students who are NOT taking BCH242Y1 as part of their program.

Prerequisite: Successful completion of (CHM138H1, CHM139H1)/CHM151Y1 NOTE: CHM1** WITH COURSE EXCLUSION TO CHM138H1 AND CHM139H1 meet the Prerequisite requirement for BCH210H1. SCI1** DOES NOT COUNT as a Prerequisite. CHM140Y5 (UTM) is equivalent to CMH139H1 ONLY. CHMA10H3 & CHMA11H3 (UTSC) are equivalent to CHM139H1

ONLY. CHMB41H3/CHMB42H3 (UTSC) are equivalent to CHM138H1 ONLY. Students that have a SDF in CHM138H1/CHM139H1 are not permitted to enrol in BCH210H1 until a final passing grade (50%) appears on the transcript. Exclusion: BCH242Y1, CHM265H5(UTM)/CHM361H5(UTM)/CHM362H5(UTM)/BGYC12H3 (UTSC) and BGYC13H3 (UTSC)

BCH441H1 F Bioinformatics

I-AEMINBIO

2/-/1/0.50

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

II-AEESCBASE, I-AEMINBIO

2/1.75/1/0.50

Introduction 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: BME105H1, CHE353H1

BME221H1 F Biomedical Design in Society

I-AEMINBIO

3/3/2/0.50

An introduction to health care technology design processes (applying the Stanford Biodesign models) illustrated by the design and implementation of health care technology 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. Topics will include disease states, treatment options, stakeholder analysis, market analysis and needs filtering. Written skills are developed in reports related to the lecture and lab activities.

BME225H1 S Biostatistics

I-AEMINBIO

3/-/3/0.50

Students will be introduced to statistical approaches to efficiently design and analyse bioengineering data sets. The course introduces fundamental statistical concepts related to design and analysis of populations (statistical distributions, the central limit theorem, linear functions of random variables and error propagation, ANOVA, multiple regressions). Applied topics will include: screening designs, full factorial designs, blocking and replication, response surface methods, custom designs, sequential design strategies, non-normal responses and transformations. The students will learn to apply these statistical approaches to solve practical problems in bioengineering. In particular, the students will be sensitized to the interactions of living systems with the physical measurements being made. They will also be expected to become proficient in the use of statistical software required to analyse data sets. Finally, students will be expected to gain enough knowledge about experimental design strategies to be able to critically analyze the current literature.

BME346H1 S Biomedical Engineering and Omics Technologies

III-AEESCBASET

2/4/-/0.50

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

BME344H1 F Modeling, Dynamics, and Control of Biological Systems

III-AEESCBASET

3/-/1/0.50

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.

BME350H1 F Biomedical Systems Engineering I: Organ Systems

IV-AEESCBASEF, III-AEESCBASET, I-AEMINBIO, I-AEMINRAM

3/1/2/0.50

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

Course Descriptions

biomedical engineering technologies in maintaining homeostasis will also be discussed.

BME358H1 S **Molecular Biophysics**

III-AEESCBASET

3/-/1/0.50

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**

IV-AEESCBASEF, IV-AEESCBASEO,
III-AEESCBASET, I-AEMINBIO

3/-/2/0.50

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**

III-AEESCBASET

3/3/1/0.50

A quantitative approach to understanding cellular behaviour. Using engineering tools (especially derived from transport phenomena and chemical kinetics) to integrate and enhance what is known about mammalian cell behaviour at the molecular level. Specific topics include: receptor-ligand interactions, cell adhesion and migration, signal transduction, cell growth and differentiation. Examples from gene therapy, and cellular and tissue engineering are used.

Prerequisite: BME395H1

BME428H1 F **Biomedical Systems Engineering IV: Computational Systems Biology**

IV-AEESCBASET

3/-/2/0.50

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

BME440H1 S **Biomedical Engineering Technology and Investigation**

2/4/-/0.50

IV-AECHEBASC, III, IV-AECPEBASC,
III, IV-AEELEBASC, I-AEMINBIO

An introduction to the principles of fundamental technologies used in biomedical engineering research including but not limited to tissue culture, protein assays or colourimetric enzymatic-based assays, spectroscopy, fluorescence microscopy, PCR, electrophoresis, DNA manipulation and transfection. Since these technologies enable the investigation of a wide range of research questions with important clinical implications, the main focus of the course is learning these technologies while subsequent application within the lab will allow evidence-based investigation into specific research questions. Scientific literature (both good and bad) pertaining to each technology will be reviewed as examples of conducting investigations. Prerequisite: CHE353H1, Engineering Biology

BME455H1 F **Cellular and Molecular Bioengineering II**

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.

BME479H1 F **Introduction to Biomedical Systems Engineering Design Concepts**

IV-AEESCBASET

-/-/1/0.10

A seminar to introduce students to concepts in biomedical systems engineering design in preparation for BME489H1 - Biomedical Systems Engineering Design. Review of general design concepts in the context of biodesign practice. Discussion of issues related to biodesign, including regulatory processes, intellectual property, and global health. Students will be introduced to clients, identify a design project, and define their design problem. At the end of the term, students will deliver a draft "elevator pitch" for their project.

BME489H1 S **Biomedical Systems Engineering Design**

IV-AEESCBASET

-/-/5/0.50

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.

Prerequisite: BME479H1

BME499Y1 Y **Innovation and Applied Research & Design in Biomedical Engineering**

-/7/-/1.00

The goal of this course is to provide the students with some perspective with respect to the innovative work being done in the field. Students will take 2 modules in this course (one per term), each of which exposes them to biomedical research and development activity that leads to applied knowledge in the field of biomedical engineering. Each module will include at minimum 90 hours of hands-on exposure to activity in one of IBBME's core or cross-appointed faculty members lab, and to carry out the development of a research proposal related to the topic given to the student. The activities will expose the student to the design of experiments, the use of analytical equipment, and the relevant literature (scientific, patent and regulatory) related to the topic of research identified by the faculty member. Approval to register in the course must be obtained from the Associate Chair, IBBME - Undergraduate and is normally restricted to students with a cumulative average of at least B in the year prior.

Prerequisite: CHE353H1 or equivalent

Corequisite: MIE331H1

BME510H1 S **Regenerative Medicine**

IV-AEESCBASET

4/-/-/0.50

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,
I-AEMINBIO

This is a first course in medical imaging. It is designed as a final year course for engineers. It has a physical and mathematical approach emphasizing engineering concepts and design. It describes magnetic resonance and ultrasound and X ray imaging in detail. These topics allow engineers to apply principles learned in the first two years in: computer fundamentals, dynamics, calculus, basic EM theory, algebra and differential equations, signals systems. It is a depth course complementing the kernels: communication systems (modulation), fields and waves (wave propagation) and on probability and random processes (Poisson and Gaussian noise). It will introduce students to the concept of measurement as an "inverse problem". The laboratory will involve hands on NMR and Ultrasound measurements as well as image analysis of MRI data.

Cells and Systems Biology

CSB435H1 F **Regulatory Networks and Systems in Molecular Biology**

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)/BIO250Y1/BIO255H1/BIO255Y1, 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

Course Descriptions

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 flow, 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: CHE204H1Y

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**

3/2/2/0.50

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/-/2/0.50

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

CHE223H1 S Statistics

II-AECHEBASC

3/-/1/0.50

Analysis of data using statistics and design of experiments. Topics include probability, properties of the normal distribution, confidence intervals, hypothesis testing, fitting equations to data, analysis of variance and design of experiments. The tutorial involves, in part, the application of commercial software to interpret experimental data, as obtained in Chemical Engineering laboratories.

Prerequisite: MAT186H1, MAT187H1

CHE230H1 S Environmental Chemistry

II-AECHEBASC, I-AEMINENV

3/-/2/0.50

The chemical phenomena occurring in environmental systems are examined based on fundamental principles of organic, inorganic and physical chemistry. The course is divided into sections describing the chemistry of the atmosphere, natural waters and soils. The principles applied in the course include reaction kinetics and mechanisms, complex formation, pH and solubility equilibria and adsorption phenomena. Molecules of biochemical importance and instrumental methods of analysis relevant to environmental systems are also addressed. (formerly EDC230H1S)

CHE249H1 F Engineering Economic Analysis

I-AECERBUS, I-AECERENTR,
II-AECHEBASC, I-AEMINBUS

3/-/1/0.50

Engineering analysis and design are not ends in themselves, but they are a means for satisfying human wants. Thus, engineering concerns itself with the materials used and forces and laws of nature, and the needs of people. Because of scarcity of resources and constraints at all levels, engineering must be closely associated with economics. It is essential that engineering proposals be evaluated in terms of worth and cost before they are undertaken. In this course we emphasize that an essential prerequisite of a successful engineering application is economic feasibility. Hence, investment proposals are evaluated in terms of economic cost concepts, including break even analysis, cost estimation and time value of money. Effective interest rates, inflation and deflation, depreciation and income tax all affect the viability of an investment. Successful engineering projects are chosen from valid alternatives considering such issues as buy or lease, make or buy, cost and benefits and 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

II-AEESCBASE, I-AEMINENR

3/0.50/1/0.50

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.

CHE297Y1 Y Seminar Course: Communications Portfolio I

II-AECHEBASC

-/-/0.25/0.00

Each student will develop a portfolio of communication assignments completed in other university courses. Contents of the portfolio will demonstrate among them a range of skills: individual and group work, written and oral communications; expository, persuasive and research-

based writings, and iterative composition. Students will generate a critical reflection on the items included in the portfolio. Those whose communication work is not up to standard will be provided with opportunity for remedial work. The course will allow for integration of communication work across the curriculum. The course will be offered on a credit/no credit basis. Students who receive no credit for this course must retake it in year 3.

CHE299H1 Y Communication

II-AECHEBASC

-/-/2/0.50

Each student will make a large number of very short speeches developing skills for speaking to large and small groups. Many elements of public speaking are explored: voice, body language, timing, word selection, speech preparation, speech structure, audience and surroundings. Students will prepare and present overheads. Extemporaneous speeches. Questions and answers. Interviewing.

CHE308H1 F Chemical Processes for Energy Generation and Storage

IV-AEESCBASEF, III-AEESCBASEJ

3/-/1/0.50

The chemistry and chemical engineering involved in various forms of power generation and storage: alternative liquid fuels, nuclear power, fuel cells, solar cells/photovoltaics. A team-taught course with instruction from leading experts within the Faculty. Lectures will be focused around the presentation and analysis of recent published accounts or a review of the state of the art, while providing the necessary background within each field to enable the students to make objective critiques of the topics discussed. Where applicable, the design of facilities and devices for the forms of generation or storage will be discussed.

CHE311H1 S Separation Processes

III-AECHEBASC

3/4/2/0.75

Staged equilibrium and rate governed separation processes for gases and liquids. Topics include equilibrium stage calculations, cascade separation, binary distillation, gas absorption and stripping, liquid-liquid extraction, membrane processes, adsorption and ion exchange. Experiments in fluid mechanics, heat transfer and related unit operations.

CHE322H1 S Process Dynamics and Control

III-AECHEBASC

3/0.25/2/0.50

The major goals of this course are to teach students how to model chemical processes and how to design control strategies for these processes. The first part of the course focuses on the types of interconnections encountered in chemical engineering, namely feedback, parallel and series connections, and their effect on the process dynamics. The second part of the course looks at the design of feedback, feedforward, cascade and multivariable control strategies for these processes and interprets these types of "engineered" interconnections in terms of the effect they have on the performance of the overall system. This course will make extensive use of interactive learning through computer simulation based on the Matlab software package and its associated Simulink block diagram simulation environment.

Course Descriptions

CHE323H1 F **Engineering Thermodynamics**

III-AECHEBASC, I-AEMINENR

3/-/2/0.50

Classical thermodynamics and its applications to engineering processes are introduced. Topics include: the concepts of energy, work and entropy; the first and second laws of thermodynamics; properties of pure substances and mixtures; the concepts of thermal equilibrium, phase equilibrium and chemical equilibrium; and heat engines and refrigeration cycles.

CHE324H1 F **Process Design**

III-AECHEBASC

3/4m/2/0.75

This course presents the philosophy and typical procedures of chemical engineering design projects. The course begins at the design concept phase. Material and energy balances are reviewed along with the design of single unit operations and equipment specification sheets. The impact of recycles on equipment sizing is covered. Safety, health and environmental regulations are presented. These lead to the development of safe operating procedures. The systems for developing Piping and Instrumentation diagrams are presented. Process safety studies such as HAZOPS are introduced. Typical utility systems such as steam, air and vacuum are discussed. Project economics calculations are reviewed.

CHE326H1 F **Thermodynamics and Kinetics Laboratory**

III-AECHEBASC

-/4m/-/0.25

This one term laboratory course involves experiments investigating thermodynamics and kinetics, complimenting two courses this term. Thermodynamic experiments include phase equilibrium and calorimetry, and kinetics experiment include investigations of rate constants and Arrhenius behaviour.

CHE332H1 F **Reaction Kinetics**

III-AECHEBASC

3/-/2/0.50

The rates of chemical processes. Topics include: measurement of reaction rates, reaction orders and activation energies; theories of reaction rates; reaction mechanisms and networks; development of the rate law for simple and complex kinetic schemes; approach to equilibrium; homogeneous and heterogeneous catalysis. Performance of simple chemical reactor types.

CHE333H1 S **Chemical Reaction Engineering**

III-AECHEBASC

3/-/2/0.50

Covers the basics of simple reactor design and performance, with emphasis on unifying the concepts in kinetics, thermodynamics and transport phenomena. Topics include flow and residence time distributions in various reactor types as well as the influence of transport properties (bulk and interphase) on kinetics and reactor performance. The interplay of these facets of reaction engineering is illustrated by use of appropriate computer simulations.

CHE334H1 S **Team Strategies for Engineering Design**

III-AECHEBASC

1/-/2/0.25

In this course, team strategies including how teams work, how to lead and manage teams, and decision making methodologies for successful teams will be taught in the context of engineering design. The development of problem solving and design steps will be undertaken. This course will be taught with an emphasis on team development and problem solving as it relates to the practice of process safety management in engineering and engineering design. The teams will develop a PFD and P&ID's, as well as an operating procedure for a portion of the process. Thus, environmental and occupational health and safety becomes the vehicle through which the teamwork is performed.

CHE341H1 F **Engineering Materials**

IV-AECHEBASC

3/-/1/0.50

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**

IV-AECHEBASC, IV-AECIVBASC,
III,IV-AECPEBASC, III,IV-AEELEBASC,
III-AEINDBASC, III-AEMECBASC,
I-AEMINBIO, IV-AEMMSBASC

3/-/1/0.50

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**

IV-AECHEBASC, IV-AECIVBASC,
III,IV-AECPEBASC, III,IV-AEELEBASC,
III-AEMECBASC, I-AEMINBIO,
IV-AEMMSBASC

3/1/2/0.50

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, hybridomas, 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: CHE353H1F

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, IV-AEESCBASET,
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.

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 module, macro economics, will introduce global aspects of business, including economic, political, societal and technological, then discuss factors such as GDP, inflation, unemployment, interest rates, foreign exchange rates, fiscal debt/surplus and balance of payments, and their impact on the financials of a given country.

CHE390H1 F Physical and Inorganic Chemistry

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,
I-AEMINBIO

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

CHE451H1 F Petroleum Processing

3/-/1/0.50

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.

Course Descriptions

CHE462H1 S **Food Engineering**

IV-AECHEBASC, I-AEMINBIO

3/-/1/0.50

The quantitative application of chemical engineering principles to the large-scale production of food. Food processing at the molecular and unit operation levels. The chemistry and kinetics of specific food processes. The application of chemical engineering unit operations (distillation, extraction, drying) and food specific unit operations such as extrusion, thermal processing refrigeration/freezing.

CHE466H1 F **Bioprocess Engineering**

IV-AECHEBASC, I-AEMINBIO,
I-AEMINENV

3/0.66/1/0.50

An introduction to the biological and engineering principles relevant to the processing of biological materials and to processing using biological agents, such as cells, enzymes or antibodies. Topics to be covered include elementary microbiology, enzyme kinetics, immobilization of biocatalysts, bioreactor design/analysis and bioseparation processes. Prerequisite: CHE353H1

CHE467H1 F **Environmental Engineering**

IV-AECHEBASC, IV-AEESCBASEO,
I-AEMINENR, I-AEMINENV

3/-/1/0.50

Core Course in the Environmental Engineering Minor A course which treats environmental engineering from a broad based but quantitative perspective and covers the driving forces for engineering activities as well as engineering principles. Models which are used for environmental impact, risk analysis, health impact, pollutant dispersion, and energy system analysis are covered.

CHE469H1 S **Fuel Cells and Electrochemical Conversion Devices**

IV-AECHEBASC, IV-AEESCBASEJ,
I-AEMINENR

3/-/1/0.50

The objective of this course is to provide a foundation for understanding the field of electrochemical conversion devices with particular emphasis on fuel cells. The topics will proceed from the fundamental thermodynamic in-system electrodics and ionic interaction limitations to mass transfer and heat balance effects, to the externalities such as economics and system integration challenges. Guest lecturers from the fuel cell industry will be invited to provide an industrial perspective. Participants will complete a paper and in-class presentation.

Exclusion: MIE517H1

CHE470H1 F/S **Special Topics in Chemical Engineering**

IV-AECHEBASC

3/-/1/0.50

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**

IV-AECHEBASC, IV-AEESCBASEF,
IV-AEESCBASET

3/-/1/0.50

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**

I-AECERRRE, IV-AECHEBASC,
IV-AEESCBASET, IV-AEMEGBASC,
I-AEMINBIO

3/-/1/0.50

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.

Exclusion: FOR424H1

CHE488H1 S **Entrepreneurship and Business for Engineers**

I-AECERBUS, I-AEMINBUS

3/-/2/0.50

A complete introduction to small business formation, management and wealth creation. Topics include: the nature of the Entrepreneur and the Canadian business environment; business idea search and Business Plan construction; Buying a business, franchising, taking over a family business; Market research and sources of data; Marketing strategies promotion, pricing, advertising, electronic channels and costing; The sales process and management, distribution channels and global marketing; Accounting, financing and analysis, sources of funding, and financial controls; The people dimension: management styles, recruiting and hiring, legal issues in employment and Human Resources; Legal forms of organization and business formation, taxation, intellectual property protection; the e-Business world and how businesses participate; Managing the business: location and equipping the business, suppliers and purchasing, credit, ethical dealing; Exiting the business and succession, selling out. A full Business Plan will be developed by each student and the top submissions will be entered into a Business Plan competition with significant cash prizes for the winners. Examples will be drawn from real business situations including practicing entrepreneurs making presentations and class visits during the term. (Identical courses are offered: ECE488H1F, MIE488H1F, MSE488H1F and CIV488H1S.)

*Complementary Studies Elective

Exclusion: APS234H1, APS432H1

CHE499Y1 Y Thesis

IV-AECHEBASC

-7/-/1.00

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

IV-AECHEBASC, IV-AEESCBASEF,
I-AEMINRAM

3/-/1/0.50

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).

This course will not be offered in 2011-2012

CHE561H1 S Risk Based Safety Management

IV-AECHEBASC, IV-AEESCBASEF

3/-/1/0.50

This course provides an introduction to Process Safety Management. The historical drivers to improve safety performance are reviewed and the difference between safety management and occupational health and safety is discussed. National and international standards for PSM are reviewed. Risk analysis is introduced along with techniques for process hazard analysis and quantification. Consequence and frequency modelling is introduced. Risk based decision making is introduced, and the course concludes with a discussion of the key management systems required for a successful PSM system.

CHE562H1 F Applied Chemistry IV – Applied Polymer Chemistry, Science and Engineering

IV-AECHEBASC, IV-AEESCBASEO,
IV-AEESCBASEJ, I-AEMINBIO,
IV-AEMMSBASC

2/-/1/0.50

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

IV-AECHEBASC, I-AEMINBIO,
I-AEMINENV

3/-/1/0.50

The processes of pulping, bleaching and papermaking are used to illustrate and integrate chemical engineering principles. Chemical reactions, phase changes and heat, mass and momentum transfer are discussed. Processes are examined on four scales: molecular, diffusional, unit operations and mill. In the tutorial each student makes several brief presentations on selected topics and entertains discussion.

CHE565H1 F Aqueous Process Engineering

IV-AECHEBASC, IV-AEESCBASEJ,
IV-AELMEBASC, I-AEMINENV,
IV-AEMMSBASC

3/-/1/0.50

Application of aqueous chemical processing to mineral, environmental and industrial engineering. The course involves an introduction to the theory of electrolyte solutions, mineral-water interfaces, dissolution and crystallization processes, metal ion separations, and electrochemical processes in aqueous reactive systems. Applications and practice of (1) metal recovery from primary (i.e. ores) and secondary (i.e. recycled) sources by hydrometallurgical means, (2) treatment of aqueous waste streams for environmental protection, and (3) production of high-value-added inorganic materials.

CHE566H1 F Introduction to Nuclear Engineering

I-AECERNUC, IV-AECHEBASC,
IV-AEESCBASEJ, I-AEMINENR

3/-/1/0.50

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

I-AECERNUC, IV-AECHEBASC,
IV-AEESCBASEJ, IV-AEESCBASEP,
I-AEMINENR

3/-/1/0.50

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

Chemistry

Course Descriptions

CHM210H1 F Chemistry of Environmental Change

I-AEMINENV

2m/-/1m/0.50

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: CHM139H1/CHM151Y1, (MAT135H1, MAT136H1)/MAT135Y1/MAT137Y1

Exclusion: ENV235Y1

CHM310H1 S Environmental Chemistry

I-AEMINENV

2m/-/0.50

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: (CHM138H1, CHM139H1)/CHM151Y1, (MAT135H1, MAT136H1)/MAT135Y1/MAT137Y1

CHM325H1 S Introduction to Inorganic and Polymer Materials Chemistry

III-AEESCBASEO

2/-/0.50

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/CHM225Y1/CHM222H1, CHM238Y1, CHM247H1/CHM249H1

CHM410H1 F Analytical Environmental Chemistry

I-AEMINENV

2/4/-/0.50

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

IV-AECHEBASC, I-AEMINENV

2/-/0.50

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: PHY138Y1/PHY140Y1/(PHY131H1, PHY132H1)/(PHY151H1, PHY152H1)

CHM426H1 F Polymer Chemistry

2/-/0.50

Scope of polymer chemistry. Classification of polymers. Synthesis and characterization. Polymers in solution. Thermodynamics of polymer solutions and blends, Flory-Huggins theory. Polymers in the solid state. Crystalline and amorphous polymers. Glass transition and melting temperature. Mechanical properties. Polymers as advanced materials. Prerequisite: CHM220H1/CHM222H1/CHM225Y1,

CHM247H1/CHM249H1

Recommended Preparation: CHM325H1

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

Civil Engineering

CIV100H1 F Mechanics

3/-/2/0.50

I-AECHEBASC, I-AECIVBASC,
I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AELMEBASC, I-AEMEGBASC,
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**

I-AEESCBASE

3/1/1/0.50

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.

CIV201H1 F **Introduction to Civil Engineering**

II-AECIVBASC

-/-/0.20

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**

II-AECIVBASC

3/2/2/0.50

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

CIV214H1 S **Structural Analysis I**

II-AECIVBASC

3/-/2/0.50

This course provides an introduction to the nature of loads and restraints and types of structural elements, and then reviews the analysis of statically determinate structures. Shear and moment diagrams for beams and frames are considered, along with influence lines, cantilever structures, three-pin arches, cables and fatigue. Virtual work principles are viewed and applied to various structural systems. An introduction to the analysis of indeterminate structures is made, and the Portal method is applied to the analysis of building frames under lateral loads. Displacement methods of an analysis including moment distribution are also studied.

Prerequisite: MAT188H1, CIV210H1/CME210H1

CIV220H1 F **Urban Engineering Ecology**

II-AECIVBASC, III,IV-AECPBASC,
III,IV-AEELEBASC, III-AEINDBASC,
III-AEMEBCASC, I-AEMINENV

3/-/1/0.50

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**

II-AECIVBASC

-/6/-/0.50

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**

IV-AECHEBASC, II-AECIVBASC,
I-AEMINENV

3/1.50/1/0.50

The hydrologic processes of precipitation and snowmelt, evapotranspiration, ground water movement, and surface and subsurface runoff are examined. Water resources sustainability issues are discussed, including water usage and water shortages, climate change impacts, land use impacts, and source water protection. Conceptual models of runoff and basics of hydrologic modelling are developed, including runoff hydrographs, the unit hydrograph method and the Rational method. Methods for statistical analysis of hydrologic data, concepts of risk and design, and hydrological consequences of climate change for design are introduced. Principles of open channel hydraulics are applied to design of lined and unlined channels. Energy and momentum principles are studied with application to channel transitions, critical flow, choked flow, hydraulic jumps, and gradually varied flow. Methods for natural channel design and channel restoration are examined.

Exclusion: EDV250H1.

Course Descriptions

CIV280H1 F Management of Construction

II-AECIVBASC, IV-AEESCBASEI

3/-/2/0.50

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

II-AECIVBASC

1/-/1/0.20

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

IV-AECHEBASC, IV-AECIVBASC,
III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASEF, III-AEINDBASC,
III-AEMEGBASC, I-AEMINENR,
I-AEMINENV

3/-/2/0.50

Core Course in the Sustainable Energy Minor Various earth systems for energy transformation, storage and transport are explored. Geological, hydrological, biological, cosmological and oceanographic energy systems are considered in the context of the Earth as a dynamic system, including the variation of solar energy received by the planet and the redistribution of this energy through various radiative, latent and sensible heat transfer mechanisms. It considers the energy redistribution role of large scale atmospheric systems, of warm and cold ocean currents, the role of the polar regions, and the functioning of various hydrological systems. The contribution and influence of tectonic systems on the surface systems is briefly introduced, as well the important role of energy storage processes in physical and biological systems, including the accumulation of fossil fuel reserves.

Exclusion: EDV300H1.

CIV301H1 S Design of Hydro and Wind Electric Plants

IV-AEESCBASEF, III-AEESCBASEJ

3/-/2/0.50

Introduction to the applications of turbo-machinery. Description of typical wind and hydroelectric plants; different types of turbo-machines. Fundamental fluid mechanics equations, efficiency coefficients, velocity triangles, characteristic curves, similarity laws, specific speed, vibration, cavitation of hydraulic turbines, pump/turbines; variable speed machines. Estimation of main dimensions of machine units, machine house, waterways, electrical and civil structure; transients and stability. Layout of electric and storage plants. Major and auxiliary equipments and systems. Small and mini plants. Case studies.

Exclusion: EDV301H1.

CIV312H1 F Steel and Timber Design

III-AECIVBASC

3/-/2/0.50

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

III-AECIVBASC

3/-/2/0.50

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

III-AECIVBASC, IV-AELMEBASC

3/1/1/0.50

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

III-AECIVBASC

3/-/1/0.50

This course introduces the fundamentals of transportation systems and the application of engineering, mathematical and economic concepts and principles to address a variety of transportation issues in Canada. Several major aspects of transportation engineering will be addressed, including transportation planning, public transit, traffic engineering, geometric design, pavement design and the economic, social and environmental impacts of transportation. The course focuses on urban transportation engineering problems.

CIV332H1 S Transport II - Performance

III-AECIVBASC

3/-/1/0.50

This course focuses on the fundamental techniques of transportation systems performance analysis with emphasis on congested traffic networks. Topics include transportation demand, supply and equilibrium, traffic assignment, network equilibrium, and system optimality, traffic flow theory, shockwaves, highway capacity analysis, introduction to deterministic and stochastic queuing analyses, intersection signal control types and related timing methods, and traffic simulation. The course also provides an introduction to basic elements of Intelligent Transportation Systems (ITS).

CIV340H1 S Municipal Engineering

III-AECIVBASC

3/-/2/0.50

Municipal service systems for water supply and wastewater disposal, land development, population forecasting, and demand analysis. Water supply: source development, transmission, storage, pumping, and distribution networks. Sewerage and drainage, sewer and culvert hydraulics, collection networks, and storm water management. Maintenance and rehabilitation of water and wastewater systems, and optimization of network design. Design projects.
Prerequisite: EDV250H1 or CIV250H1.

CIV342H1 F Water and Wastewater Treatment Processes

IV-AECHEBASC, III-AECIVBASC,
I-AEMINBIO

3/1/-/0.50

Principles involved in the design and operation of water and wastewater treatment facilities are covered, including physical, chemical and biological unit operations, advanced treatment and sludge processing. Exclusion: CIV540H1

CIV352H1 F Structural Design 1

IV-AEESCBASEF, III-AEESCBASEI

3/-/2/0.50

The course covers the analysis of determinate and indeterminate structures, with application of the principles to the design of steel bridges. The nature of loads and structural safety is considered, with reference to the Canadian Highway Bridge Design Code. Shear and bending moment diagrams for beams and frames are reviewed, as is the deflection of beams (by various methods) and the deflection of trusses. Classical bridge types, such as arches, trusses and suspension bridges are analyzed. Analysis tools studied include: Influence Lines, virtual work, fatigue, displacement methods for the analysis of indeterminate structures (including moment distribution for continuous beams), plus solution by computer frame analysis programs. The behaviour and design of basic steel members covers: tension members, compression members, beams, beam-columns and simple connections. Plastic analysis is introduced and applied to continuous beams. The expertise gained in structural analysis and steel design is then applied in a steel bridge design project.
Prerequisite: CIV102H1 or equivalent.

CIV355H1 F Urban Operations Research

III-AEESCBASEI

3/-/2/0.50

This course focuses on quantitative methods and techniques for the analysis and modelling of urban transportation and service systems. Major topics include probabilistic modelling, 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

IV-AEESCBASEF, III-AEESCBASEI

3/-/2/0.50

Building on the "Structural Design I" course, further analysis tools for indeterminate structural systems are studied with generalized flexibility and stiffness methods. Loadings due to force, support displacement, temperature change and member prestrain are covered. Timber design aspects include material properties, beams, compression members and simple connections. The behaviour and design of basic reinforced concrete elements covers concrete properties and members under axial load, shear and bending. Other practical aspects of design incorporated are crack control, minimum and maximum reinforcement ratios, durability, formwork and shoring. The aptitude for structural analysis and concrete design is then tested in a low-rise, reinforced concrete building design project.
Prerequisite: CIV352H1

CIV360H1 S Road Transportation Performance

IV-AEESCBASEF, III-AEESCBASEI

3/-/1/0.50

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

IV-AECHEBASC, III-AECIVBASC,
I-AEMINENR, I-AEMINENV

3/0.33/2/0.50

The fundamentals of the science of heat transfer, moisture diffusion, and air movement are presented. Using these fundamentals, the principles of more sustainable building enclosure design, including the design of walls and roofs are examined. Selected case studies together with laboratory investigations are used to illustrate how the required indoor temperature and moisture conditions can be maintained using more durable and more sustainable designs.
Exclusion: CIV575H1.

Course Descriptions

CIV380H1 S Sustainable Energy Systems

III-AECIVBASC, IV-AEESCBASEI

3/-/1/0.50

This course will provide students with knowledge of energy demand and supply from local to national scales. Topics include energy demands throughout the economy, major energy technologies, how these technologies work, how they are evaluated quantitatively, their economics and their impacts on the environment. In addition, the ever changing context in which these technologies (and emerging technologies) are being implemented will be outlined. Systems approaches including life cycle assessment, will be refined and applied to evaluate energy systems. A particular focus will be placed on analysis of energy alternatives within a carbon constrained economy.

Prerequisite: CIV375H1, CIV220H1.

Corequisite: CME368H1

CIV382Y1 Y Civil Engineering Communication Portfolio

III-AECIVBASC

-/-/0.25/0.00

Students will assemble a portfolio of communication assignments drawn from their second and third year Civil Engineering courses as a showcase of their ability to meet the graduate attributes for communication. The student will demonstrate competence in discipline specific written, oral, and visual communication through the selection of assignments for the portfolio. Each entry will be framed by a short introduction speaking to the context of the work and its significance in the portfolio. Students whose communication work is not up to standard will be provided with opportunities for revision. The course will be offered on a credit/no credit basis; students who receive no credit must retake the course in year 4.

CIV416H1 F Reinforced Concrete II

IV-AECIVBASC, IV-AEESCBASEI

3/-/2/0.50

This course covers the behaviour and ultimate strength of reinforced concrete structures. Members subjected to flexure, axial load, shear and torsion are treated. Detailing of reinforcement, the design of floor systems and the design of shear walls are covered. An introduction to the seismic design of reinforced concrete structures is made. Emphasis is given to the relationship between recent research results and current building codes. A brief treatment of the behaviour and design of masonry walls is included.

Prerequisite: CIV313H1.

CIV420H1 F Construction Engineering

IV-AECIVBASC

3/-/2/0.50

This course considers the engineering aspects of construction including earthmoving, equipment productivity, fleet balancing, formwork design, shoring, hoisting, aggregate production, equipment operating costs, and modular construction. Several construction projects will be reviewed to demonstrate methods and processes. Students will be expected to visit construction sites, so safety boots and hard hats are required.

CIV440H1 S Environmental Impact and Risk Assessment

IV-AECHEBASC, IV-AECIVBASC,
IV-AEESCBASEF, IV-AEESCBASEJ,
IV-AELMEBASC, IV-AEMEGBASC,
I-AEMINENR, I-AEMINENV

3/-/1/0.50

Core Course in the Environmental Engineering Minor. The process and techniques for assessing and managing the impacts on and risks to humans and the ecosystem associated with engineered facilities, processes and products. Both biophysical and social impacts are addressed. Topics include: environmental assessment processes; environmental legislation; techniques for assessing impacts; engineering risk analysis; health risk assessment; risk management and communication; social impact assessment; cumulative impacts; environmental management systems; the process of considering alternative methods for preventing and controlling impacts; and stakeholder involvement and public participation. Examples are drawn from various engineering activities and facilities such as energy production, chemical production, treatment plants, highways and landfills.

CIV455H1 F Collaborative Design Project I

IV-AEESCBASEI

1/3/-/0.50

The first of two integrated design project courses that are focussed on a single problem that has both transportation and structural design elements. This course emphasizes transportation engineering design. However, consideration of structural engineering aspects are included, in preparation for the second course in the series. Emphasis is on an integrated design process from conceptual design through to a constructible plan which addresses the functional, economic, aesthetic and environmental aspects of the problem.

CIV456H1 S Collaborative Design Project II

IV-AEESCBASEI

1/3/-/0.50

The second of two integrated design project courses that are focussed on a single problem that has both transportation and structural design elements. This course emphasizes structural engineering design. However, consideration of transportation engineering aspects are included, which are related to the first course in the series. Emphasis is on an integrated design process from conceptual design through to a constructible plan which addresses the functional, economic, aesthetic and environmental aspects of the problem.

Prerequisite: CIV455H1

CIV460H1 F Engineering Project Finance and Management

IV-AEESCBASEF, IV-AEESCBASEI

3/-/1/0.50

This course deals with the structuring, valuing, managing and financing of infrastructure projects. The financing portion builds on material covered in Engineering Economics. Key topics include; structuring projects, valuing projects, the rationale for project financing (types of funds and financing), project viability and financial modeling, risk analysis, externalities and social cost benefit analyses. Financing of large scale projects by the public and private sectors as well as through public/private partnerships is treated in detail. Project management concepts, issues, and procedures are introduced. A series of case studies analyzing both successful and unsuccessful projects are examined.

Enrolment Limits: Civil Engineering students may take this course with prior permission from the Division of Engineering Science and the Department of Civil Engineering.

CIV477H1 F/S Special Studies in Civil Engineering

IV-AECIVBASC

3/-/1/0.50

A course covering selected topics in Civil Engineering not covered in other electives. The topics, which may be different every year, are selected by Staff. Course may not be offered every year and there may be limited enrolment in particular years.

Enrolment Limits: Permission of the Department of Civil Engineering is required.

CIV488H1 S Entrepreneurship and Business for Engineers

I-AECERBUS, I-AEMINBUS

3/-/2/0.50

A complete introduction to small business formation, management and wealth creation. Topics include: the nature of the Entrepreneur and the Canadian business environment; business idea search and Business Plan construction; Buying a business, franchising, taking over a family business; Market research and sources of data; Marketing strategies promotion, pricing, advertising, electronic channels and costing; The sales process and management, distribution channels and global marketing; Accounting, financing and analysis, sources of funding, and financial controls; The people dimension: management styles, recruiting and hiring, legal issues in employment and Human Resources; Legal forms of organization and business formation, taxation, intellectual property protection; the e-Business world and how businesses participate; Managing the business: location and equipping the business, suppliers and purchasing, credit, ethical dealing; Exiting the business and succession, selling out. A full Business Plan will be developed by each student and the top submissions will be entered into a Business Plan competition with significant cash prizes for the winners. Examples will be drawn from real business situations including practicing entrepreneurs making presentations and class visits during the term. (Identical courses are offered in other Departments: MSE488H1, MIE488H1, ECE488H1 and CHE488H1.)

Exclusion: APS234H1, APS432H1.

CIV498H1 S Group Design Project

IV-AECIVBASC

-/-/3/0.50

The Group Design Project is a significant design experience that integrates the mathematics, basic sciences, engineering sciences, complementary studies, and detailed design aspects of the different civil engineering sub-disciplines.

Prerequisite: CIV497H1.

Exclusion: APS490Y1

CIV499H1 F/S Individual Project

IV-AECIVBASC

-/-/3/0.50

Individual Projects are arranged between the student and a supervising faculty member. The individual project can have either a design project focus or a research focus. If the focus is on design then the design project can be either motivated by the CIV498H1 Group Design Project experience, or it can be entirely new. The student's work must culminate in a final design report or a thesis, as well as an oral presentation. The grading of both the final written submission as well as the oral presentation is carried out by the supervising faculty member. The Individual Project may be undertaken in either the Fall (F) or Winter (S) Session, but not both (i.e., the Individual Project carries a maximum weight of 0.5; it cannot be made into a full year course)

CIV510H1 S Solid Mechanics II

IV-AECIVBASC, IV-AEESCBASEI

3/-/2/0.50

This course provides a continuing study of the mechanics of deformable solids. Stress and equilibrium conditions, strain and compatibility conditions, stress-strain relations and yield/failure criteria are considered in the context of civil engineering materials. Two- and three-dimensional elasticity theory is developed, with an introduction to the use of tensor notation. Advanced topics in bending, shear and torsion of beams are also covered, as is elementary plate bending theory. The course concludes with a further development and application of energy methods including virtual work, potential energy, strain energy, and related approaches.

Prerequisite: CIV210H1 or CME210H1.

CIV513H1 S Collaborative Engineering and Architectural Design Studio

1/5/-/0.50

Engineering and Architecture students are paired to form a design team for a specified building design project. Lectures are given on design development, aspects of structural system design, the relationship of structure to program and function, modeling and drawing, digital modeling, as well as topics related to the specific term design project. Studio design experience to familiarize students with both the synergistic and divergent goals of the engineering and architectural design and to develop collaboration skills for optimizing the outcome of the interdisciplinary professional interaction. Architecture students in this joint studio are enrolled in ARC3016Y S.

Prerequisite: CIV313H1/CIV352H1, CIV357H1.

Enrolment Limits: Enrolment will be limited to students enrolled in the

Yolles Design section of CIV498H. Graduate students may take this course by application only.

CIV514H1 F Concrete Technology

IV-AECIVBASC, IV-AEESCBASEI

3/-/2/0.50

Material aspects of concrete production will be dealt with in the context of various performance criteria with emphasis on durability. The process of material selection, proportioning, mixing, transporting, placing and curing concrete will be the framework within which topics such as: the use of admixtures, choice of cements, environmental influences, methods of consolidation and testing techniques will be studied.

Prerequisite: CIV209H1

CIV515H1 F Introduction to Structural Dynamics

IV-AECIVBASC, IV-AEESCBASEI

3/-/1/0.50

The concept of dynamic equilibrium and corresponding equation of motion will be introduced. The theoretical solution of a single degree of freedom system will be derived and the effects of various types of loads, such as impulse load, sinusoidal load, or random vibration on the structural response will be discussed. To solve dynamic problems of multi-degree of freedom (MDOF) systems, concepts of mass, stiffness, and damping matrix will be introduced, which will be followed by eigen value analysis and modal analysis. The concepts of Fourier Transformation will be introduced, which will be used to interpret dynamic responses of structures or dynamic nature of applied loads. Dynamic experiments of elastic systems will be demonstrated using an educational shaking table.

Prerequisite: CIV312H1 and CIV313H1 or equivalent

Course Descriptions

CIV516H1 S Public Transit Operations and Planning

IV-AECIVBASC, IV-AEESCBASEF,
III-AEESCBASEI

3/-/1/0.50

This course covers a broad range of topics in urban transit operations and planning, with special emphasis on best-practice strategies of modern transit systems. The course will help students: Learn the history of transit and its relationship to urban development, emerging challenges, transit role in society, and new trends and issues; Understand and analyze the factors that affect transit performance and demand; Identify and analyze transit operational and planning problems; Identify possible solutions at the operational level (mostly short-term and line-based) and the strategic level (mostly long-term and network-based), and assess alternative solutions; Understand the relative performance of various transit modes (both conventional and new modes) and their domains of application; and gain knowledge of best-practice transit systems planning and emerging innovations.

CIV517H1 F Prestressed Concrete

IV-AECIVBASC, IV-AEESCBASEI

3/-/0.50

An introduction to procedures for predicting the load-deformation response of prestressed concrete elements and structures with emphasis on how these procedures can be used in the design of new structures and in the evaluation of existing structures. Topics include: prestressing technology; control of cracking; response to axial load and flexure; response to shear and torsion; disturbed regions; restraint of deformations; design codes.

Prerequisite: CIV313H1 or CIV357H1 or equivalent.

CIV518H1 S Behaviour and Design of Steel Structures

IV-AECIVBASC, IV-AEESCBASEI

3/-/2/0.50

The behaviour and design of trusses, frames, members and connections in steel building and bridge structures is presented and design methods are developed. Ultimate strength, stability, and postbuckling are emphasized in topical examples including: plate girders, composite steel/concrete girders, second-order frame behaviour, high-strength bolted and welded framing connections. Design applications considering metal fatigue and brittle fracture, and methods of plastic analysis are also introduced. Canadian design standards and the Limit States Design concepts are used.

CIV519H1 F Structural Analysis II

IV-AECIVBASC

3/-/2/0.50

The general flexibility and stiffness methods of analysis; 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

IV-AECIVBASC

3/1/-/0.50

This course provides general analytical tools and experimental methods that are used in rock mechanics. The lectures are complemented with laboratory experiments. Theoretical topics include: stress and strain, linear elasticity, failure modes and models of rocks, fracture of rocks,

inelastic behavior of rock, seismic waves in rocks.

Experiments include: preparation of rock samples, uniaxial compressive strength measurements, Brazilian disc tests for rock tensile strength, fracture toughness measurements with core-based rock samples.

Prerequisite: CIV210H1/CME210H1

CIV523H1 S Geotechnical Design

IV-AECIVBASC, IV-AEESCBASEI,
IV-AELMEBASC

3/-/1/0.50

This course is built around a transportation project that contains all the essential geotechnical investigation and design elements and illustrates how they all come together on a project. The students will be taken through the entire design process from project initiation to construction. In essence, the project will include a bridge over a river with some property constraints requiring the use of a retaining wall as well as deep and shallow foundations and some groundwater control. The highway will require a soil cut. One section crosses a low-lying swampy area that will require embankment construction over deep soft soils. A short tunnel section is planned beneath a railway that cannot be taken out of service. A pavement design will be required along the entire route as well as materials testing and construction monitoring.

Prerequisite: CIV321H1/CME321H1; equivalent or permission of instructor

CIV531H1 F Transport Planning

IV-AECIVBASC, IV-AEESCBASEF,
III-AEESCBASEI, I-AEMINENR,
I-AEMINENV

3/-/1/0.50

This course is intended to provide the student with the following: the ability to design and execute an urban transportation planning study; a working knowledge of transportation planning analysis skills including introductions to travel demand modelling, analysis of environmental impacts, modelling transportation - land use interactions and transportation project evaluation; an understanding of current transportation planning issues and policies; and an understanding of the overall process of transportation planning and its role within the wider context of transportation decision-making and the planning and design of urban areas. Person-based travel in urban regions is the focus of this course, but a brief introduction to freight and intercity passenger transportation is also provided. A "systems" approach to transportation planning and analysis is introduced and maintained throughout the course. Emphasis is placed throughout on designing transportation systems for long-run environmental, social, and economic sustainability.

Prerequisite: CIV368H1 / CME368H1.

CIV541H1 S Environmental Biotechnology

IV-AECIVBASC, I-AEMINBIO,
I-AEMINENV

3/-/0.50

Principles involved in the design and operation of biologically-based treatment facilities are covered with considerations for energy efficiency and sustainability. The course includes water / wastewater biological unit operations, advanced treatment, sludge processing and composting, natural treatment systems and specialized bioengineered systems such as groundwater remediation and biological air treatment.

Prerequisite: CIV342H1 or equivalent.

CIV549H1 F **Groundwater Flow and Contamination**

3/-/1/0.50

IV-AECHEBASC, IV-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

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-AEMINENV,
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-AEMINENV, 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

Course Descriptions

CME263H1 S **Probability Theory for Civil and Mineral Engineers**

II-AECIVBASC, II-AELMEBASC

3/-/2/0.50

Probability theory as the study of random phenomena in Civil and Mineral Engineering systems, including the definition of probability, conditional probability, Bayes' theorem in discrete and continuous sample spaces. Common single and multivariate distributions. Mathematical expectation including mean and variance. Independence. An introduction to realizations of probability models and parameter estimation.

Exclusion: CIV263H1

CME270H1 F **Fluid Mechanics I**

II-AECIVBASC, II-AELMEBASC

3/1.50/1/0.50

Fluid and flow characteristics, applications, dimensions and units. Fluid statics. One-dimensional flow including conservation of mass, energy and momentum. Introduction to dimensional analysis and 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**

III-AECIVBASC, IV-AEESCBASEF,
III-AEESCBASEI, III-AELMEBASC

3/1/1/0.50

An introduction to elements of geotechnical analysis and design. Shear strength at constant volume; ultimate limit state design of retaining walls, shored excavations, 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)**

III-AECIVBASC, III-AELMEBASC

-/-/0.50

This two-week August field camp provides students with the opportunity to further their understanding of the vital interactions between the natural and the built environments. Through fieldwork, students gain hands-on experience in the use of various field instruments used by Civil and Mineral Engineers. The essentials of land surveying and the use of surveying instruments including Global Positioning Systems are taught as students carry out a series of field exercises that include route surveys, topographic surveys and construction surveys. Survey calculations, sources of error, corrections and adjustments are also introduced. In order to better understand our impact on the natural environment, students also perform several additional exercises. These may include the measurement of river flows, remote sensing of soil and rock, remediation of a borrow pit, and the evaluation of the renewable energy potential of the wind and solar radiation. Note: This course requires payment of an extra fee for room and board.

Exclusion: CIV358H1

CME362H1 S **Engineering Mathematics II**

III-AECIVBASC, II-AELMEBASC

3/-/2/0.50

This course continues the study of numerical and analytical methods for civil engineering analysis. Analytical and numerical methods for solving ordinary differential equations are treated in some detail, followed by numerical solution methods for partial differential equations. The final major topic of the course deals with an introduction to optimization. Emphasis is placed throughout the course on problem formulation, solution algorithm design and programming applications.

Exclusion: CIV362H1

CME368H1 F **Engineering Economics and Decision Making**

I-AECERBUS, I-AECERENTR,
III-AECIVBASC, III-AELMEBASC,
I-AEMINBUS

3/-/1/0.50

The incorporation of economic and non-monetary considerations for making decision about public and private sector engineering systems in urban and other contexts. Topics include rational decision making; cost concepts; time value of money and engineering economics; microeconomic concepts; treatment of risk and uncertainty; and public project evaluation techniques incorporating social and environmental impacts including benefit cost analysis and multi-objective analysis.

Exclusion: CIV368H1

Commerce

RSM430H1 F **Fixed Income Securities**

IV-AEESCBASEF

2/-/0.50

Describes important fixed income securities and markets. The course emphasizes traditional bond and term structure concepts crucial to understand the securities traded in these markets. Students are required to work in the Rotman Financial Research & Trading Lab to solve the assigned problems using real time data. 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**

IV-AEESCBASEF

2/-/0.50

This course examines the ways in which risks are quantified and managed by financial institutions. The principal risks considered include market risk, credit risk and operational risk. The course also covers the evolution of bank regulation and the regulatory limits on risk taking. Not eligible for CR/NCR option. Contact Rotman Commerce for details.

Prerequisite: RSM333H1

RSM434H1 S **Financial Trading Strategies (formerly RSM412H1 Financial Trading Strategies)**

IV-AEESCBASEF

2/-/0.50

This course will use finance theory applied with Excel applications to understand potential returns and risks inherent in particular investment/trading strategies. Learning-by-doing will be facilitated by simulation-based *Rotman Interactive Trader* cases focused on particular

risks. This training will be analogous to using a flight simulator for learning to fly. 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

I-AEESCBASE

3/3/-/0.50

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.

CSC190H1 S Computer Algorithms and Data Structures

I-AEESCBASE

3/3/-/0.50

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.

CSC192H1 F Computer Programming, Algorithms, Data Structures and Languages

3/3/-/0.50

An accelerated and combined version of CSC180H1 and CSC190H1 intended for students who have some previous programming experience (e.g. one year programming in Turing, Pascal, Java, C or similar languages.) Students will focus on problem decomposition and the use of programming paradigms appropriate to the problems being solved. Computational thinking is introduced as a means to solve problems through a focus on algorithm, data, and models of computation. Students will design and implement computational solutions to problems drawn from their 1F courses, and will explore new programming paradigms appropriate to these challenges. More advanced forms of computational thinking suitable for understanding and solving a wider variety of problems are introduced.

Not offered in 2014-2015.

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, CSC343H1

CSC318H1 F/S The Design of Interactive Computational Media

2/-/1/0.50

IV-AEESCBASER

User-centred design of interactive systems; methodologies, principles, and metaphors; task analysis. Interdisciplinary design; the role of graphic design, industrial design, and the behavioural sciences. Interactive hardware and software; concepts from computer graphics. Typography, layout, colour, sound, video, gesture, and usability enhancements. Classes of interactive graphical media; direct manipulation systems, extensible systems, rapid prototyping tools. Students work on projects in interdisciplinary teams. Enrolment limited, but non-computer scientists welcome.

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

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-AEESCBASER

Introduction to database management systems. The relational data model. Relational algebra. Querying and updating databases: the query language SQL. Application programming with SQL. Integrity constraints, normal forms, and database design. Elements of database system technology: query processing, transaction management.

Prerequisite: CSC165H1/CSC240H1/(MAT135H1, MAT136H1)

/MAT135Y1/MAT137Y1/MAT157Y1; CSC207H1Prerequisite for

Engineering students only: ECE345/CSC190/CSC192

Exclusion: CSC434H1

Course Descriptions

CSC373H1 F/S **Algorithm Design, Analysis & Complexity**

2/-/1/0.50

Standard algorithm design techniques: divide-and-conquer, greedy strategies, dynamic programming, linear programming, randomization, network flows, approximation algorithms. Brief introduction to NP-completeness: polynomial time reductions, examples of various NP-complete problems, self-reducibility. Students will be expected to show good design principles and adequate skills at reasoning about the correctness and complexity of algorithms.

Prerequisite: CSC263H1/CSC265H1

Exclusion: CSC375H1

CSC384H1 F/S **Introduction to Artificial Intelligence**

2/-/1/0.50

IV-AEESCBASER, 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, 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

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 **Machine Learning and Data Mining**

2/-/1/0.50

IV-AEESCBASER, 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.

Prerequisite: CSC263H1/CSC265H1,

MAT(135H1,136H1)/MAT137Y1/MAT137Y1/MAT157Y1,

STA247H1/STA255H1/STA257H1,

STA248H1/STA250H1/STA261H1

Recommended Preparation: CSC336H1/CSC350H1

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, 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

CSC446H1 S **Computational Methods for Partial Differential Equations**

2/-/1/0.50

Finite difference methods for hyperbolic and parabolic equations; consistency, convergence, and stability. Finite element methods for 2-point boundary value problems and elliptic equations. Special problems of interest. Ordinarily offered in years alternating with CSC456H1.

Prerequisite: CSC351H1/(CSC336H1 (75%))/equivalent mathematical background; MAT237Y1/MAT257Y1;

APM346H1/APM351Y1/(MAT244H1/MAT267H1 and exposure to PDEs)

CSC467H1 F Compilers and Interpreters

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

Compiler organization, compiler writing tools, use of regular expressions, finite automata and context-free grammars, scanning and parsing, runtime organization, semantic analysis, implementing the runtime model, storage allocation, code generation.

Prerequisite: ECE352H1

Earth Science

ESS221H1 F Minerals and Rocks

II-AELMEBASC

2m/3m/-/0.50

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

Recommended Preparation: (CHM138H1,CHM139H1)/CHM151Y1

ESS222H1 S Petrology

II-AELMEBASC

2m/3m/-/0.50

Origin and classification of igneous, sedimentary and metamorphic rocks and their associated ore deposits. Emphasis is placed on formation of rock types in the context of plate tectonic theory, and the practical aspects of rock identification in hand sample and thin section.

Prerequisite: ESS221H1

Exclusion: GLG207H1

ESS241H1 F Geologic Structures and Maps

III-AELMEBASC

2m/3m/-/0.50

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

Recommended

Preparation: (PHY131H1,PHY132H1)/(PHY151H1,PHY152H1)

ESS331H1 F Sedimentation and Stratigraphy

IV-AELMEBASC

2m/3m/-/0.50

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

Recommended Preparation: ESS222H1, ESS330H1

ESS423H1 F Mineral Deposits

IV-AELMEBASC

2m/3m/-/0.50

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

IV-AELMEBASC

2m/1m/-/0.50

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

Ecology and Evolutionary Biology

EEB214H1 S Evolution and Adaptation

III,IV-AECPEBASC, III,IV-AEELEBASC

2/-/1/0.50

Evolution and adaptation of life on Earth. Introduction to the theory of evolution by natural selection. Topics may include: evidence supporting the fact of evolution, and how evolutionary theory can help explain the world around us, such as how species are formed, and the evolution of sex, infanticide, and disease.

Exclusion: BIO120H1/BIO150Y1

Electrical and Computer Engineering

ECE101H1 F Seminar Course: Introduction to Electrical and Computer Engineering

I-AECPEBASC, I-AEELEBASC

1/-/0.15

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.

Course Descriptions

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.

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 the various third and fourth year ECE courses will offer a weekly seminar lecture to help guide students to select a set of practical and worthwhile upper year courses for their intended career. This courses 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 and microprogrammed control. Input-output and the use of interrupts. Arithmetic circuits. Assembly language programming. Main memory organization. Peripherals and interfacing. Microprocessors. System design considerations. The laboratory will consist of experiments involving logic systems and microprocessors. 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

II-AEESCBASE

3/3/-/0.50

Digital system design principles. Logic circuits, logic synthesis. Registers, arithmetic circuits, counters, finite state machines, and programmable logic devices. Verilog hardware description language. Computer structure, machine language instruction execution and sequencing, addressing techniques. Processors, input/output techniques, and memory hierarchy. The laboratory work consists of exercises involving the design of logic circuits, and microprocessor systems. Modern computer-aided design tools and FPGA technology are used. Design aspects constitute a major portion of laboratory work.

Exclusion: ECE341H1 and ECE370H1

ECE259H1 S Electromagnetism

II-AEESCBASE

3/-/1/0.50

The fundamental laws of electromagnetics are covered; including Coulomb's law, Gauss' law, Poisson's and Laplace's equations, the Biot-Savart's law, Ampere's law, Faraday's law, and Maxwell's equations. 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.

ECE297H1 S Communication and Design

II-AECPEBASC, II-AEELEBASC

2/2m/2m/0.50

An introduction to electrical and computer engineering design processes illustrated by the design and implementation of software systems. Creative development with appropriate organizational and reporting and recording activities, both oral and written, is emphasized. The general design cycle and pragmatic strategies used in the creation of small designs and larger systems are presented. These methods are implemented in practical lab work done in teams. Oral skills are developed in seminars and team discussions, by learning to handle questions, and by making formal presentations. Written skills are developed in reports related to the lecture and lab activities.

ECE302H1 F/S Probability and Applications

III,IV-AECPEBASC, III,IV-AEELEBASC

3/-/2m/0.50

Events, sample space, axioms of probability. Discrete and continuous random variables, distribution and density functions. Bernoulli trials, Binomial, geometric, Poisson, exponential and Gaussian distributions. Expectation, moments, characteristic function, correlation coefficient. Functions of random variables. Random vectors, joint distributions, transformations. Applications will be chosen from communication theory, estimation and hypothesis testing, and other areas of electrical engineering.

Prerequisite: MAT290H1 and MAT291H1 and ECE216H1

Exclusion: STA286H1

ECE311H1 F/S Dynamic Systems and Control

III,IV-AECPEBASC, III,IV-AEELEBASC

3/1.50m/1m/0.50

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

III,IV-AECPEBASC, III,IV-AEELEBASC,
I-AEMINENR

3/1.50m/1m/0.50

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

III,IV-AECPEBASC, III,IV-AEELEBASC,
I-AEMINRAM

3/1.50m/1m/0.50

An introductory course in analog and digital communication systems. Analog and digital signals. Signal representation and Fourier transforms; energy and power spectral densities; bandwidth. Distortionless analog communication; amplitude, frequency and phase modulation systems; frequency division multiplexing. Sampling, quantization and pulse code modulation (PCM). Baseband digital communication; intersymbol interference (ISI); Nyquist's ISI criterion; eye diagrams. Passband digital communications; amplitude-, phase- and frequency-shift keying; signal constellations. Performance analysis of analog modulation schemes in the presence of noise. Performance analysis of PCM in noise.

Prerequisite: (MAT290H1 and ECE216H1) or (MAT389H1 and

ECE355H1)

ECE318H1 S Fundamentals of Optics

IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASEO, IV-AEESCBASEP,
IV-AEESCBASER, IV-AEESCBASET

3/1.50m/1m/0.50

Geometric Optics: Spherical surfaces, lenses and mirrors, optical imaging systems, matrix method, and aberrations. Polarization: Polarizer and polarizations, anisotropic materials, dichroism, birefringence, index ellipsoid, waveplates, optical activity, Faraday effect. Interference: superposition of waves, longitudinal and transverse coherence, Young's double-slit experiment, Michelson and Fabry-Perot interferometer, thin-films. Diffraction and Fourier Optics: diffraction theory, single and double

Course Descriptions

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

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. (Background preparation in ECE320H1 - Fields and Waves is strongly recommended).
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

IV-AECPEBASC, III,IV-AEELEBASC

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-AEMECCBASC

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

IV-AEESCBASEF, 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

III-AEESCBASEO, IV-AEESCBASEP,
III-AEESCBASER

3/1.50/1/0.50

An explanation of the basic operation, design and limitations of semiconductor electronic devices, such as diodes and transistors. The topics covered include: electrons in semiconductors, semiconductors in equilibrium, transport of carriers, p-n diodes, metal-semiconductor contacts, bipolar junction transistors, metal-oxide-semiconductor (MOS) capacitors, and MOS field effect transistors. In addition, optoelectronic devices (e.g. photodiodes, light emitting diodes and lasers), semiconductor heterostructures, nanostructures and transistor scaling will be discussed.

ECE352H1 F Computer Organization

IV-AEESCBASEF, III-AEESCBASER

3/3-/0.50

A continuation of some of the topics introduced in ECE253F, Digital and Computer Systems. Synchronous and asynchronous sequential circuits, pipelining, integer and floating-point arithmetic, RISC processors.

ECE353H1 S Systems Software

IV-AEESCBASEF, III-AEESCBASER,
I-AEMINRAM

3/3-/0.50

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

III-AEESCBASER

3/1.50/0.50/0.50

A course on analog and digital electronic circuits. Topics include single-stage amplifiers, current mirrors, cascode amplifiers and differential pairs. Amplifier frequency response, feedback and stability are also covered. Digital CMOS logic circuits are introduced.

ECE355H1 F Signal Analysis and Communication

IV-AEESCBASEF, III-AEESCBASER

3/-/2/0.50

An introduction to continuous-time and discrete-time signals and systems. Topics include characterization of linear time-invariant systems, Fourier analysis, linear filtering, sampling of continuous-time signals, and modulation techniques for communication systems.

ECE356H1 S Linear Systems and Control

IV-AEESCBASEO, III-AEESCBASER

3/1.50/1/0.50

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. Frequency response. Nyquist stability. Loop shaping theory. Computer aided design using MATLAB and Simulink.

Prerequisite: ECE355H1

ECE357H1 S Electromagnetic Fields

III-AEESCBASEP, III-AEESCBASER

3/1.50/1/0.50

An introduction to transmission line theory: voltage and current waves, characteristic impedance, reflections from the load and source, transients on the line, Smith's chart, impedance matching. Fundamentals of electromagnetic theory: Maxwell's equations, Helmholtz's theorem, time retarded scalar and vector potentials, gauges, boundary conditions, electric and magnetic fields wave equations and their solutions in lossless and lossy medium. Plane wave propagation, reflection and transmission at boundaries. Constitutive relations and dispersion. Radiating dipole and waveguides.

ECE358H1 S Foundations of Computing

IV-AEESCBASEF, III-AEESCBASER,
I-AEMINRAM

3/-/1/0.50

Fundamentals of algorithm design and computational complexity, including: analysis of algorithms, graph algorithms, greedy algorithms, divide-and-conquer, dynamic programming, network flow, approximation algorithms, the theory of NP-completeness, and various NP-complete problems.

ECE360H1 F Electronics

IV-AEESCBASEF, III-AEESCBASEP,
III-AEESCBASER

3/1.50/1/0.50

An introduction to electronics. Basic electronic circuits: introductory frequency analysis, operational amplifiers, diodes, bipolar junction transistors, field-effect transistors, small-signal analysis, frequency response of single-stage circuits.

ECE361H1 F/S Computer Networks I

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

Layered network architectures; overview of TCP/IP protocol suite. Introduction to sockets; introduction to application layer protocols. Peer-to-Peer Protocols: ARQ; TCP reliable stream service; flow control. Data Link Controls: Framing; PPP; HDLC. Medium access control and LANs: Aloha; Ethernet; Wireless LANs; Bridges. Packet Switching: Datagram and virtual circuit switching; Shortest path algorithms; Distance vector and link state algorithms.

Prerequisite: STA286H1 or ECE302H1

Corequisite: ECE302H1. (Students must take the co-requisite, ECE302H1 in the same term as ECE361H, OR in a term before taking ECE361H1.)

ECE363H1 S Communication Systems

III-AEESCBASER, IV-AEESCBASET

3/1.50/1/0.50

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.

Course Descriptions

Prerequisite: MAT389H1 and ECE355H1

ECE410H1 F Control Systems

III,IV-AECPEBASC, III,IV-AEELEBASC,
I-AEMINRAM

3/1.50m/1m/0.50

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

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER, IV-AEESCBASET,
I-AEMINRAM

3/1.50m/1m/0.50

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

ECE413H1 S Energy Systems and Distributed Generation

III,IV-AECPEBASC, III,IV-AEELEBASC,
III-AEESCBASEJ, IV-AEESCBASER,
I-AEMINER

3/1.50m/1m/0.50

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 (DER); distributed energy storage; interface between DER and power system.

Prerequisite: ECE314H1 or ECE315H1 or ECE349H1 or ECE359H1

ECE417H1 S Digital Communication

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

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

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

Design issues in distributed systems: heterogeneity, security, transparency, concurrency, fault-tolerance; networking principles; request-reply protocol; remote procedure calls; distributed objects; middleware architectures; CORBA; security and authentication protocols; distributed file systems; name services; global states in distributed systems; coordination and agreement; transactions and concurrency control; distributed transactions; replication.

Prerequisite: ECE344H1 or ECE353H1

ECE422H1 S Radio and Microwave Wireless Systems

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

Analysis and design of systems employing radio waves, covering both the underlying electromagnetics and the overall system performance aspects such as signal-to-noise ratios. Transmission/reception phenomena include: electromagnetic wave radiation and polarization; elementary and linear dipoles; directivity, gain, efficiency; integrated, phased-array and aperture antennas; beam-steering; Friis transmission formulas. Propagation phenomena include: diffraction and wave propagation over obstacles; multipath propagation in urban environments; atmospheric and ionospheric effects. Receiver design aspects include: receiver figures of merit, noise in cascaded systems, noise figure, and noise temperature. System examples are: fixed wireless access; mobile and personal communication systems; wireless cellular concepts; satellite communications; radar; radiometric receivers; GPS.

Prerequisite: ECE320H1 or ECE357H1

ECE431H1 F/S Digital Signal Processing

III,IV-AECPEBASC, III,IV-AEELEBASC,
I-AEMINRAM

3/1.50m/1m/0.50

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 to communications: decimators and interpolators, estimation, equalization. DSP applications to multimedia: DCT and video coding.

ECE442H1 F Introduction to Micro- and Nano-Fabrication Technologies

IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASEO, IV-AEESCBASER,
IV-AEESCBASET, IV-AEMMSBASC

3/2m/1m/0.50

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.

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, 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 hierarchical 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.

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, 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.

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 F/S

Course Descriptions

ECE462H1 S Multimedia Systems

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/2m/-/0.50

Topics in the engineering area of multimedia systems with particular emphasis on the theory, design features, performance, complexity analysis, optimization and application of multimedia engineering technologies. Topics include sound/audio, image and video characterization, compression, source entropy and hybrid coding, transform coding, wavelet-based coding, motion estimation, JPEG coding, digital video coding, MPEG-1/2 coding, content-based processing, and MPEG-7.

ECE463H1 S Electric Drives

III,IV-AECPEBASC, III,IV-AEELEBASC,
III-AEESCBASEJ, IV-AEESCBASER

3/1.50m/1m/0.50

Electro-mechanical mechanisms for force and torque production in rotating machines. DC machine theory and DC machine dynamics, synchronous machines and their dynamics, stepper motors. Introduction to space vectors and vector control of AC machines. Steady state and variable speed operation of the induction machine via V/f control.

Prerequisite: (ECE314H1 or ECE315H1) or ECE349H1 or ECE359H1

ECE464H1 S Wireless Communication

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

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. Rayleigh 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

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

Traffic modeling; network calculus; traffic classification; traffic regulation: shaping, filtering, policing, leaky bucket; queueing systems; scheduling; quality of service: Diffserv and IntServ/RSVP; multi-protocol label switching; call admission control / congestion control; switching; pricing; optical networks.

Prerequisite: ECE361H1

ECE469H1 S Optical Communications and Networks

IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

This course provides an introduction to optical communication systems and networks at the system and functional level. Applications range from telecommunication networks (short to long haul) to computing networks (chip-to-chip, on chip communications, optical backplanes). Basic principles of optical transmission and associated components used for transmission of light and optical networks; system design tools for optical links; multi-service system requirements; optical network design tools (routing and wavelength assignment), network management and survivability.

Exclusion: ECE425H1 or ECE467H1

ECE470H1 S Robot Modeling and Control

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER, IV-AEESCBASET

3/1.50m/1m/0.50

Classification of robot manipulators, kinematic modeling, forward and inverse kinematics, velocity kinematics, path planning, point-to-point trajectory planning, dynamic modeling, Euler-Lagrange equations, inverse dynamics, joint control, computed torque control, passivity-based control, feedback linearization.

Prerequisite: ECE311H1 or ECE356H1

Exclusion: AER525H1

ECE472H1 F/S Engineering Economic Analysis & Entrepreneurship

I-AECERBUS, I-AECERENTR,
III,IV-AECPEBASC, III,IV-AEELEBASC,
I-AEMINBUS

3/-/2m/0.50

The economic evaluation and justification of engineering projects and investment proposals are discussed. Cost concepts; financial and cost accounting; depreciation; the time value of money and compound interest; inflation; capital budgeting; equity, bond and loan financing; income tax and after-tax cash flow; measures of economic merit in the private sector; sensitivity and risk analysis. Applications: evaluations of competing engineering project proposals; replacement analysis; economic life of assets; lease versus buy decisions; break-even analysis; decision tree analysis. Entrepreneurship and the Canadian business environment will be discussed.

ECE488H1 F Entrepreneurship and Business for Engineers

I-AECERBUS, I-AEMINBUS

3/-/2/0.50

A complete introduction to small business formation, management and wealth creation. Topics include: the nature of the Entrepreneur and the Canadian business environment; business idea search and Business Plan construction; Buying a business, franchising, taking over a family business; Market research and sources of data; Marketing strategies promotion, pricing, advertising, electronic channels and costing; The sales process and management, distribution channels and global marketing; Accounting, financing and analysis, sources of funding, and financial controls; The people dimension: management styles, recruiting and hiring, legal issues in employment and Human Resources; Legal forms of organization and business formation, taxation, intellectual property protection; the e-Business world and how businesses participate; Managing the business: location and equipping the business, suppliers and purchasing, credit, ethical dealing; Exiting the business and succession, selling out. A full Business Plan will be developed by each student and the top submissions will be entered into a Business Plan

competition with significant cash prizes for the winners. Examples will be drawn from real business situations including practicing entrepreneurs making presentations and class visits during the term. (Identical courses are offered: MSE488H1F, MIE488H1F, CHE488H1S and CIV488H1S.)
Exclusion: APS234 and APS432

ECE496Y1 Y Design Project

III,IV-AECPEBASC, III,IV-AEELEBASC 1/-/1.00

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

III,IV-AECPEBASC, III,IV-AEELEBASC, 3/-/2m/0.50
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

ECE512H1 S Analog Integrated Systems

III,IV-AECPEBASC, III,IV-AEELEBASC, 3/-/2m/0.50
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

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, 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

3/-/2m/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASEF, IV-AEESCBASER

Squared error and the Gaussian probability distribution. Maximum likelihood estimation. Logistic regression, neural networks, radial basis function networks. Occam's razor, validation, bagging, Bayesian techniques. Auto-encoders, principal components analysis, clustering. The EM algorithm. 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. Estimating graphical models. Applications to image classification, image processing, object tracking, speech recognition, telecommunications and genomics.

Prerequisite: STA286H1 or ECE302H1

ECE524H1 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

Course Descriptions

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.

ECE525H1 S Lasers and Detectors

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASEO, IV-AEESCBASEP,
IV-AEESCBASER

3/-/2m/0.50

This course focuses on photonic components which generate or absorb light. Lasers: spontaneous and stimulated emission, gain and absorption, gain broadening; modulation dynamics, mode-locking, Q-switching; semiconductor lasers. Photodetectors: absorption, photo-generated currents, noise in detection.

Prerequisite: One of ECE330/350H1 or PHY335/355H1, and one of ECE318/320/357H1. ECE318H1 can also be taken as a co-requisite instead of a pre-requisite.

ECE527H1 F Photonic Devices

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASEJ, IV-AEESCBASEO,
IV-AEESCBASEP, IV-AEESCBASER

3/-/2m/0.50

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

ECE530H1 F Analog Integrated Circuits

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

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

ECE532H1 S Digital Systems Design

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER, I-AEMINRAM

3/3m/-/0.50

Advanced digital systems design concepts including project planning, design flows, embedded processors, hardware/software interfacing and interactions, software drivers, embedded operating systems, memory interfaces, system-level timing analysis, clocking and clock domains. A significant design project is undertaken and implemented on an FPGA development board.

Prerequisite: ECE342H1 or ECE352H1

ECE533H1 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

ECE534H1 F Integrated Circuit Engineering

3/3m/-/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

The course deals with the technology and design of analog, digital and RF integrated circuits, including exposure to computer aided IC design tools at the semiconductor process, device, and circuit layout level. Topics include: IC fabrication review, MOS IC process modules and components; RF (Bi) CMOS IC process modules and components; compact modelling, characterization and design automation; Bipolar/CMOS digital, analog, and RF IC building blocks; packaging and yield. The labs will expose students to the major design steps in the development of a multi-purpose (Bi) CMOS process.

Prerequisite: (ECE331H1 or ECE334H1 or ECE354H1) and (ECE335H1 or ECE350H1)

ECE535H1 F Advanced Electronic Devices

3/1.50m/1m/0.50

IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

Heterojunctions, SiGe, InP and GaSb HBTs. MOS device scaling and scaling limits, Dennard's constant field scaling rules, device characteristics and short channel effects. Charge quantization, gate stack, strain and substrate engineering in nanoscale MOSFETs. Nanoscale CMOS fabrication process flow, isolation methods, strategies to suppress short channel effects, stress memorization techniques. Technology CAD for process and device simulations. SPICE models for circuit simulation. SOI (Silicon on Insulator) technology, III-V FETs and graphene transistors. High Power Devices: LDMOS, AlGaIn/GaN HEMTs.

Prerequisite: ECE335H1 or ECE350H1

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

III,IV-AECEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/3m/-/0.50

Theoretical and practical aspects of building modern optimizing compilers. Topics: intermediate representations, basic blocks and flow graphs, data flow analysis, partial evaluation and redundancy elimination, loop optimizations, register allocation, instruction scheduling, interprocedural memory hierarchy optimizations. Students will implement significant optimizations within the framework of a modern research compiler. Experience in C programming required.

ECE552H1 F Computer Architecture

III,IV-AECEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/1.50m/1m/0.50

Performance analysis and metrics and cost. Instruction set architectures. Instruction-level parallelism: pipelining, superscalar, dynamic scheduling, VLIW processors. Data-level parallelism: 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

IV-AEESCBASEA, IV-AEESCBASER,
IV-AEESCBASET, I-AEMINRAM

3/1.50/1/0.50

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 S Computer Security

III,IV-AECEBASC, III,IV-AEELEBASC,
IV-AEESCBASER

3/3m/-/0.50

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 web servers.

Prerequisite: ECE344H1 or ECE353H1

Engineering Science

ESC101H1 F Praxis I

I-AEESCBASE

3/-/2/0.50

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.

ESC102H1 S Praxis II

I-AEESCBASE

3/-/2/0.50

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.

ESC103H1 F Engineering Mathematics and Computation

I-AEESCBASE

2/-/2/0.50

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, Society & Critical Thinking

II-AEESCBASE

3/-/1/0.50

Through this course, students will examine the interrelations of science, technology, society and the environment (STSE), emphasizing a humanities and social sciences perspective. Using topics in STSE as the context, students will consider established models of critical thinking and develop their own framework for analyzing socio-technical issues. Students will have the opportunity to apply tools learned through persuasive writing and formal debate. Upon completion of the course, students will have an understanding of how structured models of thinking can aid in the analysis and evaluation of thought, and should be able to

Course Descriptions

apply tools of critical thinking in other contexts.

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

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.

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

IV-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 prepare a thesis on an approved subject. Instructions concerning the thesis requirements are issued during the Winter Session of Third Year and copies may be obtained in the Division office. The weight allocated to the thesis in each option is shown in the Fourth Year curriculum. Full year theses are graded after submission in the Winter Session and the grade included in the weighted average for that session only.

ESC499Y1 Y Thesis

3/2/-/1.00

IV-AEESCBASEA, IV-AEESCBASEF,
IV-AEESCBASEJ, IV-AEESCBASEO,
IV-AEESCBASEP, IV-AEESCBASER,
IV-AEESCBASET

Every student in Fourth Year Engineering Science is required to prepare a thesis on an approved subject. Instructions concerning the thesis requirements are issued during the Winter Session of Third Year and copies may be obtained in the Division office. The weight allocated to the thesis in each option is shown in the Fourth Year curriculum. Full year theses are graded after submission in the Winter Session and the grade included in the weighted average for that session only.

Environment

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/C
HM138H1/
CHM139H1/CHM151Y1/PHY138Y1/PHY140Y1/PHY131H1/PHY132
H1/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/GGR222H1)/ENV222Y1/GGR222
Y1/JGE221Y1 or permission of Undergraduate Coordinator

Forestry

FOR308H1 F Discovering Wood and its Role in Societal Development

3/-/1/0.50

I-AECERRRE, I-AEMINBIO,
I-AEMINBUS, I-AEMINENV

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. Recommended Preparation: Completion of at least 6 Science FCE's

FOR421H1 F Green Urban Infrastructure: Sustainable City Forests

2/-/1/0.50

I-AECERRRE, I-AEMINBIO,
I-AEMINENV

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.

FOR424H1 S Innovation and Manufacturing of Sustainable Materials

3/-/0.50

I-AECERRRE, IV-AECHEBASC,
IV-AEMECBASC, I-AEMINBIO,
I-AEMINENV, 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.

Prerequisite: MSE270H1 or CHE341H1 or equivalent.

Exclusion: CHE475H1

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

Course Descriptions

for deriving liquid, solid and gaseous fuels and valuable chemicals for other applications will be explored.

Exclusion: FOR410H1

Geography

GGR220H1 S **The Spatial Organization of Economic Activity**

2/-/1m/0.50

I-AEMINBUS

Focuses on theoretical and empirical topics aimed at describing, analyzing and explaining the spatial distribution of economic activity at macro- and micro-spatial-scales. Topics covered could include theories of regional economic growth and change, issues surrounding uneven development in space, the empirical definition of regional economic systems, and the measurement of economic growth and structural change.

Exclusion: GGR220Y1

GGR221H1 S **New Economic Spaces**

2/-/0.50

Provides an introduction to economic geography and economic geography theory from the 1970s on, illustrating the different ways that geographers have conceptualized the restructuring of resource industries, manufacturing and services. The crisis of Fordism and the rise of new production models will be given particular attention, along with the reorganization of finance, the rise of cultural industries and the globalization of commodity chains. New regimes of governance of the economy will also be considered.

Exclusion: GGR220Y1

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.

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.

Prerequisite: Physics SPH3U

Exclusion: GGR333H1, JGE348H1

Recommended Preparation: 8.0 FCE's including first year Math and/or Physics

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 (formerly HPS200Y1)**

2/-/1/0.50

Case studies in the history of science from antiquity to 1800, including the revolutionary work of Copernicus, Kepler, Galileo, Descartes, Newton, Linnaeus, Lavoisier, and Herschel. The course is designed to be accessible to science students and non-scientists alike.

Exclusion: HPS200Y1

HPS211H1 S **Scientific Revolutions II (formerly HPS200Y1)**

2/-/1/0.50

Case studies in the history of science from 1800 to 2000, including Volta, Lyell, Darwin, Mendel, Einstein, Schrodinger, 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

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

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

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

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.

HPS308H1 F/S Technology and Prosperity

2/-/1/0.50

I-AEMINBUS

The systemic nature of modern technology suggests that it has intimate interactions with society, human values, ideologies, and the economy. We will attempt to examine these interactions in history in order to promote reflection on ways in which technology and its evolution could be managed for the benefit of humankind.

Recommended Preparation: any half course in HPS at the 200-level

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

Human Biology

HMB200H1 S Introduction to Neuroscience

2/-/1/0.50

IV-AEESCBASET

A survey of brain systems, including evolution and development of the nervous system, brain stem system for defensive and approach responses, limbic and cortical systems for learning, and higher brain functions. Techniques for study of brain systems including pharmacology, gene targeting and human brain imaging are introduced.

Prerequisite: (BIO120H1+BIO130H1)/BIO150Y1, PSY100H1

Corequisite: Pre- or co-requisite:

PSL300H1/PSL302Y1/(BIO270H1+BIO271H1)

Exclusion: PSY290H1/HMB220H1

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.

Prerequisite: (BIO120H1+BIO130H1)

Corequisite: BIO230H1/BIO255H1/(BIO240H1+BIO241H1)

Exclusion: BIO260H1, BIO207H5

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.

Course Descriptions

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

I-AECERBUS, I-AEMINBUS

2/2/-/0.50

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

I-AECERBUS, I-AEMINBUS

3/1/-/0.50

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

I-AEESCBASE

3/-/1/0.50

Topics include: linear systems, matrix algebra, R^n as a vector space, a normed space and an inner-product space, linear transformations on R^n , eigenvalues, applications to circuits, mechanics and an introduction to computer methods.

MAT186H1 F Calculus I

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

3/-/1/0.50

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

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

3/-/1/0.50

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

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

3/-/1/0.50

This course covers systems of linear equations and Gaussian elimination, applications; vectors in R^n , independent sets and spanning sets; linear transformations, matrices, inverses; subspaces in R^n , basis and dimension; determinants; eigenvalues and diagonalization; systems of differential equations; dot products and orthogonal sets in R^n ; projections and the Gram-Schmidt process; diagonalizing symmetric matrices; least squares approximation.

MAT194H1 F Calculus I

I-AEESCBASE

3/-/1/0.50

Topics include: theory and applications of differential and integral calculus, limits, basic theorems and elementary functions.

MAT195H1 S Calculus II

I-AEESCBASE

3/-/1/0.50

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.

MAT234H1 S Differential Equations

II-AEINDBASC, II-AEMEGBASC

3/-/1.50/0.50

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

II-AECPEBASC, II-AEELEBASC

3/-/2m/0.50

An introduction to complex variables and ordinary differential equations. Topics include: Laplace transforms, ordinary higher-order linear differential equations with constant coefficients; transform methods; complex numbers and the complex plane; complex functions; limits and continuity; derivatives and integrals; analytic functions and the Cauchy-Riemann equations; power series as analytic functions; the logarithmic and exponential functions; Cauchy's integral theorem, Laurent series, residues, Cauchy's integral formula, the Laplace transform as an analytic function. Examples are drawn from electrical systems.

MAT291H1 F Calculus III

II-AECPEBASC, II-AEELEBASC

3/-/2m/0.50

The chain rule for functions of several variables; the gradient. Maxima and minima, Lagrange multipliers. Multiple integrals; change of variables, Jacobians. Line integrals, independence of path, Green's theorem. The gradient, divergence and curl of a vector field. Surface integrals; parametric representations, applications from electromagnetic fields, Gauss' theorem and Stokes' theorem.

MAT292H1 F Calculus III

II-AEESCBASE

3/-/2/0.50

Existence and uniqueness of solution for first-order differential equations, general second-order linear ODEs, homogeneous equations, nonhomogeneous equations, variable coefficients, variation of parameters ODEs in matrix form, Fourier series, Fourier and Laplace transforms, optimization, single-variable functions, interpretation of problems in mathematical terms, multivariable functions, Hessians, optimization in the presence of constraints, Lagrange multipliers, introduction to numerical methods, introduction to numerical and computational methods.

MAT294H1 F Calculus and Differential Equations

II-AEMMSBASC

3/-/2/0.50

Partial differentiation, grad, div, curl, multiple integrals, line integrals, surface integrals, differential equations, first order differential equations, homogeneous linear differential equations, boundary conditions. Formulation of various problems relevant to materials and mining engineering - the concepts above are used.

MAT301H1 F/S Groups and Symmetries

IV-AEESCBASEP, IV-AEESCBASER

3/-/0.50

Congruences and fields. Permutations and permutation groups. Linear groups. Abstract groups, homomorphisms, subgroups. Symmetry groups of regular polygons and Platonic solids, wallpaper groups. Group actions, class formula. Cosets, 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

III-AEESCBASEF, IV-AEESCBASEP,
IV-AEESCBASER

3/-/0.50

This course provides the foundations of analysis and rigorous calculus for students who will take subsequent courses where these mathematical concepts are central of applications, but who have only taken courses with limited proofs. Topics include topology of \mathbb{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

I-AEMINRAM

3/-/0.50

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

Exclusion: MAT367H1

MAT389H1 F Complex Analysis

III-AEESCBASEA, III-AEESCBASEO,
III-AEESCBASEP, III-AEESCBASER

3/-/1/0.50

Course examines the following: analytic functions, Cauchy-Reimann equations, contour integration, Cauchy's theorem, Taylor and Laurent series, singularities, residue calculus, conformal mapping, harmonic functions, Dirichlet and Neumann problems and Poisson integral formulas. Course includes studies of linear differential equations in the complex plane, including Bessel and Legendre functions.

Exclusion: MAT290H1

MAT401H1 F Polynomial Equations and Fields

IV-AEESCBASEP

3/-/0.50

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

IV-AEESCBASEP

3/-/0.50

Euclidean and non-euclidean plane and space geometries. Real and complex projective space. Models of the hyperbolic plane. Connections with the geometry of surfaces.

Prerequisite: MAT301H1/MAT347Y1,
MAT235Y1/MAT237Y1/MAT257Y1

Materials Science and Engineering

Course Descriptions

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: MSE260H1

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

The diffusion mechanisms in solids, liquids and gases are reviewed. The effects of imperfections in solids on diffusion rates are discussed. Topics include diffusion coefficient, Fick's law, steady state and unsteady state diffusion. The course covers factors affecting the rate at which chemical reactions take place. The effects that temperature, concentration, pressure and catalysts have on reaction rates are discussed. Topics such as homogeneous versus heterogeneous reactions, order of reaction, and activation energy are also covered.

MSE219H1 F **Structure and Characterization of Materials**

3/3/1/0.50

II-AEMMSBASC

Both the theoretical and experimental interpretation of the structure and chemistry of inorganic materials on various length scales will be examined. Crystalline and amorphous structure is discussed in terms of electronic structure of atoms, atomic bonding, atomic coordination and packing. Extended defects in crystalline solids will be covered.

Experimental techniques for characterizing materials structure and chemistry will be described including: optical and electron microscopy, x-ray diffraction, scanning probe microscopy, Auger electron spectroscopy, x-ray photoelectron spectroscopy and secondary ion mass spectrometry.

MSE235H1 S **Materials Physics**

3/-/1/0.50

III,IV-AECPEBASC, III,IV-AEELEBASC,
II-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.

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**

3/2/1/0.50

II-AEMMSBASC

An introduction to atomic and molecular structures, acid-base and redox reactions, transition metal complexes, systematic chemistry and physical properties of metals and elements in the periodic table. Examples of industrial practice from the metal processing industry and energy generation and storage technologies will also be discussed. The fundamentals of chemical analysis of inorganic compounds, by both classical "wet" volumetric analysis and instrumental methods are covered in the experiments.

MSE245H1 S **Organic Materials Chemistry and Properties**

3/2/1/0.50

II-AEMMSBASC

Introduction to organic chemistry and organic materials. Naming of organic compounds. Properties and reactions of organic compounds. Bonding and shapes of organic molecules. Analysis of organic compounds including IR and mass spectroscopy. Introduction to natural and bio-molecules. Principles of structure of polymer molecules. Polymer synthesis. Structure of polymeric materials including amorphous, crystalline, elastomeric and fibre reinforced. Mechanical and thermal properties of polymers.

MSE290H1 S **Communications I**

II-AEMMSBASC

1/-/1/0.25

Students will select assigned reading packages from one of many areas of materials science and engineering. Written communication skills will be developed through iterative report writing.

MSE301H1 S **Mineral Processing**

III-AELMEBASC

3/1.50/1/0.50

The theory and practice of mineral beneficiation including particle size measurement, comminution, sizing, liquid-solid separation and ore concentration by gravity, magnetic methods and flotation. The course also includes the relevant aspects of mineralogy, surface chemistry and the movement of solid particles in liquid media.

Prerequisite: MIN225H1 or MSE244H1

MSE315H1 S **Environmental Degradation of Materials**

I-AEMINENV, III-AEMMSBASC

3/-/2/0.50

This course deals with four major areas: electrochemistry of low temperature aqueous solvents, the corrosion of materials, mechano-chemical effects in materials and corrosion prevention in design. Electrochemistry deals with thermodynamics of material-electrolyte systems involving ion-solvent, ion-ion interactions, activity coefficients, Nernst equation and Pourbaix diagrams, and rate theory through activation and concentration polarization. Corrosion of metallic, polymeric, ceramic, composite, electronic and biomaterials will be explored along with mechano-chemical effects of stress corrosion, hydrogen embrittlement and corrosion fatigue. Corrosion prevention in terms of case histories and the use of expert systems in materials selection.

MSE316H1 S **Mechanical Behaviour of Materials**

III-AEMMSBASC

3/3/1/0.50

The mechanical behaviour of engineering materials including metals, alloys, ceramics and polymeric materials. The following topics will be discussed: macro- and micro-structural response of materials to external loads; load-displacement and stress-strain relationships, processes and mechanisms of elastic, visco-elastic, plastic and creep deformation, crystallographic aspects of plastic flow, effect of defects on mechanical behaviour, strain hardening theory, strengthening mechanisms and mechanical testing.

MSE318H1 F **Phase Transformations**

III-AEMMSBASC

3/3/1/0.50

Thermodynamics and phase stability. Free energy diagrams. Phase transformations in unary systems: primary crystallization, amorphization, crystallization of amorphous materials, recrystallization. Phase transformations in binary systems: solidification, precipitation from solid solution, binary invariant reactions. Diffusional transformations, nucleation and growth, diffusionless or martensitic transformations. Second order transformations. Spinodal, massive and order-disorder transformations. Influence of phase transformations on microstructure and properties.

MSE332H1 F **Heat and Mass Transfer for Materials Processing**

III-AEMMSBASC

3/-/2/0.50

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**

III-AEMMSBASC

2/-/1/0.25

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**

III-AEMMSBASC

2/-/1/0.25

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**

III-AEMMSBASC

3/2/1/0.50

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**

IV-AEESCBASEO, III-AEESCBASET,
I-AEMINBIO

3/-/1/0.50

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

Course Descriptions

MSE354H1 S **Materials in Manufacturing**

III-AEMMSBASC

2/-/1/0.25

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**

I-AEMINENR, III-AEMMSBASC

2/-/1/0.25

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**

III-AEESCBASEO, IV-AEESCBASEP,
IV-AEESCBASER

3/1.50/1/0.50

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.

MSE390H1 F **Communications II**

III-AEMMSBASC

1/-/1/0.25

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**

IV-AEMECSBASC, IV-AEMMSBASC

2/2/1/0.50

The principles necessary for the selection of engineering materials suitable for a given application from the full range of materials available are developed through a series of case studies. Both the material properties and the capabilities of applicable fabrication processes are considered to identify the material and process which best satisfy the design requirements. Extensive use is made of an integrated materials properties and processes database system.

MSE408H1 S **Energy Management in Materials Processing**

I-AEMINENR, IV-AEMMSBASC

3/-/1/0.50

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**

IV-AEMMSBASC

3/-/1/0.50

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**

IV-AEMMSBASC

3/-/2/0.50

The fundamentals and technologies of mechanical forming (rolling, forging, extrusion, drawing, sheet-metal forming), sintering and powder forming, thermo-mechanical processing and heat treatment are discussed. Various means to enhance surfaces for the purposes of i) improving corrosion and erosion properties, ii) change mechanical, chemical or electric properties, iii) produce a visually more appealing surface are also covered. Techniques include galvanizing, hot dipping, nitriding, vapour deposition, plasma spraying.

MSE430H1 F **Electronic Materials**

IV-AEESCBASEO, IV-AEMMSBASC

2/-/1/0.50

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 F **Forensic Engineering**

IV-AEESCBASEO, IV-AEMMSBASC

3/-/1/0.50

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

MSE432H1 S Macromolecular Materials Engineering

3/-/1/0.50

IV-AEMECBASC, 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 implications of polymers. Several leading edge examples from the electronics, transportation and medical industries are introduced during the course.

Exclusion: CHE461H1 and MSE330H1

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.

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.

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.

MSE459H1 F Synthesis of Nanostructured Materials

3/2/-/0.50

IV-AEESCBASEO, 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.

MSE462H1 S Materials Physics II

2/-/1/0.50

IV-AEESCBASEO

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

Course Descriptions

succession, selling out. A full Business Plan will be developed by each student and the top submissions will be entered into a Business Plan competition with significant cash prizes for the winners. Examples will be drawn from real business situations including practicing entrepreneurs making presentations and class visits during the term. (Identical courses are offered: ECE488H1F, MIE488H1F, CHE488H1S and CIV488H1S.)
Exclusion: APS234 and APS432

MSE490H1 F **Professional Ethics and Practice**

IV-AEMMSBASC

2/-/-0.25

The various roles of a practicing engineer in industry and society will be presented through a series of seminars. The lecturers will include practicing engineers from local companies and consulting firms and representatives from professional and technical societies.

MSE498Y1 Y **Design and Research Project**

IV-AEMMSBASC

3/6/2/1.00

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

MSE504H1 F **Extractive Metallurgy**

I-AEMINENR, I-AEMINENV,
IV-AEMMSBASC

3/-/2/0.50

Technologies and unit operations used in the production of light metals, non-ferrous and ferrous metals will be presented and analyzed. Emphasis will be placed on analyzing overall flow-sheets used by selected companies for the purpose of determining how overall process efficiency can be improved and the environmental impact reduced. Methods and technologies used for metals recycling will also be discussed. Examples will be given from the steel, copper, nickel, zinc, aluminum and magnesium industries. The students will be exposed to a series of actual industrial case studies.

MSE550H1 S **Advanced Physical Properties of Structural Nanomaterials**

IV-AEESCBASEO, IV-AEMMSBASC

3/2/1/0.50

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.

MSE558H1 S **Nanotechnology in Alternate Energy Systems**

3/0.50/1/0.50

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.

MSE561H1 F **Engineered Ceramics**

IV-AEMMSBASC

3/-/2/0.50

The unique combinations of physical, electrical, magnetic, and thermomechanical properties exhibited by advanced technical ceramics has led to a wide range of applications including automobile exhaust sensors and fuel cells, high speed cutting tool inserts and ball bearings, thermal barrier coatings for turbine engines, and surgical implants. This course examines the crystal and defect structures which determine the electrical and mass transport behaviours and the effects of microstructure on optical, magnetic, dielectric, and thermomechanical properties. The influence of these structure-property relations on the performance of ceramic materials in specific applications such as sensors, solid oxide fuel cells, magnets, and structural components is explored.

Mechanical and Industrial Engineering

MIE100H1 S **Dynamics**

I-AECPEBASC, I-AEELEBASC,
I-AEENGBASC, I-AEINDBASC,
I-AEMEGBASC

3/-/2/0.50

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: APS161H1

MIE191H1 S **Seminar Course: Introduction to Mechanical and Industrial Engineering**

1/-/0.15

I-AEINDBASC, I-AEMEGBASC

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

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-AEMEGBASC, I-AEMINENR

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

IV-AEESCBASEF, II-AEMEGBASC

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.

MIE222H1 S **Mechanics of Solids I**

3/1.50/1.50/0.50

II-AEMEGBASC

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 plane 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-AEMEGBASC

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-AEMEGBASC

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

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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

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.

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.

Prerequisite: APS105/APS106 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

MIE262H1 F 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.

MIE297H1 S Foundations of Design Portfolio

-/-/0.00

II-AEMECBASC

Students will assemble a short design portfolio with items drawn from engineering courses and extra-curricular experience. The portfolio will demonstrate an understanding and application of basic principles of engineering design through a showcase of the student's best work. The portfolio will further demonstrate competence in written and oral communication through a brief summary of each item and an introduction to the portfolio. Students whose communication work is not up to standard will be provided with opportunities for remediation. The course will be offered on a credit/no credit basis; students who receive no credit must retake the course in year 3.

MIE301H1 F Kinematics and Dynamics of Machines

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.

Prerequisite: MIE100H1

MIE303H1 F **Mechanical and Thermal Energy Conversion Processes**

IV-AEESCBASEF, III-AEESCBASEJ

3/1.50/1/0.50

Engineering applications of thermodynamics in the analysis and design of heat engines and other thermal energy conversion processes within an environmental framework; Steam power plants, gas cycles in internal combustion engines, gas turbines and jet engines. Fossil fuel combustion, Alternative fuel combustions, fusion processes and introduction to advanced systems of fuel cells.

MIE312H1 F **Fluid Mechanics I**

III-AEMEBCBASC

3/1/1/0.50

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**

III-AEMEBCBASC, I-AEMINENR

3/1.50/2/0.50

Exact and numerical analysis of steady and transient conduction in solids. Solutions of one-dimensional and multidimensional systems. Principles of convection and solutions under laminar and turbulent flow over flat plates and inside and over pipes. Free convection. Thermal radiation between multiple black and grey surfaces.

Prerequisite: MAT234H1, MIE210H1, MIE230H1, MIE312H1 or equivalent

MIE315H1 S **Design for the Environment**

IV-AEESCBASEF, IV-AEESCBASEJ,
III-AEMEBCBASC, I-AEMINENV

3/-/1/0.50

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.

MIE320H1 S **Mechanics of Solids II**

III-AEMEBCBASC

3/1.50/2/0.50

Three-dimensional stress transformation, strain energy, energy methods, finite element method, asymmetric and curved beams, superposition of beam solutions, beams on elastic foundations, buckling, fracture mechanics, yield criteria, stress concentration, plane stress and strain. Prerequisite: MIE222H1

MIE331H1 S **Physiological Control Systems**

IV-AECHEBASC, IV-AECIVBASC,
III,IV-AECPBASC, III,IV-AEELEBASC,
III-AEMEBCBASC, I-AEMINBIO,
I-AEMINRAM

3/1/1/0.50

The purpose of this course is to provide undergraduate engineering students with an introduction to physiological concepts and selected

physiological control systems present in the human body. Due to the scope and complexity of this field, this course will not cover all physiological control systems but rather a selected few such as the neuromuscular, cardiovascular, and endocrine control systems. This course will also provide an introduction to the structures and mechanisms responsible for the proper functioning of these systems. This course will combine linear control theory, physiology, and neuroscience with the objective of explaining how these complex systems operate in a healthy human body. The first part of the course will provide an introduction into physiology and give an overview of the main physiological systems. The second part of the course will focus on the endocrine system and its subsystems, including glucose regulation, thyroid metabolic hormones, and the menstrual cycle. The third part of the course will include discussion on the cardiovascular system and related aspects such as cardiac output, venous return, control of blood flow by the tissues, and nervous regulation of circulation. The fourth and final section of the course will focus on the central nervous system, the musculoskeletal system, proprioception, kinaesthetic, and control of voluntary motion. Prerequisite: CHE353H1

MIE333H1 S **Engineering Physics**

III-AEMEBCBASC

3/-/1.50/0.50

This course includes introduction to oscillations leading to periodic wave phenomena of importance to modern engineering methods and instrumentation design, specifically transverse and longitudinal waves, sound, resonance, interference, Doppler effects and phenomena encountered in supersonic speeds. Elementary quantum mechanics is introduced to extend concepts of wave theory to photons and matter waves, with a view to understanding advanced modern materials and devices/ instruments encountered at the forefront of engineering practice, specifically properties of nanomaterials, the principles of operation of electronic, magnetic resonance and X-ray microscopes, and laser operation and the nature of laser light. Prerequisite: MAT186H1 /MAT187H1

MIE334H1 F **Numerical Methods I**

III-AEMEBCBASC

3/-/1.50/0.50

This introductory course to numerical methods includes the following topics: polynomial interpolation, numerical integration, solution of linear systems of equations, least squares fitting, solution of nonlinear equations, numerical differentiation, solution of ordinary differential equations, and solution of partial differential equations. Tutorial assignments using MATLAB will focus on engineering applications relevant to the background of students taking the course.

MIE335H1 S **Algorithms & Numerical Methods**

III-AEINDBASC

3/1/1/0.50

Numerical linear algebra, solution techniques for linear and non-linear systems of equations. The conditioning and stability of linear systems. Matrix factorization, LU and Cholesky factorization, factorization in the revised simplex method. Newton's method, the minimum norm problem and applications. Algorithmic analysis, big-O asymptotic analysis. Matching algorithms: Gale-Shapely method. Greedy methods for combinatorial optimization. Graph theory and graph theoretic algorithms. Branch and bound search methods. Prerequisite: MIE262H1

Course Descriptions

MIE341H1 S Mechanical Engineering Design

III-AEMECBASC, I-AEMINRAM

3/3/1/0.50

Technical drawing including sketching. Computer-aided drafting and design analysis Mechanical components - nomenclature, function and selection. Mechanical dissection of selected mechanical devices. Group competitive conceptual design projects including technical reports, oral presentations and display posters.

MIE342H1 F Circuits with Applications to Mechanical Engineering Systems

III-AEMECBASC

3/1.50/1/0.50

This course presents analysis of complex circuits and application of circuit principles to design circuits for mechanical engineering systems. Discussions will centre around circuits and instrumentation. In-depth discussions will be given on a number of topics: (1) Mechatronics design applications of circuit principles; (2) Network theorems, node-voltage, mesh-current method, Thévenin equivalents; (3) Operational amplifier circuits; (4) 1st and 2nd order circuits; (5) Laplace transform, frequency response; (6) Passive and active filter design (low- and high-pass filters, bandpass and bandreject filters); (7) Interface/readout circuits for mechanical engineering systems, sensors, instrumentation; (8) Inductance, transformers, DC/AC machines; (9) Digital circuit and data sampling introduction.

Prerequisite: MAT186H1 and MAT187H1

Recommended Preparation: ECE110H1 or ECE159H1

MIE343H1 F Industrial Ergonomics and the Workplace

III-AEINDBASC, IV-AEMECBASC,
I-AEMINBIO

3/3/-/0.50

The Biology of Work: anatomical and physiological factors underlying the design of equipment and work places. Biomechanical factors governing physical workload and motor performance. Circadian rhythms and shift work. Measurement and specification of heat, light, and sound with respect to design of the work environment.

Prerequisite: MIE231H1/MIE236H1 or equivalent

MIE344H1 F Ergonomic Design of Information Systems

III-AEINDBASC

3/3/-/0.50

The goal of this course is to provide an understanding of how humans and machines can be integrated with information systems. The focus will be on the design of human-machine interfaces, and on the analysis of the impact of computers on people. The course will also include coverage of usability engineering and rapid prototyping design, analysis of user mental models and their compatibility with design models, and quantitative modelling of human-computer interaction.

Prerequisite: MIE240H1 or permission of the instructor

MIE345H1 S Case Studies in Human Factors and Ergonomics

III-AEINDBASC

3/-/2/0.50

A detailed analysis will be made of several cases in which human factors methods have been applied to improve the efficiency with which human-machine systems operate. Examples will be chosen both from the area of basic ergonomics and from high technology. Emphasis will be placed on the practical use of material learned in earlier human factors courses.

Prerequisite: MIE240H1

MIE346H1 S Analog and Digital Electronics for Mechatronics

III-AEMECBASC, I-AEMINRAM

3/1.50/1/0.50

A study of the fundamental behaviour of the major semiconductor devices (diodes, bipolar junction transistors and field effect transistors). Development of analysis and design methods for basic analog and digital electronic circuits and devices using analytical, computer and laboratory tools. Application of electronic circuits to instrumentation and mechatronic systems.

Prerequisite: MIE230H1, MAT234H1, MIE342H1

MIE350H1 F Design and Analysis of Information Systems

III-AEINDBASC

3/1/1/0.50

Provides students with an understanding of the methods of information system analysis and design. These include methods for determining and documenting an organization's structure (FDD), activities, behaviours and information flows (DFDs, decision tables and trees, network diagrams, etc); model acquisition (data repositories), verification and validation. Methods such as SADT, RAD and prototyping will be covered. Students will acquire a working knowledge of various frameworks for analysis (e.g., information technology categories, system and application classifications, decision types, data vs information). Throughout the course, emphasis is placed on the importance of systems thinking and organizational culture in the analysis and design process. In the laboratory, students will use a CASE-based computer program (Visible Analyst) for the analysis and design of information systems for selected organizations. Students will be asked to work in teams to create a web-based information site and to document and present their development progress through the use of a structured project log.

Prerequisite: MIE253H1

MIE354H1 F Business Process Engineering

III-AEINDBASC, I-AEMINBUS

3/2/-/0.50

This course focuses on understanding multiple perspectives for grouping, assessing, designing and implementing appropriately integrated and distributed information systems to support enterprise objectives. The emphasis is on understanding how Business Process Management techniques and tools can contribute to align an organization's business and information technology perspectives, as well as the characteristics of application and system types and the implications for their design, operation and support of information needs, including those associated with different platforms and technology infrastructure e.g., legacy systems, client/server, the Internet and World Wide Web including the emergence of a web-service-based service oriented architecture. Students will work in the laboratory to develop business processes that can be specified and executed by information systems supporting BPML, a widely supported standard for describing web-service-based business process.

Prerequisite: MIE253H1 or permission of the instructor

MIE360H1 F Systems Modelling and Simulation

3/2/1/0.50

IV-AEESCBASEF, III-AEINDBASC,
IV-AEMECCBASC

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

Features of production/service systems and methods of modelling their operation; the material flow, information flow and control systems. Topics include process design, supply chain management, line balancing, material requirements planning, distribution requirements planning, and aggregate production planning. Basic deterministic and probabilistic inventory models will be covered, as well as the application of optimization methods to capacity planning decisions. Emphasis will be placed on the modelling aspects of operations management, as well as the application of analytical approaches in the solution of systems problems.

Prerequisite: MIE231H1 / MIE236H1, and MIE262H1 or equivalent

MIE364H1 S Quality Control and Improvement

3/1/2/0.50

IV-AECHEBASC, III-AEINDBASC,
III-AEMECCBASC

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, MIE237H1

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.

MIE397Y1 Y Design Portfolio

-/-/0.00

III-AEMECCBASC

Students will assemble a comprehensive design portfolio with items drawn from engineering courses and extra-curricular experience. The portfolio will articulate and demonstrate an understanding and application of basic and advanced principles of engineering design through a showcase of the student's best work. The portfolio shall also anticipate continued development of design skills through the capstone design courses and reflect on the transition to a career in engineering. The portfolio will demonstrate competence in written and oral communication through a brief summary of each item and an introduction to the portfolio. Students whose communication work is not up to standard will be provided with opportunities for remediation. The course will be offered

Course Descriptions

on a credit/no credit basis; students who receive no credit must retake the course in year 4.

MIE402H1 S **Vibrations**

IV-AEMECBASC

3/1/2/0.50

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**

IV-AEMECBASC

3/3/2/0.50

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**

I-AECERNUC, IV-AEESCBASEJ,
IV-AEMECBASC, I-AEMINENR

3/-/2/0.50

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**

I-AECERNUC, IV-AEESCBASEJ,
IV-AEMECBASC, I-AEMINENR

3/-/2/0.50

This course covers the basic principles of the thermo-mechanical design and analysis of nuclear power reactors. Topics include reactor heat generation and removal, nuclear materials, diffusion of heat in fuel elements, thermal and mechanical stresses in fuel and reactor components, single-phase and two-phase fluid mechanics and heat transport in nuclear reactors, and core thermo-mechanical design.

Prerequisite: MIE407H1/MIE222H1, MIE312H1, MIE313H1 or equivalents

Recommended Preparation: CHE566H1

MIE411H1 F **Thermal Energy Conversion**

IV-AEMECBASC, I-AEMINENR

3/3/-/0.50

Engineering applications of thermodynamics in the analysis and design of heat engines and other thermal energy conversion processes within an environmental framework. Steam power plants, gas cycles in internal combustion engines, gas turbines and jet engines. Refrigeration, psychrometry and air conditioning. Fossil fuel combustion and advanced

systems includes fuel cells.

Prerequisite: MIE210H1, MIE313H1

MIE414H1 F *** Applied Fluid Mechanics**

IV-AEMECBASC

3/3/1/0.50

This course builds upon the material introduced in Fluid Mechanics I and connects it to a wide range of modern technical applications of fluid flow. Applications include the design of pipe and microfluidic networks, transient flow phenomena, compressible flow and shocks, characteristics of pumps, open channel flow and an overview of flow measurement techniques. Lectures are complemented by laboratory experiments on topics such as centrifugal pumps, flow transients and fluid flow in microfluidic chips.

Prerequisite: MIE312H1

MIE422H1 F **Automated Manufacturing**

IV-AEESCBASEF, IV-AEMECBASC

2/3/-/0.50

Introduction to Computer Integrated Manufacturing. 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

MIE438H1 S **Microprocessors and Embedded Microcontrollers**

IV-AEMECBASC, I-AEMINRAM

2/3/-/0.50

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**

III-AEESCBASET, IV-AEMECBASC,
I-AEMINBIO

3/2/-/0.50

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**

IV-AEESCBASEF, IV-AEESCBASET,
IV-AEMECBASC

2/2/1/0.50

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**

IV-AEMECBASC

3/2/-/0.50

Problem definition and formulation for optimization, optimization models, and selected algorithms in optimization. Design for Tolerancing, Design for Manufacturing, and Design for Assembly. State of the art 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**

IV-AEESCBASEJ, IV-AEMECBASC,
I-AEMINRAM

3/1.50/3/0.50

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**

IV-AEMECBASC, I-AEMINRAM

2/5/-/0.50

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**

IV-AEMECBASC, I-AEMINRAM

2/3/-/0.50

This course provides students with the tools to design, model, analyze and control mechatronic systems (e.g. smart systems comprising electronic, mechanical, fluid and thermal components). This is done through the synergic combination of tools from mechanical and electrical engineering, computer science and information technology to design systems with built-in intelligence. The class provides techniques for the modeling of various system components into a unified approach and tools for the simulation of the performance of these systems. The class also presents the procedures and an analysis of the various components needed to design and control a mechatronic system including sensing, actuating, and I/O interfacing components. Prerequisite: MIE342H1, MIE346H1

MIE448H1 F **Engineering Psychology and Human Performance**

IV-AEINDBASC, IV-AEMECBASC,
I-AEMINBIO

3/3/-/0.50

An examination of the relation between behavioural science and the design of human-machine systems, with special attention to advanced control room design. Human limitations on perception, attention, memory and decision making, and the design of displays and intelligent machines to supplement them. The human operator in process control and the supervisory control of automated and robotic systems. Laboratory exercises to introduce techniques of evaluating human performance. Prerequisite: MIE231H1/MIE236H1/STA286H1 or equivalent required; MIE237H1 or equivalent recommended

MIE451H1 F **Decision Support Systems**

IV-AEINDBASC

3/1/1/0.50

This course provides students with an understanding of the role of a decision support system in an organization, its components, and the theories and techniques used to construct them. The course will cover basic technologies for information analysis, knowledge-based problem solving methods such as heuristic search, automated deduction, constraint satisfaction, and knowledge representation. Prerequisite: MIE253H1, MIE350H1

MIE457H1 S **Knowledge Modelling and Management**

IV-AEESCBASEF, IV-AEINDBASC

3/1/1/0.50

This course explores both the modelling of knowledge and its management within and among organizations. Knowledge modelling will focus on knowledge types and their semantic representation. It will review emerging representations for knowledge on the World Wide Web (e.g., schemas, RDF). Knowledge management will explore the acquisition, indexing, distribution and evolution of knowledge within and among organizations. Emerging Knowledge Management System software will be used in the laboratory. Prerequisite: MIE253H1, MIE350H1

Course Descriptions

MIE459H1 S **Organization Design**

IV-AEINDBASC

4/-/0.50

Study of design, innovation, change and implementation issues in both new and existing organizations. Consideration will be given to sociotechnical systems design methodology, work teams, support systems, project management, and union-management relations.

MIE463H1 F **Integrated System Design**

IV-AEINDBASC

3/-/2/0.50

Integrated System Design is a capstone course that integrates the various perspectives of an integrated system taught in third year, including: Optimization, Quality, Management, Information, and Economics. The course approaches systems design from a Business Process perspective. Beginning with the Business Processes, it explores the concept of Business Process Re-engineering. It extends the concept of business processes to incorporate perspectives such as cost, quality, time, behaviour, etc. The second part of the course focuses on business process design tools. Namely, software tools to both design, simulate and analyse business processes. The third part of the course explores the application of process design to various domains. Guest speakers are used to provide domain background.

Prerequisite: Fourth-year, Industrial Engineering standing

MIE468H1 S **Facility Planning**

III-AEINDBASC

3/-/2/0.50

Fundamentals of developing efficient layouts of production/ service systems and determining optimal locations of facilities in a network. Activity relationships, manufacturing flow patterns, layout procedure types (construction and improvement algorithms), manual and computerized layout techniques, single and multiple facility location, and supply chain (location) network-distribution design.

Prerequisite: MIE231H1/MIE236H1 or equivalent, MIE262H1

MIE469H1 S **Reliability and Maintainability Engineering**

IV-AEESCBASEF, III-AEINDBASC,
IV-AEMECCBASC

3/-/2/0.50

An introduction to the life-cycle costing concept for equipment acquisition, operation, and replacement decision-making. Designing for reliability and determination of optimal maintenance and replacement policies for both capital equipment and components. Topics include: identification of an items failure distribution and reliability function, reliability of series, parallel, and redundant systems design configurations, time-to-repair and maintainability function, age and block replacement policies for components, the economic life model for capital equipment, provisioning of spare parts.

Prerequisite: MIE231H1 / MIE236H1 or equivalent, MIE258H1

MIE479H1 F **Engineering Mathematics, Statistics and Finance Capstone Design**

IV-AEESCBASEF

-/-/5/0.50

This will be a group project oriented course that focuses on the development of tools for solving a practical financial engineering problem. In particular, a decision support system will be developed that integrates both the mathematical and statistical modeling techniques learned in the option along with relevant computing technologies.

Problems that contain a real-time economic decision making component will be emphasized, but does not necessarily or explicitly involve financial markets. An important goal of the capstone is the articulation of the requirements to non-specialists as an exercise in communication with non-technical members of an organization.

MIE488H1 F **Entrepreneurship and Business for Engineers**

I-AECERBUS, I-AEMINBUS

3/-/2/0.50

A complete introduction to small business formation, management and wealth creation. Topics include: the nature of the Entrepreneur and the Canadian business environment; business idea search and Business Plan construction; Buying a business, franchising, taking over a family business; Market research and sources of data; Marketing strategies promotion, pricing, advertising, electronic channels and costing; The sales process and management, distribution channels and global marketing; Accounting, financing and analysis, sources of funding, and financial controls; The people dimension: management styles, recruiting and hiring, legal issues in employment and Human Resources; Legal forms of organization and business formation, taxation, intellectual property protection; the e-Business world and how businesses participate; Managing the business: location and equipping the business, suppliers and purchasing, credit, ethical dealing; Exiting the business and succession, selling out. A full Business Plan will be developed by each student and the top submissions will be entered into a Business Plan competition with significant cash prizes for the winners. Examples will be drawn from real business situations including practicing entrepreneurs making presentations and class visits during the term. (Identical courses are offered: ECE488H1F, MSE488H1F, CHE488H1S and CIV488H1S.) Exclusion: APS234 and APS432

MIE490Y1 Y **Capstone Design**

IV-AEINDBASC

-/-/4/1.00

An experience in engineering practice through a significant design project whereby student teams meet specific client needs through a creative, iterative, and open-ended design process. The project must include:

- The application of disciplinary knowledge and skills to conduct engineering analysis and design,
- The demonstration of engineering judgment in integrating economic, health, safety, environmental, social or other pertinent interdisciplinary factors,
- Elements of teamwork, project management and client interaction, and
- A demonstration of proof of the design concept.

Exclusion: APS490Y1

MIE491Y1 Y **Capstone Design**

IV-AEMECCBASC

-/-/4/1.00

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

IV-AEINDBASC, IV-AEMEBCASC

-/-/4/0.50

An opportunity to conduct independent research under the supervision of a faculty member in MIE. Admission to the course requires the approval of a project proposal by the Undergraduate office. The proposal must: 1) Explain how the research project builds upon one or more aspects of engineering science introduced in the student's academic program, 2) provide an estimate of a level of effort not less than 40 productive hours of work per term, 3) specify a deliverable in each term to be submitted by the last day of lectures, 4) be signed by the supervisor, and 5) be received by the Undergraduate Office one week prior to the last add day. 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

IV-AEINDBASC, IV-AEMEBCASC

-/-/4/1.00

An opportunity to conduct independent research under the supervision of a faculty member in MIE. Admission to the course requires the approval of a project proposal by the Undergraduate office. The proposal must: 1) Explain how the research project builds upon one or more aspects of engineering science introduced in the student's academic program, 2) provide an estimate of a level of effort not less than 40 productive hours of work per term, 3) specify a deliverable in each term to be submitted by the last day of lectures, 4) be signed by the supervisor, and 5) be received by the Undergraduate Office one week prior to the last add day.

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

IV-AEMEBCASC

3/-/-/0.50

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

MIE506H1 S * MEMS Design and Microfabrication

IV-AEESCBASET, IV-AEMEBCASC,
I-AEMINRAM

3/1.50/1/0.50

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 S Alternative Energy Systems

IV-AECHEBASC, IV-AEESCBASEF,
IV-AEESCBASEI, IV-AEESCBASEJ,
IV-AEESCBASEO, IV-AEMEBCASC,
I-AEMINENR, I-AEMINENV

3/-/1/0.50

This course covers the basic principles and design of selected alternative energy systems. Systems discussed include solar thermal systems, solar photovoltaic, wind technology, fuel cells, and energy storage. Limited enrolment.

Prerequisite: MIE210H1, MIE312H1 and some knowledge of chemistry, or equivalent courses).

MIE516H1 F Combustion and Fuels

IV-AECHEBASC, IV-AEESCBASEJ,
IV-AEMEBCASC, I-AEMINENR

3/-/1/0.50

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

IV-AECHEBASC, IV-AEESCBASEJ,
IV-AEMEBCASC, I-AEMINENR

3/-/1/0.50

Thermodynamics and electrochemistry of fuel cell operation and testing; understanding of polarization curves and impedance spectroscopy; common fuel cell types, materials, components, and auxiliary systems; high and low temperature fuel cells and their applications in transportation and stationary power generation, including co-generation and combined heat and power systems; engineering system requirements resulting from basic fuel cell properties and characteristics.

MIE518H1 S Fundamentals of Aircraft Design

2/3/-/0.50

This course aims at developing strategies for improving/optimizing the design of entire mechanical systems, applying attributes of the mechanical engineering curriculum to open-ended multidisciplinary systems/assemblies. Topics include: the developing design process, introduction to integration in systems design, computer aided design of mechanical systems, computer aided analysis of entire systems, computer integrated manufacturing, concepts in integrated mechanical systems designs, performance evaluation and cost. Assessment is based on group design projects involving weekly progress meetings and presentations. Written reports, verbal presentations and scale models of sufficient detail to justify the feasibility of the selected design projects,

Course Descriptions

accounting for originality, cost and the environment.

MIE520H1 F **Biotransport Phenomena**

IV-AEESCBASET, IV-AEMECCBASC,
I-AEMINBIO

3/-/1/0.50

Application of conservation relations and momentum balances, dimensional analysis and scaling, mass transfer, heat transfer, and fluid flow to biological systems, including: transport in the circulation, transport in porous media and tissues, transvascular transport, transport of gases between blood and tissues, and transport in organs and organisms.

Prerequisite: MIE312H1 /AER210H1 /equivalent

MIE540H1 S *** Product Design**

IV-AEESCBASEF, IV-AEMECCBASC

3/-/1/0.50

This course takes a 360° perspective on product design: beginning at the market need, evolving this need into a concept, and optimizing the concept. Students will gain an understanding of the steps involved and the tools utilized in developing new products. The course will integrate both business and engineering concepts seamlessly through examples, case studies and a final project. Some of the business concepts covered include: identifying customer needs, project management and the economics of product design. The engineering design tools include: developing product specifications, concept generation, concept selection, FAST diagrams, orthogonal arrays, full and fractional factorials, noises, interactions, tolerance analysis and latitude studies. Specific emphasis will be placed on robust and tunable technology for product optimization and generating product families. Critical Parameters will be developed using the Voice of the Customer (VOC), FAST diagrams and a House of Quality (HOQ).

Prerequisite: MIE231H1/MIE236H1 or equivalent.

MIE542H1 S **Human Factors Integration**

IV-AEINDBASC

3/-/2/0.50

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**

IV-AEMECCBASC

3/-/1/0.50

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 S **Engineering Analysis II**

3/3/2/0.50

IV-AEMECCBASC

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**

I-AECERMINR, II-AELMEBASC

3/2/1/0.50

This course introduces the global resource industries in three parts. In Module 1, students learn about mineral resources in the economy, the origin of ore deposits, mineral exploration and processing techniques, land ownership and environmental issues. Engineering applications are emphasized. Exploration and development topics are investigated. Module 2 presents an introduction to modern mining engineering. The basics of both surface (open pit) and sub-surface mining is covered. Module 3 presents an introduction on the processing of mineral resources into metals. The course helps to develop communication skills through student presentations on current issues in the industry and through training in technical communications by faculty from the Engineering Communications Program. Training for AutoCad and an extensive communications module are provided in the laboratory section. Students will participate in a field trip to an operating mine.

*Only students enrolled in the Lassonde Mineral Engineering program are eligible to participate in the 2nd year field trip.

MIN250H1 S **Surface Mining**

I-AECERMINR, II-AELMEBASC

3/-/1/0.50

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. This course cannot be taken for credit along with MIN350H1.

MIN301H1 S **Mineral Reserve and Mineral Resource Estimation**

III-AELMEBASC

3/-/1/0.50

Introduction to Mineral Resource and Mineral Reserve Estimation is an advanced level course that focuses on the stages of a mineral resource and mineral reserve estimation program from assembling the database through to reporting under industry guidelines. Major course topics include: statistical analysis of sampling data, geologic interpretation and deposit models; mineral resources estimation approaches and methods, mineral reserve estimation, classification of resources and reserves, and reporting under regulatory standards and industry guidelines for professional practice.

MIN320H1 S **Explosives and Fragmentation in Mining**

III-AELMEBASC

3/-/1/0.50

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**

I-AECERMINR, III-AELMEBASC

3/-/1/0.50

Operational aspects of underground mine design and mine planning. Topics will include: underground mining methods for hard and soft rock; shaft sinking, hoisting and materials handling; equipment selection and optimization; mine safety and mine regulations; mine personnel organization; ethics and professional issues. Development and production costs associated with mining are an inherent aspect of this course.

Exclusion: MIN350H1

MIN400H1 F **Geology Field Camp for Engineers**

IV-AELMEBASC

-/-/0.50

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

MIN401H1 S **Mineral Reserve and Mineral Resource Estimation**

IV-AEESCBASEF, IV-AELMEBASC

3/-/1/0.50

Introduction to Mineral Resource and Mineral Reserve Estimation is an advanced level course that focuses on the stages of a mineral resource and mineral reserve estimation program from assembling the database through to reporting under industry guidelines. Major course topics include: statistical analysis of sampling data, geologic interpretation and deposit models; mineral resources estimation approaches and methods, mineral reserve estimation, classification of resources and reserves, and reporting under regulatory standards and industry guidelines for professional practice.

MIN429H1 F **Engineering Rock Mechanics**

IV-AECIVBASC, III-AELMEBASC

3/1/1/0.50

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 behaviour; anisotropy, heterogeneity and the size effect; rock mass classification schemes. Rock engineering topics include: rock excavation; rock stabilisation; instability mechanisms in foundations 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.

Course Descriptions

MIN430H1 S **Mining Environmental Management**

IV-AECIVBASC, IV-AEESCBASEF,
III-AELMEBASC, I-AEMINENV

3/-/1/0.50

This course provides an overview of the major aspects of mining environmental management from exploration, through design and development of the property, into operation, and final closure implementation. An applied approach is taken utilizing case studies and examples where possible. Participation and discussion is an integral part of the course. Topics include sustainable development, environmental impacts, designing for mitigation, environmental management systems and reclamation.

MIN450H1 F **Mineral Economics**

IV-AELMEBASC

3/-/1/0.50

Course covers the evaluation of mineral projects, mining operations, and mining companies. Topics will include: discounted cash flow techniques including net present value (NPV), internal rate of return (IRR), net asset value (NAV); feasibility studies and due diligence reports; reserves and resources, data sources; metal prices and markets; cash flow modeling including revenue calculations, capital and operating costs, taxes, depreciation, inflation; risk and risk assessment, discount rates, red flags, checklists; financing. Guest lectures will provide industry insights into financing, fund raising, consulting, project control, and evaluation. There are two assignments: review of an annual report; due diligence report and net asset value calculation.

Prerequisite: CIV368H1/CME368H1

MIN466H1 F **Mineral Project Design I**

IV-AELMEBASC

2/2/1/0.50

Mineral Project Design is a two-part capstone course that draws on all course materials developed in the first three years of the Mineral Engineering Curriculum. The course will culminate in the design of a mining or civil rock engineering project. In the first half of the course (F) students perform individual detailed case history analyses. Additional instruction in technical aspects of communication is provided during both semesters (preparing and writing technical reports, industry research and analysis, presentation skills, as well as other technical elements as required). These skills will form a foundation for students to use in industry. Critical non-technical aspects of rock engineering projects will also be examined, and guest speakers will present on specialized topics such as: cultural and social effects of rock engineering projects on communities and the environment; economic planning and impact; ethical considerations; aboriginal land claims, etc.. The social license to operate will be emphasized. Students will receive a final grade at the end of each term course, but both courses must be taken in sequence. (MIN 467H1 S cannot be taken without successful completion of MIN 466H1 F) Prerequisite: MIN429H1, MIN350H1

MIN467H1 S **Mineral Project Design II**

IV-AELMEBASC

1/4/1/0.50

Mineral Project Design is a two-part capstone course that draws on all course materials developed in the first three years of the Mineral Engineering Curriculum. Part II (S) focuses on the design of a mining or civil rock engineering project. Students will be grouped into teams and provided with one or more data sets and a design problem to solve. The end product is a major engineering design report and oral presentation (including several interim reports and presentations). Technical aspects

will serve to examine a "cradle to grave" view of a project, from initial planning through to final closure and site remediation. The course will include an intensive two-day Professional Supervisors Short Course. Topics include: Discovering a commonality among supervisors and their key role in maintaining standards. The importance of sharing information and expectations about costs, production goals and business objectives are explored in the context of motivation. The necessity of successful communication skills and techniques are discussed and demonstrated to achieve behaviours on the job, producing consistent results. A reliable methodology for handling difficult situations is provided. The fundamental rationale for safety and loss control is presented as well as a relevant perspective on management structure. A workable code of conduct that is a guide to professional behaviour is developed. Students will receive a final grade at the end of each term course, but both courses must be taken in sequence (MIN 467H1 S cannot be taken without successful completion of MIN 466H1 F)

Prerequisite: MIN466H1

MIN470H1 S **Ventilation and Occupational Health**

IV-AECIVBASC, IV-AELMEBASC

3/-/1/0.50

Hydraulics of air flow through underground openings is studied leading to mine ventilation design calculations and ventilation network analysis. Related topics discussed in the course include: statutory regulations and engineering design criteria; application and selection of ventilation fans; auxiliary fan design; air conditioning (heating and cooling); dust and fume control; ventilation economics. Health hazards related to mine gasses, dust and radiation along with relevant statutory requirements are reviewed. Air quality and quantity measurement and survey techniques are presented.

Prerequisite: CIV270H1/CME270H1

MIN511H1 F **Integrated Mine Waste Engineering**

IV-AECIVBASC, IV-AELMEBASC

3/-/1/0.50

The engineering design of conventional mine waste management systems, including tailings ponds, rock dumps, and underground mine backfill systems, is considered first. Emerging trends in integrated mine waste management systems, including paste stacking and "paste rock" on surface, and cemented paste backfill for underground mining will then be covered. Engineering case studies will be used throughout, and each case study will be evaluated in terms of how the mine waste systems used contribute to the economic and environmental sustainability of the mining operation.

Prerequisite: CME321H1

MIN540H1 S **Borehole Geophysics for Engineers and Geoscientists**

IV-AECIVBASC, IV-AELMEBASC

3/-/1/0.50

The process of wireline logging of boreholes for mineral, hydrocarbon and groundwater exploration, geotechnical and environmental studies involve a number of measurement devices, or sondes. Some of these are passive measurement devices; others exert some influence over the rock formation being traversed. Their measurements are transmitted to the surface by means of wire line. Logging applications include the identification of geological environment, reservoir fluid contact location, fracture detection, estimate of hydrocarbon or water in place, determination of water salinity, reservoir pressure determination, porosity/pore size distribution determination, and reservoir fluid movement monitoring.

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 addressed. Lastly instrumentation and monitoring techniques and backfill design and behaviour are also covered. Design issues are illustrated through the use of numerous field case studies.

Prerequisite: MIN429/CIV 529

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

PHL342H1 F Minds and Machines

3/-/0.50

I-AEMINRAM

Topics include: philosophical foundations of artificial intelligence theory; the computational theory of the mind; functionalism vs. reductionism; the problems of meaning in the philosophy of mind.

Prerequisite: 7.5 courses (in any field) with at least 1.5 in philosophy or COG250Y1

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.

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.

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 Schrödinger'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-Boltzmann statistics, energy equipartition, the perfect gas laws, and blackbody radiation.

Course Descriptions

PHY327H1 F/S Advanced Physics Laboratory

III-AEESCBASEO, III-AEESCBASEP

-/6/-/0.50

Experiments in this course are designed to form a bridge to current experimental research. A wide range of experiments are available using contemporary techniques and equipment. In addition to the standard set of experiments a limited number of research projects are also available. Many of the experiments can be carried out with a focus on instrumentation.

PHY335H1 S Introduction to Quantum Mechanics

IV-AECPEBASC, III,IV-AEELEBASC

2/-/1m/0.50

Review of elementary quantum mechanics, (photo-electric and Compton effects, Bohr model, de Broglie waves); some bound (harmonic oscillator, hydrogen atom) and unbound (potential barriers) solutions of the Schrodinger equation; probability interpretation; operators and the theory of measurement; expectation values and uncertainties; angular momentum (orbital and spin); magnetic resonance as an application. Exclusion: MSE235H1

PHY354H1 S Classical Mechanics

III-AEESCBASEP

2/-/1/0.50

Symmetry and conservation laws, stability and instability, generalized coordinates, Hamiltons principle, Hamiltons equations, phase space, Liouville's theorem, canonical transformations, Poisson brackets, Noethers theorem.

Prerequisite: (MAT244H1/MAT267H1), PHY254H1

Exclusion: PHY351H1

PHY356H1 F Quantum Mechanics I

III-AEESCBASEO, III-AEESCBASEP,
IV-AEESCBASER

2/-/1/0.50

The general structure of wave mechanics; eigenfunctions and eigenvalues; operators; orbital angular momentum; spherical harmonics; central potential; separation of variables; hydrogen atom; Dirac notation; operator methods; harmonic oscillator and spin.

Prerequisite: (MAT223H1/MAT240H1), PHY250H1,
(PHY256H1/(CHM222H1,CHM223H1)/CHM225Y1), (PHY256H1 recommended)

Corequisite: MAT244H1

Exclusion: CHM326H1, PHY355H1

PHY357H1 S Nuclear and Particle Physics

IV-AEESCBASEP

2/-/1/0.50

The subatomic particles; nuclei, baryons and mesons, quarks, leptons and bosons; the structure of nuclei and hadronic matter; symmetries and conservation laws; fundamental forces and interactions, electromagnetic, weak, and strong; a selection of other topics, CP violation, nuclear models, standard model, proton decay, supergravity, nuclear and particle astrophysics. This course is not a prerequisite for any PHY 400-level course.

Prerequisite: PHY356H1

PHY358H1 S Atoms, Molecules and Solids

III-AEESCBASEO, IV-AEESCBASEP

2/-/1/0.50

Quantum theory of atoms, molecules, and solids; variational principle and perturbation theory; hydrogen and helium atoms; exchange and correlation energies; multielectron atoms; simple molecules; bonding and antibonding orbitals; rotation and vibration of molecules; crystal binding; electron in a periodic potential; reciprocal lattice; Bloch's theorem; nearly-free electron model; Kronig-Penney model; energy bands; metals, semiconductors, and insulators; Fermi surfaces. This course is not a prerequisite for any PHY400-level course.

Prerequisite: PHY356H1

PHY392H1 S Physics of Climate

IV-AEESCBASEP

2/-/0.50

This course provides an introduction to climate physics and the earth-atmosphere-ocean system. Topics include solar and terrestrial radiation; global energy balance; radiation laws; radiative transfer; atmospheric structure; convection; the meridional structure of the atmosphere; the general circulation of the atmosphere; the ocean and its circulation; and climate variability.

Prerequisite: (PHY231H1/PHY250H1), (MAT235Y1/MAT237Y1)

Exclusion: PHY315H1

PHY395H1 S Physics of the Earth

III,IV-AECPEBASC, III,IV-AEELEBASC,
IV-AEESCBASEJ, IV-AEESCBASEP,
IV-AEESCBASER, I-AEMINENR

2/-/1/0.50

Designed for students interested in the physics of the Earth and the planets. Study of the Earth as a unified dynamic system; determination of major internal divisions in the planet; development and evolution of the Earth's large scale surface features through plate tectonics; the age and thermal history of the planet; Earth's gravitational field and the concept of isostasy; mantle rheology and convection; Earth tides; geodetic measurement techniques, in particular modern space-based techniques.

Prerequisite: PHY132H1/PHY152H1/PHY180H1/MIE100H1,
MAT235Y1/MAT237Y1/MAT291H1/AER210H1,
PHY254H1/PHY293H1/MAT244H1/MAT290H1/MAT292H1

Exclusion: PHY359H1

PHY407H1 F Computational Physics

IV-AEESCBASEP

1/3/-/0.50

This is an introduction to problem solving by computer where symbolic, numeric and graphical approaches are combined. The emphasis is on a range of ordinary and partial differential equations encountered in physics. Special functions, wave functions, Lagrangians and Monte Carlo methods are also considered.

Prerequisite: PHY224H1/PHY250H1/PHY324H1

Corequisite: Any third-year lecture course in Physics. PHY407H1 may be taken in third or fourth year.

Exclusion: PHY307H1

PHY408H1 S Times Series Analysis

IV-AEESCBASEP

1/2/-/0.50

The analysis of digital sequences; filters; the Fourier Transform; windows; truncation effects; aliasing; auto and cross-correlation; stochastic processes, power spectra; least squares filtering; application to real data series and experimental design.

Prerequisite: PHY407H1/PHY224H1/PHY250H1/PHY254H1/PHY324H1

Corequisite: Any third-year lecture course in Physics

Exclusion: PHY308H1

PHY427H1 F/S Advanced Physics Laboratory

IV-AEESCBASEQ, IV-AEESCBASEP

-/6/-/0.50

Experiments in this course are designed to form a bridge to current experimental research. A wide range of experiments are available using contemporary techniques and equipment. In addition to the standard set of experiments, a limited number of research projects may be available. This laboratory is a continuation of PHY327.

Prerequisite: PHY327H1

PHY428H1 F/S Advanced Practical Physics II

IV-AEESCBASEP

-/6/-/0.50

This course is a continuation of PHY426H1, but students have more freedom to progressively focus on specific areas of physics, do extended experiments, projects, or computational modules.

Prerequisite: PHY426H1

PHY429H1 F/S Advanced Practical Physics III

IV-AEESCBASEP

-/6/-/0.50

This course is a continuation of PHY428H1, but students have more freedom to progressively focus on specific areas of physics, do extended experiments, projects, or computational modules.

Prerequisite: PHY428H1

PHY450H1 S Relativistic Electrodynamics

IV-AEESCBASEP

2m/-/1m/0.50

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

IV-AEESCBASEQ, IV-AEESCBASEP

2/-/-/0.50

Classical and quantum statistical mechanics of noninteracting systems; the statistical basis of thermodynamics; ensembles, partition function; thermodynamic equilibrium; stability and fluctuations; formulation of quantum statistics; theory of simple gases; ideal Bose and Fermi systems.

Prerequisite: PHY252H1, PHY256H1

Exclusion: PHY480H1

PHY454H1 S Continuum Mechanics

IV-AEESCBASEP

2/-/1/0.50

The theory of continuous matter, including solid and fluid mechanics. Topics include the continuum approximation, dimensional analysis, stress, strain, the Euler and Navier-Stokes equations, vorticity, waves, instabilities, convection and turbulence.

Exclusion: PHY459H1

PHY456H1 F Quantum Mechanics II

IV-AEESCBASEP, IV-AEESCBASER

2/-/1/0.50

Quantum dynamics in Heisenberg and Schrödinger Pictures; WKB approximation; Variational Method; Time-Independent Perturbation Theory; Spin; Addition of Angular Momentum; Time-Dependent Perturbation Theory; Scattering.

Prerequisite: PHY356H1

Exclusion: PHY457H1

PHY460H1 S Nonlinear Physics

IV-AEESCBASEP

2/-/-/0.50

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

IV-AEESCBASEP

2/-/-/0.50

Basis to Einstein's theory: differential geometry, tensor analysis, gravitational physics leading to General Relativity. Theory starting from solutions of Schwarzschild, Kerr, etc.

PHY484H1 S Relativity Theory II

IV-AEESCBASEP

2/-/-/0.50

Applications of General Relativity to Astrophysics and Cosmology. Introduction to black holes, large-scale structure of the universe.

PHY485H1 F Advanced Classical Optics

IV-AEESCBASEQ, IV-AEESCBASEP

2/-/-/0.50

Interference effects in coherent light requires a description beyond ray optics or simple plane waves. The first half of this course builds on your foundation of electromagnetic theory and basic optics to develop advanced topics such as interference, spatial coherence, temporal coherence, and diffraction of light. The second half of the course discusses lasers, which are the brightest sources of coherent radiation. Our treatment includes Gaussian beams, resonant cavities, threshold criteria, and a comparison to thermal radiation.

Prerequisite: PHY350H1, PHY356H1, PHY385H1

Course Descriptions

PHY487H1 F **Condensed Matter Physics**

2/-/-0.50

IV-AEESCBASEO, IV-AEESCBASEP,
IV-AEESCBASER

Introduction to the concepts used in the modern treatment of solids. The student is assumed to be familiar with elementary quantum mechanics. Topics include: crystal structure, the reciprocal lattice, crystal binding, the free electron model, electrons in periodic potential, lattice vibrations, electrons and holes, semiconductors, metals.

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.

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

PHY493H1 F **Seismology**

2/-/-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. Traveltime 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.

Recommended Preparation: PHY395H1

PHY494H1 F **Geophysical Imaging: EM and Potential Fields**

2/-/-0.50

IV-AEESCBASEP

How to investigate Earth structure at depths ranging from metres to tens of kilometres using gravity, magnetic, electrical, electromagnetic and nuclear geophysical methods. Current methodologies and the theoretical basis for them are presented.

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 enrolled in Life Science programs.

Prerequisite: BIO130H1/BIO150Y1; CHM138H1/CHM151Y1; and 1 FCE

from any of the following: MAT135H1, MAT136H1, MAT135Y1,

MAT137Y1, MAT157Y1, PHY131H1, PHY132H, PHY151H1,

PHY152H1

Exclusion: PSL201Y1, PSL302Y1

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.

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/ECO220Y1(70%)/

ECO227Y1

Exclusion: ECO375H1

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/ECO227;
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/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

Exclusion: STA348H1

Errata

Program AECERBUS State Changed

Program AECERBUS was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Feb 24, 2014

Program AECERLEAD State Changed

Program AECERLEAD was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Feb 24, 2014

Program AECERENTR State Changed

Program AECERENTR was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Feb 24, 2014

Program AECERGLOB State Changed

Program AECERGLOB was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Feb 24, 2014

Program AECERMINR State Changed

Program AECERMINR was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Feb 24, 2014

Program AECERNUC State Changed

Program AECERNUC was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Feb 24, 2014

Program AECERPESD State Changed

Program AECERPESD was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Feb 24, 2014

Program AECERRRE State Changed

Program AECERRRE was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Feb 24, 2014

Program AEMMSBASC State Changed

Program AEMMSBASC was modified in section Materials Science and Engineering on Feb 27, 2014

MSE250H1 was removed.

Course MSE250H1 State Changed

Course MSE250H1 was modified in section Materials Science and Engineering on Feb 27, 2014

MSE250H1 has been deleted.

Program AEMMSBASC State Changed

Program AEMMSBASC was modified in section Materials Science and Engineering on Feb 27, 2014

Course MIE464H1 State Changed

Course MIE464H1 was modified in section Mechanical and Industrial Engineering on Mar 3, 2014.

NOT OFFERED FOR 2014-2015

Course MSE490H1 State Changed

Course MSE490H1 was modified in section Materials Science and Engineering on Mar 6, 2014

LEC hours increased to 2/0/0

Course MAT196H1 State Changed

Course MAT196H1 was modified in section Mathematics on Mar 14, 2014

Merged with MAT186H1

Course MAT197H1 State Changed

Course MAT197H1 was modified in section Mathematics on Mar 14, 2014

Merged with MAT187H1

Course MAT188H1 State Changed

Course MAT188H1 was modified in section Mathematics on Mar 17, 2014

Course Description updated.

Course MAT187H1 State Changed

Course MAT187H1 was modified in section Mathematics on Mar 17, 2014

Course Description updated.

Course MAT186H1 State Changed

Course MAT186H1 was modified in section Mathematics on Mar 17, 2014

Course Description updated.

Program AEENGBASC State Changed

Program AEENGBASC was modified in section First Year on Mar 17, 2014

MAT196H1 is replaced by MAT186H1

MAT197H1 is replaced by MAT187H1

Program AECPEBASC State Changed

Program AECPEBASC was modified in section Electrical and Computer Engineering on Mar 17, 2014

MAT196H1 was replaced by MAT186H1

MAT197H1 was replaced by MAT187H1

Program AEELEBASC State Changed

Program AEELEBASC was modified in section Electrical and Computer Engineering on Mar 17, 2014

MAT196H1 was replaced by MAT186H1

MAT197H1 was replaced by MAT187H1

Course MIE464H1 State Changed

Course MIE464H1 was modified in section Mechanical and Industrial Engineering on Mar 19, 2014

COURSE DELETED.

Course CIV375H1 State Changed

Course CIV375H1 was modified in section Civil Engineering on Mar 19, 2014

PRA hours changed to reflect actual course hours.

Course CME321H1 State Changed

Course CME321H1 was modified in section Civil and Mineral Engineering on Mar 19, 2014

PRA hours changed to reflect actual course hours.

Program AEMECBASC State Changed

Program AEMECBASC was modified in section Mechanical and Industrial Engineering on Mar 19, 2014

MIE464H1 replaced by MSE432H1

Course ECE363H1 State Changed

Course ECE363H1 was modified in section Electrical and Computer Engineering on Apr 1, 2014

PRA hours adjusted to read 1.5 hours per week (erroneously entered as 3 hours per week).

Program AEMMSBASC State Changed

Program AEMMSBASC was modified in section Materials Science and Engineering on Apr 8, 2014

Course MIE407H1 State Changed

Course MIE407H1 was modified in section Mechanical and Industrial Engineering on Apr 9, 2014

Errata

Course term changed to F.

Course MIE515H1 State Changed

Course MIE515H1 was modified in section Mechanical and Industrial Engineering on Apr 9, 2014

Course term changed to S.

Program AEMINENR State Changed

Program AEMINENR was modified in section Minors in the Faculty of Applied Science and Engineering on Apr 9, 2014

MIE407H1 and MIE515H1 switched terms.

Program AECERNUC State Changed

Program AECERNUC was modified in section Certificate Programs in the Faculty of Applied Science and Engineering on Apr 9, 2014

MIE407H1 switched terms to F.

Program AEESCBASEJ State Changed

Program AEESCBASEJ was modified in section Engineering Science on Apr 9, 2014

MIE407H1 and MIE515H1 switched terms.

Program AEMEGBASC State Changed

Program AEMEGBASC was modified in section Mechanical and Industrial Engineering on Apr 9, 2014

MIE407H1 and MIE515H1 switched terms.

Program AEMINENV State Changed

Program AEMINENV was modified in section Minors in the Faculty of Applied Science and Engineering on Apr 9, 2014

MIE515H1 switched terms to S.

Program AECHEBASC State Changed

Program AECHEBASC was modified in section Chemical Engineering and Applied Chemistry on Apr 9, 2014

MIE515H1 switched terms to S.

Program AEESCBASEF State Changed

Program AEESCBASEF was modified in section Engineering Science on Apr 9, 2014

MIE515H1 switched terms to S.

Program AEESCBASEI State Changed

Program AEESCBASEI was modified in section Engineering Science on Apr 9, 2014

MIE515H1 switched terms to S.

Program AEESCBASEO State Changed

Program AEESCBASEO was modified in section Engineering Science on Apr 9, 2014

MIE515H1 switched terms to S.

Course CHE562H1 State Changed

Course CHE562H1 was modified in section Chemical Engineering and Applied Chemistry on May 29, 2014

Form B was filled in incorrectly (should have been 2/0/1/0.5)

Course APS101H1 State Changed

Course APS101H1 was modified in section Applied Science and Engineering (Interdepartmental) on Jun 11, 2014

This course hasn't been in the curriculum for many years.

Course HPS321H1 State Changed

AU update

Course CIV332H1 State Changed

Course CIV332H1 was modified in section Civil Engineering on Aug 13, 2014

Course APS446H1 State Changed

Course APS446H1 was modified in section Applied Science and Engineering (Interdepartmental) on Nov 17, 2014

Course APS446H1 State Changed

Course APS446H1 was modified in section Applied Science and Engineering (Interdepartmental) on Nov 17, 2014

Course APS446H1 State Changed

Course APS446H1 was modified in section Applied Science and Engineering (Interdepartmental) on Nov 17, 2014

Course CHE299H1 State Changed

Course CHE299H1 was modified in section Chemical Engineering and Applied Chemistry on Nov 17, 2014

Course CHE299H1 State Changed

Course CHE299H1 was modified in section Chemical Engineering and Applied Chemistry on Nov 17, 2014

Program AECHEBASC State Changed

Program AECHEBASC was modified in section Chemical Engineering and Applied Chemistry on Nov 17, 2014

Program AECHEBASC State Changed

Program AECHEBASC was modified in section Chemical Engineering and Applied Chemistry on Nov 17, 2014